Environmental Justice in Ecosystem Restoration Frameworks

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Abstract

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Ecosystem restoration projects are happening frequently around the globe, driven by an increase in awareness about the importance of healthy ecosystems to humans. These projects play an important role in mitigating the negative environmental impacts that vulnerable communities face. However, no clear guidelines exist on how restoration can be developed in ways that adhere to environmental justice principles. Restoration frameworks are prescriptive models giving steps for restoration processes, which guide efforts as researchers, activists, and governments work to restore ecosystems. Given these frameworks can impact the environmental justice outcomes of restoration projects, it is key to understand their current strengths and weaknesses. Here we present a systematic literature review of restoration frameworks across the globe to understand what methods for restoration exist and how they address issues of environmental justice. Environmentally just frameworks, including the framework presented here, integrate multiple types of recognition as well as community empowerment in decision-making. To address the lack of these aspects in current restoration frameworks, we propose a novel framework that incorporates key principles of environmental justice into the restoration planning and implementation process.

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1. Introduction

Restoration traditionally seeks to fix habitats or improve demographic rates for species. Despite being primarily focused on non-human communities, these restoration projects require active involvement from humans and have the potential to impact societies and lives. The impacts that restoration can have on human communities span from legal decisions to ecosystem services to mitigation of environmental harms (Bennett, 2023). The range of potential impacts makes restoration a process that can influence environmental justice. Restoration bears on environmental justice in two ways: whether such restoration is placed and enforced fairly, and how people of diverse identities are involved in the decision-making processes. These processes are referred to as procedural and recognition justice (Martin, 2016). Here we evaluate restoration frameworks for inclusion of environmental justice and propose a new framework that incorporates environmental justice goals into those of ecosystem restoration.

Environmental justice, as defined by the US Commission on Civil Rights, underscores fair treatment in environmental decision-making across race, income, and culture, yet achieving this remains a complex challenge (EPA, 2022; USCCR). Healthy ecosystems, which are crucial for provisioning food, regulating air quality, and fostering societal ties, face degradation due to industrialization, population growth, and climate change (Millennium, 2005; Blasco et al., 2016). Such degradation disproportionately affects marginalized communities, historically burdened with higher pollution levels, often due to industrial siting decisions favoring wealthier areas (Banzaf et al., 2019; Claudio, 2007). Beyond pollution, food sovereignty and access to green space can be disproportionately reduced for marginalized communities (Mbow, 2019; Wolch, 2014), which also are at high risk from climate change impacts (Wolch, 2014). These disparities,

often intertwined with racial segregation and economic inequality, perpetuate health issues, limited access to education, and economic struggles (Banzaf et al., 2019).

Environmental justice researchers have identified methods and targets that facilitate environmentally just outcomes. One of the key areas of focus is recognition (Martin, 2016). Recognition has multiple aspects including recognition of injustices, recognition of different types of knowledge, and recognition of marginalized cultures and values (Martin, 2016). In addition to focusing on recognition, environmentally just frameworks should include equity in decision-making (Martin, 2016). This refers to the inclusion and prioritization of impacted groups in the decision-making process of restoration. A final area that facilitates environmental justice is providing a blueprint for the process that allows space for communities to influence the process and adapt the process to their individual needs (Martin, 2016).

Marginalized communities, lacking resources and unable to relocate, endure the brunt of ecosystem degradation's consequences, exacerbating their vulnerabilities (United Nations, 2023; American Public Health Association, 2023). Restoration efforts, therefore, hold immense potential not only for restoring ecosystem services but also for rectifying environmental injustices. Prioritizing restoration in areas bearing the heaviest environmental burdens can bolster resilience and promote equity. Such initiatives offer pathways to address historical inequities and enhance community well-being.

While the impacts of environmental degradation are felt intensely by marginalized groups, ecosystem restoration has the ability to reduce these burdens. Healthy ecosystems are able to mitigate climate change impacts and ensure a stable food system for humans worldwide (*Becoming*, 2023). The United Nations Decade on Ecosystem Restoration calls for restoration projects to be undertaken for the good of people and nature globally (UN Environment

Programme, 2021). Investments in restoration contribute to the re-establishment of ecosystems and the ecosystem services they provide. An example of this ecosystem service improvement is seen in marine fisheries restoration, where restoring populations and establishing sustainable catch metrics can increase a fishery's output by 16.5 million tons annually (Ye et al. 2013). This fish can then be used to provide a healthy food source to a greater number of individuals, increasing human health outcomes dramatically. In addition to restoration's impact on food stability, investing in ecosystem restoration projects in the U.S. provides more than double the number of jobs that oil or gas projects create (*Becoming*, 2023). A stable food source and increased opportunities for employment have the ability to substantially reduce the burdens felt by marginalized communities and create a more just society.

Despite the interconnections between environmental restoration and justice goals (Loos, 2023), barriers remain to the integration of these efforts. Historical reviews of the environmental movement suggest that early efforts focused too heavily on species restoration, limiting what the public viewed as environmental restoration (Palamar, 2008). This focus created a homogeneity in the restoration movement and the political efforts it undertook, with protecting wilderness and biodiversity outcompeting the concerns of those most burdened by environmental degradation (Dowie, 1995). These historical viewpoints hinder the environmental restoration movement's ability to capitalize on the benefits of restoration and move forward in a way that is just. To correct for this precedent, environmental restoration must evolve to include the impacts that degradation of the environment has, and has historically had, on humans. If these impacts are considered in the design of restoration projects then the pressure on vulnerable communities could be reduced. This requires that principles of environmental justice be explicitly included in the design of restoration projects.

One way to maintain a clear link between environmental justice and restoration is through the integration of environmental justice principles in restoration frameworks. Many restoration projects are implemented within a framework that addresses prioritization, development of plans, implementation, and monitoring (Vaughn et al, 2010). A framework is a "basic conceptual structure" (Merriam-Webster, 2024). As this definition implies, a framework provides the structure that can be built upon. These frameworks allow practitioners to consider restoration goals and plan projects strategically, increasing their efficacy ("Restoration Actions framework", 2022). They frequently include guidance on how to determine the best location for a project, how to navigate local regulations, best practices for assessing restoration impacts, and guidance for follow-up monitoring (Ostrom, 2009). Frameworks can also provide examples of metrics, success indicators, definitions, and guiding principles that have been developed over time (World Business Council). Due to the structured guidance that frameworks provide they have a strong influence on how and where restoration projects are implemented.

In order to assess environmental justice's current role in restoration frameworks, a systematic literature review of restoration frameworks was performed. We systematically reviewed publications to find restoration frameworks and evaluated these frameworks for environmental justice practices (defined in Methods). Our literature review showed that, currently, not a single existent restoration framework explicitly integrates principles of environmental justice. In response, we've proposed a new restoration framework centered around justice.

2. Methods

2.1. Literature Review

A literature review of restoration frameworks was conducted following the PRISMA protocol for systematic literature review and meta-analysis to ensure a transparent, comprehensive synthesis of the state of knowledge (Page et al., 2021). Web of Science was used as the search engine for the review, and key terms were identified to guide the search. The title field was set to include “restoration framework” while “ecosystem” had to be included in any field (Title = restoration framework AND Any Field = ecosystem). This yielded 89 results from all years up to July 31, 2023 (*Appendix 1*). These results were then filtered for English language-only publications which left 88 titles. The results from this base list were filtered by their title's content, labeled as Stage 1 in Appendix 1. Those focused on the restoration of a framework species were removed from the list, as were those referring to restoration under the EU Water Framework Directive. This yielded a list of 76 titles for a more in-depth review.

The abstracts from this slimmed-down list were read and further filtering was conducted based on relevance to the search, labeled as Stage 2 in Appendix 1. This filtering removed pieces that focused solely on monitoring, were opinion pieces that did not present a framework, or were only tangentially related to a framework such as those evaluating lessons learned. Each of the remaining 38 papers was read in-depth and the ecosystem type, framework used, restoration approach, main criteria, methods, challenges, test site locations, and environmental justice components were recorded. These sections were then analyzed for commonalities and major findings are presented in this paper.

In this research environmental justice was measured in multiple ways. Each paper was searched for the use of the term ‘environmental justice’ and given a binary ‘yes’ or ‘no’ on the presence of environmental justice in the paper. Once this search was completed the papers were reviewed for the presence of practices that support or share the goals of environmental justice.

These included community-engaged participatory research approaches, equity aims, hazard reduction for impacted communities, and increased connection with culturally and socially important resources. Papers that lacked these terms and a mention of environmental justice were categorized as having no environmental justice component. The papers with environmental justice practices but no direct mention of environmental justice were categorized as having some overlapping environmental justice goals. There were no papers with a direct mention of environmental justice, so this category is not represented in the review.

Upon completion of this initial literature review, the research team chose to broaden the search to ensure that the literature review was as comprehensive as possible. The above process was carried out a second time using ProQuest as the search engine. ProQuest was selected as it is a database host, rather than a single database, so it is likely to cover a greater variety of literature. The same process was followed for the ProQuest as was used for Web of Science. The final list of additional titles - with any overlap between Web of Science removed - consisted of 9 articles (Appendix 2). The major findings were compared to those of the initial Web of Science search and corroborated its findings.

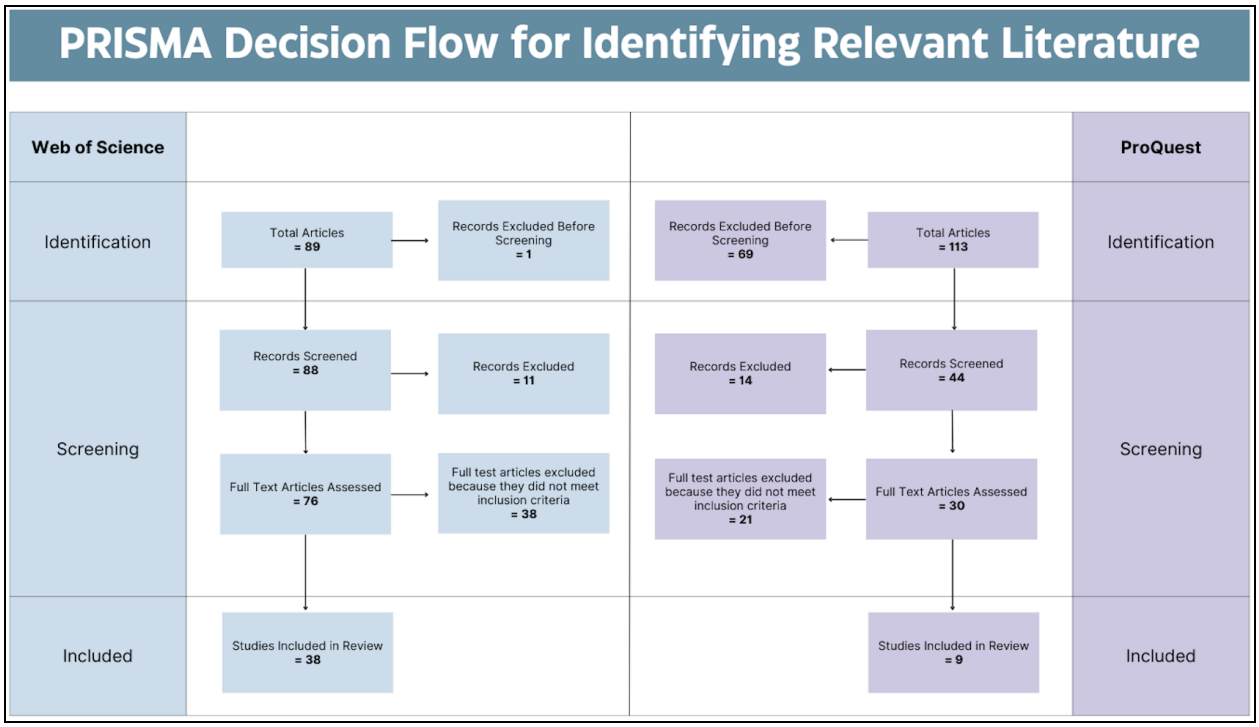

Figure 1. Flow diagram showing the literature review process using the PRISMA protocol.

2.2. Framework Design

Our first step in this research involved the systematic literature review detailed above. Through this process, we aimed to understand the current state of research on incorporating environmental justice into ecosystem restoration frameworks and sought to find examples of such work being done. This work led to the identification of gaps in restoration frameworks that informed and shaped the next steps of research. Through analysis of these gaps, as well as a review of the restoration and environmental justice literature, the creation of a restoration framework that explicitly focuses on environmental justice became a clear necessity.

Throughout the literature review process, careful account was taken of the restoration models that arose most frequently as inspirations for new models. The first step in developing the novel framework presented in this paper was to review these biologically-focused restoration

frameworks and determine which would be best suited to serve as the base of the novel framework. A restoration framework was chosen from Coutinho et al. that focused on a series of ecosystem and species targets that informed the decision process for restoration projects (Coutinho, 2022). This framework was then condensed into highly general steps and used as the primary reference for biological considerations in restoration.

Once a base biological framework had been identified and tailored to this project, research was conducted on the key criteria for environmentally just projects. This included an exploration of literature that detailed modern environmental justice theory as well as mechanisms of harm and the ethics of recognition (Martin, 2016). Environmental justice literature guided the creation of steps that are key to creating a restoration framework that effectively incorporates environmental justice principles. These steps were then incorporated into the base biological framework according to environmental justice guidelines set out in Adrian Martin's work on conservation and justice, and Meg Parson's work on Indigenous environmental justice (Martin, 2016; Parsons, 2021).

The completed draft of the environmentally just restoration framework was discussed during a workshop with experts in both biological sciences and environmental justice. The workshop allowed these practitioners to make recommendations and adjustments to the framework. Throughout the workshop, additional steps and considerations were incorporated into the initial framework draft. The largest outcome of this workshop session was the identification of the need for two frameworks rather than one. The initial draft framework focused heavily on creating an environmentally just process that included impacted groups in deciding on sites and/or target species to restore. While this method is ideal for shaping the most environmentally just process, it is not frequently realistic with the current process for ecosystem

restoration, where projects or funds already have specific biological restoration goals or are restricted to particular places. To ensure that restoration already at the implementation phase could accomplish environmental justice goals, a second framework was developed that was tailored to restoration processes where a site or species had already been identified or prescribed.

3. Results

3.1. Literature review

Of 47 publications on restoration frameworks, none referred explicitly to environmental justice (Figure 2). While many frameworks included holistic focus areas such as human health and ecosystem service benefits, none directly addressed the environmental justice implications of degradation or how environmental justice goals would be achieved through the framework. Each framework was labeled either Holistic or Biological based on their goals. Biological frameworks only included goals and success measures related to biodiversity, environmental health, and ecosystem indicators. Holistic frameworks included some biological goals as well as some goals that spanned the social realm. The frameworks that share some goals with environmental justice frequently include socio-economic, cultural, or political considerations (see Appendix A and B). Only half of the frameworks included social objectives that overlap with some aspects of environmental justice, yet none directly mention environmental justice. The majority of the frameworks – nearly 83% of reviewed frameworks– use terrestrial or freshwater ecosystems as the reference and example projects (Figure 3). Only a few frameworks focused on marine ecosystems as a whole, representing 8.5% of the frameworks reviewed (Figure 3). These frameworks are related mainly to mangrove and coral reef restoration.

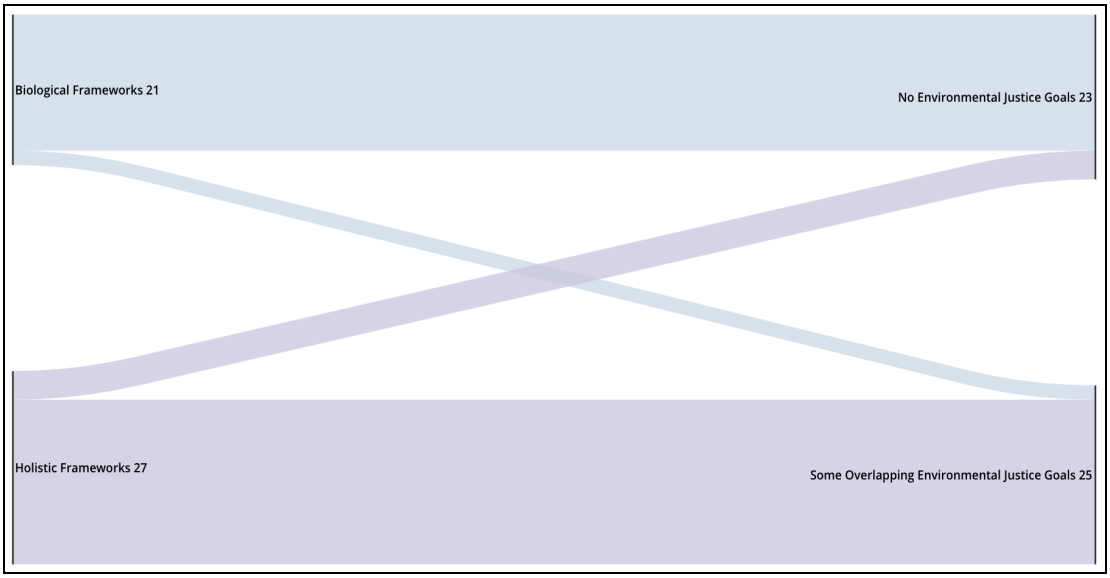

Figure 2. Relationship between the type of framework used and whether it contained environmental justice (EJ) goals. Biological frameworks were defined as those including only biodiversity, ecosystem health, abiotic, and non-human biotic factors, while the holistic frameworks included biological factors as well as socio-economic, cultural, or political considerations. Among the total 47 frameworks (publications) in this systematic review, no framework plainly stated that it had an environmental justice focus, thus environmental justice is not a standalone category.

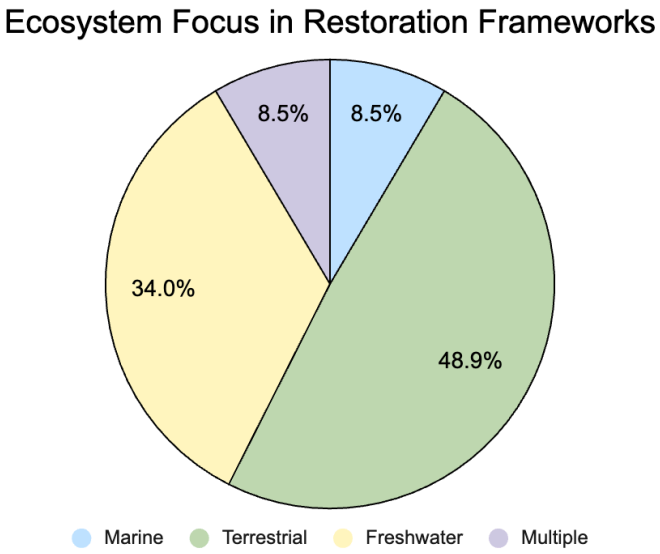

Figure 3. Restoration frameworks broken down by the main ecosystem focused upon.

Another important finding is that the majority of frameworks that were included in this review were created for specific restoration projects or used as a proof of concept for the framework. Each of these projects was mapped to describe the regional focus of published restoration frameworks (Figure 4). Examples of applications were very heavily skewed toward Asia, with a focus on China. Beyond these projects, there were only a few frameworks created for restoration efforts in Europe, Africa, South America, and North America. Australia, New Zealand, and the Pacific Islands were largely left out of project examples, and the Middle East was completely absent from the literature. Very few of the frameworks were broad enough to apply to these regions, as most were created to respond to a specific restoration need. These frameworks included governance factors such as country-specific legislation (Jin, 2023), or were focused on target ecosystems with highly specific biological conditions, such as ponds (Yadev, 2022). The level of specificity in these frameworks make them difficult to apply to other regions, ecosystems, or cases.

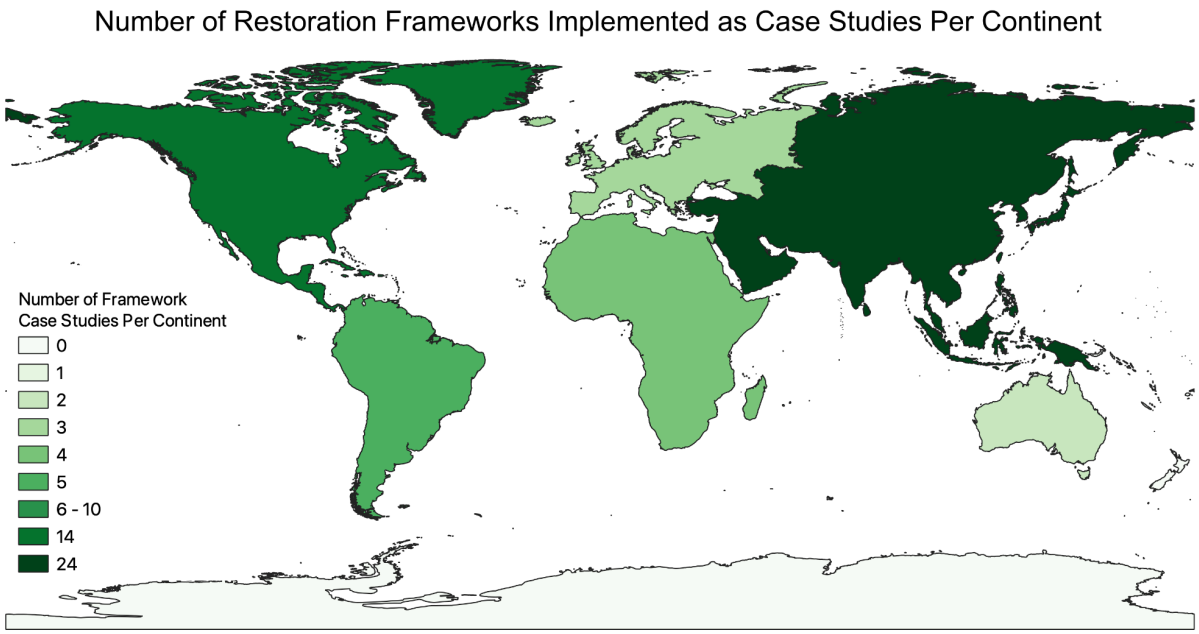

Figure 4. Density map showing the number of individual cases where frameworks were implemented and studied broken down to a continent level.

3.2. Environmental Justice Restoration Framework

Our initial research involved a systematic literature review to understand the current landscape of integrating environmental justice into ecosystem restoration. Identifying gaps in existing frameworks guided our subsequent steps. Analysis of these gaps, coupled with a review of restoration and environmental justice literature, emphasized the need for a dedicated restoration framework prioritizing environmental justice. Careful consideration of prevalent restoration models informed the development of our novel framework.

We created an environmental justice framework drawing from the biologically focused framework of Coutinho et al (2023), which served as the foundation for general steps and biological considerations. Coutinho's framework was selected as the biological base due to its ability to incorporate multiple targets and for its adaptable approach to outlining biologically-focused restoration processes. This new framework aims to guide practitioners

through the process of ideating, scoping, and implementing restoration projects that are environmentally just. It is important to note that environmental justice is a process as well as an outcome, so all areas of work and steps in the restoration process require an adjustment in order to follow environmental justice principles. This new framework proposes a process where communities and those harmed are meaningfully involved in each phase.

Table 1

Summary of restoration framework phases and associated environmental justice implications

Phase	Summary of Work	Environmental Justice Implication
Ideation	The initial phase of work includes securing funding, building an understanding of regional ecology, and identifying relevant impacted groups and stakeholders. It focuses on building an understanding of regional patterns of power and establishing a partnership between restoration planners and marginalized communities that will center their needs as drivers of the subsequent restoration steps.	Environmental justice centers impacted communities and demands that they be the decision-makers in any actions that aim to mitigate the harms inflicted on them. This initial phase focuses on building trust between communities and restoration planners through knowledge sharing.
Scoping	The scoping phase focuses on defining restoration goals through a number of social, cultural, and ecological targets. Once these targets are set funding is revisited and the impacted communities are reassessed to ensure all relevant members are included in decisions. A project assessment is completed before a restoration approach is determined that balances scientific methods with traditional knowledge.	This phase requires that environmental justice targets be integrated into the goals of the restoration project. These targets are set by the impacted communities, allowing them to dictate what mitigation will be most impactful to their community. This is key to environmental justice, as is the incorporation of traditional knowledge into the restoration approach. Given modern scientific methods frequently dismiss alternative types of knowledge, this inclusion allows communities to approach mitigation through methods beyond the Western scientific approach.
Implementation	The final phase focuses on carrying out the restoration action and also on monitoring and continued community engagement and ownership. The restoration action will be assessed for its impacts based on the goals of the community, and the community will be given the opportunity to own the management of the restored site. This stage is ongoing, with continued support for the community and opportunities to adjust the project as needed.	Community ownership over the governance of the restored area ensures access to the resource, as well as ensuring that the community can adjust the restoration approach if needed to meet the project's goals. Through continued partnership with the project planners and ongoing funding, the risk to impacted communities is mitigated and the communities are empowered to manage the restored resource in a way that maximizes their benefit.

Each phase of the framework stresses environmental justice, though the mechanisms vary slightly. The initial phase of work emphasizes community engagement and meaningful involvement in the decision-making process. As the restoration process continues environmental justice is seen in how the restoration targets are set, with impacted groups driving the creation of the goals and knowledge being sourced inclusively. The final stage of the process focuses on environmental justice in the ongoing governance of the site and the iterative monitoring process that stresses community benefits. These focus areas align with recommendations from environmental justice literature and practice to provide the maximum benefit to impacted communities (Martin, 2016; Parsons, 2021).

Ideation Phase

The Ideation Phase marks the beginning of the restoration planning process, starting with securing a versatile funding source, which allows for flexibility in addressing the needs of impacted communities. This initial step paves the way for a comprehensive biodiversity study to understand the regional ecosystems, including an assessment of climate change impacts, disturbances, and the requirements of local species. Although not directly focusing on environmental justice, these preliminary steps lay the groundwork for informed restoration planning.

Community involvement becomes central following these initial steps. Identifying and engaging with impacted communities requires an understanding of the region's socio-political and economic background. Marginalized groups are identified and involved early on and will be the first community partners for the project, with stakeholders added as a next step. Stakeholders and impacted groups here are not one and the same. While all impacted groups are stakeholders in the restoration process, the stakeholder category includes even those members for whom the outcomes of the restoration do not increase or impact individual or group justice. This includes governments, non-governmental organizations, researchers, corporations, and more. These groups should be engaged based on the degree to which the restoration will impact them and their interest in the restoration outcomes.

The ideation phase culminates with community-based participatory research, emphasizing inclusive planning and implementation (Shalowitz, 2009). Community-based participatory research is a research approach that focuses on involving those impacted by a problem in planning, implementing, and evaluating the solution (Shalowitz, 2009). In this phase

the community evaluates the alignment of the restoration project with their goals, allowing them to opt out if it contradicts their interests or traditions. There are a number of reasons why a community could decide that restoration is not in their best interest, from environmental gentrification to disturbances to traditions. This decision is not an opportunity for project developers to abandon the project, but rather a key aspect of creating an environmentally just project that centers the impacted groups. This decision-making process emphasizes the importance of environmental justice and community-centered planning in the restoration initiative.

Scoping Phase

The Ideation Phase lays the groundwork for restoration projects by establishing basic requirements and integrating impacted groups into the planning process, setting the stage for community involvement in the subsequent Scoping Phase. In the Scoping Phase, restoration goals are defined, extending beyond traditional quantitative measures to incorporate key justice factors. These encompass addressing specific harms, incorporating cultural practices, assessing societal impacts, and determining regional social values. This inclusive approach complements conventional abiotic and biotic goals, fostering a restoration process that prioritizes justice and strengthens community resilience.

During this phase, restoration targets are established in collaboration with impacted communities, ensuring equitable decision-making. Subsequently, funding is revisited to confirm adequate resources and explore additional funding sources. Stakeholder engagement is reassessed to involve relevant groups while minimizing burdens on other communities. A comprehensive project assessment follows, encompassing cost analysis, risk evaluation with a

focus on community impacts, and an assessment of community participation and management capacity. This integrative approach harmonizes environmentally just practices with traditional restoration framework steps.

The latter part of the Scoping Phase emphasizes remediation perspectives and restoration approaches, advocating for a holistic approach that incorporates community insights into the project's environmental and social impacts. This collaborative process informs the selection of restoration methods, blending traditional knowledge and scientific best practices. The Scoping Phase culminates in the development of a project timeline, with community needs serving as a central guiding principle throughout.

Implementation Phase

The final phase of the restoration framework is the Implementation Phase. This begins with implementing the restoration plan that was created in the Scoping Phase. Iterating and adjusting as needed throughout the implementation process allows new information to be accounted for. This stage involves a high degree of community involvement as members of both the impacted groups and stakeholders are encouraged to assist with the restoration work. While this involvement is encouraged, it must be done with sensitivity for the time that it requires of participants. The burden that this places on impacted groups must be reduced as much as possible. This could mean that these groups do not take an active role in the restoration, or they could take ownership of the majority of the work. The implementation process should continue to build trust between communities and other stakeholders, which can only be accomplished with community support.

Once the restoration project is implemented, funding must be reassessed. This is done to ensure that there is funding for continued monitoring and an ongoing relationship with the communities. This then feeds into the ongoing monitoring and management step. The community or impacted group will ideally take on a large amount of the ongoing governance, allowing them to maximize the long-term benefits of the restoration project. In addition to this ongoing monitoring, it is important to maintain an ongoing relationship between the impacted community and the ecosystem. This includes empowering further ecosystem decisions by the community and supporting any ongoing restoration. The final step is to monitor and evaluate the environmental justice targets. This includes further community engagement work to understand the impacts of the project as well as reviewing the quantitative targets that relate to environmental justice such as pollutant loads or natural disaster rates. This monitoring also includes continuing to build trust between restoration professionals and the community through engagement and support, as well as other factors such as supporting the cultural connection between communities and the ecosystem that was restored.

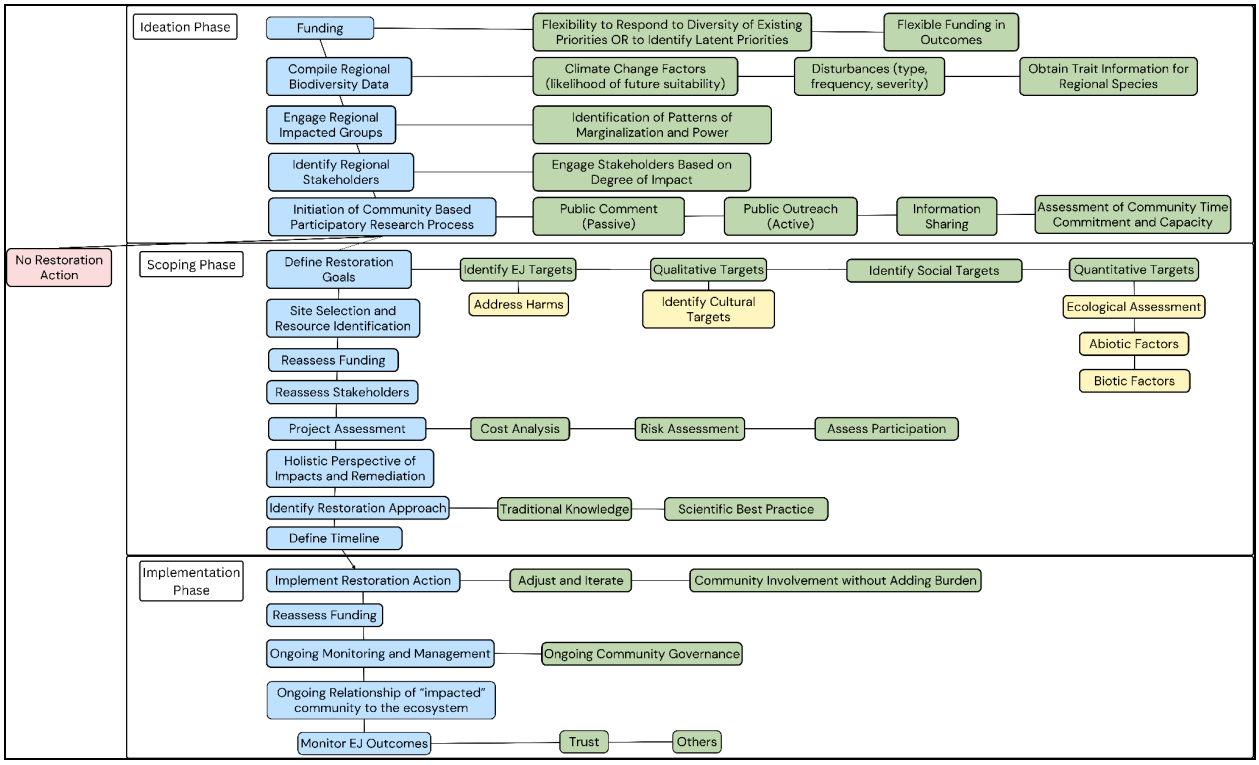

Figure 5. Restoration framework guiding environmental justice-focused projects. The main steps are in blue, recommendations for achieving the main steps are in green, and subsets of the recommendations are in yellow.

3.3. Alternate Environmental Justice Restoration Framework

While the above framework was developed with environmentally just restoration as the main objective, given the structure of many resource management institutions, we acknowledge that restoration projects may not begin with open-ended funding. Many projects are created with either a specific target species in mind or funding for restoration projects in a specific region. While these projects are not determined by the community, they still have the ability to incorporate environmental justice principles and have just outcomes. In order to ensure that all projects can incorporate environmental justice, a second framework was developed that focuses on incorporating justice into a more standard restoration planning methodology.

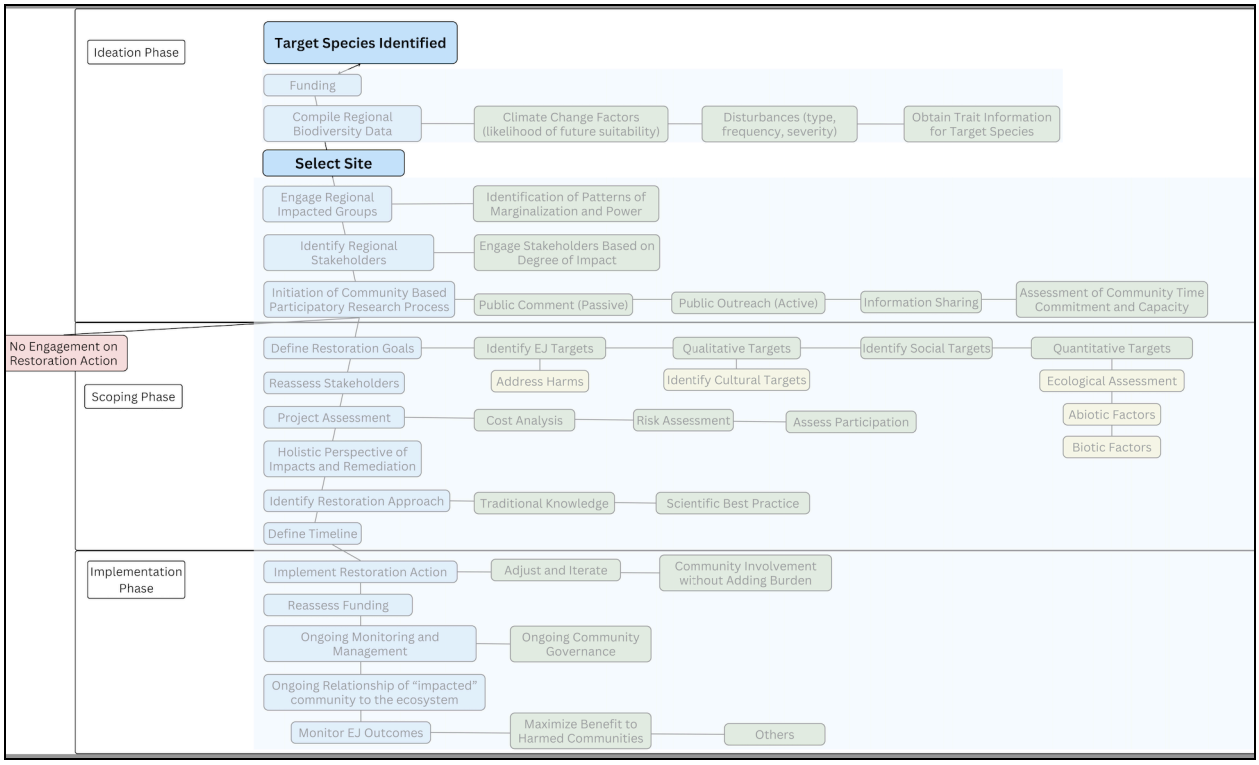

Figure 6. Restoration framework incorporating environmental justice principles into current practice whose funding dictates the target species or restoration site.

The second framework follows many of the same steps as the first, with a few key changes to the Ideation Phase, highlighted in Figure 6. Under this framework, the project begins with either a target species already chosen or funding that is tied to a region or ecosystem. This method also includes the site being selected in the initial phase before regional impacted groups and stakeholders are incorporated into the project team. While this limits the community's ability to direct restoration based on their own goals, the remainder of the process highlights community involvement. Impacted groups are engaged for each step following the site selection or target species selection, and are able to make decisions on how the restoration will be implemented. The goal of practitioners using this framework should be to maximize the benefits that impacted communities receive from the restoration and to include these groups as much as possible in the decision-making around restoration goals and approaches.

4. Discussion

The United States has seen multiple mandates related to incorporating environmental justice into environmental planning in recent years. The majority of these mandates have arisen from President Biden's Justice40 initiative. This initiative focuses on creating jobs that will withstand the impacts of climate change and will promote environmental justice (The United States Government, 2024). These goals are being implemented through a series of Executive Orders (EOs), including EO14008 and EO12898, (Environmental Protection Agency, 2024). In particular, EO14008 focuses on creating a governmentwide approach to addressing climate change, with a particular focus on environmental justice through a required 40% of benefits going to disadvantaged communities. At a global level, the United Nations Development Programme (UNDP) is addressing the need for environmental justice at a global scale through its global strategy for environmental justice (United Nations Development Programme). This strategy aims to increase the protection of environmental rights for future generations and to promote the development and enforcement of environmental laws.

While these policies are a key step in implementing environmental justice at a government level, clear guidelines on how to achieve environmental justice goals are lacking. This issue becomes crucial when it comes to restoration efforts. Restoration can help maintain healthy ecosystems, which is critical for marginalized communities that are often highly resource-dependent. Furthermore, if done correctly, restoration can help mitigate historical environmental impacts unjustly imposed in marginalized communities.

Restoration frameworks are key to achieving these goals. Frameworks are a "basic conceptual structure" that provides a base that can be built upon to suit a project

(Merriam-Webster, 2024). This is important for restoration because examples of metrics, success indicators, definitions, and guiding principles can be developed and shared between projects and nations to maximize impacts (World Business Council). However, our literature review revealed that currently, no restoration framework includes explicit environmental justice objectives.

Current frameworks both lacked environmental justice principles and were frequently too narrow in focus to be updated to include these factors (Figure 3). These frameworks were most frequently created as a response to a specific restoration project and addressed suites of degradations that were unique to the project. In addition to this narrow focus, environmental justice was never directly mentioned in the literature. While some projects included socioeconomic factors such as the economic boost of a restoration project, these factors were never tied into the larger goals of environmental justice. This can potentially be explained by the geographic roots of environmental justice (Skelton, 2023). The movement began in the 1980s in the United States and has continued gaining traction since (Skelton, 2023). While this has meant that the environmental justice movement is ingrained in the politics of the United States, this is not the case for all areas. This likely slowed the spread of environmental justice as a movement and deprioritized it for restoration frameworks in other regions.

Given that the vast majority of restoration frameworks being developed are focused heavily on species and regions in Asia, it follows that environmental justice may not yet be a focus (Figure 4). While there is a demonstrated commitment to restoration in these areas, it leaves some continents with very few restoration frameworks tailored to their environment. This finding represents a significant gap in the literature and practice of restoration. The practical explanation for this regional focus can be explained by a series of six extensive restoration projects that have been launched in China since the 1970s (Lu, 2018; UN Environment

Programme, 2023). China has been aggressive in its restoration efforts and the positive benefits that this work has provided serve as a motivator for continued work and support (Lu, 2018). While the majority of reviewed frameworks were too specific to apply to different regions, the successes can serve as a proof of concept or motivation for other nations. Many of the frameworks developed were highly site- or species-specific. This specificity can make these frameworks seem inapplicable to other regions, yet many of the frameworks were built off of earlier frameworks and methods. Frameworks from Hobbs, Higgs, and Ostrom were frequently referenced and influenced many of the new frameworks (Hobbs, 1996; Higgs, 1997; Ostrom, 2009). These referenced frameworks were used to develop restoration projects from agroforestry to coral reef restoration and as a basis for creating novel frameworks (Budiharta, 2016; Simonson, 2021; Silva, 2017).

In addition to these base frameworks, many established restoration models were referenced. These included ecosystem service models and social-ecological system models most frequently (Newcomer-Johnson, 2023; Andersson, 2021). The inVEST model and the criteria and indicator framework were cited regularly, with the former appearing in most of the ecosystem service-based frameworks and the latter featuring in most forestry-related project frameworks (Stanford University, 2024). In applying these frameworks over half of the reviewed authors cited the use of Marxan as a spatial planning tool, or included R and ArcGIS in mapping and understanding the ecosystem (Appendix 1 and 2). These commonalities provide a roadmap of proven techniques and methods that can be applied in many scenarios. This creates a strong foundation from which environmentally just frameworks could be created for nations and regions that currently lack formal guidelines for restoration.

The lack of connection between restoration frameworks and environmental justice leaves a large gap that collaborative, community-centered, co-created restoration frameworks can fill. With the increased focus on frameworks that incorporate human benefits and values in recent literature (Appendix A and B), it is the logical next step to incorporate the goals of environmental justice into the practice of ecosystem restoration to create a more just future. A framework that incorporates environmental justice principles and is broad enough to be applied in a multitude of cases is the logical response to the identified gap in restoration frameworks.

The restoration frameworks developed in this paper aim to incorporate environmental justice principles and practices into the foundations of restoration work by creating a set of guidelines that can be applied to restoration projects with a variety of focus types. These guidelines include three of the main components of environmental justice, which are recognition, procedural justice, and distributive justice (Martin, 2016). These aspects are incorporated throughout the frameworks to ensure that harmed communities are recognized, are included in decisions, and that the outcomes benefit those who have been harmed most severely. Through this process, the benefits of restoration can be maximized, and the harms done by environmental degradation can be remediated. While traditional restoration practices provide some benefits to communities, these benefits can be increased through incorporating harmed communities into the planning and implementation process.

In the proposed new framework, the Ideation Phase plays a vital role in advancing environmental justice within restoration projects by emphasizing community involvement and empowerment from the outset. This phase ensures flexible funding, allowing projects to align with the specific needs and priorities of impacted communities and address systemic inequities (Bennett, 2023). By engaging communities early on and adopting Community-Based

Participatory Research, the phase cultivates a collaborative environment where community members are viewed as equal partners, and their local knowledge is valued alongside scientific research (Shalowitz, 2009; Bennett, 2023). This approach seeks to build trust and ensure project success by integrating community insights and priorities (Martin, 2016). This collaboration also enhances research applicability and promotes culturally sensitive and socially acceptable restoration initiatives (Loos, 2022). Crucially, the Ideation Phase grants communities decision-making authority, acknowledging their right to shape their environmental futures and aligning projects with their goals, thereby recognizing and addressing the unique cultural, social, and economic contexts influencing environmental burdens and benefits.

The Scoping Phase further integrates environmental justice principles through its inclusive and participatory approach. By broadening restoration goals to encompass justice factors, such as addressing specific harms, enhancing cultural practices, and evaluating societal impacts, the phase recognizes the diverse needs and values of impacted communities (Stephens, 2008). Community involvement remains central, with equal decision-making power granted to impacted groups in setting restoration targets and identifying stakeholders (Bennett, 2023). This ensures that projects are aligned with the voices and priorities of those most affected by environmental challenges (Martin, 2016). Additionally, the phase advocates for a holistic approach that combines traditional knowledge with scientific best practices, respecting and valuing diverse perspectives (Martin, 2016). By prioritizing community needs and perspectives and assessing project impacts through an equity and social justice lens, the Scoping Phase aims to develop restoration initiatives that enhance ecological resilience while promoting fairness, inclusivity, and empowerment within affected communities.

Finally, the Implementation Phase aligns closely with environmental justice principles by emphasizing ongoing community involvement, iterative adaptation, and equitable distribution of burdens and benefits (Loos, 2022). This phase highlights the importance of collaborative implementation with impacted communities and stakeholders, recognizing the value of local knowledge in shaping effective, culturally sensitive restoration initiatives (Parsons, 2021). While encouraging active participation, the phase acknowledges potential burdens and strives to minimize these by providing flexibility in roles and responsibilities (Martin, 2016; Bennett, 2023). This approach fosters trust, strengthens relationships between communities and stakeholders, and ensures that actions are taken with community support, respecting community autonomy and agency. Additionally, the phase underscores the importance of sustained funding for ongoing monitoring and fostering relationships with communities, empowering them in the long-term governance and stewardship of the restored ecosystem (Martin, 2016). Monitoring and evaluating environmental justice targets remain central, involving ongoing community engagement to assess project impacts and review relevant quantitative indicators.

Together, the previous phases of the restoration framework significantly advance recognition, procedural, and distributional justice within environmental initiatives (Parsons, 2021). A key aspect of environmental justice is the inclusion of marginalized groups, stakeholders, and rightsholders into the process of policy creation, project development, and process creation (Martin, 2016). Another key aspect is having flexibility in a framework that allows it to be adapted to a specific place or knowledge system (Parsons, 2021). The Ideation Phase lays the groundwork by prioritizing community involvement and empowerment, ensuring that restoration projects align with the specific needs and priorities of impacted communities, thus promoting recognition of justice. This is complemented by the Scoping Phase, which

expands restoration goals to include justice factors and prioritizes inclusive decision-making processes, fostering procedural justice. Additionally, the Implementation Phase emphasizes ongoing community involvement, iterative adaptation, and equitable distribution of burdens and benefits, minimizing disparities and promoting distributional justice. By integrating these principles throughout the restoration process, from initial planning to implementation and ongoing management, the framework strives to create environmentally just outcomes that acknowledge, involve, and benefit stakeholders, thereby fostering a more equitable and sustainable relationship between communities and their environments

The frameworks presented here are intentionally designed to be broad in their recommendations and guidance. This breadth allows restoration practitioners from a variety of backgrounds to adapt the framework to their project's unique needs. Each phase of the environmental justice frameworks provides recommendations on how restoration processes can be made more just. While the ideal application of these frameworks would be to guide restoration from start to finish with justice at the forefront, it is also understood that there are difficulties in implementing this framework with current restoration practices. When this is the case practitioners are encouraged to use these frameworks to guide incorporation of justice principles into any and all steps possible in their work. This framework has the ability to assist in incorporating environmental justice into restoration in all projects regardless of their region, species, or community.

This work has the ability to answer global demands for environmental justice work in the context of degraded environments. Through the creation of broad frameworks for restoration, equity is more easily addressed as nations and communities with varying resource levels are provided with a framework that can be adapted to their needs. The creation of the frameworks

presented here (Figure 5 and Figure 6) responds to a global need for restoration work that focuses on the environmental justice implications with the same dedication that the environmental factors are given.

Given the time restrictions imposed by this degree program, the authors felt that meaningful and reciprocal community collaboration would not be possible. Just as this framework aims to create a system where the needs and wishes of the impacted communities are placed at the forefront, the creation of this framework should also follow this principle. Thus, it is the strong recommendation of the research team that the framework proposed here be implemented only after a thorough review and workshopping process has been completed with impacted groups.

5. Conclusion

Ecosystem restoration has the ability to positively impact social and ecological systems. While the burdens of ecosystem degradation have historically fallen on marginalized groups, the benefits of restoration can likewise be reaped by these communities. While nearly all restoration efforts have positive impacts on impacted groups, the incorporation of intentional environmental justice practices into the restoration process can greatly increase these benefits.

While the call for environmental justice has been growing louder over recent decades, the literature review conducted in this study did not yield any restoration frameworks that directly addressed environmental justice. To bridge the gap between current practices and the benefits that restoration can provide to justice, two frameworks have been proposed. Each framework focuses on incorporating environmental justice principles, such as community-based participatory research and traditional knowledge, into the ecosystem restoration process from

ideation to implementation. These frameworks aim to serve as guidelines for how restoration practitioners can incorporate environmental justice into their projects and maximize the benefits that those projects yield.

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Appendix 1: Web of Science Literature Review

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Palou Zúniga, N., Madrigal Ballestero, R., Schlüter, A., & Alvarado, J. J. (2023). Applying the SES Framework to coral reef restoration projects on the Pacific coast of Costa Rica. Revista De Biología Tropical, 71(S1), e54583. https://doi.org/10.15517/rev.biol.trop.v71iS1.54853	No	Eliminated in language filter.	In Spanish - cannot find full article	Spanish		
Webb, A.E., Enochs, I.C., van Hooidonk, R. et al. Restoration and coral adaptation delay, but do not prevent, climate-driven reef framework erosion of an inshore site in the Florida Keys. Sci Rep 13, 258 (2023). https://doi.org/10.1038/s41598-022-26930-4	No	Eliminated in Stage 1.	The article is focused on coral reef structural frameworks.	English		
Yadav, S., Goyal, V.C. Current Status of Ponds in India: A Framework for Restoration, Policies and Circular Economy. Wetlands 42, 107 (2022). https://doi.org/10.1007/s13157-022-01624-9	No	Eliminated in Stage 2.	Not a framework, but a literature review assessment	English		
Krishnan, A., & Osuri, A. M. (2023). Beyond the passive–active dichotomy: aligning research with the intervention continuum framework of ecological restoration. Restoration Ecology, 31(4). https://doi.org/10.1111/rec.13828	No	Eliminated in Stage 2.	Argues for using a combination of passive and active interventions in ecosystem restoration and documentation needs for the process but does not present a framework.	English		
Bakarr, M. I., & Abu-Bakarr, I. (2022). A framework for application of the landscape approach to forest conservation and restoration in Sierra Leone. Frontiers in Forests and Global Change, 5. https://doi.org/10.3389/ffgc.2022.887365	No	Eliminated in Stage 2.	Aims to develop a framework to address Upper Guinea rainforest conservation by considering trees in categories but is not a restoration framework but rather a categorization method.	English		
Rønsted, N., Campbell, R., DeMotta, M., Edmonds, M., Houck, K., Kahokuloa, M., Mayfield, K. K., Nyberg, B., Opgenorth, M., Walsh, S. K., Wolkis, D., Wood, K. R., & Nagendra, U. (2023). Restoration of threatened plant species in Limahuli Valley on the Hawaiian Island of Kaua'i in the framework of the Global Tree Assessment. Plants, People, Planet, 5(4), 547–562. https://doi.org/10.1002/ppp3.10301	No	Eliminated at Stage 1.	The content focuses on identifying species conservation status using the Global Tree Assessment Framework.	English		
Yang, W., Zhang, D., & Luo, G. (2022). A novel framework for evaluating the effect of vegetation restoration via grazing exclusion by fencing: A case-study from the Qinghai–Tibet Plateau. Land Degradation & Development, 33(14), 2619–2634. https://doi.org/10.1002/ldr.4338	No	Eliminated at Stage 2.	The content focuses on grazing and animal management using fences rather than developing a framework.	English		
Vanderklift, M. A., Herr, D., Lovelock, C. E., Murdiyarso, D., Raw, J. L., & Steven, A. D. L. (2022). A Guide to International Climate Mitigation Policy and Finance Frameworks Relevant to the Protection and Restoration of Blue Carbon Ecosystems. Frontiers in Marine Science, 9. https://doi.org/10.3389/fmars.2022.872064	No	Eliminated at Stage 2.	This piece did not create a framework but was a guide to the different policies regarding abatement services and how countries can use these in restoration.	English		
Tiansawat, P., Elliott, S. D., & Wangpakapattanawong, P. (2022). Climate Niche Modelling for Mapping Potential Distributions of Four Framework Tree Species: Implications for Planning Forest Restoration in Tropical and Subtropical Asia. Forests, 13(7), 993–. https://doi.org/10.3390/f13070993	No	Eliminated at Stage 1.	Content focused on framework species.	English		
Andersen, A. N., Einoder, L. D., Fisher, A., Hill, B., & Oberprieler, S. K. (2023). Faunal standards for the restoration of terrestrial ecosystems: a framework and its application to a high-profile case study. Restoration Ecology, 31(1). https://doi.org/10.1111/rec.13735	No	Eliminated at Stage 2.	The content focused on creating a framework for incorporating fauna into existing restoration frameworks.	English		
Shryock, D. F., DeFalco, L. A., & Esque, T. C. (2022). Seed Menus: An integrated decision-support framework for native plant restoration in the Mojave Desert. Ecology and Evolution, 12(4), e8805–n/a. https://doi.org/10.1002/ece3.8805	No	Eliminated at Stage 2.	The content focused on creating seed manus that guide practitioners on where to plant certain seeds.	English		
Eger, A. M., Earp, H. S., Friedman, K., Gatt, Y., Hagger, V., Hancock, B., Kaewsrikhaw, R., Mcleod, E., Moore, A. M., Niner, H. J., Razafinaivo, F., Sousa, A. I., Stankovic, M., Worthington, T. A., Bayraktarov, E., Saunders, M., Vergés, A., & Reeves, S. (2022). The need, opportunities, and challenges for creating a standardized framework for marine restoration monitoring and reporting. Biological Conservation, 266, 109429–. https://doi.org/10.1016/j.biocon.2021.109429	No	Eliminated at Stage 2.	The author is arguing for the development of a standardized framework for restoration in the marine sphere, but does not present a framework.	English		
Gutierrez, V., Hallett, J. G., Ota, L., Sterling, E., Wilson, S. J., Bodin, B., & Chazdon, R. L. (2022). Forest and landscape restoration monitoring frameworks: how principled are they? Restoration Ecology, 30(4). https://doi.org/10.1111/rec.13572	No	Eliminated at Stage 1.	The piece is a review of frameworks and their shortcomings	English		
Bodin, B., Garavaglia, V., Pingault, N., Ding, H., Wilson, S., Meybeck, A., Gitz, V., d'Andrea, S., & Besacier, C. (2022). A standard framework for assessing the costs and benefits of restoration: introducing The Economics of Ecosystem Restoration. Restoration Ecology, 30(3). https://doi.org/10.1111/rec.13515	No	Eliminated at Stage 2.	The content focused on creating a cost-benefit analysis method for determining whether to conduct restoration.	English		
Cowan, E. L., Standish, R. J., Miller, B. P., Enright, N. J., & Fontaine, J. B. (2021). A framework for measuring the effects of disturbance in restoration projects. Restoration Ecology, 29(4). https://doi.org/10.1111/rec.13379	No	Eliminated at Stage 2.	The content focuses on creating a framework to measure the response of restored or partially restored ecosystems to disturbances.	English		
Klaus, V. H., & Kiehl, K. (2021). A conceptual framework for urban ecological restoration and rehabilitation. Basic and Applied Ecology, 52, 82–94. https://doi.org/10.1016/j.baae.2021.02.010	No	Eliminated at Stage 2.	The content is an urban restoration guide and the author's arguments for needing well-functioning ecosystem references.	English		
Ding, Z., Li, R., O'Connor, P., Zheng, H., Huang, B., Kong, L., Xiao, Y., Xu, W., & Ouyang, Z. (2021). An improved quality assessment framework to better inform large-scale forest restoration management. Ecological Indicators, 123, 107370–. https://doi.org/10.1016/j.ecolind.2021.107370	No	Eliminated at Stage 2.	The content is monitoring framework for forestry to assess quality, not a restoration framework.	English		
Li, S., Sun, T., Yang, W., Cui, B., & Yin, X. (2021). A biodiversity evaluation framework for restoration of aquatic macrophyte communities in shallow lakes driven by hydrological process management. Hydrological Processes, 35(1). https://doi.org/10.1002/hyp.13983	No	Eliminated at Stage 2.	The content focused on focusing on measuring biodiversity for management decisions.	English		

Appendix 1 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Weigelhofer, G., Feldbacher, E., Trauner, D., Pölz, E., Hein, T., & Funk, A. (2020). Integrating Conflicting Goals of the EC Water Framework Directive and the EC Habitats Directives Into Floodplain Restoration Schemes. Frontiers in Environmental Science, 8. https://doi.org/10.3389/fenvs.2020.538139	No	Eliminated at Stage 1.	Referencing an EU framework for increasing river system health, not actually using a framework.	English		
Wang, C., Zhang, H., Liu, H., Jian, S., Yan, J., Liu, N., & Ostertag, R. (2020). Application of a trait-based species screening framework for vegetation restoration in a tropical coral island of China. Functional Ecology, 34(6), 1193–1204. https://doi.org/10.1111/1365-2435.13553	No	Eliminated at Stage 2.	The content focused on creating a framework for selecting species to use in restoration.	English		
Schweiger, A. H., Svenning, J., & Higgs, E. (2020). Analogous losses of large animals and trees, socio-ecological consequences, and an integrative framework for rewilding-based megabiota restoration. People and Nature (Hoboken, N.J.), 2(1), 29–41. https://doi.org/10.1002/pan3.10066	No	Eliminated at Stage 2.	The content focused on reintroducing locally extinct species, not restoration.	English		
Bessa da Silva, M., Gonçalves, F., & Pereira, R. (2019). Portuguese shallow eutrophic lakes: evaluation under the Water Framework Directive and possible physicochemical restoration measures. Euro-Mediterranean Journal for Environmental Integration, 4(1). https://doi.org/10.1007/s41207-018-0090-9	No	Eliminated at Stage 1.	Focused on the EU Water Framework Directive.	English		
Dyste, J. M., & Valett, H. M. (2019). Assessing stream channel restoration: the phased recovery framework. Restoration Ecology, 27(4), 850–861. https://doi.org/10.1111/rec.12926	No	Eliminated at Stage 2.	The paper aims to create benchmarks based on predictable habitat structure and community composition to measure the success of stream ecosystem recovery, but does not present a restoration framework.	English		
Li, X., Yang, W., Sun, T., & Su, L. (2019). Framework of multidimensional macrobenthos biodiversity to evaluate ecological restoration in wetlands. Environmental Research Letters, 14(5), 54003–. https://doi.org/10.1088/1748-9326/ab142c	No	Eliminated at Stage 2.	The aim is to use a framework of species to evaluate wetland restoration outcomes, but does not create a restoration framework.	English		
McDonald, T., & Dixon, K. (2018). National standards: Reasserting the ecological restoration framework in uncertain times. Ecological Management & Restoration, 19(S1), 79–89. https://doi.org/10.1111/emr.12317	No	Eliminated at Stage 2.	The piece is a review article and an opinion piece on restoration importance.	English		
Flávio, H. M., Ferreira, P., Formigo, N., & Svendsen, J. C. (2017). Reconciling agriculture and stream restoration in Europe: A review relating to the EU Water Framework Directive. The Science of the Total Environment, 596-597, 378–395. https://doi.org/10.1016/j.scitotenv.2017.04.057	No	Eliminated at Stage 1.	The paper is a review of the EU Water Framework Directive.	English		
Rinella, M. J., & James, J. J. (2017). A modelling framework for improving plant establishment during ecological restoration. Ecological Modelling, 361, 177–183. https://doi.org/10.1016/j.ecolmodel.2017.08.005	No	Eliminated at Stage 2.	The framework created is focused on ensuring seed diversity in restoration but is not a restoration framework.	English		
Wong, M. C., & Dowd, M. (2016). A Model Framework to Determine the Production Potential of Fish Derived from Coastal Habitats for Use in Habitat Restoration. Estuaries and Coasts, 39(6), 1785–1800. https://doi.org/10.1007/s12237-016-0121-1	No	Eliminated at Stage 2.	The content was not relevant as it focuses on creating a modeling framework to estimate the production potential of fish.	English		
Buxton, R. T., Jones, C. J., Lyver, P. O., Towns, D. R., & Borrelle, S. B. (2016). Deciding when to lend a helping hand: a decision-making framework for seabird island restoration. Biodiversity and Conservation, 25(3), 467–484. https://doi.org/10.1007/s10531-016-1079-9	No	Eliminated at Stage 2.	The paper was eliminated as it guides the decision of whether to restore a space, but does not describe the actual restoration process.	English		
Christin, Z. L., Bagstad, K. J., & Verdone, M. A. (2016). A decision framework for identifying models to estimate forest ecosystem services gains from restoration. Forest Ecosystems, 3(1), 1–137. https://doi.org/10.1186/s40663-016-0062-y	No	Eliminated at Stage 2.	The piece is not a restoration framework, framework for deciding what models to use as a restoration framework.	English		
Chaves, R. B., Durigan, G., Brancalion, P. H. S., & Aronson, J. (2015). On the need of legal frameworks for assessing restoration projects success: new perspectives from São Paulo state (Brazil). Restoration Ecology, 23(6), 754–759. https://doi.org/10.1111/rec.12267	No	Eliminated at Stage 2.	The paper was eliminated as it is an overview of Brazil's restoration regulations, but does not present a framework for guiding restoration.	English		
Mongil, J., Navarro, J., & Díaz, V. (2015). An ecological framework applied to a forest restoration program on badlands in Sierra de Avila (Central Spain). Madera y bosques, 21(1), 11–19.	No	Eliminated at Stage 1.	Content was not in English	Spanish		
Dias, A. T. C., Bozelli, R. L., Zamith, L. R., Esteves, F. de A., Ferreira, P., & Scarano, F. R. (2014). Limited relevance of studying colonization in degraded areas for selecting framework species for ecosystem restoration. Natureza & Conservação, 12(2), 134–137. https://doi.org/10.1016/j.ncon.2014.08.002	No	Eliminated at Stage 1.	The paper was eliminated as it is focused on framework species.	English		
Kirkman, L. K., Barnett, A., Williams, B. W., Hiers, J. K., Pokswinski, S. M., & Mitchell, R. J. (2013). A dynamic reference model: a framework for assessing biodiversity restoration goals in a fire-dependent ecosystem. Ecological Applications, 23(7), 1574–1587. https://doi.org/10.1890/13-0021.1	No	Eliminated at Stage 2.	The focus was on creating a framework for establishing reference sites.	English		
Jacobs, D. F., Dalgleish, H. J., & Nelson, C. D. (2013). A conceptual framework for restoration of threatened plants: the effective model of American chestnut (Castanea dentata) reintroduction. The New Phytologist, 197(2), 378–393. https://doi.org/10.1111/nph.12020	No	Eliminated at Stage 2.	The content focused on engineering blight-resistant trees.	English		
Franklin, J. F., & Johnson, K. N. (2012). Restoration Framework for Federal Forests in the Pacific Northwest. Journal of Forestry, 110(8), 429–439. https://doi.org/10.5849/jof.10-006	No	Eliminated at Stage 2.		English		

Appendix 1 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Gonzalez del Tanago, M., Garcia de Jalon, D., & Roman, M. (2012). River Restoration in Spain: Theoretical and Practical Approach in the Context of the European Water Framework Directive. Environmental Management (New York), 50(1), 123–139. https://doi.org/10.1007/s00267-012-9862-1	No	Eliminated at Stage 1.	Focused on the EU Water Framework Directive.	English		
Matthews, J. W., & Spyreas, G. (2010). Convergence and divergence in plant community trajectories as a framework for monitoring wetland restoration progress: Convergence, divergence and restoration progress. The Journal of Applied Ecology, 47(5), 1128–1136. https://doi.org/10.1111/j.1365-2664.2010.01862.x	No	Eliminated at Stage 2.	The piece was eliminated as it is a monitoring framework not a restoration framework.	English		
Pyke, D. A., Brooks, M. L., & D'Antonio, C. (2010). Fire as a Restoration Tool: A Decision Framework for Predicting the Control or Enhancement of Plants Using Fire. Restoration Ecology, 18(3), 274–284. https://doi.org/10.1111/j.1526-100X.2010.00658.x	No	Eliminated at Stage 2.	The content was focused on the use and response of ecosystems to fire for restoration purposes.	English		
Brooks, K. J., Setterfield, S. A., & Douglas, M. M. (2010). Exotic Grass Invasions: Applying a Conceptual Framework to the Dynamics of Degradation and Restoration in Australia's Tropical Savannas. Restoration Ecology, 18(2), 188–197. https://doi.org/10.1111/j.1526-100X.2008.00470.x	No	Eliminated at Stage 2.	The piece was eliminated as it applies a previous framework to measure the impact of invasive grass species, but does not focus on restoration.	English		
Firn, J., House, A. P. N., & Buckley, Y. M. (2010). Alternative states models provide an effective framework for invasive species control and restoration of native communities. The Journal of Applied Ecology, 47(1), 96–105. https://doi.org/10.1111/j.1365-2664.2009.01741.x	No	Eliminated at Stage 2.	The content focuses on invasive species control and not ecosystem restoration.	English		
Suding, K. N. (2009, March 6). Threshold models in restoration and conservation: A developing framework. Trends in Ecology and Evolution. https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(09)00047-0	No	Eliminated at Stage 2.	The article was eliminated as it is focused on establishing thresholds in restoration, but is not a restoration framework.	English		
Florsheim, J. L., Mount, J. F., & Constantine, C. R. (2006). A geomorphic monitoring and adaptive assessment framework to assess the effect of lowland floodplain river restoration on channel-floodplain sediment continuity. River Research and Applications, 22(3), 353–375. https://doi.org/10.1002/rra.911	No	Eliminated at Stage 2.	The content focuses on geomorphology and assessing its impacts.	English		
Kulp, M., Penland, S., Williams, S. J., Jenkins, C., Flocks, J., & Kindinger, J. (2005). Geologic Framework, Evolution, and Sediment Resources for Restoration of the Louisiana Coastal Zone. Journal of Coastal Research, 44, 56–71.	No	Eliminated at Stage 1.	The paper focused on framework geologic structures.	English		
Marzluff, J. M., & Ewing, K. (2001). Restoration of Fragmented Landscapes for the Conservation of Birds: A General Framework and Specific Recommendations for Urbanizing Landscapes. Restoration Ecology, 9(3), 280–292. https://doi.org/10.1046/j.1526-100x.2001.009003280.x	No	Eliminated at Stage 2.	The piece focuses on fragmented communities caused by urbanization.	English		
Kolka, R., Nelson, E. A., & Trettin, C. C. (2000). Conceptual Assessment Framework for Forested Wetland Restoration: The Pen Branch Experience. Restoration of a Severely Impacted Riparian Wetland System - The Pen Branch Project. Ecological Engineering, 15(1).	No	Eliminated at Stage 2.	The piece is a wetland assessment framework and not a restoration framework.	English		
Hobbs, R. J., & Norton, D. A. (1996). Towards a Conceptual Framework for Restoration Ecology. Restoration Ecology, 4(2), 93–110. https://doi.org/10.1111/j.1526-100X.1996.tb00112.x	No	Eliminated at Stage 2	The piece is an opinion and review of current frameworks but presents no new framework.	English		
Pérez, D. R., Rassetto, M. J., & Farina, J. (2021). Relationships between ecological restoration and environmental education: a critical view from Enrique Leff's conceptual framework. Desenvolvimento e Meio Ambiente, 58. https://doi.org/10.5380/dma.v58i0.76060	No	Excluded at Stage 1.	The content was a review and critique of Leff's restoration framework.	English		
Cao, S., Xia, C., Suo, X., & Wei, Z. (2021). A framework for calculating the net benefits of ecological restoration programs in China. Ecosystem Services, 50, 101325–. https://doi.org/10.1016/j.ecoser.2021.101325	No	Excluded due to access.	The piece was not available to the researcher so was excluded.	English		
Zhao, Y., Luo, J., Li, T., Chen, J., Mi, Y., & Wang, K. (2023). A Framework to Identify Priority Areas for Restoration: Integrating Human Demand and Ecosystem Services in Dongting Lake Eco-Economic Zone, China. Land, 12(5), 965. MDPI AG. Retrieved from http://dx.doi.org/10.3390/land12050965	Yes	N/A	The framework ranks potential restoration areas based off of ecosystem service .	English	Identify restoration areas based on their ecosystem service value and low-cost, high-supply factors	Environmental Justice not directly mentioned but overlapping goals are present.
Pfeifer, M., Sallu, S. M., Marshall, A. R., Rushton, S., Moore, E., Shirima, D. D., Smit, J., Kioko, E., Barnes, L., Waite, C., Raes, L., Braunholtz, L., Olivier, P. I., Ishengoma, E., Bowers, S., & Guerreiro-Milheiras, S. (2023). A systems approach framework for evaluating tree restoration interventions for social and ecological outcomes in rural tropical landscapes. Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences, 378 (1867), 20210111–20210111. https://doi.org/10.1098/rstb.2021.0111	Yes	N/A	The authors relied on participatory restoration using hypothetical scenarios of a forest landscape restoration intervention to develop a framework.	English	To develop a framework to identify restoration opportunities that consider local knowledge, value systems, and human wellbeing	Environmental Justice not directly mentioned but overlapping goals are present.
de Groot, R., Moolenaar, S., de Vente, J., De Leijster, V., Ramos, M. E., Robles, A. B., Schoonhoven, Y., & Verweij, P. (2022). Framework for integrated Ecosystem Services assessment of the costs and benefits of large scale landscape restoration illustrated with a case study in Mediterranean Spain. Ecosystem Services, 53, 101383–. https://doi.org/10.1016/j.ecoser.2021.101383	Yes	N/A	The authors present a framework very similar the ecosystem services model to analyze broad impacts of restoration.	English	To develop and implement a framework to analyze, quantify, and monetize the externalities of land use and land use changes	Environmental Justice not directly mentioned but overlapping goals are present.
Guimarães, L. F., Teixeira, F. C., Pereira, J. N., Becker, B. R., Oliveira, A. K. B., Lima, A. F., Veról, A. P., & Miguez, M. G. (2021). The challenges of urban river restoration and the proposition of a framework towards river restoration goals. Journal of Cleaner Production, 316, 128330–. https://doi.org/10.1016/j.jclepro.2021.128330	Yes	N/A	The authors present a literature review and proposed framework to identify comprehensive benefits of river restoration including social and urban results, and incorporating public involvement and awareness.	English	To create an integrated and synergistic set of varied actions and techniques aimed at enhancing environmental value while satisfying socio-economic objectives	Environmental Justice not directly mentioned but overlapping goals are present.

Appendix 1 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Ndiritu, G. G., Terer, T., Njoroge, P., Muiruri, V. M., Njagi, E. L., Kosgei, G., Njoroge, L., Kamau, P. W., Malonza, P. K., Muchane, M., Gathua, J., Odeny, D., & Courtemanch, D. (2021). Using the Biological Condition Gradient Model as a Bioassessment Framework to Support Rehabilitation and Restoration of the Upper Tana River Watershed in Kenya. Frontiers in Environmental Science, 9. https://doi.org/10.3389/fenvs.2021.671051	Yes	N/A	The paper presents an adaptation of the Biological Condition Gradient framework for the terrestrial application. It includes biological indices for monitoring and assessing wetlands and aquatic ecosystems	English	Adapting the Biological Condition Gradient into a framework for restoration of terrestrial environments	Environmental Justice not directly mentioned but overlapping goals are present.
Tao, Q., Gao, G., Xi, H., Wang, F., Cheng, X., Ou, W., & Tao, Y. (2022). An integrated evaluation framework for multiscale ecological protection and restoration based on multi-scenario trade-offs of ecosystem services: Case study of Nanjing City, China. Ecological Indicators, 140, 108962–. https://doi.org/10.1016/j.ecolind.2022.108962	Yes	N/A	The authors present an integrated ecosystem services model applied in urban environments to determine the most efficient restoration locations.	English	To propose an integrated evaluation framework for multiscale ecological protection and restoration based off of trade-offs of ecosystem services	None
Simonson, W. D., Miller, E., Jones, A., García-Rangel, S., Thornton, H., & McOwen, C. (2021). Enhancing climate change resilience of ecological restoration — A framework for action. Perspectives in Ecology and Conservation, 19(3), 300–310. https://doi.org/10.1016/j.pecon.2021.05.002	Yes	N/A	The paper is a literature review on restoration in a climate change context, and presents a framework based on in-house expert knowledge of climate vulnerability of species and ecosystems.	English	To develop a framework that outlines where ecological restoration needs to be adapted for climate change in order to inform the design and implementation of climate change resilient restoration projects	None
Shao, D., Liu, K., Mossman, H. L., Adams, M. P., Wang, H., Li, D., Yan, Y., & Cui, B. (2021). A prioritization metric and modelling framework for fragmented saltmarsh patches restoration. Ecological Indicators, 128, 107833–. https://doi.org/10.1016/j.ecolind.2021.107833	Yes	N/A	The study presents a framework and an example of an application for saltmarsh patch restoration. It details a schematization of study area, an assessment of the functional connectivity of patch networks, and a simulation of restoration prioritization using increasing-patch-area or increasing-number-of-patches strategies.	English	Develop a metric and modeling framework to prioritize salt marsh patches for restoration with a focus on creating connectivity within landscapes	None
Dhyani, S., Bartlett, D., Kadaverugu, R., Dasgupta, R., Pujari, P., & Verma, P. (2020). Integrated climate sensitive restoration framework for transformative changes to sustainable land restoration. Restoration Ecology, 28(5), 1026–1031. https://doi.org/10.1111/rec.13230	Yes	N/A	The paper presents a novel restoration framework, incorporating ecosystem services into the Integrated Climate Sensitive Restoration Framework	English	To develop a methodology (used interchangeably with framework) that bridges the gap between participatory socio-ecology and digital technology/big data to accomplish sustainable restoration goals.	Environmental Justice not directly mentioned but overlapping goals are present.
Angelopoulos, N. V., Cowx, I. G., & Buijse, A. D. (2017). Integrated planning framework for successful river restoration projects: Upscaling lessons learnt from European case studies. Environmental Science & Policy, 76, 12–22. https://doi.org/10.1016/j.envsci.2017.06.005	Yes	N/A	The authors present a literature review and a framework for restoration. They create a decision support tool for project identification, formulation, implementation, and monitoring. It includes a requirement that environmental and socio-economic objectives be identified.	English	To present an integrated project planning framework for river restoration that will help practitioners and river managers address the common challenges when designing and implementing the most appropriate river restoration project. Focusing on adaptive management	Environmental Justice not directly mentioned but overlapping goals are present.
Coutinho, A. G., Carlucci, M. B., & Cianciaruso, M. V. (2023). A framework to apply trait-based ecological restoration at large scales. The Journal of Applied Ecology., 60(8), 1562–1571. https://doi.org/10.1111%2F1365-2664.14439	Yes	N/A	This framework presents a method for implementing multiple restoration solutions in one project in order to maximize the impact of the restoration and account for the largest number of species possible.	English	To create a framework that uses simulations to obtain a large number of restoration solutions to achieve multiple targets.	None
Dickie, M., Bampfylde, C., Habib, T. J., Cody, M., Benesh, K., Kellner, M., McLellan, M., Boutin, S., & Serrouya, R. (2023). Where to begin? A flexible framework to prioritize caribou habitat restoration. Restoration Ecology, 31(5). https://doi.org/10.1111/rec.13873	Yes	N/A	The piece presented mapping and valuation methods in its framework that are useful for developing other restoration projects, though it is limited by the operational specificity.	English	The authors aim to develop a prioritization algorithm and demonstrate how it can be used to predict and monitor progress toward restoring caribou habitat.	None
Yang, R., Chen, S. & Ye, Y. Toward potential area identification for land consolidation and ecological restoration: an integrated framework via land use optimization. Environ Dev Sustain (2022). https://doi.org/10.1007/s10668-022-02767-9	Yes	N/A	This piece is included due to its restoration site identification framework that incorporates land use type data, precipitation, soil types, a spatial grid for population, geographic data, and current natural reserve maps to identify land for restoration.	English	The paper aims to develop an area identification framework for land consolidation and ecological restoration. It explores how land use optimization and LCER are linked.	None
Han, Q., Ding, Y., & Peng, S. (2021). Sustainable and cost-effective vegetation restoration framework under climate change. Forest Ecology and Management, 496, 119436–. https://doi.org/10.1016/j.foreco.2021.119436	Yes	N/A	The piece presents a framework for quantifying growing potential using Potential Natural Vegetation patterns and dividing promising areas into restoration sites.	English	To plan sustainable and cost-effective revegetation projects with consideration given to potential impacts of climate change based on growing potential index.	None
Copeland, S. M., Baughman, O. W., Boyd, C. S., Davies, K. W., Kerby, J., Kildisheva, O. A., & Svejcar, T. (2021). Improving restoration success through a precision restoration framework. Restoration Ecology, 29(2). https://doi.org/10.1111/rec.13348	Yes	N/A	Copeland et al present a new framework based off of standard restoration frameworks in order to understand variability and address it in restoration actions.	English	To build a precision framework that will address sepcific barriers to improve outcomes for standard restoration approaches.	None
Han, B., Jin, X., Xiang, X., Rui, S., Zhang, X., Jin, Z., & Zhou, Y. (2021). An integrated evaluation framework for Land-Space ecological restoration planning strategy making in rapidly developing area. Ecological Indicators, 124, 107374–. https://doi.org/10.1016/j.ecolind.2021.107374	Yes	N/A	This piece presents a framework for integrating multi-level factors into planning for restoration in order to more efficiently designate restoration zones in developing areas.	English	Evaluation framework building on Land-Space Ecological Restoration policy models that gives a multi-scale planning approach taking socio-economic, environmental, and landscape elements into account at different government levels.	None
Yin, X., Li, J., Kadry, S. N., & Sanz-Prieto, I. (2021). Artificial intelligence assisted intelligent planning framework for environmental restoration of terrestrial ecosystems. Environmental Impact Assessment Review, 86, 106493–. https://doi.org/10.1016/j.eiar.2020.106493	Yes	N/A	The paper presents a novel Artificial Intelligence framework that assists with restoration planning.	English	To manage the environmental restoration of the terrestrial ecosystem through use of artificial intelligence to plan the assessment of restoration	Environmental Justice not directly mentioned but overlapping goals are present.
Ram Pandit, John A. Parrotta, Ashok Kumar Chaudhary, Douglas L. Karlen, Daniel Luis Mascia Vieira, Yaakov Anker, Ruishan Chen, Joe Morris, Jim Harris & Phumza Ntshotsho (2020) A framework to evaluate land degradation and restoration responses for improved planning and decision-making, Ecosystems and People, 16:1, 1-18, DOI: 10.1080/26395916.2019.1697756	Yes	N/A	Both biophysical and socio-economic responses. environmental, social, economic, technical, cultural, and political Within IPBES and the Economics of Land Degradation, this is adaptation	English	To develop a multi-criteria framework to assess the effectiveness of land degradation responses for use in planning and restoration	Environmental Justice not directly mentioned but overlapping goals are present.
Carl Kraft, B., & Crandall, R. (2020). A Framework for Considering Climate Change Impacts in Project Selection for Deepwater Horizon Restoration Efforts. Wetlands (Wilmington, N.C.), 40(4), 893–899. https://doi.org/10.1007/s13157-019-01226-y	Yes	N/A	This paper presents a novel framework based off of the Deepwater Horizon spill restoration and develops a disaster-response restoration framework	English	To consider future anticipated conditions in project selection in order to achieve short-term project objectives while maximizing long-term project benefits and monetary investment	Environmental Justice not directly mentioned but overlapping goals are present.
Diamond, J., Tonning, B., Parry, K., & Boschen, C. (2019). Integrating Aquatic Designated Use Protection and Restoration Strategies Using an Ecosystem Goods and Services Framework. Integrated Environmental Assessment and Management, 15(5), 808–818. https://doi.org/10.1002/ieam.4178	Yes	N/A	This piece created an ecosystem good and services framework designed to create integrated management strategies.	English	To create a framework that approaches watershed management in a holistic manner, incorporating watershed stakeholders and integrative management strategies to achieve multiple beneficial uses in an aquatic system	Environmental Justice not directly mentioned but overlapping goals are present.
Hong, C., Chang, H., & Chung, E. (2019). Comparing the functional recognition of aesthetics, hydrology, and quality in urban stream restoration through the framework of environmental perception. River Research and Applications, 35(6), 543–552. https://doi.org/10.1002/rra.3423	Yes	N/A	This piece creates a framework based on the social-ecological systems model to create a hierarchy of preferences for use in restoration siting.	English	To apply residents' perceptions of aesthetic, hydrologic, and environmental quality improvement functions to improve urban stream environments and project competitiveness	Environmental Justice not directly mentioned but overlapping goals are present.

Appendix 1 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Park, K., & Lee, K. (2019). Development of Sustainable Integrated Design Framework for Stream Restoration. Sustainability (Basel, Switzerland), 11(3), 674–. https://doi.org/10.3390/su11030674	Yes	N/A	The authors create a novel three-design phase framework that yields three design plans considering different stream flow conditions. The framework created has aspects that can be applied to other restoration types.	English	To establish a sustainable integrated design framework for urban stream restoration that supplemented the limited scope of application and identified the resulting problems.	None
Derak, M., Cortina, J., Taiqui, L., & Aledo, A. (2018). A proposed framework for participatory forest restoration in semiarid areas of North Africa. Restoration Ecology, 26(S1), S18–S25. https://doi.org/10.1111/rec.12486	Yes	N/A	The piece details a novel participatory framework based on typical restoration steps but including community perspectives and needs.	English	To develop a framework for forest restoration based on knowledge share, trust, and active stakeholder participation in all restoration steps	Environmental Justice not directly mentioned but overlapping goals are present.
Jiang, X., Liu, Y., Xu, S., & Qi, W. (2018). A Gateway to Successful River Restorations: A Pre-Assessment Framework on the River Ecosystem in Northeast China. Sustainability (Basel, Switzerland), 10(4), 1029–. https://doi.org/10.3390/su10041029	Yes	N/A	Social-ecological systems are used as the base for this framework as it explores methods for determining the lowest impact and highest ecosystem return restoration projects will be.	English	A pre-assessment framework to determine the priority of social-ecological restoration objectives for river ecosystems using ecological, technical, and socio-economic factors	Environmental Justice not directly mentioned but overlapping goals are present.
Canto-Perello, J., Morera-Escrich, J. L., Martin-Utrillas, M., & Curiel-Esparza, J. (2018). Restoration prioritization framework for roadway high cut slopes to reverse land degradation and fragmentation. Land Use Policy, 71, 470–479. https://doi.org/10.1016/j.landusepol.2017.11.020	Yes	N/A	This paper presents a novel hybrid framework using the Analytical Hierarchy Process with the Delphi Method and VIKOR technique to create an assessment method for restoration strategies. This aids in the decision process for restoration projects.	English	Developing a hybrid model that is capable of dealing with environmental criteria as well as territorial and economic criteria	None
Silva, A. M. da, Bortoleto, L. A., Castelli, K. R., Silva, R. A. e, & Mendes, P. B. (2017). Prospecting the potential of ecosystem restoration: A proposed framework and a case study. Ecological Engineering, 108, 505–513. https://doi.org/10.1016/j.ecoleng.2017.07.024	Yes	N/A	This novel framework is based on Higgs' guidelines and allows users to map habitat vs non-habitat, concern level for conservation, suitability for restoration, and establish conservation unit presence.	English	To allow for the identification of areas where interventions of passive restoration have the potential to be successful vs where assisted actions are necessary to reach ecosystem resilience capacity	None
Aronson, J., Blignaut, J. N., & Aronson, T. B. (2017). CONCEPTUAL FRAMEWORKS AND REFERENCES FOR LANDSCAPE-SCALE RESTORATION: REFLECTING BACK AND LOOKING FORWARD. Annals of the Missouri Botanical Garden, 102(2), 188–200. https://doi.org/10.3417/2017003	Yes	N/A	This framework is scalable and widely applicable as it facilitates decisions using a set of questions including: who decides on the objectives? Which decision-making processes should be followed? What are the desired outputs? What success indicators will be used? Which combo of restoration activities should be applied and where? Who should pay? Who are the beneficiaries? What is the potential loss if no action is taken?	English	To identify essential elements of restoration frameworks and propose a new framework that can be used to assist with the realization of long-lasting and effective restoration	Environmental Justice not directly mentioned but overlapping goals are present.
Reinhardt, J. R., Naugle, D. E., Maestas, J. D., Allred, B., Evans, J., & Falkowski, M. (2017). Next-generation restoration for sage-grouse: a framework for visualizing local conifer cuts within a landscape context. Ecosphere (Washington, D. C), 8(7). https://doi.org/10.1002/ecs2.1888	Yes	N/A	The framework outlines a mapping method that can be used in other restoration contexts. It focuses on species density versus potential habitat locations to determine priority restoration.	English	To provide a demonstrative framework for identifying priority areas for conifer removal to support sage grouse rehabilitation and maximize benefits.	None
Budiharta, S., Meijaard, E., Wells, J. A., Abram, N. K., & Wilson, K. A. (2016). Enhancing feasibility: Incorporating a socio-ecological systems framework into restoration planning. Environmental Science & Policy, 64, 83–92. https://doi.org/10.1016/j.envsci.2016.06.014	Yes	N/A	The framework focuses on diagnosing the social-ecological system that represent an opportunity for restoration. This is done by 2) Identifying the context for restoration activities including ecological, socio-ecological, political contexts 3) Opportunity cost 4) Prioritsation analysis and planning scenarios	English	To develop an analytical framework for operationalising a contextual and systematic approach to restoration planning that employs Ostrom's SES framework in conjunction with methods for systematic decision-making	Environmental Justice not directly mentioned but overlapping goals are present.
Martin, D. M., Hermoso, V., Pantus, F., Olley, J., Linke, S., & Poff, N. L. (2016). A proposed framework to systematically design and objectively evaluate non-dominated restoration tradeoffs for watershed planning and management. Ecological Economics, 127, 146–155. https://doi.org/10.1016/j.ecolecon.2016.04.007	Yes	N/A	This framework engages in a social-scientific process with elements of hierarchical planning phases and feedback loops. The framework uses methods that can be widely applied including Pareto efficiency measurements, stakeholder inclusions methods, and tradeoff analysis.	English	To develop a decision framework for systematic river restoration planning where economic-environment systems design and tradeoff analyses are employed concurrently. The goal of this framework is to incorporate empirical ecological and socio-economic research and models into multidisciplinary decision support methods	Environmental Justice not directly mentioned but overlapping goals are present.
Wagner, A. M., Larson, D. L., DalSoglio, J. A., Harris, J. A., Labus, P., Rosi-Marshall, E. J., & Skrabis, K. E. (2016). A framework for establishing restoration goals for contaminated ecosystems. Integrated Environmental Assessment and Management, 12(2), 264–272. https://doi.org/10.1002/ieam.1709	Yes	N/A	The authors present a decision tree that provides a framework for goal setting and to identify outcomes of restoration acitvities.	English	Present a framework for developing a comprehensive set of achievable goals for ecological restoration of contaminated sites to be used in concert with determining goals for remediation.	Environmental Justice not directly mentioned but overlapping goals are present.
Speed, R. A., Li, Y., Tickner, D., Huang, H., Naiman, R. J., Cao, J., Lei, G., Yu, L., Sayers, P., Zhao, Z., & Wei, Y. (2016). A framework for strategic river restoration in China. Water International, 41(7), 998–1015. https://doi.org/10.1080/02508060.2016.1247311	Yes	N/A	The authors present a framework that balances human demands, natural environment needs, and river function to maximize services through assessing drivers and pressures, nutrient cycle questions, ecosystem services, and community priorities.	English	Present a framework for strategic river restoration that is inclusive and to establish a set of eight golden rules for successful planning and implementation of restoration activities.	Environmental Justice not directly mentioned but overlapping goals are present.
Glenk, K., Schaafsma, M., Moxey, A., Martin-Ortega, J., & Hanley, N. (2014). A framework for valuing spatially targeted peatland restoration. Ecosystem Services, 9, 20–33. https://doi.org/10.1016/j.ecoser.2014.02.008	Yes	N/A	A novel framework based on the social-ecological systems model, the authors present a method for performing a cost-benefit analysis of restoration including baseline scenario and restoration, biophysical assessment of ecosystem services changes and welfare impacts, economic assessment, sensitivity analysis, spatially explicit estimation of welfare impacts, spatially explicit data used in decision making.	English	To create a framework to guide spatially explicit economic impact assessments of peatland restoration using ecosystem services	Environmental Justice not directly mentioned but overlapping goals are present.
Tambosi, L. R., Martensen, A. C., Ribeiro, M. C., & Metzger, J. P. (2014). Framework to Optimize Biodiversity Restoration Efforts Based on Habitat Amount and Landscape Connectivity. Restoration Ecology, 22(2), 169–177. https://doi.org/10.1111/rec.12049	Yes	N/A	This framework considers restoration impacts at both local and large scales through calculating landscape connectivity and inferring resilience of communities based on connectivity in order to prioritize restoration that will be most impactful.	English	To define priority restoration areas based on landscape structure at multiple scales in order to optimize restoration efforts by enhancing landscape connectivity while reducing cost.	None
Yoshioka, A., Akasaka, M., & Kadoya, T. (2014). Spatial Prioritization for Biodiversity Restoration: A Simple Framework Referencing Past Species Distributions. Restoration Ecology, 22(2), 185–195. https://doi.org/10.1111/rec.12075	Yes	N/A	The framework presented guides the collection of requisite information, mapping the cost index of restoration sites, prioritizing sites, and assessing the results. These methods can be applied to other restoration activities.	English	To create a simple framework for spatial restoration prioritization using complementarity analysis based on the differences between past and present species distribution. Focuses on cost-efficient planning and implementation over large areas	None
Song, X., & Frostell, B. (2012). The DPSIR Framework and a Pressure-Oriented Water Quality Monitoring Approach to Ecological River Restoration. Water (Basel), 4(3), 670–682. https://doi.org/10.3390/w4030670	Yes	N/A	The framework focuses on the selection of system boundaries, cost-effectiveness measurements, and metabolic accounting as measurements. It argues that environmental pressures should be considered through discussion and inclusion of the human activities that give rise to them.	English	To develop a driver-pressure-responses framework to better address the need for pressure-oriented indicators	Environmental Justice not directly mentioned but overlapping goals are present.
Biswas, S. R., Mallik, A. U., Choudhury, J. K., & Nishat, A. (2009). unified framework for the restoration of Southeast Asian mangroves--bridging ecology, society and economics. Wetlands Ecology and Management, 17(4), 365–383. https://doi.org/10.1007/s11273-008-9113-7	Yes	N/A	This novel restoration framework focuses on identifying the causes of degradation and addressing them to prevent further degradation as well as developing a detailed practical guideline for restoring already degraded mangroves. The causal identification and practical guidelines can all be applied to other projects.	English	To present a framework for tropical mangrove restoration that addresses the ecology, economy, and social issues simultaneously by considering the cause of mangrove degradation	Environmental Justice not directly mentioned but overlapping goals are present.

Appendix 1 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
King, E. G., & Hobbs, R. J. (2006). Identifying Linkages among Conceptual Models of Ecosystem Degradation and Restoration: Towards an Integrative Framework. Restoration Ecology, 14(3), 369–378. https://doi.org/10.1111/j.1526-100X.2006.00145.x	Yes	N/A	The piece uses an analysis of connections and distinctions between ecosystem components to strengthen restoration planning efforts. These methods can be applied across many ecosystem types to aid restoration.	English	To present a framework for considering ecosystem degradation and restoration options from a synthesis of three conceptual models.	None
Pastorok, R. A., MacDonald, A., Sampson, J. R., Pace Wilber, Yozzo, D. J., & Titre, J. P. (1997). An ecological decision framework for environmental restoration projects. Ecological Engineering, 9(1), 89–107. https://doi.org/10.1016/S0925-8574(97)00036-0	Yes	N/A	The framework includes methods to define ecosystem appropriateness, measure site uncertainties, develop ecological models, and implement monitoring methods. These methods can be used in many types of restoration frameworks.	English	To create a formal restoration planning framework based on the U.S. Army Corps of Engineer's project planning framework that is focused specifically on guiding ecosystem restoration projects.	None
Wyant, J. G. (Decision R., Meganck, R. ., & Ham, S. . (1995). A planning and decision-making framework for ecological restoration. Environmental Management (New York), 19(6), 789–796. https://doi.org/10.1007/BF02471932	Yes	N/A	This framework presents a method for including a wider range of participants and more decision criteria than earlier frameworks.	English	To provide a definition for restoration ecology and present a decision framework that organizes different phases of restoration and associated decisions.	Environmental Justice not directly mentioned but overlapping goals are present.

Appendix 2: Proquest Literature Review

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Dan, Y., Peng, J., Zhang, Z., Xu, Z., Mao, Q., & Dong, J. (2020). Territorially ecological restoration zoning based on the framework of degradation pressure,supply state and restoration potential:a case study in the Pearl River Delta region. Shengtai Xuebao = Acta Ecologica Sinica, 23, 8451-.	No	Eliminated at Stage 1.	Not English language	Chinese		
McCoy, A. L., Holmes, S. R., & Boisjolie, B. A. (2018). Flow Restoration in the Columbia River Basin: An Evaluation of a Flow Restoration Accounting Framework. Environmental Management (New York), 61(3), 506–519. https://doi.org/10.1007/s00267-017-0926-0	No	Eliminated at Stage 1.	focused on restoring flow levels to previously regulated water bodies, not ecological restoration	English		
Nam, J., Son, K.-H., & Khim, J. S. (2015). Multiple Implications of the Restoration of Coastal Wetland Ecosystem and the Establishment of a Strategic Restoration Framework. Ocean and Polar Research, 37(3), 211–223. https://doi.org/10.4217/OPR.2015.37.3.211	No	Eliminated at Stage 1.	Not English language	Korean		
Park, H., & Higgs, E. (2018). A criteria and indicators monitoring framework for food forestry embedded in the principles of ecological restoration. Environmental Monitoring and Assessment, 190(3), 113–120. https://doi.org/10.1007/s10661-018-6494-9	No	Eliminated at Stage 1.	Focused on food forests and applying ecological restoration principles to improving their agricultural yield, not restoration work.	English		
Ye, Y., Lin, Y., Liu, S., & Luo, M. (2019). Social-ecological system (SES) analysis framework for application in ecological restoration engineering of mountains-rivers-forests-farmlands-lakes-grasslands: Utilizing the source area of Qiantang River in Zhejiang Province as an example. Sheng Tai Xue Bao, 39(23), 8846-. https://doi.org/10.5846/stxb201905301139	No	Eliminated at Stage 1.	Not English language	Chinese		
Zhao, L., Xia, J., Yang, F., Yang, L., & Xu, F. (2021). Current situation, framework, problems and prospect of water ecological restoration in Guangdong-Hong Kong-Macao Greater Bay Area. Sheng Tai Xue Bao, 41(12), 5054-. https://doi.org/10.5846/stxb202005011077	No	Eliminated at Stage 1.	Not English language	Chinese		
Jantawong, K., Kavinchan, N., Wangpakapattanawong, P., & Elliott, S. (2022). Financial Analysis of Potential Carbon Value over 14 Years of Forest Restoration by the Framework Species Method. Forests, 13(2), 144-. https://doi.org/10.3390/f13020144	No	Eliminated at Stage 1.	Framework species-focused.	English		
Muhar, S., Januschke, K., Kail, J., Poppe, M., Schmutz, S., Hering, D., & Buijse, A. D. (2016). Evaluating good-practice cases for river restoration across Europe: context, methodological framework, selected results and recommendations. Hydrobiologia, 769(1), 3–19. https://doi.org/10.1007/s10750-016-2652-7	No	Eliminated at Stage 1.	Not a restoration framework	English		
Sagar, R., Mondragon-Botero, A., Dolins, F., Morgan, B., Vu, T., McCrae, J., & Winchester, V. (2021). Forest Restoration at Berenty Reserve, Southern Madagascar: A Pilot Study of Tree Growth Following the Framework Species Method. Land (Basel), 10(10), 1041-. https://doi.org/10.3390/land10101041	No	Eliminated at Stage 1.	Framework species-focused	English		
England, J., Skinner, K. S., & Carter, M. G. (2008). Monitoring, river restoration and the Water Framework Directive. Water and Environment Journal : WEJ, 22(4), 227–234. https://doi.org/10.1111/j.1747-6593.2007.00090.x	No	Eliminated at Stage 1.	Water Framework Directive	English		
Mouton, A. M., Van Der Most, H., Jeuken, A., Goethals, P. L. M., & De Pauw, N. (2009). Evaluation of river basin restoration options by the application of the Water Framework Directive Explorer in the Zwalm River basin (Flanders, Belgium). River Research and Applications, 25(1), 82–97. https://doi.org/10.1002/rra.1106	No	Eliminated at Stage 1.	Water Framework Directive	English		
Gołdyn, R., Podsiadłowski, S., Dondajewska, R., & Kozak, A. (2014). The sustainable restoration of lakes—towards the challenges of the Water Framework Directive. Ecohydrology & Hydrobiology, 14(1), 68–74. https://doi.org/10.1016/j.ecohyd.2013.12.001	No	Eliminated at Stage 1.	Water Framework Directive	English		
Zauner, Gerald & Jung, Michael & Ratschan, Clemens & Mühlbauer, M.. (2016). Ecological restoration of free flowing and impounded stretches of the Austrian Danube River – towards the objectives of the Water Framework Directive. Österreichische Wasser- und Abfallwirtschaft. Österr Wasser- und Abfallw. xx.	No	Eliminated at Stage 1.	Water Framework Directive.	English		
Brown, B.J., Ray, G.J. (1993). Restoring Caribbean dry forest. In: Lieth, H., Lohmann, M. (eds) Restoration of Tropical Forest Ecosystems. Tasks for vegetation science, vol 30. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-2896-6_5	No	Eliminated at Stage 1.	Content was not accessible to researchers			
Atakul, N., Thaheem, M. J., & De Marco, A. (2014). Risk management for sustainable restoration of immovable cultural heritage, part 1: PRM framework. Journal of Cultural Heritage Management and Sustainable Development, 4(2), 149–165. https://doi.org/10.1108/JCHMSD-12-2012-0068	No	Eliminated at Stage 2.	Risk-management methodology, not a restoration framework	English		
Bouchard, M., & Garet, J. (2014). A framework to optimize the restoration and retention of large mature forest tracts in managed boreal landscapes. Ecological Applications, 24(7), 1689–1704. https://doi.org/10.1890/13-1893.1	No	Eliminated at Stage 2.	This is a framework for coordinating forest harvesting in managed forest ecosystems in order to reduce pressure on mature forests, but is not a restoration framework.	English		
Bried, J., Tear, T., Shirer, R., Zimmerman, C., Gifford, N., Campbell, S., & O'Brien, K. (2014). Framework to Integrate Habitat Monitoring and Restoration with Endangered Insect Recovery. Environmental Management (New York), 54(6), 1385–1398. https://doi.org/10.1007/s00267-014-0351-6	No	Eliminated at Stage 2.	Monitoring and evaluation steps to incorporate into a restoration framework, but not a restoration framework of their own	English		

Appendix 2 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Chazdon, R. L., Gutierrez, V., Brancalion, P. H. S., Laestadius, L., & Guariguata, M. R. (2020). Co-Creating Conceptual and Working Frameworks for Implementing Forest and Landscape Restoration Based on Core Principles. Forests, 11(6), 706-. https://doi.org/10.3390/f11060706	No	Eliminated at Stage 2.	This piece focuses on how to tailor existing frameworks in forest and landscape management to create alignment between projects, but does not present a framework.	English		
Efroymson, R., Nicolette, J., & Suter, G. (2004). A framework for net environmental benefit analysis for remediation or restoration of contaminated sites. Environmental Management (New York), 34 (3), 315–331. https://doi.org/10.1007/s00267-004-0089-7	No	Eliminated at Stage 2.	Not a restoration framework but is a framework for deciding whether or not to actively remove contaminants from an area.	English		
Egner, L. E., Sütterlin, S., & Calogiuri, G. (2020). Proposing a Framework for the Restorative Effects of Nature through Conditioning: Conditioned Restoration Theory. International Journal of Environmental Research and Public Health, 17 (18), 6792-. https://doi.org/10.3390/ijerph17186792	No	Eliminated at Stage 2.	The piece focuses on using nature in psychological restoration, not on restoring ecosystems.	English		
Fedorowick, J. M. (1993). A landscape restoration framework for wildlife and agriculture in the rural landscape. Landscape and Urban Planning, 27(1), 7–17. https://doi.org/10.1016/0169-2046(93)90024-8	No	Eliminated at Stage 2.	This paper is a study of habitat connectivity and how to maximize the benefits of ecosystems on agricultural production, but is not a restoration framework.	English		
Funk, J. L. (2021). Revising the trait-based filtering framework to include interacting filters: Lessons from grassland restoration. The Journal of Ecology, 109(10), 3466–3472. https://doi.org/10.1111/1365-2745.13763	No	Eliminated at Stage 2.	This piece does not present a restoration framework but rather updates a method for filtering species into communities based on shared traits.	English		
Hanson, D., Hachmeister, L., Hale, D., & Hassler, E. (2014). Gulf Of Mexico Ecosystem Restoration: A Risk-based Integrated Environmental, Economic, And Social Resource Management Decision Support Framework. Environmental Impact 11, 181, 531-. https://doi.org/10.2495/EID140451	No	Eliminated at Stage 2.	This piece presents a support framework for decision-making systems that can be incorporated into a restoration framework, but is not a restoration framework of its own.	English		
Kondolf, G.M., Micheli, E.R. Evaluating stream restoration projects. Environmental Management 19, 1–15 (1995). https://doi.org/10.1007/BF02471999	No	Eliminated at Stage 2.	The piece is an evaluation framework and does not focus on initiating restoration work.	English		
Mansourian, S., & Vallauri, D. (2020). How to Learn Lessons from Field Experience in Forest Landscape Restoration: A Tentative Framework. Environmental Management (New York), 66(6), 941–951. https://doi.org/10.1007/s00267-020-01295-4	No	Eliminated at Stage 2.	A framework for capturing the lessons learned from forest restoration, not a restoration framework	English		
Podolak, C. J. P. (2014). visual framework for displaying, communicating and coordinating a river restoration monitoring project. River Research and Applications, 30(4), 527–535. https://doi.org/10.1002/rra.2651	No	Eliminated at Stage 2.	This piece presents a monitoring framework for restoration projects but does not present a restoration framework.	English		
Shadkam, S., van Oel, P., Kabat, P., Roozbahani, A., & Ludwig, F. (2020). The Water-Saving Strategies Assessment (WSSA) Framework: An Application for the Urmia Lake Restoration Program. Water (Basel), 12(10), 2789-. https://doi.org/10.3390/w12102789	No	Eliminated at Stage 2.	The piece is an assessment framework for water use reduction strategies.	English		
Sivapalan, M., & Bowen, J. (2020). Decision frameworks for restoration & adaptation investment-Applying lessons from asset-intensive industries to the Great Barrier Reef. PloS One, 15 (11), e0240460-. https://doi.org/10.1371/journal.pone.0240460	No	Eliminated at Stage 2.	argument for using asset-intensive industry frameworks in restoration using the Great Barrier Reef's investment case to demonstrate application.	English		
WALSH, C. J. (2000). Urban impacts on the ecology of receiving waters : a framework for assessment, conservation and restoration. Hydrobiologia, 431(2–3), 107–114. https://doi.org/10.1023/a:1004029715627	No	Eliminated at Stage 2.	This piece is a review of the need for restoration and a call for ecologists to increase cooperation in efforts.	English		
Wang, C., Zhang, H., Liu, H., Jian, S., Yan, J., Liu, N., & Ostertag, R. (2020). Application of a trait-based species screening framework for vegetation restoration in a tropical coral island of China. Functional Ecology, 34(6), 1193–1204. https://doi.org/10.1111/1365-2435.13553	No	Eliminated at Stage 2.	This piece presents a new method for selecting target species, but does not go into the restoration steps after this point.	English		
Zhang, Y. S., Gittman, R. K., Donaher, S. E., Trackenberg, S. N., van der Heide, T., & Silliman, B. R. (2021). Inclusion of Intra- and Interspecific Facilitation Expands the Theoretical Framework for Seagrass Restoration. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.645673	No	Eliminated at Stage 2.	Experiment on increasing the efficacy of seagrass restoration to improve other frameworks. Not presenting a framework of its own	English		
Marlier, M. E., Liu, T., Yu, K., Buonocore, J. J., Koplitz, S. N., DeFries, R. S., Mickley, L. J., Jacob, D. J., Schwartz, J., Wardhana, B. S., & Myers, S. S. (2019). Fires, Smoke Exposure, and Public Health: An Integrative Framework to Maximize Health Benefits From Peatland Restoration. Geohealth, 3(7), 178–189. https://doi.org/10.1029/2019GH000191	No	Eliminated at Stage 2.	Health framework but not ecosystem health.	English		
Bodin, B., Garavaglia, V., Pingault, N., Ding, H., Wilson, S., Meybeck, A., Gitz, V., d'Andrea, S., & Besacier, C. (2022). A standard framework for assessing the costs and benefits of restoration: introducing The Economics of Ecosystem Restoration. Restoration Ecology, 30(3). https://doi.org/10.1111/rec.13515	No	Eliminated at Stage 2.	Economic framework, not restoration	English		
Schweizer, D., Meli, P., Brancalion, P. H. S., & Guariguata, M. R. (2021). Implementing forest landscape restoration in Latin America: Stakeholder perceptions on legal frameworks. Land Use Policy, 104, 104244-. https://doi.org/10.1016/j.landusepol.2019.104244	No	Eliminated at Stage 2.	Legal frameworks and public opinion piece.	English		
Alayan, R., Rotich, B., & Lakner, Z. (2022). A Comprehensive Framework for Forest Restoration after Forest Fires in Theory and Practice: A Systematic Review. Forests, 13(9), 1354-. https://doi.org/10.3390/f13091354	Yes	N/A	six criteria and indicator framework for creating restoration projects post-fire would be used in many different types of restoration projects	English	To create an indicator framework for forest restoration after disturbances.	None

Appendix 2 Continued

Citation	Included (Y/N)	Elimination Stage (If Applicable)	Reason for Inclusion/Exclusion	Language	Study Purpose	Environmental Justice Factors
Brancalion, P. H. S., Viani, R. A. G., Calmon, M., Carrascosa, H., & Rodrigues, R. R. (2013). How to Organize a Large-Scale Ecological Restoration Program? The Framework Developed by the Atlantic Forest Restoration Pact in Brazil. Journal of Sustainable Forestry, 32(7), 728–744. https://doi.org/10.1080/10549811.2013.817339	Yes	N/A	This piece presents the restoration framework that Brazil used in its recent forest restoration initiative, as well as reflections on challenges in the process.	English	To develop a template to help other initiatives to mainstream isolated restoration projects into a large and well-organized movement, which may increase the chances of successful restoration in the future.	Environmental Justice not directly mentioned but overlapping goals are present.
Doll, B. A., Kurki-Fox, J. J., & Line, D. E. (2020). A Framework for Planning and Evaluating the Role of Urban Stream Restoration for Improving Transportation Resilience to Extreme Rainfall Events. Water (Basel), 12(6), 1620-. https://doi.org/10.3390/w12061620	Yes	N/A	This piece was included as its framework for determining the best combination of restoration and engineered solutions could be applied to other regions and problems beyond stream flooding.	English	The overall goal of this paper is to propose a planning-level framework for evaluating the potential impacts of stream and floodplain restoration in urbanized catchments with a focus on increasing resilience to extreme events.	None
Hyman, J. B., & Leibowitz, S. G. (2000). general framework for prioritizing land units for ecological protection and restoration. Environmental Management (New York), 25(1), 23–35. https://doi.org/10.1007/s002679910003	Yes	N/A	The framework presented develops a process for selecting restoration sites that maximize ecosystem benefits.	English	• This paper aims to develop a common and rigorous framework for ranking restoration sites, such that the process is explicit and repeatable, necessary assumptions are highlighted, and commonalities and significant differences among prioritizations can be readily assessed, particularly when resources are limited and limiting.	None
Kozak, J. P., & Piazza, B. P. (2015). proposed process for applying a structured decision-making framework to restoration planning in the Atchafalaya River Basin, Louisiana, U.S.A. Restoration Ecology, 23(1), 46–52. https://doi.org/10.1111/rec.12125	Yes	N/A	This piece created a decision framework for restoration that incorporated community value into the process of siting, implementing, and monitoring restoration projects.	English	This paper proposes a process to apply a structured decision-making framework with a values-based approach to promote stakeholder-driven restoration efforts in the ARB and to better prepare for and manage long-term environmental issues. The goals of this approach are: (1) to create a process founded on stakeholder values and supported by rigorous scientific assessment to meet management agency mandates and (2) to establish a transparent process for restoration planning in the ARB that incorporates current and future non-governmental stakeholders into the decision-making process.	Environmental Justice not directly mentioned but overlapping goals are present.
Mulvaney, K., Ayvazian, S., Chaffee, C., Wigand, C., Canfield, K., & Schoell, M. (2022). Open SESAME: a social-ecological systems framework for collaborative adaptive management and engagement in coastal restoration and climate adaptation. Wetlands Ecology and Management, 30(6), 1291–1302. https://doi.org/10.1007/s11273-022-09891-3	Yes	N/A	This framework incorporated social dynamics into previously established, ecologically-focused restoration planning frameworks in order to increase success of restoration projects.	English	To develop a Social-Ecological Systems, Adaptive Management, and Engagement (SESAME) framework that provides reciprocal connections between the human and ecological components of restoration efforts and the resulting management and engagement needs	Environmental Justice not directly mentioned but overlapping goals are present.
Murphy, B. M., Russell, K. L., Stillwell, C. C., Hawley, R., Scoggins, M., Hopkins, K. G., Burns, M. J., Taniguchi-Quan, K. T., Macneale, K. H., & Smith, R. F. (2022). Closing the gap on wicked urban stream restoration problems: A framework to integrate science and community values. Freshwater Science, 41(3), 521–531. https://doi.org/10.1086/721134	Yes	N/A	This piece is included as it presents a novel framework for creating restoration projects that increased benefit for communities, both biological and social.	English	Based on these and other results, we propose a conceptual framework that integrates diverse perspectives and knowledge to enhance social and ecological outcomes of urban stream restoration. The framework also emphasizes the importance of setting objectives that support incremental solutions to foster more realistic expectations amongst stakeholders.	Environmental Justice not directly mentioned but overlapping goals are present.
Perkins, L. B., & Leffler, A. J. (2018). Conceptualizing ecological restoration: a concise and adaptable framework for researchers and practitioners. Restoration Ecology, 26(6), 1024–1028. https://doi.org/10.1111/rec.12881	Yes	N/A	This paper presents a restoration triangle of priorities to guide practitioners that includes the attributes and characteristics of the desired focal restoration species, the biotic characteristics of the restoration site, and the environmental conditions of the restoration site and is widely applicable.	English	To propose a simple, adaptable conceptual framework that contains these three sets of factors with the hope of increasing generalization among diverse projects, improving communication among researchers and between researchers and practitioners, and encouraging ecological restoration to be more holistic or comprehensive by acknowledging all three sets of factors at least during planning phases.	None
Singh, M., & Sinha, R. (2022). Integrating Hydrological Connectivity in a Process–Response Framework for Restoration and Monitoring Prioritisation of Floodplain Wetlands in the Ramganga Basin, India. Water (Basel), 14(21), 3520-. https://doi.org/10.3390/w14213520	Yes	N/A	It's two fundamental restoration steps could be applied to other restoration scenarios	English	This work aims to develop a process-response based protocol for basin-scale assessment of wetland health status through hydrological connectivity analysis and their prioritisation for the alluvial catchment basin of the Ramganga Basin	None