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Measuring the Short-Term Economic Impacts of Ecological Restoration[1]

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Abstract

Increasing demand for ecological restoration has resulted in a multitude of restoration efforts in the United States. Restoration efforts involve substantial capital and labor investments, which are evident in the planning and construction phases of restoration efforts. These investments can lead to short-term economic impacts, which can be appropriately calculated based on traditional economic impact analysis methods. This publication describes the relevant economic impact analysis methods and summarizes a case study application of these methods for the restoration of the Lone Cabbage Reef (LCR) complex, a recently restored oyster reef in Florida. The information in this publication should be useful to local governments, outreach and Extension agents, and land and coastal management agencies who want to better understand the economic impacts of ecological restoration actions.

Introduction

Estuarine and coastal environments have been greatly affected by the ongoing climate crisis and anthropogenic impacts, including sea-level changes, changes in freshwater flow, changes in precipitation patterns, changes in prevalence of pathogens, and changes in frequency and intensity of coastal storms (Scavia et al. 2002; Harley et al., 2006; Halpern et al., 2007). In response to these and other changes, there has been an increase in ecological restoration efforts, especially in keystone habitats important to Florida, such as tidal wetlands, oyster reefs, and seagrass beds (NAS 2017). Restoration of these crucial but sensitive habitats often requires large investments in terms of both capital and labor, involving many people, industries, and activities, which can have significant economic effects (Mohr and Metcalf 2018). Often, a large portion of such investments comes during the preliminary stages of ecological restoration (in this context, the planning and construction phases of a restoration project), meaning that these stages of the project can be particularly important to local economies. Calculating the short-term economic impacts of these phases of restoration can be important for understanding both the immediate and overall effects of restoration activities.

While the planning and construction phases of an ecological restoration project are often short-lived, the economic impacts of these phases of the overall project are likely to be some of the first noticeable effects of restoration. Unfortunately, most restoration studies focus on the ecological outcomes of restoration efforts and overlook how the preliminary stage of restoration can affect regional economies (NAS 2017; Browne et al. 2018; Bayraktarov et al. 2019). In addition to providing an understanding of the investments directly associated with the planning and construction phases of a restoration project, estimation of the short-term economic impacts associated with these

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investments can provide information on the number of jobs supported or the sales revenues associated with these phases of the project throughout the broader regional economy.

This publication describes how to measure the broader regional economic impacts of the planning and construction phases of ecological restoration projects, also referred to as the short-term economic impacts of ecological restoration. The publication first describes a method that can be used to calculate the short-term economic effects of ecological restoration. Then, the publication provides an example of such an analysis based on the restoration of the Lone Cabbage Reef (LCR) Complex in Suwannee Sound, Florida. Additionally, the publication provides a glossary for commonly used terms related to economic studies. The information in the publication should be useful to local governments, outreach and Extension agents, and a variety of land and coastal management agencies who want to better understand the total effects of restoration actions. Specifically, it should guide efforts to evaluate the restoration from a socioeconomic perspective.

Economic Impact Analysis

Economic impact analysis is one of the most appropriate methods used to assess the immediate economic effects of restoration efforts in a region. Economic impact analysis measures the total amount of economic activity generated through multiple rounds of spending that are initiated by restoration expenditures (Miller and Blair 2009). In doing so, it provides a better understanding of how changes in spending (i.e., purchases of commodities and services to help restore a wetland) can cause a ripple effect of additional spending throughout the economy. It is important to understand that economic impact analyses do not calculate benefits to individual people, economic value, or economic surplus (see Camp et al. in review, for details).

A few key factors should be considered when conducting an economic impact analysis. General considerations include the economic and spatial scale of a project, the composition of the regional economy of interest (e.g., county, metropolitan area, region, state), and the extent to which local industries are involved with the restoration project. These factors influence the final economic impacts of a restoration project beyond the substantial capital and labor investments that are needed to conduct restoration efforts. These investments are referred to as **direct expenditures** (or **direct effects**) because they are spent directly on restoration activities. These expenditures lead to additional rounds of spending, namely **indirect effects** and **induced effects**. Indirect effects are the business-to-business expenditures that are initiated from the direct expenditures. For example, an oyster restoration project will require the goods or services produced by a variety of local industries to complete the project. A local company might be hired to provide the equipment used to place concrete on the restoration site. These businesses are paid to provide these goods or complete these tasks (i.e., direct effects); they will, in turn, spend a portion of that money on other materials, employee wages, rent, and other business expenditures (i.e., indirect effects). The remainder of the money paid to local businesses is either spent on goods and services outside of the local economy or saved and is considered to "leak out" of the rounds of spending. Similar interindustry purchases occur throughout several rounds of spending until the proportion of the expenditures remaining within the regional economy are negligible. Employees of the business that are supported through direct and indirect expenditures then spend a portion of their wages in the local economy (i.e., rent, groceries, utilities). These expenditures constitute induced effects. The direct, indirect, and induced expenditures can be summed to quantify the **total economic impacts**, which describe the total economic activity that was generated by initial expenditures within a region. Thus, the larger the scale of the restoration efforts and the more of these expenditures that remain within the local economy, the larger the opportunity for sizable, short-term economic impacts of restoration.

Total economic impacts can be expressed in several metrics, including **output**, **value added**, **labor income**, and **employment**. Output is the total value of industry activity (e.g., sales revenue). Value added describes the total value that is contributed to the region's gross domestic product (GDP). Labor income represents the total value that is spent on employee wages and salaries as well as proprietor income. Employment is measured as jobs (both full-time and part-time) that are supported by the economic activity. It is important to note that each of these four metrics is a different measure of economic activity, which means they are not additive. These metrics can be used to gain a more in-depth understanding of how the economic activity is being generated.

One method of estimating the economic impacts of an activity, such as restoration, is Input-Output (IO) analysis. To do these analyses, one must know quite a bit about the specific region's economy, not only in terms of its size but how the different components of the economy are related to one another and how money and jobs move through the system. Usually, researchers use a licensed version of the **Impact Analysis for Planning (IMPLAN)** regional economic modeling software (IMPLAN Group, LLC, 2019), or a similar software package, that includes data on the size and structure of the regional economy. IMPLAN is a trusted source of county- and state-level economic data that includes details on a region's economic structure, such as the value of production of goods and services for each of the region's industries, intermediate and final consumption of the goods and services produced, inter-regional trade flows, capital investment, taxes, and transfer payments. Within this software, users can also customize the region of study by combining areas based on administrative boundaries (e.g., counties, states, etc.) to ensure the region of study accurately represents the restoration activity's economic region of interest. Defining the region is important when someone might be interested in the economic impacts of expenditures that might happen across several counties that make up a metropolitan statistical area or a multi-county area under the purview of one regional development council. Additionally, the software allows the user to assign expenditures to one or more of 546 **industry sectors**. Each of these industry sectors is representative of an individual industry or group of industries that produce similar products or services or have similar production processes. The expenditures associated with the activity being analyzed (e.g., an ecological restoration effort) are assigned to the appropriate industry sectors and essentially drive the economic impact analysis within the IMPLAN software.

With some planning, data, and a bit of analysis, one can assess the short-term economic impacts of a restoration project. One would need to have detailed information on how much money was spent, on what, and, importantly, whether the goods and services were purchased from within the specified local economy or not. One would generally need to have a product license for IMPLAN and the appropriate associated databases (it is not free, but often universities, management agencies, or Extension agents will have access to it through a licensed user in their organization). To run the analysis, one not only needs to know a bit about IMPLAN or IO analysis methods generally, but also must make decisions about what specific metrics to focus on and present for the research question at hand. Total output (in dollars) and employment (in jobs) tend to be the most commonly used metrics for restoration projects, though multiple metrics can be assessed with the same study because each provides additional information on the overall economic effects of the activity being assessed. Estimating the short-term economic impacts of restoration projects can help provide the people involved with the restoration (like those leading the work or even those funding it) with a better understanding of the local economic effects of such projects.

Case Study: Restoration of the Lone Cabbage Reef Complex

A notable type of ecological restoration that has gained an increased amount of attention, especially in the Gulf of Mexico, is oyster reef restoration. Oyster reefs have declined on a global scale (Beck et al. 2011; Camp et al. 2015). This continual decline of wild oyster reefs provides an optimal application for the estimation of short-term economic impacts of restoration and the inclusion of economic impact information within the overall evaluations of ecological restoration efforts. Despite this, there has been a lack of studies assessing the short-term economic impacts surrounding oyster reef restoration (Bendick et al. 2018; Bloomberg 2020). We use the LCR complex restoration as an example to demonstrate how to apply these economic methods, which can be applied to a wide variety of restoration efforts.

The LCR complex is a historically productive oyster reef located in Levy County, Florida (Figure 1). Its degradation over time spurred restoration efforts, which occurred from June to November 2018. This restoration project restored 22 discrete oyster reefs across nearly 5 km and created an opportunity for substantial short-term economic impacts through a multi-million-dollar investment (Figure 1). While the LCR complex is located in Levy County, the LCR complex restoration involved labor and products that were sourced from surrounding counties. As a result, it is necessary to define a functional economic region that encompasses all of the counties that were affected by the expenditures from the restoration efforts. Thus, the North Central Florida Economic Development District was selected as the functional economic region for this analysis (NCFRP 2017).

The expenditures associated with this investment and their assigned IMPLAN industry sectors can be seen in Table 1. The direct expenditures were used as inputs within IMPLAN using the 2018 economic data that were representative of the 12-county region during the restoration project. IO analysis was used to estimate the economic activity within the 12-county region that was generated by the portion of the expenditures directly associated with restoring the LCR complex and that remained in the 12-county region.

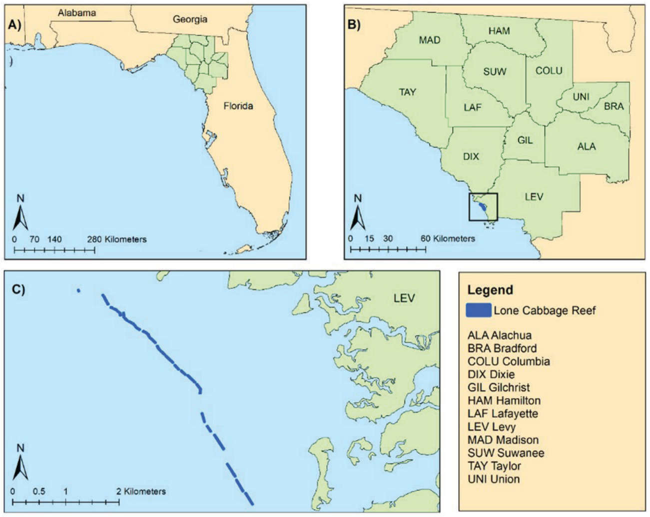

Figure 1. Location of the LCR restoration project and the 12-county region used in analysis, where A) shows the 12-county region in the relation to the state of Florida, B) shows each county included in the analysis and the relative location of the LCR complex, and C) shows a closer look at the LCR in relation to Levy County's coastline.
Credits: ArcGIS software by Esri©, M. Moreno, 2021, personal communication

The economic impact estimates for the LCR complex restoration efforts can be seen in Table 2 detailed by impact type (or effect) for three stages of the project and across four distinct metrics. Notably, the $3.4 million in direct expenditures generated a total industry output of $5 million and supported 44 full-time and part-time jobs. The economic impacts for industry output can be described through an **imputed multiplier** of 1.45, which is the ratio of the total effects to the direct effects. This means that for every $100,000 spent on oyster reef restoration activities in this region, we can expect an additional $45,000 of industry output to be generated. This is substantial and should be included in the full evaluation of this restoration effort, especially considering the expenditures only spanned across half a year. Although the restoration of the LCR complex was conducted with ecological goals in mind, there was an increased impact beyond the ecological system that was felt across a variety of businesses.

Conclusions

Economic impact analysis provides information that can be used by a variety of individuals and institutions. With output metrics such as industry output, labor income, value added, and employment, this analysis provides a deeper understanding of how expenditures can affect multiple aspects of a regional economy. Extension agents and policymakers can use this information to account for local spending patterns associated with various restoration activities, as well as the "ripple effects" that are created through these activities. With a more fundamental knowledge of the economic effects of restoration, governance officials or agencies can determine the merits of supporting new or existing restoration projects. The nature of ecological restoration makes economic impact analysis a useful tool that can be used alongside other economic and ecological analyses. Every ecological restoration activity requires some sort of financial investment, so there will always be some short-term economic impacts created by these expenditures, at least during the construction or implementation phase of the project. Often, these restoration efforts have a detailed budget outline during the planning and/or approval phase, so the costs of implementing a restoration project are already available and can be directly used within the impact analysis. Because of this, Extension agents can work alongside economists to calculate the short-term economic impacts of a restoration project. Having this information readily available can be useful to garner support and a greater understanding for restoration projects, while targeting a wide audience that can include both the general public and local policymakers. Using economic impact analysis in future restoration activities can provide a simple but effective basis for understanding one component of the overall outcomes of the restoration project.

Glossary

Direct effects: initial effects to a local industry or industries due to the activity being analyzed.

Employment: measure of the number of jobs involved, including full-time, part-time, and seasonal positions; one of the output metrics used in IO analyses.

Impact Analysis for Planning (IMPLAN): a computer-based input-output modeling system that enables users to create regional economic models and multipliers for any region consisting of one or more counties or states in the United States. The current version of the IMPLAN software, IMPLAN Pro, accounts for commodity production and consumption for 546 industry sectors, 10 household income levels, taxes to local/state and federal governments, capital investment, imports and exports, transfer payments, and business inventories.

Imputed multiplier: the ratio of the total impact divided by direct effect for any given measure (e.g., output, employment).

Indirect effects: the first component of market activity beyond direct activity; the summed value of input goods and services that are required for the direct market activity and that are sourced from within a region across multiple rounds of spending.

Induced effects: the second component of market activity beyond direct activity; the spending by employees who work in the directly or indirectly supported industries, often including items such as groceries, housing, and clothing.

Industry sector: an individual industry or group of industries that produce similar products or services or have similar production processes.

Input-output (IO) analysis: analysis based on the interdependencies between different economic sectors or industries, which is used to estimate the impacts of economic shocks and analyzes the ripple effects throughout the economy.

Labor income: total amount of money paid to local workers within a region; one of the output metrics used in IO analyses.

Output: dollar value of a good or service produced or sold; equivalent to sales revenue plus changes in business inventories; one of the output metrics used in IO analyses.

Total economic impacts: the sum of direct market activity, indirect activity, and induced activity.

Value added: broad measure of income, representing the sum of employee compensation, proprietor income, other property income, indirect business taxes, and capital consumption; comparable to Gross Domestic Product; one of the output metrics used in IO analyses.

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Table 1. Breakdown of IMPLAN inputs and their associated costs. These data were obtained through the principal investigator's outlined budget. Dollar values are expressed in 2018 USD.

Activity	Cost Breakdown	Expenditure ($)	IMPLAN Code	IMPLAN Sector Name
Pre-Planning	Principal investigator	$51,658.42	5001	Employee compensation
	Principal investigator	$14,187.70	5001	Employee compensation
	Co-principal investigator	$33,596.52	5001	Employee compensation
	Co-principal investigator	$9,274.71	5001	Employee compensation
	BioScientist I	$39,615.05	5001	Employee compensation
	BioScientist I	$15,002.03	5001	Employee compensation
	Engineering services	$60,000.00	457	Architectural, engineering, and related services
	Surveying services	$14,400.00	457	Architectural, engineering, and related services
	Total expenditures	$237,734.43		
Project Management	Contract manager fee	$241,807.11	56	Construction of other new nonresidential structures
	Bonds and insurance	$26,918.69	445	Insurance agencies, brokerages, and related activities
	General liability insurance	$19,660.48	445	Insurance agencies, brokerages, and related activities
	Final clean-up	$6.41	60	Maintenance and repair construction of nonresidential structures
	Temp utilities/facilities	$1,076.30	39	Utilities
	Reproduction of documents	$252.15	152	Printing
	Total expenditures	$289,721.14		
Sitework	Transportation and maintenance costs/travel	$11,725.68	408	Retail – Gasoline Stores
	Transportation and maintenance costs/marine	$20,030.22	408	Retail – Gasoline Stores
	Project manager	$34,011.82	5001	Employee compensation
	Project engineer	$5,343.94	5001	Employee compensation
	Project verification assistance	$5,983.02	5001	Employee compensation
	Superintendent 1	$35,511.43	5001	Employee compensation
	Superintendent 2	$15,817.22	5001	Employee compensation
	Limestone boulders: materials and placement	$2,403,900.00	28	Stone mining and quarrying
	Shell materials and placement[1]	$363,829.27	92	Seafood product preparation and packaging
	Shellfish relocation	$393,750.00	17	Commercial fishing
	Aids to navigation, installation, and materials	$49,020.00	92	Seafood product preparation and packaging
	Survey/maintenance of survey	$74,759.39	457	Architectural, engineering, and related services
	Temporary signage/maintenance of travel (MOT)[1]	$2,908.78	385	Sign manufacturing
	Costs to correct elements	$50,000.00	28	Stone mining and quarrying
	Total Expenditures	$3,466,590.77		

[1] Concerted efforts were made by the project managers to identify local sources of required goods and services. A large majority of shell was sourced from outside of the region, so a local purchasing percentage of 5% was used for the "Shell Materials and Placement" category. Temporary signage was also difficult to acquire locally, so the local purchase percentage of 0.86% was used for the category "Temporary Signage/maintenance of travel (MOT)," as derived from the region's Social Accounting Matrix. For more information on the usage of local purchasing percentages and Social Accounting Matrices, refer to Miller and Blair (2009).

Table 2. Summary of economic impacts of oyster reef construction activities, 2018. Total effects may not equal column sums due to rounding. Dollar values are expressed in 2018 USD.

Industry Activity	Impact Type	Employment (Jobs)	Labor Income (Thousand $)	Value Added (Thousand $)	Industry Output (Thousand $)
Pre-planning	Direct effect	1	$28	$35	$74
	Indirect effect	0	$8	$11	$24
	Induced effect	1	$34	$71	$126
	Total effect	2	$70	$118	$225
Project management	Direct effect	3	$149	$120	$290
	Indirect effect	1	$31	$51	$114
	Induced effect	1	$31	$65	$115
	Total effect	5	$211	$236	$519
Sitework	Direct effect	30	$382	$2,010	$2,997
	Indirect effect	5	$201	$334	$717
	Induced effect	3	$117	$245	$435
	Total effect	37	$700	$2,589	$4,148
Total all activities	Direct effect	34	$558	$2,166	$3,361
	Indirect effect	5	$240	$397	$855
	Induced effect	5	$182	$381	$676
	Total effect	44	$980	$2,944	$4,892