United Nations
Convention to Combat
Desertification

G20 GLOBAL
LAND INITIATIVE

GLOBAL LAND RESTORATION ECONOMY

STATE OF PLAY AND RECOMMENDATIONS FOR SCALE-UP

GLOBAL LAND RESTORATION ECONOMY

STATE OF PLAY AND RECOMMENDATIONS FOR SCALE-UP

Todd BenDor
Distinguished Professor of Sustainable Community Design and Chair
Department of City and Regional Planning
UNC-Chapel Hill

G20 Global Land Initiative
United Nations Convention to Combat Desertification

December 2024

FOREWORD

Land degradation, a pervasive global issue affecting over two billion hectares, impacts diverse land types including agricultural, forest, mining, rangeland, and urban areas. This degradation compromises land productivity, depletes soil organic carbon, and reduces biodiversity. Recognizing the urgency of this crisis, international policymakers and technical experts have increasingly prioritized land and ecosystem restoration.

Initiatives such as the Bonn Challenge and commitments under the UN Conventions on Biological Diversity and Desertification have spurred global efforts to restore degraded lands. Additionally, numerous countries have enacted national laws mandating restoration. These endeavours have collectively fostered a burgeoning "restoration economy," characterized by dedicated resources and projects aimed at land and ecosystem restoration.

The restoration economy supports an emerging industry encompassing services from large-scale restoration planning and implementation to monitoring activities and ancillary services like native species seed banks and nurseries. While this industry is still developing, it holds significant potential. The recent EU restoration law, along with ambitious targets set by the G20 Global Land Initiative and mega projects like the Great Green Wall of Africa and Middle East Green Initiative, are driving its growth.

The G20 Global Land Initiative has been instrumental in framing the concept of the restoration economy and supporting the emerging industry. Through a commissioned study by Prof. Todd Bendon and market reports from Worldwide Market Reports, we have analyzed the industry's potential. Our findings indicate that the restoration economy is poised for significant expansion. With countries committed to restoring over one billion hectares, the industry could generate $1.5 to $2 trillion in economic value, creating jobs and fostering innovation.

This report, part of the G20 Global Land Initiative's "Target 50" series, aims to raise awareness of the restoration economy and promote enabling activities. By understanding the industry's potential and supporting its development, we can contribute to a more sustainable and resilient future.

Muralee Thummarukudy

Director, G20 Global Land Initiative Coordination Office

Bonn, 53113, Bonn

TABLE OF CONTENT

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The United Nations has declared 2021-2030 the Decade on Ecosystem Restoration, emphasizing the urgent need for large-scale ecological restoration worldwide. The degradation of land has far-reaching consequences, impacting not only agricultural productivity and environmental quality but also the social and economic well-being of entire communities. Reversing land degradation through ecological restoration is crucial for achieving land degradation neutrality and the Sustainable Development Goals.

This paper explores the concept of a "restoration economy," highlighting the potential of ecological restoration to drive economic growth and create sustainable jobs. By investing in the restoration of degraded land, governments can foster a thriving industry that contributes to both environmental and economic well-being. The experience of the United States, where a robust restoration economy has emerged, offers valuable lessons for other nations.

The economic benefits of restoration are well-documented, including increased property values, tourism revenue, and cost savings from improved ecosystem services. However, defining "restoration" itself can be challenging. This paper proposes an inductive approach, focusing on the activities and industries involved in restoration efforts in defined geographic areas. By analyzing the specific practices and expenditures associated with restoration projects, we can gain a clearer understanding of the restoration economy's scope and impact.

The paper outlines a framework for defining and measuring the restoration economy, emphasizing the need for nations to align their restoration efforts with their commitments under the Rio conventions and the Bonn Challenge. It also highlights the importance of developing domestically owned and operated restoration industries to maximize economic benefits and ensure long-term sustainability.

The economic impacts of restoration can be assessed using input-output modeling, which captures the direct, indirect, and induced employment and economic output effects of restoration investments. The paper discusses various approaches to measuring these impacts, depending on the availability of data and the structure of a nation's economy. It also cautions against overestimating the potential impacts of future restoration efforts, as input-output models are based on static data and do not account for price changes or market dynamics.

The paper identifies several key drivers of restoration, including government initiatives, public procurement, private investments, internal agency policies, and regulations. The relative importance of these drivers varies across nations, depending on factors such as funding availability, property rights regimes, and regulatory frameworks.

To foster the growth of restoration economies, the paper outlines several enabling conditions, drawing on the experience of the United States. These include broadening the circumstances that require restoration, strictly enforcing restoration requirements, incentivizing professionalization, establishing high ecological standards, and streamlining regulatory processes. The professionalization of the restoration industry, supported by stable funding streams and training programs, is crucial for its long-term success.

Finally, the paper presents actionable steps for G20 leaders to incentivize restoration and build their own restoration economies. These include creating disincentives for land degradation, investing in capacity-building and training programs, establishing high ecological standards, managing risks associated with restoration projects, and developing policies that drive both public and private sector investment in restoration. By taking these steps, governments can create a virtuous cycle where environmental restoration and economic growth reinforce each other, leading to a more sustainable and prosperous future.

INTRODUCTION

1 INTRODUCTION

The United Nations has heralded 2021-2030 to be the *Decade on Ecosystem Restoration*, underscoring the extensive role that ecological restoration must begin to play around the world. In response, and as part of the Rio conventions and the Bonn Challenge, 115 countries have committed to restore a total of 765.4 million to 1.0 billion hectares of degraded land (Sewell, van der Esch, and Löwenhardt 2020). For perspective, this is equivalent to a land area between the size of Australia (768.7 million ha) and the United States (983.4 million ha), or between 5.8 and 7.5 percent of all land mass on Earth. Additionally, many nations have created their own, internal restoration and conservation commitments; for example, the Biden-Harris Administration (2021) has declared a "locally led and voluntary nationwide conservation goal to conserve 30 percent of U.S. lands and waters by 2030."

While I will discuss the localized *nature* of land degradation in the next section, it is important to note that degraded lands can have wide-ranging impacts on entire communities or regions. These can include somewhat obvious impacts, such as loss of agricultural productivity (e.g., Pacheco et al. 2018) or site-scale water or soil deterioration (e.g., erosion problems; Issaka and Ashraf 2017), along with more intangible, spatially diffuse, hard to measure, longer-term, or indirect impacts. We can see this in McCarthy's (2002) examination of contaminated lands in urban areas ("brownfields"), wherein she highlights the dual challenge of first incentivizing the cleanup of degraded lands, which is thereafter complicated by the task of re-connecting rehabilitated areas back into the communities that had long viewed the degraded sites as a source of blight. As a result, it is not just about recovering the value of degraded sites alone, but instead a community-wide recovery of the broad loss of land values (see examples across Africa and the Middle East: Ahmad et al. 2018; Gebremariam et al. 2019; Goosen and Fitchett 2020) for all surrounding areas. Moreover, recovery from social stresses affecting community cohesion (Accordino and Johnson 2000; Bacot and O'Dell 2006), and spatially-diffuse environmental spillovers (e.g., non-point source flooding and water quality degradation; Myers et al. 1985) are essential in not only halting the on-going impacts of degraded site existence, but reversing the effects on the psyche of entire communities.

Strong social (Fischer et al. 2021), environmental (Wortley, Hero, and Howes 2013), and economics arguments (Sutton et al. 2016) have long made the case to halt land degradation. In 2015, a major product of the 12th Conference of the Parties (COP12) of the United Nations Convention to Combat Desertification (UNCCD) was an effort to define, and achieve, land degradation "neutrality" (LDN), with LDN eventually becoming a target of Sustainable Development Goal 15 (Life on Land, 15.3 *By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world*). Strong arguments have been made for reversing the effects of land degradation through ecological restoration (Alexander et al. 2016).

In this paper, I explore an emerging – and perhaps more politically forceful – argument for reversing land degradation, based on the idea that ecological restoration can offer a strong source of localized economic development. That is, in the process of restoring degraded land to productive and safe uses, governments can foster sustainable economic growth, driving one of the "greenest" industries imaginable. Governments – within a constellation of other institutional actors – can do this by building, incentivizing, and supporting a domestic ecological restoration industry, thereby creating a strong, local "restoration economy."

It is essential that policy makers, the media, and the public understand the connections between the initiatives and policies that promote restoration and the economic change that results. Importantly, they must understand these connections using the same language used to evaluate other public investments and economic activities. As part of this, studies of the economic impacts of restoration projects and programs can create a clear link between employment and economic activity that results from restoration funding. For example, my on-going work in the United States, where multiple legal requirements and funding programs have grown the extent of restoration activity, has revealed an economic sector that directly employs ~126,000 workers and (very) conservatively generates ~USD2015 $9.5 billion in economic output (sales), annually (BenDor et al. 2015a). Importantly, this restoration activity supports over 95,000 more jobs (totaling over 225,000 jobs) and more than $15 billion in additional economic output through restoration supply chains and overall increased household spending. Notably, these figures pre-date the now- burgeoning investments that the Biden-Harris Administration has aimed at using "nature-based solutions" (see IUCN 2020) to address climate, flooding, water quality, and other problems (Lydia Olander, Laymon, and Tallis 2022). Ultimately, the US experience in creating a restoration economy offers important lessons for other nations in promoting – and stifling (even if unintentionally) – the growth of their restoration economies.

In the next section, I will review the nascent literature on the ecological restoration economy, discussing different ways of functionally defining "restoration", as well as the array of economic impacts that restoration can have on local, regional, and national economies. Finally, in the third section, I will review enabling conditions for growing the restoration economy, including how the professionalization of the restoration industry can drive growth in regional economies. As part of this, I will introduce an array of actionable steps that G20 leaders can take moving forward, particularly in the wake of numerous global initiatives (e.g., the UN Decade for Ecosystem Restoration, the G20 Global Land Initiative, and the Global Biodiversity Framework). As analogues, I will draw on the policy histories governing a number of evolving environmental markets and incentive structures in the United States, which have been responsible for driving (and sometimes inhibiting) the rapid growth of restoration industry in the United States (see BenDor et al. 2023).

THE RESTORATION ECONOMY

2 THE RESTORATION ECONOMY

2.1 The economic benefits vs. economic impacts of restoration

Analyses of the economic ramifications of ecological restoration can be broadly split into two categories: (1) studies of economic benefits and (2) studies of economic impacts (or economic contributions). Economic benefits studies, also known as cost-benefit analyses, examine the net economic benefit, including market and non-market value, of restoration activities. On the other hand, economic impacts studies describe how expenditures in an industry cycle throughout the economy and stimulate impacts in other industries.

While economic evaluations of restoration projects can use methods from both types of analyses, it is important to consider that benefits and impacts are different measures, with benefits analyses focusing on the net value of a restoration project (i.e., a cost-benefit approach; calculated with an eye towards the opportunity costs of restoration projects), while impacts studies focus on gross output and employment (DOI 2012). For example, a cost-benefit analysis could help us choose between building 1) a wetland restoration site or 2) a series of stormwater retention basins to address flooding problems. As a part of this cost-benefit analysis, we could consider the employment and gross economic output impacts of constructing either option; that is, we could include an economic impact assessment as part of the cost-benefit analysis.

While I am focused on the economic impacts of restoration in this paper, I will note that the economic benefits of restoration are extremely well-documented, having been informed by decades of investigation by researchers around the world as part of efforts to measure and model the production of ecosystem services (Chen et al. 2020) and, eventually, measure the values of ecosystem services (Costanza et al. 2017), which have historically been left out of cost-benefit analyses. Per BenDor et al.'s (2015, pg. 213 and Supp. Info 6, pg. 3) review, the economic benefits of restoration include,

> **"[I]ncreased property values and local tax revenue (Acharya and Bennett 2001; Bark et al. 2009; Isley, Isley, and Hause 2011; Kiel and Zabel 2001), increased revenues associated with tourism and outdoor recreation (Isley, Isley, and Hause 2011; McCormick et al. 2010), increased fish and game revenues (Kroeger 2014; Kruse and Scholz 2006; McCormick et al. 2010), and avoided costs associated with improved ecosystem services. Because environmental assets tend to provide positive externalities and services for which there is no market, traditional price-based approaches cannot be used to assess their value (Barbier 2007)....[However,] Pascual et al. (2012) provide a detailed review of over 150 studies on the valuation of environmental assets. This extensive literature shows that there is a growing consensus that environmental restoration can provide long-term benefits to property owners and businesses, increased tourism and recreation activity, increased yields for fisheries, and cost savings for local governments and state and federal agencies.**

Ding et al. (2017) offer a strong overview of restorations' economic benefits, including Verdone and Seidl's (2017) estimate that every $1 invested in restoring degraded forests within Bonn Challenge commitments could yield between $7 and $30 in economic benefits. They also cited a synthesis report by the Global Commission on the Economy and Climate (GCEC 2014), which estimated that restoring 150 million hectares of degraded agricultural land could provide additional food for nearly 200 million people, generate $85 billion in net benefits to national and local economies, and provide $30–40 billion a year in extra income for smallholder farmers.

2.2 What counts as "restoration"?

Defining 'ecological restoration' is difficult (Allison 2004; Elias, Joshi, and Meinzen-Dick 2021; Mendes et al. 2023) and definitions have become increasingly broad over the decades (D. M. Martin 2017). The Society for Ecological Restoration (SER 2004, pg. 3) has offered an authoritative and enduring description as:

> **"[T]he process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."**

Ultimately, however, efforts to define restoration are stymied when we require that the definition allows us to meaningfully evaluate whether restoration has been "successful" (Higgs et al. 2018; Wortley, Hero, and Howes 2013) – i.e., when can say that a site is successfully "restored"? While this appears to be a simple requirement, the breadth of modern restoration activities, approaches, constraints, goals, ecosystems, and social, economic, and historic contexts wildly complicates the effort (D. M. Martin 2017).

However, economic impact studies largely sidestep this issue, instead defining "restoration" inductively, based on the actual activities– and ultimately, the industries and firms that perform those activities– that are part of what would be accepted to be "restoration" to a given organization or in a particular nation, region, or locality.[1] This approach re-frames restoration to focus on the activities – and the work that they require – that yield functional restoration sites.

By defining restoration as a set of activities, we must be careful to be very explicit about the activities – and the firms/industries performing those activities – that our definition includes and excludes. As no definition of restoration is comprehensive (or streamlined) enough to fully reflect local needs or history, we trade the theoretical controversies over what constitutes "restoration," for the inevitable controversies over the activities, industries, and firms that our analyses include or exclude.

For example, in their economic impact analysis of restoration in the United States, BenDor et al. (2015a) broadly defined restoration as "any combination of activities intended to result in ecological uplift, improve ecosystem health, and result in a functioning ecosystem that provides a suite of ecosystem services." However, under their expansive definition, they were faced with many questions; for example, should they include conservation activities, such as land acquisition or water rights transfers?

At the time, the National Fish and Wildlife Federation had recently completed a very comprehensive, national-scale economic impact analysis of conservation activities (Southwick Associates 2013), but it had not considered the impacts of conservation investments that were part of larger restoration efforts. Conservation activities become a key component of restoration anytime that improved ecosystem health depends on the long-term protection of that ecosystem (Hobbs and Harris 2001). Therefore, BenDor et al. (2015a) concluded that conservation should be included, but only when it was related to restoration.

However, they then asked, should hazardous site remediation or bio-remediation – a biotechnology field that uses living organisms to decontaminate polluted areas –be included as part of the "restoration economy" in their study? While remediation produces ecological "uplift" on a site (i.e., increases ecosystem services) and surely falls under the SER definition, many remediation projects are performed on former industrial sites, where land uses either remain unchanged (an industrial site remains an industrial site) or are converted to new urban uses (e.g., a former petrol station is converted to an office complex). Could a restoration project result in an oil refinery or a new petrol station?

Ultimately, they realized that their intent had been to focus on restoration activities that yielded functioning ecosystems. However, no data were available that would have allowed the authors to specifically remove remediation projects that did not yield functional ecosystems. While the authors did not exclude remediation activities from their analysis, they excluded oil and gas companies, and a variety of other industrial firms that likely engaged in some types of restoration, from their analysis. Ultimately, they defined the restoration industry as "the set of economic activities that contribute to restoration, from project planning, engineering, and legal services, to intermediate suppliers of inputs, to on-the-ground earthmoving, forestry, and landscaping work."

1. Ultimately, defining restoration based on activities – and the organizations and businesses that perform those activities – mirrors Bradshaw's (2002, pg. 7) definition of restoration as "…all those activities which seek to upgrade damaged land or to recreate land that has been destroyed and to bring it back into beneficial use, in a form in which the biological potential is restored."

The choice to include or exclude specific activities may hinge more on the availability of data (or resolution of data; e.g., if a specific activity cannot be separated from broader restoration projects; see Shropshire and Wagner 2009; USDOI 2020)) than on whether the activity constitutes "restoration," in a theoretical sense. The decision to exclude oil and gas and industrial firms, among other factors, led BenDor et al.(2015a) to conclude that their results were conservative (likely, very conservative), as inclusion of industrial firms would have more consistently counted activities in response to oil spills and other, large-scale contamination events (Barnthouse and Stahl 2017), thereby dramatically increasing economic impact estimates. However, in the context of the G20's Global Land Initiative (GLI), any reasonable definitions of remediation, restoration, rehabilitation, and protection of degraded lands should place industrial remediation on center stage.

2.3 Defining restoration activities for Rio and Bonn Challenge commitments

So, what does "restoration" mean for the commitments made as part of the Rio conventions or the Bonn Challenge? And how can individual nations define – and measure – their restoration economies?

Sewell, et al. (2020, pg. 2) have conveniently divided these commitments into two overarching types: *restoration and protection, and management and rehabilitation. Restoration and protection* include "measures that aim to bring ecosystems back to a natural state or measures that aim at conservation and the prevention of degradation [emphasis added]." Within this are a variety of categories (and further disaggregated subcategories), including improvements to coastal management (via reductions in coastal erosion), increases in forest land and protected areas, restoration and improvement in protected areas and specific ecosystems (e.g., wetlands, peatlands, mangroves, grasslands and savannas), and improved management of "artificial area and mining" (e.g., slowing/reducing expansion of urban area; mine reclamation). Sewell, et al. (2020) document that these activities could cover ~522 million ha of land committed. To some degree, these activities reflect BenDor et al.'s (2015a) conception of restoration that yields functioning, restored ecosystems.

Meanwhile, management and rehabilitation activities, which Sewell, et al. (2020, pg. 21) estimate cover ~480 million ha of land committed, include (emphasis added):

> **"...measures that aim to rehabilitate areas that are under human use but are degraded, or to rehabilitate degraded areas for human use, or to improve the management of used areas to at least partially restore natural condition and functions (e.g. restore soils in agricultural areas), while maintaining the area for human use."**

With this type are an equally widely-varying set of categories, including increasing soil fertility and carbon stocks, managing artificial areas and mining (in this case, aimed at improving land productivity in artificial areas), restoring/improving forest lands (e.g., fire management, land productivity, water use for irrigation, watershed/landscape management), restoring and improving grasslands and savannas (e.g., rehabilitate bare lands), restoring and improving croplands (e.g. via sustainable land management), and improving coastal management (reducing saltwater intrusions). Contrasting *restoration and protection activities, management and rehabilitation* activities reflect a broader conception of ecological uplift that results in functional landscapes, which may be partially or fully dedicated to human use.

To define their domestic restoration industries, nations will need to:

1. Tightly define the practices that should occur as part of the country's Rio/Bonn commitments. This includes a detailed inventory of the commitments made and the practices intended for land within those commitments.

For example, take Country A's commitment to "restore, preserve, or reduce degradation" of 60,000 ha of wetlands. While this represents the most disaggregated sub-category contained in Sewell et al.'s (2020) assessment of Rio/Bonn commitments, Country A needs to ultimately understand the breakdown of restoration (e.g., 30,000 ha), preservation (e.g., 20,000 ha), and degradation reduction ("sustainable management"; e.g., 10,000 ha) that it intends for these wetlands. Are there regional differences in restoration, preservation, and sustainable management across Country A?

2. Track the payments currently made into restoration efforts. Where do these payments go? What types of organizations currently perform restoration work in the Country? Are these organizations private firms, NGOs, governments, or individuals (e.g., farmers)? This is the "top-down" approach to tracking the economic impacts of public restoration funding programs employed by BenDor et al. (2015b). Ultimately, this will be key for determining the organizations that could be surveyed and/or interviewed for the next step.

3. Define the specific activities – and the industries – that are involved in implementing these practices. Will restoration activities be performed by landowners or by firms specializing in the tasks necessary for restoration? Unfortunately, even in developed nations that consistently manage and update industry classifications, most activities required as part of ecological restoration processes do not consistently fit within any single, traditional economic industry (BenDor et al. 2015b). Instead, restoration work ranges broadly, from project planning and landscape design to tree planting and earth moving (Hovis et al. 2022). Restoration projects are very often collaborative, including multiple levels of government and funding from the public and private sectors. The variety of programs, funding sources, and implementing authorities will undoubtedly suggest a complex restoration industry that may be especially difficult to delineate. As a result, many past efforts to assess the restoration industry have been small-scale, focusing on a limited set of programs, specific projects, and individual funding sources. However, we can start by asking, what does wetland restoration in Country A entail, exactly?

For example, Hovis et al. (2022) examined the activities –and resulting costs – that needed to implement a variety of nature-based solutions (including wetland restoration) in the southeastern United States. Using interviews with local restoration practitioners, the authors disaggregated the practice of "wetland restoration" into a set of very specific activities, including earthwork, matting, seeding, planting, installing rip rap or stone, water pumping, and other tasks. Their interviews also allowed them to collect real-world data on a variety of restoration projects, allowing them to estimate typical costs – and per area (ha) unit costs – for each of these activities.

Importantly, Hovis et al. (2022) were able to understand the specific types of organizations that perform these tasks. In the United States, all of these tasks are performed (or supplied) by firms that are part of known, categorized industries (e.g., earth moving businesses; plant nurseries). In the United States, each of these businesses are classified through a system called the North American Industry Classification System (NAICS), where they are given industry codes, from '*Nursery and Tree Production*' to '*Other Heavy and Civil Engineering Construction*,' allowing their activity, including their purchasing activity (discussed below), to be tracked at a variety of geographic scales (US Bureau of Labor Statistics 2024).

In lesser developed nations, there may not be the same type of industrial specialization. For instance, all activities might be performed by a single construction company or by a government that re-assigns existing workers or hires new workers specifically for the restoration project. In some circumstances, overseas firms may be brought in for design or engineering purposes. In each of these cases, understanding the specific activities, the sources of labor for completing those activities, and the costs of those activities, will be key in understanding the context and structure of Country A's existing restoration industry.

If none of this information is available, estimates can be generated using techniques drawn from the scholarship and practice on fiscal impact assessment – techniques aimed at understanding the cost of infrastructure to support new activities – such as development or infrastructure – in the landscape (Kotval 2006; Lamie, Campbell, and Molnar 2012).

Once a nation has defined restoration – and thus has a sense of the type of restoration that is occurring, or will occur, because of its Rio Convention or Bonn Challenge commitments – it can proceed with an evaluation of the economic impact of restoration projects and programs, drawing a clear line between the jobs and business activity generated and supported by restoration funding.

A recent analysis of job creation and economic impacts of "environmentally beneficial investments" in the United States, published by the Theodore Roosevelt Conservation Partnership (Martin and McCoy 2021), established several action items for improving the economic arguments around investing in environmentally beneficial activities. Among these suggestions was a recommendation to develop "a cohesive strategy for integrating economic analyses among governmental agencies." Even in the United States, where many government agencies are involved in restoration, few (if any) have established concrete methods or best practices for economic analyses, which inhibit any effort to directly compare restoration policies or funding programs across agencies or over time.

Martin and McCoy (2021) go on to suggest establishing a "typology" of job creation, which allow governments to identify restoration projects that "… are likely to be widely beneficial in that they create a range of positions across a spectrum of entry-level versus highly experienced positions, short-term and long-term positions and positions that benefit job seekers with a range of experience and education levels (pg. 23)."

This job creation typology could go hand in hand with Martin and McCoy's (2021) third relevant recommendation: the creation of a cost-benefit index (i.e., "bang for your buck") that could be used to compare restoration projects. One example of this type of index can be seen in the calculation of the jobs created per $1 million invested in a project (akin to a "job creation efficiency"), which is common among impact assessment studies. However, Martin and McCoy (2021) suggest that this measure could be expanded to consider the economic benefits generated by improved ecosystem services (as scaled by project costs). It could also consider economic output per worker and the types of jobs created.

2.4 The economic impacts of restoration

To visualize the variety of restoration's economic impacts, and to tease apart their significance, consider an analogy: investing in building a house.

Here, the final product of this investment is a house, which has value for the buyer. As part of a cost-benefit analysis, the buyer could weigh their value for the house against other uses of their funds – say, renting an apartment, investing in a business, or just saving the money for future investments. Likewise, we could also weigh the value of the house to the surrounding community, considering that the house is located on formerly degraded land, and construction included a cleanup of hazardous chemicals, thereby increasing the values, safety, and appeal of neighboring homes. However, beyond these values, we can consider that, in expending money on the house, a variety of people are employed in its construction, including those that build the house directly, as well as those that produce and supply all the requisite materials, tools, and capital needed for its construction.

The range of economic benefits of ecological restoration – which themselves can be quantified into cost savings, productivity increases, etc. (Li et al. 2023) – is extraordinarily broad, with many benefits being difficult to observe (i.e., benefits may be a weak "signal" within the "noise" of all the other activities of the landscape)[2] or difficult to measure (i.e., indirect benefits or benefits that can only be accurately measured over large time periods)[3].

Along with the economic benefits that restoration projects produce (i.e., ecosystem services), investments in restoration – like most investments – also produce a short-term economic and employment stimulus, which can be measured through economic impact analyses. Ultimately, economic impact analyses describe the marginal economic impacts of changes in investment levels. The stimulating effects of investment (i.e., spending) increases, in any industry (as well as in the public sector), are the result of interdependencies among industries, whereby changes in demand for the products or services of one industry can have ripple effects for suppliers and related businesses.

The inter-related nature of industries can be captured as total demand multipliers, which allow us to holistically describe the direct, indirect, and induced effects of restoration investments on a national, regional, or local economy (Hughes 2018). Multiplier effects can be described at each of these three levels. First, direct economic effects are the changes in economic activity that result from an initial investment in a given industry. The direct effects can be measured as changes in output, earnings, or employment. Ultimately, direct investment in restoration constitutes the industry's *direct effects*; the "cost" of restoration – the money put directly into restoration activities – is equivalent to the "sales" of the restoration industry.

2. Difficult to observe benefits include, for example, increases in surrounding land values due to ecological restoration (Ghermandi et al. 2010; Kaza and BenDor 2013; Richardson, Liu, and Eggleton 2022).
3. Some examples of difficult to measure benefits include the reduced frequencies of major floods due to wetland restoration and natural infrastructure (Douglas 2018; Rebelo et al. 2015) and crop productivity improvements due to pollinator habitat enhancement (Garibaldi et al. 2014; Wratten et al. 2012)

Second, *indirect* effects represent the secondary effects resulting from changes in demand within other industries in the geographic region due to increases or decreases in input purchases from suppliers. In the case of restoration, indirect effects represent the economic impacts on restoration's supply chain – all of the suppliers and subcontractors supplying the labor, capital, and materials needed for restoration activities.

Third, and finally, restoration's *induced* effects represent the changes in economic activity resulting from household spending by workers employed directly by restoration businesses, as well as the restoration supply chain (BEA 2012). The sum of these three effects represents the total impacts within a national, regional, or local economy. However, the magnitudes of these impacts depend on where the workers of restoration firms –and the workers of restoration firms' suppliers – live and spend money.

Ultimately, these multipliers describe the amount of output, earnings, and employment, across all industries, which can be attributed to a capital investment in one or more related industries (Hughes 2018).

Direct effect *multipliers* convey the earnings or employment in related industries that are attributable to an increase in earnings or employment in restoration (Hughes 2018). For example, an output multiplier of 2.5 for the restoration industry would mean that for a US$1 million investment in restoration, all related industries experience a total of $2.5 million in combined, increased output. So, spending $1 million creates an additional $1.5 million as portions of the direct investment (the $1 million) are used to pay suppliers (in other industries), who pay their suppliers, and so on down the supply chain (the indirect impact), as well as the payments that workers throughout the supply chain make as they spend money in the local or regional economies where they live (the induced impacts).

If an investment in restoration increases employment in the restoration industry by 50 jobs, a direct effect *employment multiplier* could be used to determine the increase in jobs outside of the textile industry. BenDor et al. (2015b) reviewed studies calculating employment multipliers from ~1.5 to ~2.9 for a variety of restoration projects. To the extent they can be compared, these multiplier values are in line with those of other US industries, including the oil and gas (~3.0 in 2009; ~4.5 in 2019; PWC 2011, 2021), crop agriculture and livestock (~2.3-3.3; as derived from Garrett-Peltier and Pollin 2009), environmental protection (3.4; Southwick Associates 2013), and outdoor recreation industries (~2.0; Southwick Associates 2007).

In some instances, lower employment multipliers for some restoration projects may be the result of large number of direct jobs required for a restoration activity. As a result, the total employment effects of a project or program may better represent the impact of these projects. BenDor et al. (2015b) also found total employment effects ranging from 10.4 to 39.7 jobs per $1 million in direct investment – a measure that standardizes the cost of restoration projects and can be thought of as the "employment efficiency of investment" in restoration. However, these values vary enormously with geographic scale, location, ecosystem, and restoration approach, so it is important to use caution in any direct comparisons between values.

2.5 Estimating the size and impact of your nation's restoration economy

How do we measure the direct, indirect, and induced effects of restoration? Studies typically turn to a technique called input-output (I-O) modeling (Nielsen-Pincus and Moseley 2013), a common method for calculating the net changes in economic activity that result due to funding for development or infrastructure expansion (Watson et al. 2007). I-O modeling has been used in many countries in a variety of different ways, including in efforts to measure the economic impacts of 1) national, regional, and local regulations on specific industries, 2) government investments in particular industries, 2) transportation projects, and 4) private investments (US BEA 2018).

I-O models are built from Input-Output Tables (IOTs), which describe the sale and purchase relationships between producers and consumers in an economy. These producers and consumers are individual organizations (firms), which are categorized into industries and agglomerated into a range of industrial "resolutions"; For example, *Potato Farming* (industry) is a type of *Vegetable Farming* (industry group), which is a type of *Crop Production* (subsector), which is a type of *Agriculture* (sector). I-O models are highly nation-specific and are entirely dependent on the structure of nations' economies, as well as how nations classify firms into industries and collect data on inter-industry spending and employment (Hughes 2018; International Input-Output Association 2024). Significant efforts have been made to harmonize nation IOTs for longitudinal and import-export analysis, a process that the OECD (2024) has described for ~71 nations.

I-O modeling platforms, like RIMS (Regional Input-Output Modeling System; US BEA 2018) or IMPLAN (Economic Impact Analysis for Planning; IMPLAN 2019) then use IOT data to describe how direct investments – or changes to those investments – ripple through the economy. For direct, indirect, and induced impacts, I-O modeling estimates the change in demand (spending) that may occur due to constructing and maintaining a restoration project in terms of employment, labor income (annual wages), value-addition (the difference between total economic output and the cost of intermediate inputs) and output (annual value of increased production). The total economic impact is found by summing the direct, indirect, and induced impacts.

I-O models can also be constructed at a variety of spatial scales; while IMPLAN offers national-scale I-O models for 66 countries (IMPLAN 2023), in the United States, IMPLAN data can also be used to estimate impacts at the county (local), regional, and state levels. This is important because scale-dependent differences in economic impacts reflect the relative ability of different local and regional economies to support or supply a given industrial category. This is a key issue for the global restoration economy; if a nation invests in restoration in region X, where do the workers/firms that perform this work come from? If there are firms in region X to do the work, where are those firms' supply chains located? If both the firms and their supply chains are in region X, then the resulting direct, indirect, and induced economic impacts will be much larger within the region than if firms from outside the region must be imported. While this finding would not be reflected in a national-level I-O model, it would be clearly evident in regionally-specific models. This concept has recently become a focal topic as the restoration economy has been suggested as a potential engine for economic growth in economically depressed rural areas (see extensive work over several decades at the University of Oregon's Ecosystem Workforce Program (2024) and Labor Education and Research Center (LERC 1998).

This concept also reflects the strong need for nations to develop domestically owned and operated restoration industries. A cursory search for institutional members of the Society for Ecological Restoration's Restoration Resource Center (SER 2024) revealed 64 private firms operating in Asia, Africa, and South America, of which only four (6.3 percent) were based outside the US, Canada, Europe, or Australia. If a nation invests in restoration, are there domestic workers/firms that can perform this work? If not, labor must be imported and much of the direct investment funds (and their direct economic impacts) will flow out of the country. This is a frequent situation for international engineering firms, such as AECOM, STANTEC, or Tetra Tech. There is also a need for domestic development of restoration supply chains; if intermediate materials are not available, they must be imported, thereby reducing (and even eliminating) indirect and induced economic impacts.

Ultimately, nations that have established national input-output tables (international IOT data can be found via a portal maintained by the International Input-Output Association 2024) can establish an input-output model of restorations' direct, indirect and induced effects using three approaches.

1. First, in the unlikely event that a nation has specifically identified "ecological restoration" as an official industry category, then all firms leading restoration projects would be classified as such (with their purchasing relationships documented in a nation's IOT), and economic impacts can be directly identified due to that industry, much as they would be determined for any other industry (e.g., the video game industry; Grueber and Yetter 2024). However, as of this writing, I am aware of no nation has established formal, industrial categorization for firms performing ecological restoration. While it has not yet been adopted, formal categorization has been proposed in the United States by Kellon and Hesselgrave (2014) and BenDor et al. (2023).

2. In nations where there are professional firms doing restoration work (i.e., firms that are regularly contracted to work on restoration projects), then analysts could survey these firms to collect data on each firm's formal industrial categorization, their role in restoration, their annual sales, and the portion of their annual sales from restoration work. This approach allows analysts to understand the unique mix of industries performing restoration activities locally, allowing analysts to create a new, "restoration industry," whose purchasing patterns (IOT) would resemble a sales-weighted average of the classified industries of the survey respondents. For example, BenDor et al. (2023) found that over 90 percent of the restoration industry was a mix of firms classified as "Architectural, Engineering, and Related Services (NAICS 5413)", "Management, Scientific, and Technical Consulting Services (5416)", "Social Advocacy Organizations (8133)", "Other Specialty Trade Contractors (2389)", "Other Heavy and Civil Engineering Construction (2379)", or "Other Professional, Scientific, and Technical Services (5419)." The authors then used an I-O model to

4. BenDor et al (2015 and 2023) have publicly shared their survey questionnaires and implementation details in each study's supplementary material.

estimate the economic impacts of investment in this restoration industry, assuming that it would equal the impacts of the same investment into a weighted mix of those industries. This is a major assumption, and one that is extremely vulnerable to *ecological fallacies*, which occur when erroneously making inferences about the purchasing patterns of an individual firm, based on averages of other firms in the same formal industry, which the restoration firm may not resemble very closely.

3. In nations where restoration projects are constructed by a variety of "sub-contractor" firms, akin to many types of construction projects (e.g., plumbers, electricians, roofers), analysts can collect records of restoration projects to determine the typical tasks required. They can also use these records to determine each tasks' requisite unit costs, as well as the contractors (and their associated industries) that typically fulfill those tasks. This approach is called "analysis by parts" (Henderson et al. 2017), and these data can then be used to create a custom "industry spending pattern" (Schmit, Jablonski, and Kay 2013), which, in a sense, mimics the addition of a new industry to an IOT.

4. Finally, we can consider nations that do not have readily available IOTs, or have IOTs that are too outdated, geographically coarse, or industrially aggregated to facilitate meaningful estimates. In these cases, nations can set out to establish a strong, in-depth, and representative case studies of restoration projects (see Yin's 2008 classic work on case study research). These approaches are documented in work by Kelmenson et al. (2017). Specifically, analysts will want to establish case studies that capture the largest possible variations in restoration projects – such as project sizes, approaches, ecosystems, geographies, and other relevant factors – and thus to establish a "universe" of possible restoration situations. Within these case studies, analysts can interview key informants (project managers, workers, etc.) to understand hiring and training processes. They can also examine project timelines and collect detailed data on project expenditures, conducting subsequent interviews with contractors, sub-contractors, and suppliers (i.e., examining the specific supply chains of each restoration project). This process, while time-consuming, will allow analysts to essentially establish custom IOTs for each type of restoration project. With this information, analysts can then analyze "what if?" scenarios associated with restoration policy changes or changes to spending (Metzger et al. 2017), upscaling from available case studies to broadly estimate the impacts to the local, regional, or national restoration economy (more on this in the next section).

2.6 Problems estimating future changes to the restoration economy

A word of warning regarding efforts to estimate the "what if?" impacts of an imagined, larger future restoration economy: the primary technique that has been employed to model restoration's economic impacts, I-O modeling, is entirely based on aggregation of real-world data that represents a current (or past) snapshot in time. When industry X purchased $10M in products or services from industry Y, this observed level of purchasing was the result of a specific level of demand placed on industry X. If we wanted to model a situation where that level of demand for industry X increases dramatically, then we are confronted with the reality of dynamic economies– when demand increases dramatically, we expect prices to increase, thus pushing demand back down (all else equal).If we were to double or triple funding (i.e., demand) for restoration, we would expect the prices of restoration to increase rapidly, especially as demand would likewise increase for restoration's supply chains, such as native plants, earthmovers, engineering services, etc.

This is not accounted for in I-O models, which are static and do not account for price changes. Therefore, we can only use I-O models to estimate relatively small changes in demand; for example, if policy X increased restoration demand by 5% or decreased it by 10%.

However, what would happen if we dramatically increased spending on restoration? We would need to construct a computational general equilibrium model of the economy (see Ohanian, Prescott, and Stokey 2009), a much more sophisticated, dynamic model that would allow us to understand how employment, prices, and supply and demand relationships between industries, would react to this additional spending.

In these situations, we could also rely on qualitative and scenario analysis akin to those described in the previous section.

GROWING THE RESTORATION ECONOMY

3 GROWING THE RESTORATION ECONOMY

3.1 Drivers of restoration

A variety of recent studies have looked at factors driving ecological restoration activity around the world from a variety of different vantage points. For example, Faruqi et al. (2018) studied the business models of for-profit "restoration enterprises" aiming to restore degraded forests. They evaluated 140 firms along five metrics, including profitability, scalability, replicability, environmental benefit, and social benefit, identifying four primary business models:

1. **Technology – firms that develop and deploy technology to facilitate restoration (improving efficiency or lowering costs)**
2. **Consumer products – firms selling products to consumers using materials from restoration activities (e.g., bamboo pulp packaging materials)**
3. **Project management – firms that develop, implement, and manage restoration projects on behalf of clients (often originating with government pledges or policies)**
4. **Commercial forestry – firms that manage forests and harvest trees for timber and wood fibers.**

However, this type of study – while incredibly helpful for understanding the state of the activity of restoration industries around the world – does not get at the fundamental question of what causes demand for restoration. Perhaps the most relevant efforts to address this issue include:

1. The World Resource Institute's (Ding et al. 2017) study, "*Roots of Prosperity: The Economics and Finance of Restoring Land*," which crafted a strong economic case for land restoration and offered several key recommendations for growing the restoration economy, globally;

2. Worldwide Market Reports' (WMR 2024) market research report on the status and future potential of global habitat restoration markets, which is effectively an in-depth analysis of growth potential of several of the drivers identified by BenDor et al. (2015b); and

3. BenDor et al.'s (2015b) earlier review of restoration economy literature and subsequent categorization of the drivers of ecological restoration.

By far the most important factor in increasing demand for restoration concerns the incentives to restore degraded land. Achieving any semblance of land degradation neutrality (LDN) will require major shifts in the long-standing incentive structures that cause degradation to far outpace restoration. Importantly, land degradation is not an artifice of a distant past – most land degradation has occurred in the last 50 years (Ding et al. 2017). Today, it remains far easier and cheaper to degrade land than restore it, and widespread subsidies for agriculture, paired with poor enforcement of logging prohibitions encourage largescale degradation.

Therefore, we need to ask, what are the current – and potential future – drivers (motivators) of land restoration? How do these drivers create incentives to restore land? Another way of framing these questions is: if restoration is a product of an industry, who, or what, is "buying" restoration?

WMR (2024) frames this in terms of customer type, projecting that the proportions of global revenue from governmental (~53 percent), non-governmental organizations (NGOs; 15-17 percent), and private (30-32 percent) "customers" of habitat restoration will remain stable between now and 2031. Despite this stability, however, they also project slightly diverging compound annual growth rates (CAGRs) of 8.0 percent, 6.5 percent, and 9.2 percent for these customer groups, respectively. These growth rates suggest a near doubling in the total size of the habitat restoration market, from $37.98 billion in 2023 to over $70.84 billion in 2031.

WMR (2024, 56) attributes growth in the governmental customer segment to restoration mandates and policies set by a variety of governmental and intergovernmental organizations. Meanwhile, NGOs collaborate with government and private customers to develop restoration plans and actuate restoration projects, thereby bridging funding and capacity gaps between sectors. WMR (2024, 61) asserts that NGOs "…will likely continue leading the industry due to their established restoration expertise and focus on large-scale conservation projects beyond protected areas." Finally, private customers – including landowners, corporations, and businesses – can contribute to restoration efforts by implementing sustainable land management practices, such as reforestation, erosion control, and wildlife corridor establishment, on their properties. Specifically, WMR (2024, 58) recognizes the role of private capital; private customers… "have the financial resources to invest in technologies and innovations that support habitat restoration.

However, WMR's (2024) analysis does not explain **why** customers are buying restoration. While we can imagine many specific programs or regulations driving restoration, we can probably put most of them into one of the five categories described by BenDor et al. (2015). While their categorization originally focused on the United States, it remains broadly applicable around the world, with the caveat that the relative importance of each driver varies considerably between nations.

1. Regional government initiatives enabled by national legislation and partnerships at different levels of government. This driver is present in both highly developed and lesser developed nations, with the former relying on domestic public funding, and the latter often relying on external funding. Examples include efforts funded by the Global Environment Facility (GEF; see Rakotoarisoa et al. 2020) to restore Kenya's Mukogodo Forest Reserve (IUCN 2022) and federal- and state-funded programs to restore the Everglades, a large area of wetlands in the US State of Florida (National Academies of Science 2019).

2. Public procurement of restoration through programs that contract directly with restoration providers. In contrast to the previous driver, where public projects target specific geographic areas (e.g., national parks or historically important ecosystems), these programs are often diffuse, issuing payments to a wide variety of entities, including farmers or other landowners, as well as restoration firms. In most cases, we can consider this type of driver as articulated through Payment for ecosystem services (PES) programs (Salzman et al. 2018), which typically involve government agencies (or NGOs) contracting with private landowners to perform restoration or improve their management activities.

3. Private (voluntary) investments by NGOs, foundations, corporations, etc. to increase sustainability or meet social responsibility goals. Very importantly, these efforts do not require public financing, which falls far short of the needs for restoration funding. Ding et al. (2017) highlighted this problem, noting that existing restoration funding is shouldered almost exclusively by the public and charitable sectors, the former of which is often limited (and compartmentalized) to the small environmental budgets of governments.

Credit Suisse and WWF (2014) estimated that the annual funding needs for conservation and restoration ranged from $300 to $400 billion per year. Comparatively, Buchner et al. (2023) found that only $43 billion (less than 4 percent of the $1.3 trillion spent on climate financing in 2022) was used for financing land-use projects, of which only a small portion was used for restoration. While this is a six-fold increase over the same figure in their 2015 analysis (Buchner et al. 2014), it is actually a smaller proportion as total climate financing has increased almost 10-fold. Viewed together, there is a continuing, massive financing gap for ecological restoration, worldwide, which cannot be met with public funds alone.

4. Internal government agency policies requiring restoration for regular agency activities. This driver requires regulations and public pressure to ensure "good housekeeping" by government agencies, which are often major sources of degradation or pollution (Doyle and Havlick 2009). These types of rules require that funding for restoration of environmental damage be automatically built into public budgets or proposals for public infrastructure projects. This driver can include requirements that governments impose on themselves for improving their management practices; For example, the US Clean Water Act Phase II provisions for municipal stormwater management (USEPA 2000) or China's nascent ecological compensation scheme (Gao et al. 2023).

5. Regulations that require or incentivize private investment in restoration. A variety of requirements are now appearing around the world that require private investments in restoration as part of other development processes or business activities. Examples the recent European Commission (2024) and United Kingdom (2023) biodiversity regulations, mine reclamation requirements (see AMLA 2024), and invasive species regulations (e.g., South Africa's Conservation of Agricultural Resources Act of 1983 [Amended 1996]; UN FAO 2024).

In possibly the oldest example of this driver, provisions in the US Clean Water Act have required wetland and stream restoration to offset development-induced environmental damage for over 30 years (Hough and Robertson 2009). These requirements are now the driver of the most visible part of the US restoration economy: the wetland and stream compensatory mitigation industry. Alongside the portfolio of restoration completed as part of natural resource damage assessments – required as part of national regulations on contaminated sites (Lyndall, Brown, and Pearce 2023) – the mitigation industry has created a significant proportion of restoration in the United States, much of which is funded by payments from private businesses.

In August 2024, the EU's "Nature Restoration Law" went into effect, establishing a broad target of restoration of at least 30% of the EU's land and sea areas by 2030. Member countries must finalize submit National Restoration Plans by mid-2026 that show how they will deliver on country-specific targets. These plans will need to identify potential synergies with other policies, such as nations' climate change mitigation and adaptation laws, and policies that impact land degradation, disaster and hazard prevention and response, agriculture, fisheries, forestry, and energy development. Nations will likely need to enact a variety of additional legal mandates – particularly mandates for privately-funded restoration – as, by 2050, restoration measures are required to be in place for all ecosystems that need restoration. These requirements have the potential for vastly increasing the volume of restoration performed across Europe, and firms with restoration expertise will likely be in high demand.

As an exercise that may help readers to better distinguish between these drivers, we can explore ways of re-ordering these categories based on the relative amount of restoration driven in each. For example, let us theorize[5] that this ordering is linked to nations' ability to internally fund restoration projects (a factor likely correlated with their Human Development Index [HDI]; see Iftekhar et al. 2017), and nations' property rights and regulatory regimes (i.e., whether continuing land degradation is, *de facto*, allowed or not).

The current ordering above therefore reflects the theorized relevance of drivers to lesser developed nations, where current restoration practices are largely (but not entirely) driven by international funding that is expended on restoration via (1) regional government initiatives, (2) public procurement of restoration, and (3) voluntary restoration performed by international NGOs.

For wealthier nations, we might re-order these drivers to reflect higher levels of internal funding, which may facilitate greater roles for restoration as part of (4) internal agency policies, and (1) regional government initiatives (internally funded). We could also theorize that nations with strong regulatory regimes that prohibit new land degradation activities may have reduced need for (2) public procurement of restoration. Conversely, nations with stronger property rights regimes – such as the United States – might tend to rely more heavily on (5) regulations requiring privately-funded restoration as offsets to new degradation.

5. While no comprehensive, international data exist to conclusively describe the importance of drivers across nations, the IUCN's (2019) Global Inventory of Biodiversity Offset Policies (GIBOP) suggests that offset policies (i.e., [Category 5] regulations requiring or incentivizing private investment in restoration) are largely clustered in developed nations. Moreover, survey data in BenDor et al. (2015; 2023) and program evaluations in BenDor et al. (2015) support this characterization of relative driver importance in the United States.

3.1 Enabling conditions for restoration economy growth

What has enabled the growth of the restoration economy in places where it has successfully grown? Given these enabling conditions, what is the state of the modern restoration industry? What are its future directions? To answer these questions, I will draw on literature and policy analyses, as well as recent interviews conducted with officials from the United States' Ecological Restoration Business Association, the largest industry association concerned entirely with land restoration in the world.

The restoration industry in the United States is large in comparison with virtually all other countries, with a variety of estimates (Bennett and Carroll 2014; Bennett and Ruef 2016) suggesting that it is, most certainly, a multibillion-dollar economic sector. BenDor et al. (2015a) estimated that the industry directly employed ~126,000 workers and conservatively generated ~USD2015 $9.5 billion in economic output (sales), annually. The primary domestic driver of restoration remains the US Clean Water Act's wetland and stream mitigation requirements, requiring ecological restoration as offsets for aquatic ecosystem damage. BenDor et al.'s (2023) follow-up analysis suggested that the mitigation industry – a subset of the overall restoration economy – had grown from $2.6 billion in sales per year in 2014 to over $3.5 billion in 2019. Adding indirect (supply chain) and induced (spillover) economic impacts suggested that restoration performed as mitigation contributed over $9.6 billion in total output and support over 53,000 total jobs. This represents a five-year growth of ~35.2 percent in revenues, ~32.6 percent in total economic impacts, and a compound annual growth rate (CAGR) of 5.25%, placing the mitigation industry in roughly the top third of all US industry growth.

To discuss the enabling conditions in the US context, it is important to acknowledge some baseline conditions; the US is a highly developed nation with strong property rights regimes, widespread higher education and workforce training institutions, and extensive natural resources (that have been highly altered by a long history of extractive industries). These factors – which can be viewed as critical forms of policy, human resources, and education infrastructure – have been fundamental in creating the conditions needed to even conceive of a large-scale restoration industry. However, having acknowledged this existing infrastructure, important lessons can be gleaned by focusing on the legal, regulatory, and institutional decisions that have enabled (and stifled) the growth of the restoration economy.

In particular, we can focus on the role(s) of regulators and their efforts to:

(1) (demand side) broaden the circumstances that require restoration;

(2) (demand side) strictly and consistently enforce restoration requirements;

(3) (supply slide) incentivize professionalization and take advantage of the scale economies of restoration;

(4) (supply slide) establish ecological standards that are high, stable, and equitably enforced; and

(5) (supply slide) focus regulatory processes to reduce "dead weight loss" and maximize ecological uplift.

(1) (Demand side) Broaden the circumstances that require restoration. As discussed in the previous section, unmitigated land degradation does nothing to prompt restoration. For example, early US Clean Water Act "regulations" allowed large tracts of wetlands and streams to be destroyed without penalty; for example, until 1997 in the Chicago metropolitan region, only impacts >4 hectares required offsets and only those over 0.25 hectares even required impactors to notify authorities that the damage was taking place. Unsurprisingly, landmark analyses showed that these regulations did nothing to slow wetland destruction (NRC 2001), and rates of restoration only increased when these requirements became more stringent (BenDor and Brozovic 2007). Eventually, regulators began to require restoration to offset impacts of diminishing size: ~1.2 ha (1997), ~0.2 ha (2000), ~0.1 ha (2001), and 0.04 ha (2011), which remains the local standard today. Work by BenDor and Brozovic (2007) suggested that a key driver of the professionalization of the US wetland and stream mitigation industry (see next growth factor) involved the growth in small impacts that were included in the gradually expanding umbrella of regulations requiring restoration to offset impacts.

Now, let us briefly flip the discussion: how have regulatory decisions over the circumstances that require restoration prevented growth of the restoration industry? Over the last 30 years, a series of complex legal fights have created enormous uncertainty regarding the geography of aquatic ecosystems that are under the purview of US Clean Water Act regulations. Various Presidential administrations and legal interpretations (see history in Harrison and Singh 2021) have expanded and contracted the extent of regulated ecosystems.

The most recent, and now binding, legal interpretation arising from a 2023 court case, *Sackett vs. US Environmental Protection Agency* (143 S. Ct. 1322), vastly reduces the jurisdiction of federal (i.e., national scale) regulations. An estimate by Gold (2024) suggests that this interpretation removes protections for 19% (6.9 million hectares) of all non-tidal wetlands in the contiguous US. Unfortunately, because most US state governments have relied on federal regulations, approximately half of these now-unprotected wetlands also have no protection at the state or property level. In the parlance of the G20 GLI: without extensive new regulation on the part of lower-level governments (US states), this legal interpretation will substantially affect the ability of the US to achieve wetland degradation neutrality. Restoration of damage to these now-unregulated wetlands will not occur as there is nothing forcing impactors to pay for that restoration.

As we will see throughout this section, certainty in the restoration market is paramount. In this case, certainty comes from stability in the interpretation of the extent of regulated ecosystems (the wetlands and streams that require restoration as offsets). The larger the "umbrella" of regulated ecosystems, the more demand there will be for restoration as a means of offsetting ecosystem degradation.

(2) (Demand side) Strictly and consistently enforce restoration requirements. In many cases, offset requirements represent a very small portion of the total development cost of an infrastructure-, urban-, or agricultural-development project. For companies and governments constructing multi-billion-dollar infrastructure projects, these restoration requirements represent a truly miniscule proportion of overall costs (<0.1% of project cost; Green 2020; Sunding and Zilberman 2002). Despite this, there have been countless examples of legal actions being necessary to enforce offset requirements (USEPA 2015). Often, environmental and community groups end up fighting for scraps, spending years in litigation to ensure that offset requirements are equitably enforced. In some cases, there are politically driven decisions by legislators to reduce or entirely bypass offset requirements as a means of ensuring that a development project is completed (often based on the jobs that the project will create). Over the last 30+ years, political pressure has forced regulators to create numerous exemptions to offset requirements (or offer expedited pathways lowering their requirements; see Allen 2014; Gilman 1998).

Unfortunately, what many companies and governments that want to save money and avoid restoration requirements fail to appreciate is that, by not enforcing permitting requirements transparently and uniformly, lawmakers and regulators unravel the business models of restoration firms. Over time, these decisions reduce demand for restoration and increase uncertainty that demand for restoration will exist in the future. This increases what economists refer to as the "sovereign risk" of investing in restoration firms (see BenDor et al. 2011) destabilizing firms' ability to gain future investments. Firms that cannot gain investors cannot perform restoration, and these market entry barriers ultimately lower the supply of restoration, driving restoration to be far more expensive. While we might expect that expensive restoration would induce additional restoration firms to enter the market, institutional investors are likely to shy away from the risk profile that regulators have created for these firms. Over the long term, irregular enforcement of restoration requirements slows the growth of the restoration industry and reduces the impact of the restoration economy. Certainty in the form of equitable and transparent enforcement is paramount.

(3) (Supply side) Incentivize professionalization and take advantage of the scale economies of restoration. Hough and Robertson (2009) offer an extensive policy history that documents the evolution and maturation of wetland and stream mitigation industry in the United States. At first, private firms engaged in this market lightly, largely treating ecological restoration as a side business (for example, the first restoration firm in Chicago was originally an earthmoving company; Robertson 2004). Until the late 2000s, firms degrading wetlands and streams attempted to construct restoration projects themselves, or hired consultants who, themselves were often not very experienced (an arrangement called "permittee responsible mitigation").

Surprisingly, this practice is still very common, despite a long history of scientific criticism due to the repeated ecological failures of many sites (GAO 2005; Reiss, Hernandez, and Brown 2009). Part of these failures derive from regulatory difficulties in managing and monitoring these restoration sites, which are often small and fragmented across the landscape as they are created one by one to offset each individual impact.

An important impetus for the professionalization of the mitigation industry is that restoration typically has significant economies of scale – as restoration projects get larger, the marginal costs of performing more and more restoration often decrease (Andres et al. 2024; Armsworth et al. 2011). Thus, building small offset sites for single impacts is comparatively expensive, while building very large sites to offset many impacts would lower average costs dramatically (BenDor and Brozovic 2007).

As demand for restoration has increased, some local governments and NGOs began special programs focused on producing restoration projects, typically through a funding mechanism called an "in-lieu fee" program (where impactors paid these organizations to create restoration projects on their behalf Kihslinger et al. 2019).

In the private sector, a variety of successful business models emerged. A key facet of the industry's evolution has been the creation of firms that entirely specialize in ecological restoration (these are typically called "mitigation bankers"). Other, larger firms – often highly diversified environmental consulting companies – have established units that specialize in restoration (e.g., SWCA, Inc. or The Westervelt Company). Alternatively, some firms function as private equity companies; for example, between 2012 and 2020, Ecosystem Investment Partners (EIP) grew its institutional investment fund from $181 million to over $1 billion, which it has used to manage 55 active mitigation banks and large-scale restoration projects comprising almost 17,500 ha of wetlands and over 360 km of streams. Interviews revealed a trend towards concentration in the industry, with large companies, such as Resource Environmental Solutions, LLC. (RES) which is widely regarded as the largest environmental restoration firm in the United States (with assets nearing, or now exceeding, $1 billion; see its "restoring at scale" docuseries), purchasing a variety of smaller firms to leverage established restoration sites and acquire talented employees that are savvy in local regulatory approval processes (i.e., "acqui-hiring," a common tactic in the tech industry; Makinen, Haber, and Raymundo 2012).

Conversations around concentration in any industry – and associated economies of scale that concentration brings – also tend to involve discussions around *industry clustering*, and the associated "agglomeration economies" gained from firms physically locating near one another. Long a major topic in the field of economic geography, creating and growing industry clusters has been the focus of many investment and policy strategies around the world, especially in fields like computing and biotechnology (Feser and Bergman 2000; Prevezer 1997). Famous industry clusters include tech centers in Silicon Valley (California, USA), Chennai and Bangalore (India), or the Rhine-Main-Neckar region (Germany), Milan's "fashion cluster" (Italy), and the Boston/Cambridge biotech cluster (Massachusetts, USA). An important area that remains unstudied – but will assuredly be of intense future interest to all nations' restoration economies – concerns the tendency towards, and causes of, geographic clustering by restoration firms.

(4) (Supply side) Establish ecological standards for restoration that are high, stable, and equitably enforced. What will incentivize better, faster, and cheaper restoration? The economic rationale for environmental markets – policies that give private firms the flexibility to figure out, on their own or in conjunction with other firms – the lowest cost pathways to mitigating environmental damage (in this case, through ecological restoration) requires high and reliably enforced ecological standards for that restoration. Perhaps most important here is the conception of the wetland and stream mitigation market as a technology forcing policy instrument, which creates a profit motive for restoration firms that can more cheaply and quickly achieve given ecological standards. While high ecological standards could, in theory, create barriers for additional firms to enter the market, there is little evidence that they do so. The key is to couple high ecological standards for restoration sites with assurances of regulatory "stability" – here I refer to the idea that regulatory decisions are *not* determined by the whim of the regulator, thereby lowering sovereign risk. In this type of situation, high ecological standards instead can incentivize restoration investments, as firms that invest in constructing restoration projects are ensured that other firms will not be allowed to flood the offset market with cheap, low quality alternatives (see Ungaro et al. 2022).

Several useful studies offer notable insights into the risks experienced by impactors, regulators, the public, and restoration firms in these types of environmental market arrangements (BenDor et al. 2011; Hook and Shadle 2013; Olander 2016).

(5) (Supply side) Finally, focus regulatory processes to reduce "deadweight loss" and maximize ecological uplift. When we earnestly consider the processes of enforcing regulations that induce restoration, we must ask: are these processes efficient? Are regulators doing all they can to reduce risks within the market? If not, then these regulatory processes may represent an important disabler of the restoration economy.

From the perspective of governments, the goal of these regulatory processes should be to ensure that costs placed on restoration firms are expended to improve ecological outcomes (e.g., higher density of planting, a greater variety of native seeds, improved fire control regimes). If a government pays more for ecological restoration (or requires that private sector entities purchase restoration as offsets), those costs should go towards higher investment in the restoration itself.

"Deadweight loss" refers to the cost of market inefficiencies, borne by society, which occur when supply and demand are out of equilibrium. If a government is the consumer of restoration, and a restoration firm is the producer, we can think of deadweight losses as the costs of building a project that create neither surplus for the government (i.e., better ecological outcomes; more "uplift" of ecosystem services) nor for the restoration firm (i.e., higher profit margins in achieving a given ecological standard). Stated differently: what happens if restoration costs go up, but these increased payments do not manifest as more money for restoration firms or more investment in ecological uplift?

Unfortunately, this is a common occurrence in the US wetland and stream mitigation market. For example, Martin and Madsen (2023) chart the timelines for getting wetland and stream restoration projects approved by regulators across the United States. For restoration projects to be certified to use as offsets, they must go through a multi-stage approval process; current regulations allow regulators 225 days for this approval, which includes time for public comment and feedback on the project from government experts. However, in reality, regulator reviews take far longer – averaging at least 336 days, with many cases extending over two years (one outlier project required ~4 years for review, and total approval took over 12 years).

In response, regulators typically argue that restoration projects are complex and take large amounts of time to review. While this is true – restoration projects are often vast in scale (see previous discussion on scale economies) and require input from federal, regional, and local agencies tasked with management of wildlife, fisheries, environmental protection, coastal areas, transportation, management, cultural and archaeological resources – the reality is that regulators (and staff across these agencies) are frequently under-resourced and overwhelmed rev to reduce delays. Readers are referred to valuable work by Kihslinger et al. (2020), who offer comprehensive insights into the review process for restoration projects and highlight meaningful ways of limiting delays that do nothing for environmental outcomes.

During this time, restoration firms are required to have entirely purchased (or gained access to) degraded areas to restore, and often are required to initiate a variety of physical restoration activities, capital for which they typically borrow. As a result, these delays – especially frivolous[6] or badly timed delays – can induce enormous dead weight loss, ultimately wiping out restoration firm's margins. A financial analysis of practitioner data by BenDor et al. (2010) suggested that an 170 day delay for a typical project could easily induce a ~$90,000 loss ($2.62/ha/day [2010USD]) to the restoration firm, primarily due to debt payments for land and capital machinery.

While Martin and Madsen (2023) offer the first, definitive analysis on this issue, surveys of restoration professionals have suggested that these delays have been a problem for decades (BenDor and Riggsbee 2011a; BenDor and Riggsbee 2011b). Most concernedly, suggestions have been made that these delays – additional manifestations of sovereign risk – have depressed large-scale investment in restoration firms, thus slowing the overall growth of the restoration industry.

3.2 Professionalization of the restoration industry

We can frame the issue of professionalization in terms of supply and demand. For much of this manuscript, we have discussed the demand side – how do we grow the demand for restoration? If restoration – as an activity, as a business, as a career – becomes a large enough calling for a large enough number of people, we would expect specialization and, eventually, individuals and groups to become professionals in the practice. Interviews with restoration leaders also suggested that professionalization in the restoration industry must be spurred by stable, longer-term funding streams – whether these originate from the public or private sectors. Anyone hoping to train for, and begin, a career in restoration will need to have certainty that the profession has a future in the place that they live and work. This issue mirrors the common economic development problem of sustaining transformation beyond one-time, external payments (Johnson and Muro 2024).

What about the supply side? An early – and particularly useful – example of ecosystem management- or restoration-based economic development efforts can be seen in the visionary work of the University of Oregon's Ecosystem Workforce Program (EWP). Started in 1994, the EWP centered on the premise that "communities can meet economic and environmental objectives only with a clear focus on creating quality jobs for the community."

6. In one interview, a restoration firm president revealed that a key benchmark meeting during their project's approval process was delayed six months because one representative of a regional government agency – the only individual who could serve in that role – could not attend due to child's sports obligation. The interviewee suggested that this delay cost his firm hundreds of thousands of dollars.

The EWP's workforce training and economic development efforts were well-documented in the University's Labor Education and Research Center's (LERC 1998, pg. 8) report, "*Improving jobs, community, and the environment: lessons from the Ecosystem Workforce Project,*" which detailed its "quality jobs" approach to developing and validating a "skill-based education program that combined classroom and field training.... to produce "applied ecologists" who could solve problems on the ground." The EWP's efforts attempted to transform the forestry industry in a strongly rural and economically depressed State where "low-bid contract awards, abuse of undocumented workers, and unpredictable forestry practices have made contracting in the forest industry highly competitive and resistant to outside influence... [Moreover,] in the private sector, industrial landowners usually have long-standing agreements with preferred contractors and little incentive to enhance that relationship (with the high-skill approach) or seek alternatives (pg. 22)."

To change this reality, the EWP formally established a novel type of apprenticeship and occupational category (relevant for future educational and economic development focused grants), training more 150 ecosystem management apprentices over four years. By establishing an apprenticeship program that combined work and learning, the program sought to upgrade the skills of existing workers, thus targeted the "supply side" of the labor force. To create a "certified" workforce, the EWP expended substantial resources to develop, deliver, and institutionalize ecosystem management training, convening a task force of stakeholders from industry, education, governments, and NGOs to create a 25-module curriculum[7] on science, technical, and business topics that included competency standards and instructor guides. Ultimately, the task force proposed the "Institutional Model for Developing an Ecosystem Workforce (IMDEW)," a system that included common skill and competency standards and recommendations for fostering recognition across multiple accreditation systems.

On the demand side, with the stated goal to "have watershed-based, multi-tasked, multi-season ecosystem management work (quality jobs) as a primary focus for public land management agencies and private landowners, (pg. 12)" the EWP worked with land management agencies to change how they conceptualized, planned, and contracted for ecosystem management projects, such that they focused on creating "quality jobs" (i.e., long-term and paying a 'family wage') for local skilled workers. This involved designing work as bundled contracts, exploring new forms of land stewardship contracting, and proposing longer-term contracting arrangements. Moseley (2007) offers excellent advice conducting assessing the status and needs of local ecosystem workforces.

There have been several efforts to create training materials that are widely applicable to restoration applications around the world. G20 GLI's effort, "Trigger Change! Innovative Sustainable Agriculture Solutions for Land Restoration: A Resource for University Professors," will be rapidly expanding from agriculture to include courses on forestry, urban restoration, and mine reclamation. An additional example is the Society for Ecological Restoration's (SER) E-Learning Course: Overview of the Practice of Ecological Restoration and its restoration resource database, that includes academic programs.

3.3 Actionable steps for growing restoration economies around the world

What can G20 leaders do to incentivize restoration and build their own restoration industries and restoration economies? First, leaders can leverage numerous global frameworks and initiatives, including the G20 Global Land Initiative, the Global Biodiversity Framework, the EU's Nature Restoration Law, the UN Decade for Ecosystem Restoration, and each nation's own Bonn Challenge and Rio Conventions' commitments, to justify long-term investment in building a restoration economy. Each of these initiatives suggests a driver of restoration, either through public support or legal requirements. Nations should respond by taking actions to establish the locally specialized restoration capacities of firms and government agencies, to not only meet global commitments, but to generate economic growth. Several key actions can be taken now to grow restoration economies in the future:

1. As stated previously, governments must create and uniformly enforce disincentives to degrade land, thereby reducing the need for future restoration. The need to remove perverse incentives – such as unsustainable agricultural, mining, and hydrocarbon subsidies – that rationalize profit through land degradation is paramount. Land degradation neutrality will be impossible to achieve if land degradation continues at the scales that has created current problems. Governments have a wide variety of policy tools for shifting incentives from land degradation towards restoration (Ding et al. 2017).

7. This was also translated into Spanish to support Central and South American immigrant workers, a practice far ahead of its time.

2. Create the conditions to build a restoration industry. Ultimately, governments must improve the capacity of their nation to engage with and implement restoration programs. This capacity-building is key for the long-term success of any restoration program and requires efforts on multiple fronts:

a. Almost two centuries of experience in the US and Europe in strengthening landholders' capacities has demonstrated the need for extensive support systems, including training plans, community groups and other voluntary organizations. This should include strong investment in government agencies that support farmers and businesses, ensuring that they are able to learn, implement, and gradually improve upon the best available agricultural, land management, and restoration practices. For example, in the United States, each state has university-based "cooperative extension services" that work closely with farmers and acts as a resource for improving their practices. This can also be found in Europe in the form of agricultural and rural "advisory services."

b. Invest in large-scale training and professionalization programs for restoration. Like any other environmental technology or practice, building the capacity for restoration requires educational programs. Importantly, this includes training for the future restoration workforce, as well as for regulators that are tasked with ensuring that high ecological standards are maintained. By not focusing on creating a well-trained group of regulators, we will likely experience major bottlenecks in creating restoration projects, as is common in the United States (see extensive documentation in Martin and Madsen 2023).

c. Establish high ecological standards for restoration. These standards must be localized, scientifically supported, and uniformly enforced. Key to this is the explicit acknowledgement that these standards must also be maintained over very long time periods (decades or more). To achieve these standards, governments must create efficient tools to help the public and restoration businesses, including ecosystem-specific assessment techniques and economic valuation approaches (Ding et al. 2017).

3. View and manage restoration programs in terms of *risk*. When restoration projects fail, the public is harmed. Risk of failure includes the risk that that restoration projects will fail due to environmental conditions (e.g., drought, flooding), poor site construction or design, or the financial collapse of restoration firms (see BenDor et al. 2011; Hook and Shadle 2013; Olander 2016). Therefore, governments should consider ways to reduce risks, and shift responsibility for these risks to those responsible for restoration. To do this, governments should:

a. Create monitoring requirements that, ideally, require third party monitoring to reduce conflicts of interest, so restorers are not left to judge the success of their own restoration projects.

b. Establish clear requirements for financial "assurances" that ensure restoration is completed successfully, even if the restorer goes out of business or abandons the site. As part of this, governments should leverage widely used strategies for reducing risk, including allowing financial instruments that rely on pooled risk (e.g., long term insurance contracts).

4. Create incentives that drive *public sector* investment in restoration. A variety of actions should be taken to drive restoration investments from the public sector, including:

a. Restoration programs, philosophies, and actions should be integrated *into* many government units – such as ministries of defense, agriculture, finance, energy, and the treasury – because land generates benefits *across* the economy and should not be isolated as if it is purely an environmental concern.

b. Restoration programs, philosophies, and actions should be integrated across government units. Currently, funding for restoration is often limited to small environmental budgets and lack of awareness and coordination among government units means that restoration projects tend to be underfunded. Restoration benefits many aspects of government operations and should be funded across government agencies.

c. Climate finance – when available – is often needlessly made difficult to access. Governments should do everything possible to reduce transaction costs and lower bureaucratic barriers to accessing sources of climate finance (Buchner et al. 2023; Ding et al. 2017).

d. Develop policies that direct funding towards restoration, such as carbon taxes or other regulatory instruments. Developing the financial architecture to do this requires setting up mechanisms to reduce risk (as discussed previously), which will help to attract investments. This will also require collaboration with the private sector on the development of sustainable investments pathways using a variety of restoration activities, such as agroforestry, silvopasture and assisted (or natural) reforestation (Ding et al. 2017).

5. Create incentives that drive *private sector* investment in restoration. Governments should collaboratively approach a variety of organizations, including banks, insurance companies, philanthropic organizations, and NGOs, to develop strategies that can augment public funding for restoration with a range of private investments.

a. In incentivizing privately funded restoration, governments should first look for techniques to reduce investor risk. Ding et al. (2017, 7) has argued that investment in "[r]estoration is considered risky as there is no investment track record, and countries where restoration is needed most may have governance and land tenure issues." Moreover, when evaluated strictly in financial terms, "most restoration projects generate returns that are too low to attract private investors…are too small to be attractive to institutional investors…[and] have very long investment horizons of 10 to 20 years because restoration is a multiyear process. This extended time frame significantly limits investor interest." In addressing this, governments should create and support financial mechanisms that reduce risk from new investors, including insurance guarantees, tax credits, and first-loss capital structures (i.e., where governments cushion private financial risk by accepting losses prior to other investors).

b. Mirroring the action items to drive public sector restoration investments, governments should develop regulations that help to remove the burden for funding restoration from public agencies. "Polluter pays" principles can be key here, with regulations like pollution taxes, offset markets, and innovative mitigation requirements (e.g., tree mitigation ordinances; Bardon and King 2024) all helping to deter future land degradation and ease the strain on public coffers for restoration funding.

c. Upon creating regulatory structures requiring private financing of restoration, governments should also streamline and expedite the creation of high quality restoration projects, whether these projects are created by public or private organizations. This means understanding and addressing aspects of "sovereign risk" (as discussed earlier) that can otherwise stifle private investments if restoration projects are subjected to arbitrary and capricious decisions while they are being permitted (see BenDor and Riggsbee 2011a, 2011b).

d. In many ways, restoration has long held the role as the "technological arm" of ecological science. This idea dates back to 1984, when noted British ecologist Tony Bradshaw famously claimed that "land restoration is the acid test of our ecological understanding a technology" (see Egan 2001). If ecological restoration is a technology, then governments should treat it as they treat the rest of technology sector, viewing it as an industry that they can foster as a form of regional economic growth.

6. Track restoration activities. Governments should each institute a national restoration strategy – a restoration priorities plan – that defines objectives and establishes ecological baselines from which progress can be made. Holistically and accurately estimating the benefits and costs of restoration is key to prioritizing investments in projects based on specific objectives laid out in a nation's restoration priorities plan. Economic analyses can also help to document successes and estimate the effects of restoration on job creation, greenhouse gas emissions, food security, poverty alleviation, and GDP growth. The results of these analyses can aid in engaging a wide range of stakeholders, like local governments and energy and water utilities, to coordinate restoration efforts at a landscape scale.

a. Countries should work to develop standardized economic valuation frameworks that allow comparison across analyses of many restoration projects. Creating a system for standardizing these analyses and collecting them in a central repository can help streamline efforts and prompt improved decision-making by policymakers, funders, and practitioners (Ding et al. 2017).

b. As restoration programs become more prevalent and successful within a country, the need for systems and dedicated entities to track restoration activity will grow enormously.

Unfortunately, while many efforts have attempted to create standardized frameworks for tracking restoration in the United States (Bernhardt et al. 2005; Bernhardt et al. 2007), restoration databases are still woefully incomplete (including regulatory databases; Martin and Madsen 2023). Governments seeking to build their restoration economies should address this issue up front, incentivizing the creation of, and project participation in, centralized restoration databases.

c. Tracking restoration efforts should also be complemented by efforts to track the economic activities around restoration. How much does a nation spend on restoration? Strategies should be developed to track restoration spending programs as they grow (see BenDor et al. 2015b) for an example of how difficult this is to do in the United States).

d. Governments can also track growth in restoration activity by creating standardized industry classifications to track the hiring and sales activities of restoration firms. This will facilitate tracking restoration firms through a nation's standardized input-output tables, allowing the restoration industry to be studied as easily as other industries.

By taking these actions, governments around the world can improve their environments, reverse land degradation trends, and transform their restoration economies.

REFERENCES

REFERENCES

Accordino, John, and Gary T. Johnson. 2000. "Addressing the Vacant and Abandoned Property Problem." *Journal of Urban Affairs* 22(3): 301–15. doi:10.1111/0735-2166.00058.

Acharya, Gayatri, and Lynne Lewis Bennett. 2001. "Valuing Open Space and Land-Use Patterns in Urban Watersheds." *The Journal of Real Estate Finance and Economics* 22(2): 221–37.

Ahmad, Naveed, Yuming Zhu, Muhammad Ibrahim, Muhammad Waqas, and Abdul Waheed. 2018. "Development of a Standard Brownfield Definition, Guidelines, and Evaluation Index System for Brownfield Redevelopment in Developing Countries: The Case of Pakistan." *Sustainability* 10(12): 4347. doi:10.3390/su10124347.

Alexander, Sasha, James Aronson, Oliver Whaley, and David Lamb. 2016. "The Relationship between Ecological Restoration and the Ecosystem Services Concept." *Ecology and Society* 21(1). https://www.jstor.org/stable/26270353 (July 11, 2024).

Allen, Lucy. 2014. "Making Molehills out of Moutaintop Removal: Mitigated Minimal Adverse Effects in Nationwide Permits." *Ecology Law Quarterly* 41: 181.

Allison, Stuart K. 2004. "What Do We Mean When We Talk about Ecological Restoration?" *Ecological Restoration* 22(4): 281–86.

AMLA. 2024. "African Mining Legislation Atlas." https://www.a-mla.org/en (July 8, 2024).

Andres, Samantha E., Charlotte H. Mills, Rachael V. Gallagher, and Vanessa M. Adams. 2024. "A Framework for Ecological Restoration Cost Accounting across Context and Scale." *Biological Conservation* 295: 110671. doi:10.1016/j.biocon.2024.110671.

Armsworth, Paul R., Lisette Cantú-Salazar, Mark Parnell, Zoe G. Davies, and Rob Stoneman. 2011. "Management Costs for Small Protected Areas and Economies of Scale in Habitat Conservation." *Biological Conservation* 144(1): 423–29. doi:10.1016/j.biocon.2010.09.026.

Bacot, H., and C. O'Dell. 2006. "Establishing Indicators to Evaluate Brownfield Redevelopment." *Economic Development Quarterly* 20: 142–61.

Barbier, Edward B. 2007. "Valuing Ecosystem Services as Productive Inputs." *Economic policy* 22(49): 178–229.

Bardon, Robert, and Brandon King. 2024. *Protecting and Retaining Trees: A Guide for Municipalities and Counties in North Carolina (AG-705)*. Raleigh, NC: NC State University Cooperative Extension. https://content.ces.ncsu.edu/protecting-and-retaining-trees-a-guide-for-municipalities-and-counties-in-north-carolina (September 5, 2024).

Bark, R. H., D. E. Osgood, B. G. Colby, G. Katz, and J. Stromberg. 2009. "Habitat Preservation and Restoration: Do Homebuyers Have Preferences for Quality Habitat?" *Ecological Economics* 68(5): 1465–75.

Barnthouse, Lawrence W., and Ralph G. Stahl. 2017. "Assessing and Managing Natural Resource Damages: Continuing Challenges and Opportunities." *Environmental Management* 59(5): 709–17. doi:10.1007/s00267-017-0840-5.

BenDor, Todd K., and Nicholas Brozovic. 2007. "Determinants of Spatial and Temporal Patterns in Compensatory Wetland Mitigation." *Environmental Management* 40: 349–64.

BenDor, Todd K., Joungwon Kwon, and T. William Lester. 2023. "Assessing the Size and Growth of the US Wetland and Stream Compensatory Mitigation Industry." *PLOS ONE* 18(9): e0285139. doi:10.1371/journal.pone.0285139.

BenDor, Todd K., T. William Lester, Avery Livengood, Adam Davis, and Logan Yonavjak. 2015. "Estimating the Size and Impact of the Ecological Restoration Economy." *PLOS ONE* 10(6): e0128339. doi:10.1371/journal.pone.0128339.

BenDor, Todd K., Avery Livengood, T. William Lester, Adam Davis, and Logan Yonavjak. 2015. "Defining and Evaluating the Ecological Restoration Economy." *Restoration Ecology* 23(3): 209–19.

BenDor, Todd K., and J. Adam Riggsbee. 2011. "A Survey of Entrepreneurial Risk in U.S. Wetland and Stream Compensatory Mitigation Markets." *Environmental Science and Policy* 14: 301–14.

BenDor, Todd K., J. Adam Riggsbee, and M.W. Doyle. 2011. "Risk and Ecosystem Service Markets." *Environmental Science and Technology* 45(24): 10322–30.

BenDor, Todd, and J. Adam Riggsbee. 2011. "Regulatory and Ecological Risk under Federal Requirements for Compensatory Wetland and Stream Mitigation." *Environmental Science & Policy* 14(6): 639–49. doi:10.1016/j.envsci.2011.05.005.

BenDor, Todd, Daniel Spethmann, and David Urban. 2010. “Economic Impact of Regulatory Timing on Mitigation Bank Returns.” In Austin, TX: National Mitigation Banking Association.

Bennett, Genevieve, and Nathaniel Carroll. 2014. *Gaining Depth: State of Watershed Investment 2014*. Washington, DC: Ecosystem Marketplace. www.ecosystemmarketplace.com/reports/sowi2014.

Bennett, Genevieve, and Franziska Ruef. 2016. *Alliances for Green Infrastructure: State of Watershed Investment 2016*. Washington, DC: Ecosystem Marketplace.

Bernhardt, E. S., M. A. Palmer, J. D. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, et al. 2005. “Synthesizing U.S. River Restoration Efforts.” *Science* 308(5722): 636–37.

Bernhardt, Emily S., Elizabeth B. Sudduth, Margaret A. Palmer, J. David Allan, Judy L. Meyer, Gretchen Alexander, Jennifer Follastad-Shah, et al. 2007. “Restoring Rivers One Reach at a Time: Results from a Survey of U.S. River Restoration Practitioners.” *Restoration Ecology* 15(3): 482–93. doi:10.1111/j.1526-100X.2007.00244.x.

Biden-Harris Administration. 2021. *Conserving and Restoration America the Beautiful*. Washington, DC: US Department of the Interior. https://www.doi.gov/sites/doi.gov/files/report-conserving-and-restoring-america-the-beautiful-2021.pdf (August 22, 2024).

Bradshaw, A. D. 2002. “Introduction and Philosophy.” In *Handbook of Ecological Restoration: Volume 1, Principles of Restoration*, eds. M. R. Perrow and A. J. Davy. Cambridge, UK: Cambridge University Press.

Buchner, Barbara, Baysa Naran, Rajashree Padmanabhi, Sean Stout, Costanza Strinati, Dharshan Wignarajah, Jake Connolly, and Nikita Marini. 2023. *Global Landscape of Climate Finance 2023*. Washington, DC: Climate Policy Initiative. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2023/ (July 8, 2024).

Buchner, Barbara, C. Trabacchi, Federico Mazza, Dario Abramskiehn, and D. Wang. 2014. *Global Landscape of Climate Finance 2015*. Washington, DC: Climate Policy Initiative. https://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf (July 8, 2024).

Chen, Wei, Yong Geng, Shaozhuo Zhong, Mufan Zhuang, and Hengyu Pan. 2020. “A Bibliometric Analysis of Ecosystem Services Evaluation from 1997 to 2016.” *Environmental Science and Pollution Research* 27(19): 23503–13. doi:10.1007/s11356-020-08760-x.

Costanza, Robert, Rudolf de Groot, Leon Braat, Ida Kubiszewski, Lorenzo Fioramonti, Paul Sutton, Steve Farber, and Monica Grasso. 2017. “Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go?” *Ecosystem Services* 28: 1–16. doi:10.1016/j.ecoser.2017.09.008.

Credit Suisse, and WWF. 2014. *Conservation Finance: Moving beyond Donor Funding toward an Investor-Driven Approach*. Geneva, Switzerland: Credit Suisse and World Wildlife Fund. https://www.cbd.int/financial/privatesector/g-private-wwf.pdf (July 8, 2024).

Ding, Helen, Sofia Faruqi, Andrew Wu, Juan-Carlos Altamirano, Andres Achondo Ortega, René Zamora Cristales, Robin Chazdon, Walter Vergara, and Michael Verdone. 2017. *Roots of Prosperity: The Economics and Finance of Restoring Land*. Washington DC: World Resources Institute. https://research.usc.edu.au/esploro/outputs/report/Roots-of-Prosperity-The-Economics-and/99658171102621 (July 8, 2024).

Douglas, Ian. 2018. “The Challenge of Urban Poverty for the Use of Green Infrastructure on Floodplains and Wetlands to Reduce Flood Impacts in Intertropical Africa.” *Landscape and Urban Planning* 180: 262–72. doi:10.1016/j.landurbplan.2016.09.025.

Doyle, Martin W., and David G. Havlick. 2009. “Infrastructure and the Environment.” *Annual Review of Environment and Resources* 34(Volume 34, 2009): 349–73. doi:10.1146/annurev.environ.022108.180216.

Ecosystem Workforce Program. 2024. “Ecosystem Workforce Program.” https://resilient.uoregon.edu/ewp (July 11, 2024).

Egan, Dave. 2001. “A New Acid Test for Ecological Restoration.” *Ecological Restoration* 19(4): 205–6. doi:10.3368/er.19.4.205.

Elias, Marlène, Deepa Joshi, and Ruth Meinzen-Dick. 2021. “Restoration for Whom, by Whom? A Feminist Political Ecology of Restoration.” *Ecological Restoration* 39(1–2): 3–15. doi:10.3368/er.39.1-2.3.

European Commission. 2024. “The EU Nature Restoration Law.” https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en (July 8, 2024).

Faruqi, Sofia, Andrew Wu, Eriks Brolis, Andrés Anchondo Ortega, and Alan Batista. 2018. *The Business of Planting Trees: A Growing Investment Opportunity*. Washington, DC: World Resources Institute and The Nature Conservancy. https://www.nature.org/en-us/what-we-do/our-insights/perspectives/the-business-of-planting-trees/ (July 8, 2024).

Feser, Edward J., and Edward M. Bergman. 2000. “National Industry Cluster Templates: A Framework for Applied Regional Cluster Analysis.” *Regional Studies* 34(1): 1–19. doi:10.1080/00343400050005844.

Fischer, Joern, Maraja Riechers, Jacqueline Loos, Berta Martin-Lopez, and Vicky M. Temperton. 2021. “Making the UN Decade on Ecosystem Restoration a Social-Ecological Endeavour.” *Trends in Ecology & Evolution* 36(1): 20–28. doi:10.1016/j.tree.2020.08.018.

GAO. 2005. *Corps of Engineers Does Not Have an Effective Oversight Approach to Ensure That Compensatory Mitigation Is Occurring: Report to the Ranking Democratic Member, Committee on Transportation and Infrastructure, House of Representatives*. Washington, D.C.: U.S. Government Accountability Office.

Gao, Shuo, Joseph W. Bull, Julia Baker, Sophus O. S. E. zu Ermgassen, and E. J. Milner-Gulland. 2023. “Analyzing the Outcomes of China’s Ecological Compensation Scheme for Development-Related Biodiversity Loss.” *Conservation Science and Practice* 5(10): e13010. doi:10.1111/csp2.13010.

Garibaldi, Lucas A, Luísa G Carvalheiro, Sara D Leonhardt, Marcelo A Aizen, Brett R Blaauw, Rufus Isaacs, Michael Kuhlmann, et al. 2014. “From Research to Action: Enhancing Crop Yield through Wild Pollinators.” *Frontiers in Ecology and the Environment* 12(8): 439–47. doi:10.1890/130330.

Garrett-Peltier, H., and R. Pollin. 2009. “Job Creation per $1 Million Investment.” In *The Jobs Are in the Trees*, ed. G. Hurowitz. Seattle, WA: Grist. http://grist.files.wordpress.com/2010/02/job_creation_for_investment_-_garrett-peltier.pdf.

GCEC. 2014. *Better Growth Better Climate: The New Climate Economy, the Synthesis Report.* Washington, DC: World Resources Institute. https://sustainabledevelopment.un.org/content/documents/1595TheNewClimateEconomyReport.pdf (July 11, 2024).

Gebremariam, Mikiale Gebreslase, Yuming Zhu, Naveed Ahmad, and Dawit Nega Bekele. 2019. “Influencing Sustainability by Controlling Future Brownfields in Africa: A Case Study of Ethiopia.” *World Journal of Science, Technology and Sustainable Development* 16(3): 102–20. doi:10.1108/WJSTSD-04-2018-0031.

Ghermandi, Andrea, Jeroen C. J. M. van den Bergh, Luke M. Brander, Henri L. F. de Groot, and Paulo A. L. D. Nunes. 2010. “Values of Natural and Human-Made Wetlands: A Meta-Analysis.” *Water Resour. Res.* 46(12): W12516. doi:10.1029/2010wr009071.

Gilman, Eric L. 1998. “Nationwide Permit Program: Unknown Adverse Impacts on the Commonwealth of the Northern Mariana Islands’ Wetlands.” *Coastal Management* 26(4): 253–77. doi:10.1080/08920759809362357.

Gold, Adam C. 2024. “How Wet Must a Wetland Be to Have Federal Protections? Estimating a Range of Potential Impacts from Sackett v. EPA Using Wetland Flooding Frequency.” doi:10.22541/essoar.171052545.55380305/v1.

Goosen, Johan, and Anne Fitchett. 2020. “Success Factors for Urban Brownfield Developments in Johannesburg, South Africa.” *Urban Forum* 31(1): 41–59. doi:10.1007/s12132-019-09366-4.

Green, Mark. 2020. “The High Cost of Singling Out Pipelines in NWP 12 Ruling.” https://www.api.org/news-policy-and-issues/blog/2020/06/24/the-high-cost-of-singling-out-pipelines-in-nwp-12-ruling (July 24, 2024).

Grueber, Martin, and Dylan Yetter. 2024. *Video Games in the 21st Century: The 2024 Economic Impact Report*. Washington, DC: The Entertainment Software Association. https://www.theesa.com/wp-content/uploads/2024/02/EIR_ESA_2024.pdf (July 11, 2024).

Harrison, Hannah N., and Amarjit Singh. 2021. “Modern Evaluation of the Status of WOTUS.” *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction* 13(1): 03720006. doi:10.1061/(ASCE)LA.1943-4170.0000440.

Henderson, James E., Omkar Joshi, Shaun Tanger, Leslie Boby, William Hubbard, Matthew Pelkki, David W. Hughes, et al. 2017. “Standard Procedures and Methods for Economic Impact and Contribution Analysis in the Forest Products Sector.” *Journal of Forestry* 115(2): 112–16.

Higgs, Eric, Jim Harris, Stephen Murphy, Keith Bowers, Richard Hobbs, Willis Jenkins, Jeremy Kidwell, et al. 2018. “On Principles and Standards in Ecological Restoration.” *Restoration Ecology* 26(3): 399–403. doi:10.1111/rec.12691.

Hobbs, R.J., and J.A. Harris. 2001. “Restoration Ecology: Repairing the Earth’s Ecosystems in the New Millennium.” *Restoration Ecology* 9(2): 239–46.

Hook, Patrick W., and Spenser T. Shadle. 2013. “Navigating Wetland Mitigation Markets: A Study of Risks Facing Entrepreneurs and Regulators.” *Ecosystem Marketplace, Washington, DC*. https://www.conservationfund.org/wp-content/uploads/2023/08/Hook_and_Shadle_2013.pdf (July 23, 2024).

Hough, Palmer, and Morgan Robertson. 2009. “Mitigation under Section 404 of the Clean Water Act: Where It Comes from, What It Means.” *Wetlands Ecology and Management* 17(1): 15–33.

Hovis, Meredith, Frederick Cubbage, Joseph Chris Hollinger, Theodore Shear, Barbara Doll, J. Jack Kurki-Fox, Daniel Line, et al. 2022. “Determining the Costs, Revenues, and Cost-Share Payments for the ‘Floodwise’ Program: Nature-Based Solutions to Mitigate Flooding in Eastern, Rural North Carolina.” *Nature-Based Solutions* 2: 100016.

Hughes, D. 2018. *A Primer in Economic Multipliers and Impact Analysis Using Input-Output Models*. Knoxville, TN: University of Tennessee Extension. https://utia.tennessee.edu/publications/wp-content/uploads/sites/269/2023/10/W644.pdf (July 8, 2024).

Iftekhar, Md Sayed, Maksym Polyakov, Dean Ansell, Fiona Gibson, and Geoffrey M. Kay. 2017. “How economics can further the success of ecological restoration.” *Conservation Biology* 31(2): 261–68. doi:10.1111/cobi.12778.

IMPLAN. 2019. “Economic Impact Analysis for Planning | IMPLAN.” https://implan.com/ (February 15, 2023).

IMPLAN. 2023. “IMPLAN International Data.” *IMPLAN - Support*. https://support.implan.com/hc/en-us/articles/18728632236571-IMPLAN-International-Data (July 8, 2024).

International Input-Output Association. 2024. “IO-Data.” https://www.iioa.org/news/io-data.html (July 8, 2024).

Isley, Paul, E. S. Isley, and Carrie Hause. 2011. “Muskegon Lake Area of Concern Habitat Restoration Project: Socio-Economic Assessment.” *Final Project Report. Grand Valley State University*. http://wmsrdc.org/wp-content/uploads/2018/04/Muskegon-AOC-Habitat-Restoration-Socio-Economic-Assessment.pdf (July 11, 2024).

Issaka, Sakinatu, and Muhammad Aqeel Ashraf. 2017. “Impact of Soil Erosion and Degradation on Water Quality: A Review.” *Geology, Ecology, and Landscapes* 1(1): 1–11. doi:10.1080/24749508.2017.1301053.

IUCN. 2019. “World View - A Snapshot of National Biodiversity Offset Policies | Global Inventory of Biodiversity Offset Policies (GIBOP).” https://portals.iucn.org/offsetpolicy/ (July 8, 2024).

IUCN. 2020. *IUCN Global Standard for Nature-Based Solutions: A User-Friendly Framework for the Verification, Design and Scaling up of NbS (First Edition)*. Gland, Switzerland: IUCN. https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf.

IUCN. 2022. “The Restoration Initiative: A Kenya Drylands Story.” https://www.iucn.org/story/202212/restoration-initiative-kenya-drylands-story (July 8, 2024).

Johnson, David, and Mark Muro. 2024. *Financing Transformation: How to Sustain Place-Based Economic Development beyond Early Federal Awards*. Washington, DC: Brookings Institution. https://www.brookings.edu/articles/financing-transformation-how-to-sustain-place-based-economic-development-beyond-early-federal-awards/ (July 25, 2024).

Kaza, Nikhil, and Todd K. BenDor. 2013. “The Land Value Impacts of Wetland Restoration.” *Journal of Environmental Management* 127: 289–99. doi:10.1016/j.jenvman.2013.04.047.

Kellon, C.P., and T. Hesselgrave. 2014. “Oregon’s Restoration Economy: How Investing in Natural Assets Benefits Communities and the Regional Economy.” *SAPIENS* 7(2): 65–73.

Kelmenson, Sophie, Todd K. BenDor, and T. William Lester. 2017. “Os Impactos Econômicos ee um Projeto de Restauração (The Economic Impacts of a Single Restoration Project).” In *Economia da restauração florestal (Forest Restoration Economy)*, eds. Rubens de Miranda Benini and Sergio Adeodato. São Paulo, Brazil: The Nature Conservancy.

Kiel, Katherine, and Jeffrey Zabel. 2001. “Estimating the Economic Benefits of Cleaning Up Superfund Sites: The Case of Woburn, Massachusetts.” *The Journal of Real Estate Finance and Economics* 22(2): 163–84. doi:10.1023/A:1007835329254.

Kihslinger, Rebecca, Christina Libre, Kathryn Ma, Erin Okuno, and Royal C. Gardner. 2019. *In-Lieu Fee Mitigation: Review of Program Instruments and Implementation Across the Country*. Washington, DC: Environmental Law Institute. https://papers.ssrn.com/abstract=3619484 (December 13, 2022).

Kihslinger, Rebecca, James M. McElfish, and Dominic Scicchitano. 2020. *Improving Compensatory Mitigation Project Review*. Washington, DC: Environmental Law Institute. https://www.eli.org/sites/default/files/files-pdf/improving-compensatory-mitigation-project-review.pdf (July 23, 2024).

Kotval, Zenia. 2006. *Fiscal Impact Analysis: Methods, Cases, and Intellectual Debate*. Lincoln Institute of Land Policy.

Kroeger, T. 2014. “Dollars and Sense: Economic Benefits and Impacts from Two Oyster Reef Restoration Projects in the Northern Gulf of Mexico.” http://www.conservationgateway.org/Files/Pages/dollars-and-sense-economi.aspx.

Kruse, Sarah A., and Astrid J. Scholz. 2006. “Preliminary Economic Assessment of Dam Removal: The Klamath River.” *Ecotrust, Portland, Oregon*. https://sites.lafayette.edu/raicha/files/2011/01/Siskiyou_Co_Economic_Assessment1.pdf (July 11, 2024).

Lamie, R. David, Wallace Campbell, and William Molnar. 2012. “The Fiscal-Geographic Nexus: An Overview of Fiscal Impact Assessment in Local Policy Development.” *Applied Geography* 32(1): 54–60. doi:10.1016/j.apgeog.2010.07.007.

LERC. 1998. *Improving Jobs, Community, and the Environment: Lessons from the Ecosystem Workforce Project*. Eugene, OR: University of Oregon Labor Education and Research Center. https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/2298/Improving.pdf?sequence=1&isAllowed=y (July 11, 2024).

Li, Feifei, Fukai Wang, Hui Liu, Kai Huang, Yajuan Yu, and Baorong Huang. 2023. “A Comparative Analysis of Ecosystem Service Valuation Methods: Taking Beijing, China as a Case.” *Ecological Indicators* 154: 110872. doi:10.1016/j.ecolind.2023.110872.

Lyndall, Jen, Kegan Brown, and Thomas Pearce. 2023. “The Missing Component: Incorporating Biodiversity into Natural Resource Remediation and Restoration.” *Natural Resources & Environment* 38(2): 34–39.

Makinen, Marita, David Haber, and Anthony Raymundo. 2012. “Acqui-Hires for Growth: Planning for Success.” *Venture Capital Review* 28: 31–42.

Martin, David M. 2017. “Ecological Restoration Should Be Redefined for the Twenty-First Century.” *Restoration Ecology* 25(5): 668–73. doi:10.1111/rec.12554.

Martin, Steve, and Becca Madsen. 2023. *The Time It Takes for Restoration: An Analysis of Mitigation Bank Instrument Timelines*. Washington, DC: Environmental Policy Innovation Center and Ecological Restoration Business Association.

McCarthy, Linda. 2002. “The Brownfield Dual Land-Use Policy Challenge: Reducing Barriers to Private Redevelopment While Connecting Reuse to Broader Community Goals.” *Land Use Policy* 19: 287–96.

McCormick, B., R. Clement, D. Fischer, M. Lindsay, and R. Watson. 2010. *Measuring the Economic Benefits of America’s Everglades Restoration. Prepared for the Everglades Foundation.* Roswell, GA: Mather Economics, LLC.

Mendes, Ana, Lorena Martínez Hernández, Léa Badoz, Lydia Slobodian, and João E. Rabaça. 2023. “Towards a Legal Definition of Ecological Restoration: Reviewing International, European and Member States’ Case Law.” *Review of European, Comparative & International Environmental Law* 32(1): 3–17. doi:10.1111/reel.12476.

Metzger, Jean Paul, Karen Esler, Cornelia Krug, Melissa Arias, Leandro Tambosi, Renato Crouzeilles, André Luis Acosta, et al. 2017. “Best Practice for the Use of Scenarios for Restoration Planning.” *Current Opinion in Environmental Sustainability* 29: 14–25. doi:10.1016/j.cosust.2017.10.004.

Moseley, Cassandra. 2007. *A Quick Guide to Conducting an Ecosystem Workforce Assessment*. Eugene, OR: University of Oregon Ecosystem Workforce Program. http://scholarsbank.uoregon.edu/xmlui/handle/1794/19471 (July 24, 2024).

Myers, Carl F., James Meek, Stuart Tuller, and Anne Weinberg. 1985. “Nonpoint Sources of Water Pollution.” *Journal of Soil and Water Conservation* 40(1): 14–18.

National Academies of Science. 2019. *Progress Toward Restoring the Everglades: The Seventh Biennial Review-2018*. National Academies Press. https://books.google.com/books?hl=en&lr=&id=6e6UDwAAQBAJ&oi=fnd&pg=PR1&dq=everglades+restoration+initiative&ots=cew2jZPAjo&sig=MimUlAuOEZUYb6K8sBNvJtHqm9o (July 8, 2024).

Nielsen-Pincus, Max, and Cassandra Moseley. 2013. “The Economic and Employment Impacts of Forest and Watershed Restoration.” *Restoration Ecology* 21(2): 207–14.

NRC. 2001. *Compensating for Wetland Losses Under the Clean Water Act*. Washington, D.C.: National Academy Press.

OECD. 2024. *Input-Output Tables*. Paris, France: Organisation for Economic Cooperation and Development. https://www.oecd.org/en/data/datasets/input-output-tables.html (July 11, 2024).

Ohanian, Lee E., Edward C. Prescott, and Nancy L. Stokey. 2009. “Introduction to Dynamic General Equilibrium.” *Journal of Economic Theory* 144(6): 2235–46.

Olander, L. 2016. *Managing Risk in Environmental Markets (Working Paper NI WP 16-02)*. Durham, NC: Duke University, Nicholas Institute for Environmental Policy Solutions. https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_16-02.pdf (July 23, 2024).

Olander, Lydia, Krystal Laymon, and Heather Tallis. 2022. *Opportunities to Accelerate Nature Based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, & Prosperity. A Report to the National Climate Task Force.* Washington, DC: White House Council of Environmental Quality. https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Roadmap.pdf.

Pacheco, Fernando António Leal, Luís Filipe Sanches Fernandes, Renato Farias Valle Junior, Carlos Alberto Valera, and Teresa Cristina Tarlé Pissarra. 2018. "Land Degradation: Multiple Environmental Consequences and Routes to Neutrality." *Current Opinion in Environmental Science & Health* 5: 79–86. doi:10.1016/j.coesh.2018.07.002.

Pascual, Unai, Roldan Muradian, Luke Brander, Erik Gómez-Baggethun, Berta Martín-López, Madhu Verma, Paul Armsworth, et al. 2012. "The Economics of Valuing Ecosystem Services and Biodiversity." In *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*, Routledge, 183–256. https://www.taylorfrancis.com/chapters/edit/10.4324/9781849775489-6/economics-valuing-ecosystem-services-biodiversity-unai-pascual-roldan-muradian-luke-brander-erik-g%C3%B3mez-baggethun-berta-mart%C3%ADn-l%C3%B3pez-madhu-verma-paul-armsworth-michael-christie-hans-cornelissen-florian-eppink-joshua-farley-john-loomis-leonie-pearson-charles-perrings-stephen-polasky-jeffrey-mcneely-richard-norgaard-rehana-siddiqui-david-simpson-kerry-turner-david-simpson (July 11, 2024).

Prevezer, Martha. 1997. "The Dynamics of Industrial Clustering in Biotechnology." *Small business economics* 9: 255–71.

PWC. 2011. *The Economic Impacts of the Oil and Natural Gas Industry on the U.S. Economy in 2009: Employment, Labor Income and Value Added*. Washington, DC: American Petroleum Institute.

PWC. 2021. *The Economic Impacts of the Oil and Natural Gas Industry on the U.S. Economy in 2019: Employment, Labor Income and Value Added*. Washington, DC: American Petroleum Institute. https://www.api.org/-/media/files/policy/american-energy/pwc/api-pwc-economic-impact-report.pdf.

Rakotoarisoa, J. N., A. Vidal, M. Pagliani, O. Keo, A. Schiavone, C. Ann, and S. Sar. 2020. "When Institutions Work Together on Restoration." In *Restoring the Earth-The next Decade: Unasylva No. 252-Vol. 71 2020/1*, Geneva, Switzerland: UN Food and Agriculture Organization, 102.

Rebelo, Alanna J., David C. Le Maitre, Karen J. Esler, and Richard M. Cowling. 2015. "Hydrological Responses of a Valley-Bottom Wetland to Land-Use/Land-Cover Change in a South African Catchment: Making a Case for Wetland Restoration." *Restoration Ecology* 23(6): 829–41. doi:10.1111/rec.12251.

Reiss, Kelly Chinners, Erica Hernandez, and Mark T. Brown. 2009. "Evaluation of Permit Success in Wetland Mitigation Banking: A Florida Case Study." *Wetlands* 29(3): 907–18.

Richardson, Matthew, Pengfei Liu, and Michael Eggleton. 2022. "Valuation of Wetland Restoration: Evidence from the Housing Market in Arkansas." *Environmental and Resource Economics* 81(3): 649–83. doi:10.1007/s10640-021-00643-0.

Robertson, Morgan M. 2004. "The Neoliberalization of Ecosystem Services: Wetland Mitigation Banking and Problems in Environmental Governance." *Geoforum* 35: 361–73.

Salzman, James, Genevieve Bennett, Nathaniel Carroll, Allie Goldstein, and Michael Jenkins. 2018. "The Global Status and Trends of Payments for Ecosystem Services." *Nature Sustainability* 1(3): 136–44. doi:10.1038/s41893-018-0033-0.

Schmit, Todd M., Becca B.R. Jablonski, and David Kay. 2013. *A Practitioner's Guide to Conducting an Economic Impact Assessment of Regional Food Hubs Using IMPLAN: A Step-by Step Approach*. Washington, DC: US Department of Agriculture and Cornell University.

SER. 2004. *The SER International Primer on Ecological Restoration*. Tucson, AZ: Society for Ecological Restoration International. https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/SER_Primer/ser_primer.pdf.

SER. 2024. "Restoration Resource Center Restoration Database." https://ser-rrc.org/restoration-database/ (July 8, 2024).

Sewell, Annelies, Stefan van der Esch, and Hannah Löwenhardt. 2020. *Goals and Commitments for the Restoration Decade: A Global Overview of Countries' Restoration Commitments under the Rio Conventions and Other Pledges*. The Hague, Netherlands: PBL Netherlands Environmental Assessment Agency. https://www.pbl.nl/en/publications/goals-and-commitments-for-the-restoration-decade (July 8, 2024).

Shropshire, R., and B. Wagner. 2009. "An Estimation of the Economic Impacts of Restoration in Montana." http://www.ourfactsyourfuture.org/admin/uploadedPublications/3669_Restoration.pdf.

Southwick Associates. 2007. *State-Level Economic Contributions of Active Outdoor Recreation – Technical Report on Methods and Findings*. Boulder, CO: Outdoor Industry Foundation.

Southwick Associates. 2013. *The Conservation Economy in America: Direct Investments and Economic Contributions (February 18, 2013)*. Washington, D.C.: National Fish and Wildlife Foundation.

Sunding, David, and David Zilberman. 2002. “The Economics of Environmental Regulation by Licensing: An Assessment of Recent Changes to the Wetland Permitting Process.” *Natural Resources Journal*: 59–90.

Sutton, Paul C., Sharolyn J. Anderson, Robert Costanza, and Ida Kubiszewski. 2016. “The Ecological Economics of Land Degradation: Impacts on Ecosystem Service Values.” *Ecological Economics* 129: 182–92. doi:10.1016/j.ecolecon.2016.06.016.

UN FAO. 2024. “Conservation of Agricultural Resources Act. | FAOLEX.” https://www.fao.org/faolex/results/details/en/c/LEX-FAOC122989/ (July 8, 2024).

Ungaro, Matthew, Todd K. BenDor, and J. Adam Riggsbee. 2022. “Prioritizing Streams: The Impacts of in-Kind Mitigation Rules on an Ecosystem Offset Market.” *Environmental Science & Policy* 132: 131–41. doi:10.1016/j.envsci.2022.02.005.

United Kingdom. 2023. “Understanding Biodiversity Net Gain.” *GOV.UK*. https://www.gov.uk/guidance/understanding-biodiversity-net-gain (July 8, 2024).

US BEA. 2018. *RIMS II: An Essential Tool for Regional Developers and Planners. Https://Www.Bea.Gov/Sites/Default/Files/Methodologies/RIMSII_User_Guide.Pdf*. Washington, DC: US Bureau of Economic Analysis. https://www.bea.gov/sites/default/files/methodologies/RIMSII_User_Guide.pdf.

US Bureau of Labor Statistics. 2024. “Quarterly Census of Employment and Wages.” *Bureau of Labor Statistics*. https://www.bls.gov/cew/ (July 11, 2024).

USDOI. 2020. *The Department of the Interior’s Economic Contributions, FY 2019*. Washington, DC: U.S. Department of the Interior, Office of Policy Analysis,. https://www.doi.gov/sites/doi.gov/files/econ-report-2019-final.pdf.

USEPA. 2000. *Storm Water Phase II Final Rule Small Construction Program Overview (EPA 833-F-00-013)*. Washington, DC: US Environmental Protection Agency. https://www.epa.gov/sites/default/files/documents/fact3-0.pdf (July 8, 2024).

USEPA. 2015. *Enforcement under CWA Section 404*. Washington, DC: US Environmental Protection Agency. https://www.epa.gov/cwa-404/enforcement-under-cwa-section-404 (July 24, 2024).

Verdone, Michael, and Andrew Seidl. 2017. “Time, Space, Place, and the Bonn Challenge Global Forest Restoration Target.” *Restoration Ecology* 25(6): 903–11. doi:10.1111/rec.12512.

Watson, Philip, Dawn Thilmany, Josh Wilson, and Susam Winter. 2007. “Determining Economic Contributions and Impacts: What Is the Difference and Why Do We Care?” *Journal of Regional Analysis and Policy* 37: 140–46.

WMR. 2024. *Habitat Restoration Market: Global Industry Insights, Trends, Outlook, and Opportunity Analysis, 2024-2031*. Maharashtra, India: Worldwide Market Reports.

Wortley, Liana, Jean-Marc Hero, and Michael Howes. 2013. “Evaluating Ecological Restoration Success: A Review of the Literature.” *Restoration Ecology* 21(5): 537–43.

Wratten, Stephen D., Mark Gillespie, Axel Decourtye, Eric Mader, and Nicolas Desneux. 2012. “Pollinator Habitat Enhancement: Benefits to Other Ecosystem Services.” *Agriculture, Ecosystems & Environment* 159: 112–22.

Yin, Robert K. 2008. *Case Study Research: Design and Methods*. Thousand Oaks, CA: Sage.

g20ico@unccd.int
www.g20land.org
Initiative Coordination Office
UN Convention to Combat Desertification
1, Platz der Vereinten Nationen
D-53113, Bonn, Germany