National Assessment of Job Creation and Economic Benefits for Environmentally Beneficial Investments

Phase 2 Report

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Overall Summary

The past decade has provided a window to the more significant, on-going and future challenges likely to result from the combined impacts of the continued growth in water and land use, the natural variation of precipitation and runoff, and the increasingly noticeable effects of climate change and other landscape-level factors such as declining forest health, reductions in native riparian vegetation, and diminished coastal ecosystem health. It is critical to begin to identify and implement additional proactive, environmentally beneficial investments that could be deployed to manage system vulnerability and avoid a crisis that could wreak economic and environmental havoc throughout the United States, and particularly in the Colorado River Basin, the US Coasts and Great Lakes, and the Upper Mississippi region.

Environmentally beneficial investments will build resilience through adaptation and mitigation measures and can generate jobs as well as local and regional economic benefits. These environmentally beneficial investments include projects or programs that:

- Invest in watershed restoration and management (including rivers and riparian habitat)
- Upgrade aging agricultural irrigation infrastructure to improve reliability while also increasing water use efficiency and resulting in improved flow regimes or fish and wildlife habitat
- Invest in urban water, sewer and stormwater systems (including both green and grey infrastructure)
- Expand urban water efficiency and conservation
- Restore coastal and marine habitat
- Restore watersheds with a focus on floodplain restoration in the Mississippi River System
- Encourage modified agricultural practices such as cover crops and fallowing
- Restore native species, with an emphasis on wetland and riparian restoration

This report is broken into four main sections: 1) a literature review to compile academic articles and white papers on job creation and economic benefits associated with investment in the environmentally beneficial investments outlined above across three key regions in the United States, the Colorado River Basin, the US Coasts and Great Lakes, and the Upper Mississippi region, 2) a summary of protocols used by federal agencies used to generate economic analyses of projects and programs, 3) a summary of economic impacts across all project types and geographies that compares average job creation to other sectors and 4) a series of recommendations that stem from this work to make a stronger case for the economic output of environmentally beneficial investments.

Economic benefits are reported in a variety of formats including avoided costs[1], impact to GDP[2], and economic output[3]. For the purposes of this report, the literature search focused on literature documenting economic output per $1M investment in the activity. Jobs are also presented as the number of jobs created for every $1M investment. In general, jobs presented in the case studies

[1] Avoided costs represent the difference in costs between a baseline condition and alternative.
[2] GDP or gross domestic product measures the valued added or the gross output minus the intermediate inputs.
[3] Economic output measures the value of all sales of goods and services.

below are an underestimation of the jobs created because they are limited by the geographic extent of the analysis and many local investments create jobs regionally (BenDor, Livengood, et al. 2015). Additionally, analysis of indirect and induced job creation is difficult and therefore not consistently reported.

Colorado River Basin

Overview

The Colorado River Basin summary includes four main categories of environmentally beneficial investment types: investments in watershed restoration and management, upgrading aging agricultural irrigation infrastructure, investing in urban water, sewer and stormwater systems and expanding urban water efficiency programs. In general, there are few concrete examples of analyses of the economic impact of these project types within the basin, as a result this summary primarily aggregates and synthesizes research from other geographic regions to provide estimated ranges of benefits in the basin. Overall, investment in watershed restoration and management resulted in a range of job creation with the highest maximum estimate – 39.7 jobs created per $1 million spent (Table 1).

Table 1: Summary of job creation and economic impact per $1M investment by sector.

Environmentally Beneficial Investment Type	Estimated Creation of Jobs[4] per $1M Investment	Economic Output per $1M Investment
Invest in watershed restoration and management (including rivers and riparian habitat)	All 6.8 to 39.7[5] Rivers/Riparian 6.8 – 31.5[6]	$2.2 to 3.4 Million[7]
Upgrade aging agricultural irrigation infrastructure	4.9[8]	No data
Invest in urban water, sewer and stormwater systems (includes both green and grey infrastructure)	3.6 -15.5[9]	$2.7 Million[10]
Expand urban water efficiency programs		$2.5 to 2.8 Million[12]

[4] Estimates include direct, indirect, and induced jobs.

[5] (BenDor, Livengood, et al. 2015; Edwards, Sutton-Grier, and Coyle 2013; Festa 2020; Huber et al. 2019; Mather Economics LLC 2012; Nature Conservancy 2017; Thomas et al. 2016; Wagner and Shropshire 2009)

[6] (Kantor 2012; Nature Conservancy 2017; Wagner and Shropshire 2009)

[7] (Kantor 2012; Nature Conservancy 2017; Thomas et al. 2016)

[8] Does not include indirect or induced jobs: (Eberhart and Pelly 2020)

[9] (American Rivers 2017; Econsult Solutions 2016; Nature Conservancy 2017; Value of Water Campaign 2017)

[10] (American Rivers 2017; Econsult Solutions 2016; Value of Water Campaign 2017)

[12] (Mitchell, Chesnutt, and Pekelney 2017)

	12 to 26[11]

Invest in watershed restoration and management (including rivers and riparian habitat)

Strengths, Weaknesses and Gaps

Numerous studies have focused on job creation from the Restoration Economy (Bezdek, Wendling, and DiPerna 2008; BenDor et al. 2014) at a broad geographic scale. While there are few studies that examine the economic output of environmentally beneficial investments in the Colorado River Basin, these broader studies provide context for the basin. Habitat restoration in coastal area generates, on average, 17 jobs per million dollars spent, which is higher than extractive industries such as coal and gas (Edwards, Sutton-Grier, and Coyle 2013). Restoration investments in coastal southern Oregon totaled at least $57.6 million from 2001 to 2010 (Davis, Sundstrom, and Moseley 2011) and supported an average of 73 local jobs per year in Linn County specifically (Davis et al. 2013). On the Gulf Coast, some modeling suggests that over 50 years, $25 billion in restoration funding could promote the creation of as many as 88,011 incremental jobs in the region, with an average of 7,449 jobs created per year during the first ten years of funding (Mather Economics LLC 2012). Estimates on job creation and economic benefits have been compiled by BenDor et al. (2015) from various studies by restoration activity, which are modified and added to based on the literature review (Table 2).

Table 2: Job creation by project types relevant to the Colorado River Basin (adapted from BenDor, Livengood, et al. 2015)

Type of Restoration	Jobs per $1 Million Invested	Geographic Scale (State)	Source
Forest, land and watershed	39.7	National	Garrett-Peltier and Pollin (2009)
Grassland	13.0	County	Derived from DOI (2012)
Upland	15.0	State (OR)	Neilson-Pincus and Moseley (2010)
Fish passage & Habitat	10.4	State (MA)	Industrial Economics, Inc. (2012)
Fish passage & Habitat	15.2	State (OR)	Neilson-Pincus and Moseley (2010)
Fish passage/dam removal	18.2	State	Edwards et al. (2013)
Dam removal	10.3	State (MA)	Industrial Economics, Inc. (2012)
Dam removal	20.5	State (CA)	Kruse and Scholz (2006)
River	9.7	County	Derived from DOI (2012)
In-stream	14.7	State (OR)	Neilson-Pincus and Moseley (2010)
In-stream	31.5	State (MT)	Shropshire and Wagner (2009)
Hydrologic reconnection	14.6	State	Edwards et al. (2013)
Hydrologic reconnection	49 (total, no project costs reported)	Region (Illinois River)	Sparks et al. (2015)
Riparian	19.0	State	Edwards et al. (2013)
Riparian	23.1	State (OR)	Neilson-Pincus and Moseley (2010)
Riparian	30.6	Region (Illinois River)	Prato & Hey (2007)
Invasive Species Removal	33.3	State	Edwards et al. (2013)
Watershed Restoration	16.3	State (OR)	Neilson-Pincus and Moseley (2013)
Watershed Restoration	2.1	Region (Lake Michigan)	Kashian et al. (2014)
Wetland	6.8	County	Derived from DOI (2012)
Wetland	12.9	State (MA)	Industrial Economics (2012)
Wetland	17.6	State (OR)	Neilson-Pincus and Moseley (2010)
Wetland	30	Region (MRS)	Batker et al. (2014)

[11] (Mitchell, Chesnutt, and Pekelney 2017)

Because restoration activities focus on revitalizing or recreating localized habitats, investment in these activities bolstered local economic benefits by up to 80 cents of each dollar staying local (BenDor, Livengood, et al. 2015). Additionally, compensation from restoration jobs compares favorably to average wages in other sectors (BenDor, Lester, et al. 2015). A recent study found that between $2.2 and $3.4 million in total economic outputs are contributed to the U.S. economy for every $1 million invested in ecosystem restoration (Thomas et al. 2016).

The majority of case studies and academic articles investigate a wide variety of restoration activities. There is considerably less data on the economic output from river restoration activities specifically, including activities that improve streamflow conditions and habitat for aquatic species.

Case Examples

In Montana, public restoration projects include ecosystems impacted by industrial uses such as mining, as well as other river restoration activities. Approximately 31.5 jobs are created for each million dollars of restoration funds spent, though employment trends and wage differentials indicate that restoration jobs are often filled by non-specialized temporary workers (Wagner and Shropshire 2009).

Upgrade aging agricultural irrigation infrastructure

Strengths, Weaknesses and Gaps

There is fairly limited documentation of job generation and local/regional economic benefits that result from upgrading aging agricultural irrigation infrastructure to concurrently: a) expand reliability, b) increase water use efficiency, and c) improve flow regimes or fish and wildlife habitat. The case studies identified demonstrated stable regional economic productivity (Kendy et al. 2018) as well as direct jobs associated with project implementation averaging 4.4 jobs per $1M funding commitment (Eberhart and Pelly 2020).

The current gaps include data on indirect or induced jobs; the length of employment, the type of employment; the geographic distribution of such jobs; and economic output.

Case Examples

Whychus Creek, OR (Kendy et al. 2018)

The Deschutes River Conservancy, Oregon Water Trust and local partners worked with the agricultural community in Whychus Creek to implement a variety of water transactions including large scale upgrades to irrigation conveyance infrastructure. As of 2015, irrigated land acreage declined by 5% but economic productivity from agriculture remained constant (Kendy et al. 2018).

Yakima Plan Implementation, WA (Eberhart and Pelly 2020)

Trout Unlimited is implementing a canal lining and irrigation water distribution infrastructure project in the Kittitas Reclamation District, Yakima River Basin. The project is expected to cost $50 million over three years and generate 7.1 jobs in 2020 (per $1.24M funding commitment), 28.7 jobs in 2021 (per $5.14M funding commitment), and 36.8 jobs in 2022 (per $10.14M funding commitment) (Eberhart and Pelly 2020).

Invest in urban water, sewer and stormwater systems (includes both green and grey infrastructure)

Strengths, Weaknesses and Gaps

A 2017 study by the Value of Water Campaign estimated a need for a $82 billion per year investment in water, wastewater and stormwater infrastructure for 10 years, which would in turn generate $220B per year in economic activity and would produce and sustain 1.3 million jobs over the 10-year period (Value of Water Campaign 2017). The estimated economic effects included direct, indirect and induced impacts from predicted successive rounds of spending on good and services in sectors beyond water infrastructure and 15 jobs for every $1M invested.
The needed investments in urban and rural community water infrastructure will either be traditional grey infrastructure or natural infrastructure solutions. Natural water infrastructure (also referred to as green infrastructure) mimics natural water systems to take advantage of natural process while working with traditional infrastructure (American Rivers 2017; Nature Conservancy 2017). Natural infrastructure projects are gaining recognition as viable, sustainable, and affordable solutions for a ranges of drinking water, wastewater, and stormwater issues facing communities around the country. Typically, these projects are site specific and tailored to the unique needs of the climate, economy, and design of the community. There are documented benefits from natural infrastructure projects to revitalized green spaces, energy savings, increased local development, and improvements in public health (Koehler and Koch 2019). However, specific quantifiable economic numbers documenting benefits such as new jobs, property values, or improvements in local business are more difficult to extract from the investments in water infrastructure broadly.

Case Examples

Milwaukee Metropolitan Sewerage District (Koehler and Koch 2019)
Milwaukee Metropolitan Sewerage District expects to capture and store more stormwater with green infrastructure than with conventional grey infrastructure. By choosing a green infrastructure option MMSD projects $44M in avoided costs, 500 green maintenance jobs and 160 construction jobs per year.

Expand urban water efficiency and conservation

Strengths, Weaknesses and Gaps

Jobs and economic benefits associated with expanding urban water efficiency and conservation are fairly well documented. Water efficiency and conservation programs such as indoor water use efficiency (e.g. high-efficiency toilets and other appliances), outdoor water use efficiency (e.g. smart irrigation, turf removal), and utility efficiency (e.g. leak detection, water rate reform) provide significant job and economic benefits. "Direct investment on the order of $10 billion in water efficiency programs can boost U.S. GDP by $13 to $15 billion and employment by 120,000 to 260,000 jobs" (Mitchell, Chesnutt, and Pekelney 2017).

The current gaps include specific details on length of employment, the type of employment, and the geographic distribution of such jobs which would likely be driven by need. Additionally, there are many case studies outlining the avoided costs associated with water efficiency and conservation, but they often lack any analysis of impacts on jobs.

Case Examples

Tucson Water, AZ (Rupprecht, Allen, and Mayer 2020)

Despite an increase 40% increase population in Tucson between 1989 and 2015, per capital water use remained nearly constant 96.4 mgd (1989), 93.3 mgd (2015). Water efficiency and conservation measures (e.g. utility sponsored conservation programs, community outreach campaigns, tiered rate structures, and technology improvements) instituted during that period resulted in water system avoided costs of $22.4M annually; wastewater system avoided costs $6.4M annually; $351M in infrastructure avoided costs.

City of Westminster, CO (Feinglas, Gray, and Mayer 2013)

The City of Westminster has decreased use by 30% between 1980 and 2010 where water use has dropped from 180 gpcd to 149 gpcd. Associated avoided costs for that period of time were calculated to be $218M for water supply, $130M for water treatment infrastructure, $20M for wastewater treatment, $223M for estimated debt payments totaling $591M. In addition, avoided annual operating costs accrued to $1.3M per year.

US Coasts and Great Lakes

Overview

Seven main project types for the US Coasts and Great Lakes region are included in this summary: marine debris removal, fish passage and dam removal, hydrologic reconnection, invasive species removal, oyster reef restoration, riparian restoration and living shorelines projects. Coastal projects are particularly well represented in work examining the economic impact of outputs, and a few studies (e.g. Edwards et al. 2013) have focused on these project types explicitly. Overall, projects focusing on invasive species removal and in-stream restoration had the two highest job creation rates, with 33.3 and 31.5 jobs created per $1 million spent, respectively (Table 3).

Table 3 Job creation by project types relevant to the US Coasts and Great Lakes Region (adapted from BenDor, Livengood, et al. 2015)

Type of Restoration	Jobs per $1 Million Invested	Geographic Scale (State)	Source
Fish passage	10.4	State (MA)	Industrial Economics, Inc. (2012)
Fish passage	15.2	State (OR)	Neilson-Pincus and Moseley (2010)
Fish passage/dam removal	18.2	State	Edwards et al. (2013)
Dam removal	10.3	State (MA)	Industrial Economics, Inc. (2012)
Dam removal	20.5	State (CA)	Kruse and Scholz (2006)
River	9.7	County	Derived from DOI (2012)
In-stream	14.7	State (OR)	Neilson-Pincus and Moseley (2010)
In-stream	31.5	State (MT)	Shropshire and Wagner (2009)
Hydrologic reconnection	14.6	State	Edwards et al. (2013)
Hydrologic reconnection	49	Region (Illinois River)	Sparks et al. (2015)

Riparian	19.0	State	Edwards et al. (2013)
Riparian	23.1	State (OR)	Neilson-Pincus and Moseley (2010)
Riparian	30.6	Region (Illinois River)	Prato & Hey (2006)
Oyster reef	16.6	State	Edwards et al. (2013)
Oyster reef	20.5	County	Kroeger (2012)
Invasive Species Removal	33.3	State	Edwards et al. (2013)

Marine Debris Removal

Strengths, Weaknesses and Gaps

Generally, estimates of the economic impacts of marine litter or debris focus on direct losses born by economic activities that are negatively affected by the presence of marine debris, but often do not account for costs for social and ecological impacts (Bergmann et al. 2015). Marine debris can also amplify other challenges (like aquatic invasive species [Bergmann et al. 2015]), so generating accurate economic impacts can be difficult. Moreover, marine debris can have wide-ranging economic impacts on recreation and tourism, shipping and yachting, fisheries, aquaculture, agriculture and even human health (Newman et al. 2015). Estimates from efforts to quantify the economic impacts of removal focus mostly on case studies, and range widely depending on the size and scope of the effort, from €8.6 million over 10 years in an effort in the U.K. (Holt 2009) to $32-148 million over three months in California (Leggett et al. 2014) and others have extrapolated case-studies to estimate of €1 billion per year to marine industries in the Asia-Pacific region (McIlgorm, Campbell, and Rule 2011).

Current gaps are large – to our knowledge, there has not been specific analyses that focus on economic impact at mid-sized geographic scales (work often attempts to estimate global scales, or local case studies, without any information between these two extremes). Additionally, though there are some case studies outlining the avoided costs of removing marine debris and litter, there is little information on how debris removal might directly impact jobs. However, a review by Edwards et al. in 2013 estimated an average of 17.3 jobs per $1 million spent across three American Recovery and Reinvestment Act (ARRA) projects. Job types included cleanup crew, small boat operators, administrative staff, marine salvors, welders, heavy equipment managers, lawyers and accountants.

Case Examples

Orange County, CA (Leggett et al. 2014)

This work focused on examining how marine debris influenced people's decisions to go to the beach and what it might cost them, directly assessing the welfare losses imposed by marine debris on citizens who frequently use beaches for recreation. Overall, the study found that reducing marine debris by 50% at beaches in Orange County could generate $67 million in benefits over the course of three months.

Fish Passage and Dam Removal

Strengths, Weaknesses and Gaps

Significant work has gone into identifying areas of interest across the United States where dam removal would have direct positive benefits on diadromous fish species (e.g. steelhead trout, Chinook salmon, American eel; (Patrick 2005)). NOAA's Community-Based Restoration Program that supports grassroots restoration efforts has been particularly successful and can leverage $4-10 dollars for every federal dollar spent by collaborating with communities, government units and nonprofit organizations (Lenhart 2003). Only a few efforts have quantified the number of jobs created by fish passage and dam removal restoration projects, and job creation ranges from 10.4-20.5 jobs per $1 million invested (BenDor et al. 2015; Table 3). Fish passage and dam removal projects typically have below-average project costs compared to other potential projects for the US Coasts and Gulf States, with an average number of direct and total jobs created, indicating a positive return on investment (Edwards et al. 2013). Job types range widely, including environmental consultants, engineers, construction workers, landscapers, lawyers, scientists and administrative positions (Edwards et al. 2013).

Fish passage and dam removal efforts are relatively well-documented among the project types for US Coasts and Great Lakes, but documentation and estimates of job creation are still limited in number, and the few studies that have focused on this topic provide estimates primarily from the Western US (e.g. Edwards et al. 2013), so a direct extrapolation to other geographic areas may generate more or less jobs per $1 million invested.

Case Examples

Eel River Headwater Restoration, MA (Industrial Economics, Inc. & Massachusetts Department of Fish and Game - 2012)

This project involved the removal of six dams, replacement of two culverts and naturalization of 40 acres of wetland near Plymouth, Massachusetts. The project cost was approximately $2.4 million, and IMPLAN analysis showed a total effect of 24.1 worker-years and a total effect output (labor income + total value added) of $3.28 million. The majority of the jobs created were in maintenance and repair, greenhouse and nurseries, and architectural and engineering.

Hydrologic Reconnection

Strengths, Weaknesses and Gaps

Hydrologic Reconnection projects are relatively well-examined, and typically have average project costs but below-average direct and total job creation compared to other project types in the US Coasts and Great Lakes region (Edwards et al. 2013). Work examining 15 ARRA projects showed an average of 14.6 jobs created per $1 million spent, with a variety of created positions, including geologists, engineers, landscapers, heavy equipment operators, construction workers, helicopter pilots, biotechnologists, and project managers.

Though Hydrologic Reconnection projects are relatively well-represented in the few studies that have reviewed job creation and economic impacts (Edwards et al. 2013; BenDor et al. 2015), there are still major gaps in our understanding of their economic impact, including differences among geographic locations, and how the use of expensive specialty equipment and nuanced engineering techniques (Edwards et al. 2013) pay off in the long-term.

Case Examples

Illinois River Naturalization and Floodplain Reconnection (Sparks et al. 2003)

Investments (habitat rehabilitation and enhancement, stream bank stabilization and conversion of agricultural drainage and levee districts into historic floodplains) have been made along the Illinois River. Here, the authors use IMPLAN, in combination with biophysical and ecological models to analyze the benefits of these investments. Overall, they show the addition of 49 jobs and over $2 million in output value (at one of the three sites they analyzed), with the addition of refuge management and recreational development.

Invasive Species Removal

Strengths, Weaknesses and Gaps

Invasive species removal can span both aquatic and terrestrial habitats and are estimated to generate approximately $40.31 billion in economic loss in the United States (Pimentel, Zuniga, and Morrison 2005). While there are success stories of widespread and well-funded programs in other countries (van Wilgen and Wannenburgh 2016; Bek, Nel, and Binns 2017), to our knowledge, the economic impact of only a few programs have been assessed in the US. However, the programs that have been assessed have demonstrated a remarkably high number of jobs per $1 million spent (an average of 33.3 in Edwards et al. 2013), more than double the amount created by other programs like hydrologic reconnection and oyster reef restoration. Invasive species removal projects also had the second-highest average project cost across all ARRA projects reviewed (~$2.25 million; Edwards et al. 2013). Typical positions created were pilots, construction workers, feral goat hunters (due to the nature of the projects analyzed), landscapers and administrative positions.

Overall, many gaps remain. A larger assessment of invasive species removal projects across a wider geographic scope would be useful in determining better estimates of average project costs, and number of jobs created. Additionally, the types of removal programs (aquatic, terrestrial) and scale should be factored in as considerations when assessing economic impact.

Case Examples

Ukuvuka Campaign, Cape Peninsula Table Mount Range, South Africa (Koenig 2009)

One of 300 projects initiated by the Working for Water campaign, started in 1995 that aims to remove 200 invasive plant species that have a myriad of impacts in South Africa, from clogging waterways to heightening wildfire threats. Over 15 years, the campaign has cleared approximately 1 million hectares of invasive species and employed 29,000 part-time employees per year with a $100 million per year effort.

Oyster Reef Restoration

Strengths, Weaknesses and Gaps

Oyster reefs are a vital resource in the Gulf Coast with numerous benefits including direct harvest, marine habitat, water filtering, and shoreline protection (the last of which is estimated to be a $23 billion per year ecosystem service; [Stokes et al. 2012]). The economic impacts of oyster reef restoration projects are relatively under–examined - a summary of 5 ARRA projects using IMPLAN in 2013 showed an average of 16.6 jobs created per $1 million spent, with a wide array of positions from barge and tug operators, fishermen, scientists, technicians, project managers, outreach specialists and others (Edwards et al. 2013). However, average project costs for oyster reef restoration projects were the highest of all the project types examined at approximately $2.5 million, with the lowest job creation per $1 million (Edwards et al. 2013). In a 2012 analysis, Stokes et al. also showed that the vast majority of companies (85%) that would benefit from oyster reef restoration projects qualify as small businesses.

Despite being relatively well-examined (five ARRA projects in Edwards et al. 2013 and one additional case-study added by BenDor et al. 2015), gaps in knowledge about the economic impact of oyster reef restoration projects remain. Specifically, if low job-creation to cost ratios could be increased, and if the continued shifts in climate could drastically impact restoration efforts.

Case Examples

Assessing Planned Oyster Reef Restoration Projects at Mobile Bay, Alabama (Kroeger 2012)

In a 2012 report assessing the benefits of two planned oyster reef restoration projects in Alabama, the author demonstrates significant potential positive economic impacts, including $8.4 million in local output and a total of 88 jobs created where each dollar spent on the project generates $2 in total local economic output and $0.64 in household earnings. This work was analyzed using the RIMS II platform (similar to IMPLAN, used by some federal agencies, but discontinued in 2013).

Riparian Restoration

Strengths, Weaknesses and Gaps

Overall, there are relatively few examinations of the economic impact of wetland restoration (compared to fish passage and dam removal projects and hydrologic reconnection projects). Work from 2013 summarized four ARRA riparian restoration projects (which was combined with living shorelines projects) and presented an above-average amount of job creation (19 jobs per $1 million spent), with a variety of positions created including construction workers, project managers, environmental consultants and administrative positions (Edwards et al. 2013). Riparian restoration projects (combined with living shorelines projects) had the lowest total project costs at approximately $1 million, which delivers a strong benefit to cost ratio in terms of job creation. Additionally, the other example provided by BenDor et al. 2015 summary of riparian restoration projects has an estimated 23.1 jobs created per $1 million, highlighting the potential benefit of these types of projects.

Though the relative economic impacts of riparian restoration projects appear promising, gaps in understanding remain. The work surveyed here represents a small number of projects (5 at most, as this project type is combined with living shorelines in assessments). It is also unknown how geographic region might influence these outputs, as most of the ARRA projects in Edwards et al. 2013 were carried out in the western United States (California, Washington and Oregon).

Case Examples

Economic Analysis of Wetland Restoration Along the Illinois River (Prato and Hey 2006)

This project converted ~1000 hectares of cropland to bottomland forest, backwater lakes and flood-plain wetland habitat. The authors used IMPLAN analysis to estimate an annual net benefit of

$1,827 per hectare restored, for a total us $1.83 million annual net benefit, with an increase to household income by $1.38 million and the creation of 56 jobs.

Living Shorelines

Strengths, Weaknesses and Gaps

Overall, there are relatively few examinations of the economic impact of living shorelines restoration (compared to fish passage and dam removal projects and hydrologic reconnection projects). Work from 2013 summarized four ARRA riparian restoration projects (which was combined with living shorelines projects) and presented an above-average amount of job creation (19 jobs per $1 million spent), with a variety of positions created including construction workers, project managers, environmental consultants and administrative positions (Edwards et al. 2013). Living shoreline projects (combined with riparian restoration projects) had the lowest total project costs at approximately $1 million, which deliver a strong benefit to cost ratio in terms of job creation. The cost-avoidance benefit provided by coastal ecosystems in terms of mitigating waves, floods and storm surge is incredibly valuable, and an analysis in 2008 estimated that a 1-hectare loss in coastal wetlands increased average storm damage of $33,000 (Costanza et al. 2008).

Although examples of studies examining living shorelines is relatively well reviewed (Smith et al. 2020), few studies explicitly outline the economic impacts, and the few that do lump living shorelines projects together with riparian restoration, making a separation of economic impacts between the two project types difficult.

Case Examples

Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay (Leo et al. 2017)
This study outlines a cost-benefit analysis of a suite of coastal climate change adaptation strategies (including living shorelines approaches) for four reaches in southern Monterey Bay. Shoreline changes under a range of sea level rise projections were used in conjunction with predictions for dynamics such as beach erosion, beach nourishment and other physical processes, and the economic costs and benefits for each strategy were outlined. Overall, the work demonstrates that living coastlines approaches (scheduled nourishment and restoration) has significant economic benefits in the long-term (up to $164 million in one scenario).

Upper Mississippi

Overview

Mississippi River Delta ecosystems provide at least 12-47 billion in ecosystem goods and services benefits, and natural capital asset value between 330 billion and 1.3 trillion (Batker et al. 2014). We focused on six main categories of projects: wetland restoration (with an emphasis on floodplain restoration), cover crops, fallowing, restoration of native species, wetlands restoration and riparian restoration. Overall, there was a mix of coverage for examinations of the economic impact of different environmentally beneficial investments – one major complication is the combination of project types in this region (e.g. it’s not always clear whether a project is riparian restoration, wetlands restoration, native species restoration or a combination). Projects that fell into in-stream or riparian categories had relatively high economic impact with 31.5 and 23.1 jobs created per $1 million spent, respectively.

Table 4 Job creation by project types relevant to the Upper Mississippi Region (adapted from BenDor, Livengood, et al. 2015)

Type of Restoration	Jobs per $1 Million Invested	Geographic Scale (State)	Source
Wetland	6.8	County	Derived from DOI (2012)
Wetland	12.9	State (MA)	Industrial Economics (2012)
Wetland	17.6	State (OR)	Neilson-Pincus and Moseley (2010)
Wetland	30	Region (MRS)	Batker et al. (2014)
River	9.7	County	Derived from DOI (2012)
Dam removal	20.5	State (CA)	Kruse and Scholz (2006)
River	9.7	County	Derived from DOI (2012)
In-stream	14.7	State (OR)	Neilson-Pincus and Moseley (2010)
In-stream	31.5	State (MT)	Shropshire and Wagner (2009)
Hydrologic reconnection	14.6	State	Edwards et al. (2013)
Riparian	19.0	State	Edwards et al. (2013)
Riparian	23.1	State (OR)	Neilson-Pincus and Moseley (2010)
Watershed Restoration	16.3	State (OR)	Neilson-Pincus and Moseley (2013)
Watershed Restoration	2.11 (per project)	Region (Lake Michigan)	Kashian et al. (2014)

Watershed Restoration

Strengths, Weaknesses and Gaps

While there are a number of case studies that have examined the economic impact of watershed restoration on local or regional scales, there has been less effort in examining average economic output and job creation across wider geographic regions in the US. A 2012 study compiled 99 projects from Oregon and used IMPLAN analysis to show an average of 16.3 jobs created per project, with an average economic output of $2.3 million (Nielsen-Pincus and Moseley 2013). This is the combined average of a variety of project types that would fall into the watershed restoration category, including some of the categories described above (riparian, in-stream, wetland, fish-passage and upland). Another examination of a suite of projects (all of which fall under the general category of improve the quality of Lake Michigan) funded by the Fund for Lake Michigan using IMPLAN analysis showed that helping fund 71 projects resulted in creating over 150 jobs with a total economic output of over $14 million (Kashian, Reid, and Kueffer 2014).

Overall, watershed restoration is a broad category of project, and can involve many different efforts. Generally, though there are valuable case studies that clearly demonstrate positive economic impacts on local or regional scales, there has not been a synthesis of the broader economic impacts that these type of recovery efforts can have.

Case Examples

Local Economic Benefits of Restoring Deckers Creek, West Virginia (Hansen and Schrecongost 2005).

In a preliminary IMPLAN analysis, the authors examine the economic impact of potential restoration efforts of the Deckers Creek watershed, which is comprised of 64 square miles near Morgantown

West Virginia. Most of the proposed restoration efforts focus on remediating acid mine drainage pollution including active and passive treatment remediation. Overall, the authors estimate $1.9 million in non-market quality of life value and $1.16 million in local expenditure by increased visitors. Though they do not estimate the number of increased jobs created, they do outline significant benefits to property values (on average ~ $568,000).

Agricultural Practices

Cover Crops

Cover crop systems can provide numerous benefits to farmers interested in increasing sustainability or reducing negative environmental challenges such as soil erosion or chemical runoff. While they can be an added upfront cost to farmers (~$42-$119 per acre; (Bergtold et al. 2019)), they can also provide tremendous economic benefits, including yield benefits, soil protection, fertilizer cost savings, herbicide savings, reduced tillage operations and biofuel feedstock potential, and one estimate has a return of $28 per acre for dryland farming and $7 per acre for irrigated systems (Bergtold et al. 2019).

Based on this review, it appears that there has not been a comprehensive examination of the practice of cover cropping on job creation. Though it's often quoted as an important factor when considering the economic benefits of the practice (e.g. White 2014), the lack of assessment in job creation is one major gap in understanding the full economic impact.

Fallowing

The economic impact of fallowing has been examined in two main contexts: 1) the effect of reduced irrigated acreage and 2) the effect of different cropping systems that include fallowing. In an examination of reductions in irrigated acreage in four river basins in Colorado, Thorvaldson and Pritchett found significant negative economic impacts using IMPLAN analysis across all acreage reductions (between 20k-159.5k acres), ranging from a loss of $13 million to $110 million. However, the goal of this work was to assess what would happen if farms were forced to lower production or go out of business because of a lack of irrigation water, and the analysis doesn't include more nuanced alternative scenarios such as programs that encourage crop switching or cropping systems that incorporate fallowing practices (as opposed to simply describing the economic impact if farms in this particular geographic region stopped production altogether). Analysis of cropping strategies in prairie agriculture in Canada shows that the cost-effectiveness of increased fallowing practices is highly dependent on soil zones and climate, where some areas show increased economic performance in with reduced summer fallow frequency, while other areas do not (Zentner et al. 2002).

Generally, there appears to be a substantial gap in understanding of how modified fallowing practices can impact economies, and while there are some examinations of economic benefits to agriculture (e.g. Zentner et al. 2002), these studies represent summaries of localized case studies, and don't provide an general estimate of the effects, nor do they provide any specific estimated or concrete outputs regarding job creation.

Case Examples
Economic Impacts of Cover Crops for a Missouri Wheat-Corn-Soybean Rotation (Cai et al. 2019)
Researchers examined the economic impact of implementation of a cover crop system over the course of four years in fields growing corn, soybean and wheat. Overall, benefit-cost ratios were above 1 for 5 out of 6 of the experimental fields, with positive yields for corn and soybean (net revenue of $61.31 per acre and $198.10 per acre respectively). Overall, they show that cover crops can lead to an increase in revenue from the cash crop outside of benefits to soil erosion and improved soil health, but that these benefits often take time to accumulate.

Restoration

Restoration of Native Species
Examination of the economic impacts of native species restoration is very limited, despite being a point of discussion about the relative effectiveness of this strategy in the field (Rohr et al. 2018; Hobbs 2009). Native species restoration is also difficult to parse out from other project types with wider scopes – wetland restoration, watershed restoration, riparian restoration and invasive species removal projects could all have components that restore or bolster native species.

Wetlands Restoration
Wetland restoration in the Upper Mississippi River System has been the subject of a lot of work over the last 50 years, as the system is a large complex floodplain river ecosystem that spans multiple states. Wetland and floodplain restoration projects have been proposed as a solution to a myriad of challenges, including flooding (Hey and Philippi 1995) and recurring hypoxic conditions in the Gulf of Mexico (Mitsch et al. 2005), and significant work has shown that riparian wetland restoration has the potential to remove sediment and nutrients from flowing into the Mississippi (Kreiling et al. 2013). Analysis of ecosystem service from wetlands restoration in the Mississippi valley suggests that social value surpasses public expenditure in only 1 year, indicating a strong return on investment, and the authors only focused on three services (greenhouse gas mitigation, nitrogen mitigation and waterfowl habitat), so this estimate is likely a lower bound (Jenkins et al. 2009). Wetlands were also shown to be the most cost-effective way of removing excess nitrogen from the Mississippi River basin compared to two-stage ditches and cover crops (Roley et al. 2016). Though there are few studies that examine the impact of wetland restoration in the Mississippi River System on job creation, it is estimated that projects might create up to 30 jobs for each $1 million spent and can stimulate indirect jobs in industries that supply project materials (Batker et al. 2014).

Riparian Restoration
Strengths, weaknesses and gaps for Riparian Restoration in the Upper Mississippi System are generally the same as in the US Coasts and Great Lakes region (described above), as any of the general assessments of economic impacts includes projects from different geographic regions that are not specific to the Mississippi River System region. Significant work has been done examining projects on the Mississippi that focus on restoring ecological and hydrologic function in riparian wetlands, as well as mitigating nutrient flow into the Gulf of Mexico (Mitsch et al. 2005; Mitsch and Day 2006) but economic impact analyses are rare, and often overlap in scope with wetland restoration projects (see above).

Federal Agency Economic Tracking Protocols

Overview

This review of federal economic tracking protocols found significant variation among departments and agencies in the level of guidance or standard protocols, and on the types of protocols used. Though some agencies use (and have used) the widely used IMPLAN analysis, many of custom modeling and analytical toolkits that solve specific challenges with a division, but often don't produce outputs that are comparable across agencies.

U.S. Department of Agriculture (USDA)

USDA is one of six agencies that uses a general framework which estimates the impact of programs in the American Recovery and Reinvestment Act (ARRA). Additionally, the USDA departmental manual outlines that "federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs" and contain sections outlining guidance that points towards tools for economic analysis (pg. 36), and an entire section devoted to Regional Impact Analysis (pg. 46).

Natural Resources Conservation Service (NRCS)

NRCS has a plethora of IMPLAN-focused resources that outline protocols and methodology. These resources include a summary website with training resources and regional studies, a basic overview, and guidelines for how the agency uses IMPLAN models. Generally, NRCS provides a useful model for access to resources, transparency, and consistent use of a single tool, and has developed a clear protocol to translate their internal financial tracking system and practice codes to IMPLAN sectors.

U.S. Forest Service (USFS)

USFS has a long history with IMPLAN, as it played a role in the creation of FORPLAN (forest planning) and IMPLAN during the development of the models in the 1970s, and continues to use the IMPLAN and a suite of tailored tools today to support "economic impact, contribution and efficiency analysis as well as protocols for assessing ecosystem services." Tailored tools include a number of Excel-based add-ons that focus on a variety of topics, from affected environment analysis and rural community diversity and dependency analysis to support for the ARRA act effort. Specific tools include: TREAT (Treatments for Restoration Economic Analysis Tool) which assists in the estimate of the economic effects of restoration activities tied to the Collaborative Forest Landscape Program, Quick-Silver, which focuses on long-term, on-the-ground resource management projects, and FEAST (Forest Economic Analysis Spreadsheet Tool) which is an older spreadsheet modeling tool that serves as an interface between user inputs imported data from an existing IMPLAN model.

A USFS report outlines requirements for assessing social and economic sustainability in National Forest planning under the 2012 Forest Planning Rule, which requires that officials consider and evaluate existing and possible future conditions and trends of the plan area and assess the sustainability of social, economic and ecological systems within the area, in the context of the broader landscape. Main indicators of economic context are the Montreal Process Criterion 6 indicators (64 indicators in total) and the inclusive wealth index, created by the United Nations.

Farm Service Agency (FSA)

FSA has few documented examples of IMPLAN use, other than one example from a Conservation Reserve Program (CRP).

U.S. Department of Homeland Security

Federal Emergency Management Agency (FEMA)

FEMA partnered with the USFS to create IMPLAN in the early 1970s but has moved toward using an internal risk-modeling tool: HAZUS. HAZUS is a free tool that requires GIS for input and output, and is flexible, but focuses on estimation of impacts (economic and otherwise) of natural disasters (floods, earthquakes, tsunamis and hurricanes). FEMA provides a lot of documentation and resources on HAZUS, including detailed technical manuals and manuals specific to disaster types, such as floods (which projects economic impact assessments for state and federal resource allocation and support, including supporting the declaration of a state and/or federal disaster by calculating the economic impact on public and private resources). Additionally, FEMA uses a Cost-Benefit Analysis Toolkit that is required for grant applications and is used to determine the cost-effectiveness of projects.

U.S. Department of Commerce

Bureau of Economic Analysis (BEA)

The BEA eliminated the RIMS II Product (Regional Input-Output Modelling System) in 2013.

National Oceanic and Atmospheric Administration (NOAA)

A 2010 panel was conducted in acknowledgement that NOAA's economic impact tracking required more attention.

NOAA Fisheries

The Fisheries Economics and Social Sciences program uses IMPLAN to model the economic impact of commercial fishing, with a focus on annual reporting. Additionally, NOAA Fisheries formed a formal National IMPLAN Working Group in 2001, with a goal of 1) ensuring that economic impacts are estimated consistently within the agency and 2) placing a focus on training, building a national model for commercial fisheries, and developing recommendations for the development of regional models. There are a variety of use examples from NOAA Fisheries, including a Fisheries Economics report from 2016, a report quantifying ARRA habitat restoration award recipient expenditures, and a report outlining the economic impacts of U.S. Aquaculture.

NOAA Office for Coastal Management

The Office for Coastal management employs a variety of socioeconomic tools, but there appears to be no standardization or use of IMPLAN in the tool library.

SeaGrant Program

SeaGrant manages a PIER (Planning, Implementation and Evaluation Resources) database, and requires that economic benefits and impacts are reported directly, so that tools such IMPLAN (but also REMI and BEA RIMS II) can be used to assess the ripple effect of cost savings, revenue and jobs. This is outlined specifically in the program's guide to using Economic Evaluation Methodology.

U.S. Department of the Army

Army Corps of Engineers (USACE) - Institute for Water Resources

The USACE Institute for Water Resources uses a regional economic development analysis in their project planning process, focused primarily around two tools: IMPLAN and the Regional Economic System (RECONS [User Guide]). The Institute for Water Resources' Regional Economic Development Procedures Handbook outlines that RECONS is used extensively, and is the only USACE certified Regional Economic Development model certified for agency-wide use, as IMPLAN is deemed powerful, but many of the embedded industries are not applicable to the USACE. RECONS is very close in function to IMPLAN and was built by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations by the IMPLAN group.

Environmental Protection Agency (EPA)

The EPA uses Economic Impact Analyses to understand the economic implications of regulatory policies and has documented guidelines that outline internal best practices. Specifically, they use a modelling framework called SAGE, which is an applied general equilibrium model designed specifically for the analysis of environmental regulation and policies. Broadly, the model uses IMPLAN data and then disaggregates these data to further refine sector inputs. The EPA has also designed EMPAX-CGE, another applied general equilibrium model, which focuses specifically on the analysis of air pollution regulation.

U.S. Department of Housing and Urban Development (HUD)

Community Development Block Grant - Disaster Recovery Fund and Mitigation

Multiple grants and projects have embedded requirements for demonstrating cost-effectiveness and economic impact of projects, but there appears to be no standard toolkit or protocol. For example, mitigation grants require a demonstration of benefits via the FEMA BCA Toolkit, while Rebuild by Design projects must submit a Benefit-Cost analysis (which no specific methodology), and documentation also allows grantees receiving Community Development Block Grant Mitigation (CDBG-MIT) funds to identify and document jobs created and retained.

U.S. Department of the Interior (DOI)

IMPLAN is used widely in the Department of the Interior. Annual economic reports indicate use across agencies (detailed below), and DOI has also led focused workshops and reports on the role of Economics at the Department of Interior.

National Park Service (NPS)
NPS identified a need for a systemic Socioeconomic Monitoring program and ran a pilot project from 2014-2017, while using IMPLAN for reporting on the effects of visitor spending.

Bureau of Land Management (BLM)
BLM appears to rely heavily on IMPLAN and the internal FEAST program (also used by USFS). Many individual Resource Management Plans and Environmental Impact Statements use IMPLAN for analysis including work developing Resource Management Plans for Western Oregon, drafting Resource Management Plans and Environmental Impact State in New Mexico, and a Social and Economic Impact Analysis report in Eastern Colorado.

U.S. Fish and Wildlife (USFW)
USFW has a Branch of Economics, which is an internal group that conducts economic analyses for regulatory decision-making, hydropower relicensing, endangered species critical habitat designation, natural resource damage assessment, National Wildlife Refuges and National Fish Hatcheries and natural resource based economic development. IMPLAN has been used in a number of projects including a report on the economic benefits of Coastal Program Restoration Projects and a report focusing on the economic contributions of recreational visitation to local communities near National Wildlife Refugia.

U.S. Bureau of Reclamation (USBR)
USBR has a clear guide that outlines the Bureau's best practices for estimating Regional Economic Impacts and Economic Analysis and has used IMPLAN in a variety of projects including Regional Economics Modelling of the Sites Reservoir Project, and an Environmental Impact Statement for long-term operations in the Central Valley Project and State Water Project.

U.S. Bureau of Geological Survey (USGS)
USGS uses a Benefit Transfer Toolkit that compiles economic values estimates and information on resources not priced in conventional markets, which was developed in collaboration with NPS and BLM. The toolkit is wide-ranging and includes a large amount of data in the form of spreadsheet-based databases from 500 existing original valuation studies. USGS also uses an Assessing Socioeconomic Planning Needs (ASPN) tool to provide guidance on appropriate social and economic methods to address identified issues.

U.S. Bureau of Indian Affairs (BIA)
IMPLAN appears to be used frequently by BIA. Specific work has focused on challenges of tribal business data in IMPLAN, and there are specific use examples including a report on the economic impact of a downstream casino resort in Oklahoma, and the Chickasaw nation's response to a Department of Interior letter. Additionally, though the language in the description of Native American Business Development Institute Grants outlines that proposal should be evaluated on potential to create jobs and stimulate economic activity, it doesn't provide clear guidance on how economic development should be tracked.

State and Other Organization Use

Florida Division of Emergency Management's Bureau of Mitigation

Florida's Division of Emergency Management (DEM) operates to reduce or eliminate long-term risks to property and human life from natural disasters by implementing mitigation activities. The DEM is frequently funded by FEMA, but also receives funding for a variety of state sources. In a report from 2011, the DEM outlines an IMPLAN analysis to demonstrate that DEM created 12,206 full-time jobs as a result of mitigation activities, equivalent to 1,525 jobs per year.

National Fish and Wildlife Foundation (NFWF)

NFWF has a model of working with third-party experts to conduct evaluations of conservation programs, which includes cost-effectiveness and an understanding of the long-term economic benefits of projects. One example of this third-party evaluation is a report on a joint project between DOI and NFWF in 2019 - the Hurricane Sandy Coastal Resilience Program. Ultimately, the economic-focused outcomes of this evaluation acknowledge that the DOI and NFWF do not have adequate economic tracking models, and these tools would allow for better financial tracking and oversight, while also providing a source of contingency funding for project shortfalls.

Summary of Job Creation

Table 5 below is a summary of all the tables in geographic regions above. It builds on work by BenDor, Livengood et al. 2015, but adds a variety of examples and estimates from across geographic regions and project types.

Table 5. Total job creation by project type (adapted from BenDor, Livengood, et al. 2015)

Type of Restoration	Jobs per $1 Million Invested	Geographic Scale (State)	Source
Watershed restoration and management	6.8-39.7 (avg: 23.25[13])	Multiple	See Table 1 and Footnotes
Upgrade AG Irrigation Infrastructure	4.9	Local (Yakima, WA)	See Table 1 and Footnotes
Invest in Urban Water, Sewer and Storm Water	3.6-15.5 (avg: 9.55)	Multiple	See Table 1 and Footnotes
Expand Urban Water Efficiency Programs	12-26 (avg: 19)	National	See Table 1 and Footnotes
Forest, land and watershed	39.7	National	Garrett-Peltier and Pollin (2009)
Grassland	13.0	County	Derived from DOI (2012)
Upland	15.0	State (OR)	Neilson-Pincus and Moseley (2010)
Fish passage	10.4	State (MA)	Industrial Economics, Inc. (2012)
Fish passage	15.2	State (OR)	Neilson-Pincus and Moseley (2010)
Fish passage/dam removal	18.2	State	Edwards et al. (2013)
Dam removal	10.3	State (MA)	Industrial Economics, Inc. (2012)
Dam removal	20.5	State (CA)	Kruse and Scholz (2006)
River	9.7	County	Derived from DOI (2012)
In-stream	14.7	State (OR)	Neilson-Pincus and Moseley (2010)
In-stream	31.5	State (MT)	Shropshire and Wagner (2009)

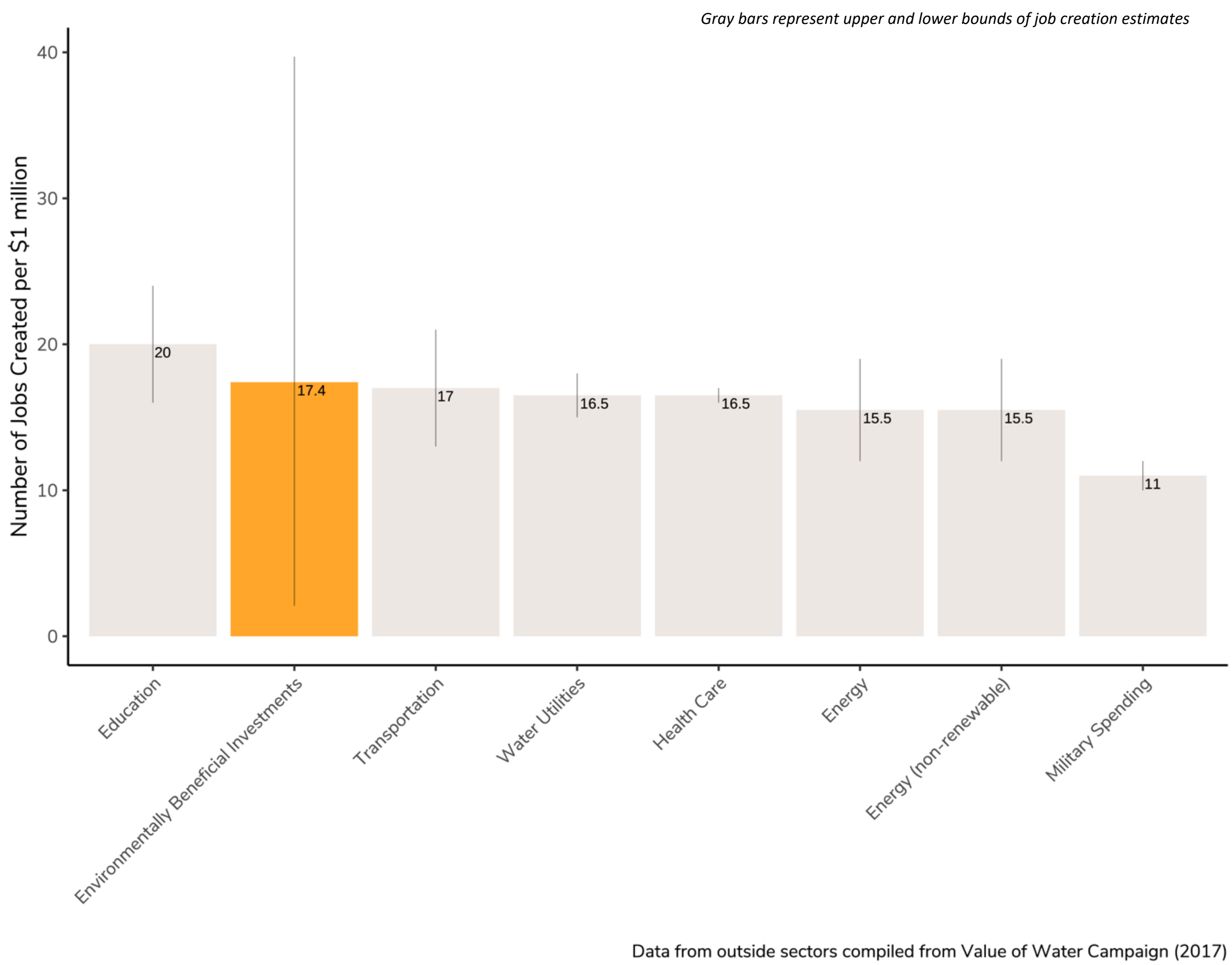
[13] Includes some job creation range data from BenDor, Livengood et al. 2015 – average of this range is used to calculate total average.

Hydrologic reconnection	14.6	State	Edwards et al. (2013)
Hydrologic reconnection	49 (total, no project costs reported)	Region (Illinois River)	Sparks et al. (2015)
Riparian	19.0	State	Edwards et al. (2013)
Riparian	23.1	State (OR)	Neilson-Pincus and Moseley (2010)
Riparian	30.6	Region (Illinois River)	Prato & Hey (2007)
Oyster reef	16.6	State	Edwards et al. (2013)
Oyster reef	20.5	County	Kroeger (2012)
Tidal Marsh	7.1	County	Derived from DOI (2012)
Invasive Species Removal	33.3	State	Edwards et al. (2013)
Watershed Restoration	16.3	State (OR)	Neilson-Pincus and Moseley (2013)
Watershed Restoration	2.1	Region (Lake Michigan)	Kashian et al. (2014)
Wetland	6.8	County	Derived from DOI (2012)
Wetland	12.9	State (MA)	Industrial Economics (2012)
Wetland	17.6	State (OR)	Neilson-Pincus and Moseley (2010)
Wetland	30	Region (MRS)	Batker et al. (2014)

Comparisons to Investments in Other Sectors

Overall, environmentally beneficial investments rate the second highest in average number of jobs at 17.4 jobs created per $1 million when compared to other sectors and expenditure types (Figure 1). The review shows a large spread among estimates of job creation for environmentally beneficial investments with some projects that are very low (2.1 jobs per $1 million), while others have tremendous potential for job creation (39.7 jobs per $1 million), which is more than three times the job creation of a similar $1 million in military spending. Of the sectors compared, education is the only sector that ranks higher. Environmentally beneficial investments rank roughly equivalent to the transportation sector and above the water utilities, health care, and energy sectors.

Figure 1. Average Job Creation of Environmentally Beneficial Investments per $1 million is higher than most other sectors



Recommendations

Recommendations for developing analyses or strategies needed to make a more robust economic case for investing in environmentally beneficial water projects:

1. **Develop credible methodology for scaling job creation and economic benefits to meaningful funding levels**. There are likely limitations in the job and economic benefit data that require a nuanced approach to forecasting. An additional literature review on forecasting techniques and subsequent development of a scaling methodology would provide increased confidence in the projections.

2. **Develop analysis and business case for a jobs first approach to investment.** Given the scale of unemployment and the significant likelihood that many small businesses will fail in the coming months, job creation and economic development will become an increasingly high priority. Building off this preliminary analysis, the development of a jobs first approach could

drive significantly more funding into environmentally beneficial investments than previous thought feasible.

3. **Encourage a typology of job creation.** Some analyses report the types of jobs that are created (or projected). Continued encouragement of reporting on these data is recommended, and continued assessment using these data as criteria for success. These data are incredibly useful in identifying 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.

4. **Develop and deploy a cost-benefit ('bang for your buck') index.** Though a metric of this type is hinted at in Edwards et al. 2013, it is not used consistently, and could provide a powerful unified way to assess the economic benefits and successes of environmentally beneficial investments. It would be helpful to incorporate jobs created per $1 million spent, as well as economic outputs generated by ecosystem services scaled by project costs as a starting point.

5. **Account for the future impacts of climate change when assessing the efficacy and economic impacts of environmentally beneficial investments.** Very little work has explicitly incorporated future climate projects directly into scenarios when estimating economic impacts. As global climate continues to shift, and different geographic regions are impacted it is crucial to take the long view and encourage an increased focus in incorporating state-of-the-art climate projections into economic analyses.

6. **Develop a cohesive strategy for integrating economic analyses among governmental agencies**. This review of economic analysis protocols across agencies shows that 1) many agencies do not have concrete methodology outlining best practices for economic analyses related to environmentally beneficial investments and 2) the agencies that do use a myriad of tools, which are useful in specific use-cases within an agency, but don't allow for direct comparisons across agencies. Pursuing a strategy that either unifies guidelines to use the most widely-used framework (IMPLAN) or developing a national conversion chart that allows for a direct comparison of project inputs and outputs across agencies is recommended.

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