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Economic and Employment Impacts of Forest and Watershed Restoration in Oregon

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With the current political focus on building a green economy as a strategy for economic recovery, there has been an increasing emphasis on investing in renewable energy development, energy efficiency, and businesses that have more sustainable supply chains and end products. Today's focus on a green economy builds on a much longer standing effort in the agricultural and natural resource sectors to foster organic agricultural products, certified wood, and ecological restoration of forests and watersheds. Since the mid-1990s, following "crises" in the Pacific Northwest over owls and salmon, public-land managers and political officials have focused on the need to restore forests and watersheds as a strategy for sustainable land management and economic transition. With the end of the spotted owl crisis and the adoption of the Northwest Forest Plan, the U.S. Forest Service and Bureau of Land Management established a new focus on ecosystem management and creating "jobs in the woods." Since then, federal land management policies have greatly reduced the amount of management activities associated with timber production and increased focus on reducing wildfire hazard and activities to improve forest and stream habitat. Concurrently, the State of Oregon began to invest in watershed restoration on private lands, initially through the Oregon Watershed Health Program and later through the Oregon Plan for Salmon and Watersheds. Oregon's approach has been to foster the development of local watershed organizations (primarily watershed councils) to work collaboratively at the local level to develop assessments of watershed conditions, action plans comprising local natural resource priorities to improve watershed health, and restoration projects that address critical local watershed issues.

The rapid national economic decline that began in 2008 has contributed to Oregon's high unemployment rate over the past two years. The recession has placed public investment on infrastructure on the national and state political agenda. This investment has been linked to job creation and economic stimulus. The green focus of much of the discussion has created the need to understand the job creation and economic impacts of investments in new economic sectors. In many cases, these new green activities may dramatically transform the structure of economic activity. For example, a transition from fossil-fuel energy to renewable biomass energy

not only requires a new combustion system, but also requires the production of forest, agricultural, or waste biomass products. This transition shifts traditional economic activities and creates whole new ones. When these types of transitions occur, estimating the economic impacts of new investments can be difficult because existing models built on traditional activities do not adequately represent the new activities. Estimates of economic impact that do not attend to the changes in the ways goods and services are produced will likely result in inaccuracies.

The shift from traditional natural resource management activities such as timber management and road construction to forest and watershed restoration has dramatically impacted the types of goods and services used to manage forest and streams, including a decline in the role played by wood products manufacturing. But even excluding the shift in manufacturing, considerable change

in natural resource management has occurred. Furthermore, forest and watershed restoration activities do not necessarily fit neatly into traditional economic sectors. Forest and watershed restoration include a diverse set of activities ranging from thinning and hazardous fuels, removing noxious weeds, and modifying culverts, bridges, and damns to improving fish passage and stream habitat. These activities also require project design, data collection, surveying, and engineering in new contexts and for new purposes.

Typically, restoration projects are planned and coordinated by one entity—a government agency (e.g., a local U.S. Forest Service office or a soil-and-water conservation district) or a nonprofit organization (e.g., a watershed council)—but implemented by contractors.[1] The amount of money spent in-house on planning and coordination may vary substantially depending on the type of project. Moreover, although some data exists for contract spending, data for in-house expenditures on project planning and coordination are not readily available.

The purpose of this study was to examine the employment and economic impacts of public investments in forest and watershed restoration in Oregon. We investigated both in-house and contracted restoration activities by creating two different types of economic impact estimates:

- The effects of forest and watershed restoration contracting
- The effects of forest and watershed restoration projects, combining both contracted activities and in-house costs

The Input-Output Model

Oregon's economy consists of many different types of interdependent business activities. In some rural areas, agriculture, forestry, recreation, and tourism are integral components of local economic activity, whereas in more populated areas, technology, manufacturing, and professional services play more important roles. Each sector has differing degrees of dependence on other sectors. Through these linkages, goods and services flow through the economy, income is generated, and jobs are created. An input-output model for Oregon describes these patterns of trade and the degree to which goods and services are sold and purchased outside the state's economy. Based on the dependencies among different economic activities, input-output models can project the impact that changes in one sector will have on economic activity in other sectors of the economy.

The economic impacts from a change in economic activity can be measured in employment, wages, economic output, and other economic measures such as a multiplier. Economic multipliers measure the impact on the economy from a change in policy or a change in production. For example, an employment multiplier for forest and watershed restoration measures the number of jobs created in the economy from each job created doing forest and watershed restoration work. Multipliers and other economic impact measures have three sources: direct, indirect, and induced effects. We describe each source of economic impact in the context of forest and watershed restoration.

1. ***Direct Effects*** are those created by the planning and implementation of the restoration projects. These include, for example, the jobs, wages, and economic activity produced as a government agency, watershed council, or soil-and-water conservation district plans, coordinates, and monitors a salmon habitat enhancement project. We also define direct effects as those created in businesses and other entities contracted to implement the project. Using a salmon habitat enhancement project as an example, direct effects would include the jobs, wages, and economic activity generated by the environmental consulting and design firm that engineers the project, the loggers and equipment operators contracted to gather and place large, woody debris into the stream channel, and the planting crew that uses nursery-grown native plants to revegetate the stream bank and remove invasive weeds.

2. ***Indirect Effects*** are those associated with the demand for materials, supplies, equipment, and other services needed to implement projects. Indirect effects include the increase in sales generated by the increase in direct activity. Again, following our example of a salmon habitat restoration, indirect effects may include sales from a local native plant

nursery, supplies purchased at a local wholesaler of building materials and landscaping supplies, equipment rental for a specialized excavator that can work on the stream bank with minimal impact, repair and maintenance services for tools and equipment, and fuel for travel to the work site and operate equipment. Indirect effects arise out of the patterns of trade of the directly affected sectors as they demand goods and services from other businesses, government entities, and households.

3. ***Induced Effects*** are those produced when people employed in the direct and indirect sectors spend their incomes on goods and services. Induced effects typically include household expenditures for goods and services such as food, housing, medical care, and entertainment. Induced effects are often considered somewhat differently than direct and indirect effects because of their dependence on macroeconomic conditions rather than on industrial patterns of trade (Heintz et al. 2009). When unemployment is high and the economy has the capacity to expand in response to increased consumer demand, employers are more likely to bring on new employees to support increases in consumer activity. In contrast, when the economy is robust or unemployment is low, employers may find that increased consumer demand can be met through increases in worker productivity or a shortage of skilled employees to hire. Given the current economic climate and the significant role public investment plays in encouraging forest and watershed restoration, we expect induced effects to be greater than during better economic times. However, induced effects will be moderated when employers are apprehensive about hiring even in the face of increased consumer demand or when recovery is based on productivity increases rather than employment increases. We suggest that readers view the induced effect as a guide rather than a definitive outcome.

INPUT-OUTPUT DATA

We used the economic impact modeling software IMPLAN 3.0 to describe the impacts from public investments in forest and watershed restoration. We used 2008 Oregon data from the Minnesota IMPLAN Group as the basic economic structure of Oregon's economy. To customize the Minnesota IMPLAN Group's data and develop the economic impacts of public investments in forest and watershed restoration in Oregon, we first used average payroll data from the U.S. Census Bureau for the sectors important to our model. We then collected and used data from three sources to develop custom forest and watershed restoration inputs to our model. We compiled fiscal data from a sample of Oregon Watershed Enhancement Board grants, and conducted surveys of businesses that provide services for forest and watershed restoration projects, and watershed councils that manage forest and watershed restoration projects. All data were inflation-adjusted and reported in 2005 U.S. dollars. Details on our methods, data, and collection procedures are located in the technical appendix.

Oregon Watershed Enhancement Board Grants

We analyzed expenditures from a stratified random sample of ninety-nine Oregon Watershed Enhancement Board (OWEB) restoration grants. We classified projects as in-stream, riparian, wetland, fish passage, forest, and other projects. We then classified invoices from each grant (approximately 3,000 invoices from more than 700 vendors representing nearly $7.5 million in grant expenditures) using detailed North American Industrial Classification System and IMPLAN 440 sectoring system codes. Each invoice was also classified according to whether the vendor is located in Oregon or out of state. Last, we summarized the entire sample of grants by the percentage of expenditures in invoiced in each economic sector.

Survey of Restoration Businesses

We conducted detailed surveys with owners and managers from 190 businesses that were contracted between 2002 and 2008 to provide forest and watershed restoration services. We surveyed contractors who worked on OWEB-funded restoration projects or were hired by the U.S. Forest Service, Bureau of Land Management, or U.S. Fish and Wildlife Service. Contractors reported expenditure patterns for their common restoration activities. They reported the proportion of dollars they typically spend on labor, equipment, repairs and main-

tenance services, several subcategories of materials and supplies, and overhead, including profit. In addition, owners and managers reported the percentage of each expenditure that they typically make within the county where the work occurs as well as the percentage they purchased wholesale or retail versus the percentage they purchased from a manufacturer or producer. We organized contractor data by the types of restoration work that contractors perform.

Survey of Watershed Councils

We elicited from fifteen watershed council coordinators to elicit expenditure patterns on OWEB restoration grants. Watershed council coordinators reported average proportions of expenditures for labor, contracted services, materials, and administrative costs for various types of projects. We used this data to help guide our model allocation of labor and administrative costs for project managers.

CONSTRUCTING ECONOMIC IMPACT MODELS FOR FOREST AND WATERSHED RESTORATION

In the technical appendix we present a detailed discussion of the methods used to construct the economic impact models; here we present a brief nontechnical overview. To measure the impact of forest and watershed restoration contracting on Oregon's economy, we first developed economic impact models for four types of work that restoration project managers typically hire contractors to perform:

- ***Equipment-intensive watershed work*** such as constructing stream habitat features or excavating of floodplain and wetland features
- ***Equipment-intensive forestry work*** such as forest thinning, small-diameter and selective logging, and mowing and masticating ground fuels
- ***Labor-intensive work*** such as site preparation, tree and shrub planting, and cutting small trees and brush by hand
- ***Technical planning and design work*** including conducting field surveys, engineering, and writing planning documents

Each contracting model is based on our survey of forest and watershed restoration contractors. We then created models representing restoration projects by combining the contractor models with models of in-house project management. We defined in-house project management to include grant-recipient spending on labor, materials, and administrative expenses. We created economic impact models for six types of common forest and watershed restoration projects:

- ***In-stream projects*** that focus on enhancing stream habitat and function
- ***Riparian projects*** that focus on enhancing and restoring native riparian vegetation
- ***Wetland projects*** that focus on restoring wetland and estuarine habitat
- ***Fish passage projects*** that focus on removing barriers to fish passage such as culverts and dams, and screening to protect fish from water withdrawals
- ***Upland projects*** that focus on agricultural water management, juniper management, and noxious weed treatments
- ***Other projects*** that typically combine a diversity of the above project types together in one comprehensive restoration project

We developed impact model to examine the effects of $1 million in contracting or project work. We used grant invoices to divide the remainder of spending into the four categories of contracted work. We decomposed the impacts of both the contracting and project models into three effects: direct, indirect, and induced. The direct effect reflects the wages of the sectors from which restoration contractors and project managers typically come and the indirect effect reflects the requirements for supplies and services specific to restoration work. Induced effects represent the household consumption by employees in the sectors affected by the direct and indirect effects. We consider the employment, total economic output, and main economic sectors affected by the indirect and induced effects.

Results

We first examine the economic impacts of restoration contacting and then turn to exploring the impacts of restoration projects.

ECONOMIC IMPACTS OF CONTRACTING FOREST AND WATERSHED RESTORATION

Employment by Contractor Type

Our model predicts that $1 million invested in forest and watershed restoration contracting will generate between 15.7 and 23.8 jobs, depending on the work type (Table 1). Investments in labor-intensive contracting create the greatest number of jobs, whereas technical and equipment-intensive watershed contracting creates the fewest jobs. Direct effects on employment ranged from 4.8 (equipment-intensive watershed) to 13.1 (labor-intensive) jobs per $1 million invested in each work type (Table 1). Direct employment effects followed a predictable pattern. For example, equipment-intensive watershed contracting resulted in the smallest direct effect (4.8 jobs per $1 million) because labor makes up a relatively small proportion of spending (36 percent) and per worker payroll costs are relatively high (about $55,000) compared to other contracted work types. By contrast, labor-intensive work has the largest direct employment effect (13.8 jobs per $1 million). Labor makes up a relatively large proportion of spending in labor-intensive work (67 percent) and payroll costs are relatively low (about $31,000 per job) resulting in more jobs, albeit lower-wage jobs.

Indirect employment effects ranged from 3.9 to 5.7 jobs per $1 million. The largest indirect effects occur in the two equipment-intensive work types, reflecting their relatively large proportion of nonlabor expenditures (approximately 65 percent) for equipment, materials, and other services.

Labor-intensive contracting has the smallest employment multipliers (1.3–1.8), again reflecting the relatively large requirements for direct labor and the relatively smaller amount of economic activity that is created through indirect effects. Equipment-intensive watershed contracting has the largest employment multipliers (2.2–3.3), reflecting a pattern of labor and other factors of production opposite from labor-intensive contracting.

Economic Output by Contractor Type

An investment of $1 million in each contracted work type to Oregon contractors results in a total economic output ranging from $2.1 to $2.4 million. The two equipment-intensive contractor types create the greatest indirect economic impacts (more than $800,000), whereas the indirect effect of labor-intensive activities is only about $450,000. The greater indirect economic impact of equipment-intensive activities is the result of larger requirements for supplies and services rather than labor needed to conduct equipment-intensive work. In contrast, the smaller indirect effects for labor and technical contracting reflect the larger requirements for labor and smaller requirements for supplies and services. Output multipliers are smallest for technical (1.4–2.1) and labor (1.5–2.2) contracting, again reflecting the relatively greater requirements for labor. Output multipliers are greatest for the two equipment contracting types (1.8–2.4), again reflecting a pattern of limited labor needs and greater use of supplies and services than labor and technical contracting types.

Economic Sectors Affected by Contracting

Beyond the direct effects of employment and economic activities for labor, equipment, and technical work, restoration contracting leads employment and economic activity in a variety of other economic sectors. Consistently across all four contracting types, the top two economic sectors affected are wholesale and retail trade, including transactions for fuel, wood products, rock, metal, and other building and landscaping products. Impacts to wholesale and retail trade from $1 million invested in forest and watershed contracting range from about $130,000 for technical planning and design work to nearly $450,000 in equipment-intensive forestry work and resulting in between 2.5 and 3.1 jobs in those sectors. Other common but less affected sectors include employment services, commercial and industrial machinery rental, commercial and industrial machinery repair and maintenance, and professional services (insurance brokers, accountants).

EFFECTS OF FOREST AND WATERSHED RESTORATION PROJECTS

We constructed restoration project models that combined the contracting models with a model for project management to evaluate the impact of $1 million invested in each forest and watershed restoration project. We then

report the percentages of each contracting component that is awarded to Oregon-based businesses. Last, we report the effects of restoration projects on employment, economic output, and other economic sectors.

Composition of Restoration Projects

We conceptualized restoration projects as a combination of contracting and project management (in-house labor, materials purchases, and administrative costs). We used grant invoices to allocate a project's cost to each component (Table 2). Overall, project management makes up approximately 55 percent of total project costs; the remaining costs are then allocated to contracting: technical planning and design (4 percent), equipment-intensive watershed work (34 percent), equipment-intensive forestry work (5 percent), and labor-intensive work (2 percent). Project management costs are highest for riparian projects (80 percent) where grant recipients often manage the purchasing of nursery grown native plants, planting supplies and equipment, and labor to implement projects (labor may consist of a mix of in-house labor, temporary work crews, and volunteers). By contrast, wetland and fish passage projects have the smallest project management components (about one-third of project costs) and largest equipment contracting components (more than 60 percent of project costs). Equipment contracting tends to occur more for watershed than forestry work, except in upland contracts where the two types of equipment contracting are equal (14 percent). Contracting for labor-intensive work tends to be relatively small across all project types (5 percent or less), while technical planning and design costs typically range from 2 percent to 8 percent of project costs.

Oregon-Based Purchasing and Contracting

Depending on the type of purchase, project managers bought between 0 percent and 100 percent equipment, materials, and services from vendors in Oregon. For example, across all restoration projects, purchases of quarried rock were entirely from Oregon-based quarries, while 80 percent of wholesale purchases were from wholesalers located in Oregon and only 22 percent of fabricated structural metal products—used in bridges, culverts, and agricultural diversions—were purchased in Oregon. Specific values for in-state purchases for project management expenditures are reported in the technical appendix.

Grant recipients contracted almost entirely with Oregon-based businesses. With one exception, the grant invoice

Table 1. Employment and output effects per $1 million invested in forest and watershed contracting

Employment (jobs)	*Labor-intensive contracting*	*Equipment-intensive contracting (watershed)*	*Equipment-intensive contracting (forestry)*	*Technical contracting*
Direct effects	*13.1*	*4.8*	*6.6*	*8.7*
Indirect effects	*4.4*	*5.7*	*5.4*	*3.9*
Induced effects	*6.3*	*5.2*	*5.2*	*6.5*
Total effects	*23.8*	*15.7*	*17.2*	*19.1*
Multiplier[1]	*1.3–1.8*	*2.2–3.3*	*1.8–2.6*	*1.4–2.2*
Economic output				
Direct effects	*$1,000,000*	*$1,000,000*	*$1,000,000*	*$1,000,000*
Indirect effects	*$472,068*	*$814,997*	*$810,804*	*$408,638*
Induced effects	*$681,334*	*$565,189*	*$567,191*	*$704,418*
Total effects	*$2,153,402*	*$2,380,186*	*$2,377,995*	*$2,113,056*
Multiplier[1]	*1.5–2.2*	*1.8–2.4*	*1.8–2.4*	*1.4–2.1*

[1] The multiplier is reported as a range reflecting the Type I and Type II multiplier values. The Type I multiplier is calculated as the sum of the direct and indirect effects divided by the direct effects. The Type II multiplier equals the sum of all effects divided by the direct effect. For more detailed discussion on multipliers, see the technical appendix.

data show that more than 90 percent of contracts by restoration project managers occurred with Oregon-based businesses, ranging from 93 percent for labor-intensive work, 95 percent for equipment-intensive watershed work, and 100 percent for equipment-intensive forestry work. However, technical planning and design work is more variable, with some activities like environmental consulting occurring exclusively with Oregon-based businesses and others such as engineering services involving out of state contractors that potentially represent specialties not available (or in limited supply) in Oregon.

Employment by Project Type

The number of jobs created or retained range from a low of 14.7 jobs per $1 million invested in in-stream projects to 21.1 jobs per $1 million invested in riparian projects (Table 3). The direct effects on employment ranged from 3.7 (upland projects) to 7.4 (riparian projects) jobs per $1 million invested. The patterns of direct effects by project type can best be explained by the labor costs associated with each component of a project. For example, although 62 percent of upland project costs and 80 percent of riparian project costs are expended on project management, the percent of project management spent on labor is very different for the two project types. Labor costs for riparian projects consumes more than a quarter of project expenses, while upland project costs are less than 7 percent labor. Furthermore, more than a quarter of upland project costs are contracted to equipment operators, which also tend to have relatively smaller labor requirements. Indirect employment effects ranged from 5.9 to 8.2 jobs per million invested, with the largest indirect employment effects resulting from riparian projects. Although the indirect effects may seem counterintuitive given the above discussion about high labor costs for riparian projects, project managers coordinate the majority of riparian projects directly, only contracting about 20 percent of total project costs to other restoration contracting businesses. Project managers then spend about 55 percent of total riparian project costs on equipment, materials, and other services thereby boosting indirect effects.

In general, restoration projects tend to have relatively high employment multipliers (2.7–3.8), meaning that for every job created doing the direct work of forest and watershed restoration projects, between 1.7 and 2.8 additional jobs are created in other parts of the economy. Riparian projects have the smallest employment multipliers (2.1–2.8), again reflecting the relatively large requirements for direct labor, and therefore relatively smaller indirect effects. Upland projects have the largest employment multipliers (2.9–4.0).

Economic Output by Project Type

The total economic impacts of all types of projects were relatively similar, with an investment of $1 million leading to total economic output in the range of $2.2 to $2.5 million (Table 4). Direct effects of a $1 million dollar investment in forest and watershed restoration projects range from more than $950,000 to nearly $995,000. This means that project managers hire between 95 and 99.5 percent Oregon-based businesses for contracted work. Indirect effects range from about $735,000 to about $985,000. Upland projects have the largest indirect ef-

Table 2. Percentage of restoration project costs by contracting type and project management

	Labor-Intensive	Equipment (Watershed)	Equipment (Forestry)	Technical Planning and Design	Project Management	Total
All restoration projects	*2*	*34*	*5*	*4*	*55*	*100*
In-stream	*1*	*43*	*4*	*2*	*50*	*100*
Riparian	*3*	*8*	*0*	*8*	*80*	*100*
Fish passage	*<1*	*59*	*5*	*3*	*33*	*100*
Wetland	*1*	*61*	*<1*	*6*	*31*	*100*
Upland	*2*	*14*	*14*	*7*	*62*	*100*
Other	*5*	*17*	*<1*	*7*	*71*	*100*

fect due to the relatively small labor requirements and relatively larger costs for equipment, materials, and other services both in project management and the two equipment-intensive work types.

Output multipliers for all restoration projects range from 1.9 to 2.4, indicating that every dollar invested in forest and watershed restoration results in an additional $0.90 to $1.40 in additional economic activity as project managers and contractors purchase goods and services, suppliers restock their inventories, and employees spend their wages. Output multipliers are smallest for in-stream projects (1.7–2.2) and greatest for upland projects (2.0–2.6), reflecting the relatively larger requirements for materials and supplies on upland projects and relatively limited labor costs.

Economic Sectors Affected by Projects

Forest and watershed restoration projects result in impacts to a wide variety of Oregon's economic sectors. Grant invoices from the ninety-nine grants we examined reflected purchases in 187 North American Industrial Classification System economic sectors ranging from cattle ranches and timber producers to environmental non-profit organizations. Consistently across all project types, the most common invoices were from wholesale and

THE ECONOMIC IMPACTS OF OREGON PLAN INVESTMENTS

The Oregon Plan for Salmon and Watersheds was established in 1997 as a strategy for the State of Oregon to restore salmon habitat. The Oregon Watershed Enhancement Board (OWEB) administers the Oregon plan, including a grant program for restoration activities.

Since 1997, OWEB has awarded more than $168.5 million (in 2005 dollars) for Oregon plan restoration investments. We applied our economic impact models to OWEB's restoration investments to estimate the effects of Oregon plan funding on Oregon's economy (Table 4). The models suggest that OWEB's restoration investment of approximately $168.5 million has resulted in nearly 2,700 jobs and $400 million in total economic activity. Furthermore, OWEB's grant databases show that, for every dollar invested by OWEB, an additional $1.48 is invested by state and federal programs, philanthropic organizations, private landowners, and others. This additional funding increases the economic effects of OWEB's restoration investments beyond what our multipliers suggest.

Table 3. Employment and output effects per $1 million invested in forest and watershed projects

Employment (jobs)	*All projects (aggregate)*	*In-stream projects*	*Riparian projects*	*Wetland projects*	*Fish passage projects*	*Upland projects*	*Other projects*
Direct effects	*4.3*	*4.6*	*7.4*	*5.1*	*4.7*	*3.7*	*4.3*
Indirect effects	*7.4*	*5.9*	*10.1*	*7.4*	*5.9*	*7.1*	*6.1*
Induced effects	*4.6*	*4.2*	*5.6*	*5.1*	*4.6*	*4.2*	*4.3*
Total effects	*16.3*	*14.7*	*23.1*	*17.6*	*15.2*	*15.0*	*14.7*
Multiplier[1]	*2.7–3.8*	*2.3–3.2*	*2.4–3.1*	*2.4–3.4*	*2.3–3.3*	*2.9–4.0*	*2.4–3.4*
Economic output							
Direct effects	*$973,616*	*$994,688*	*$979,296*	*$957,984*	*$958,908*	*$961,276*	*$977,372*
Indirect effects	*$834,029*	*$744,471*	*$717,412*	*$744,557*	*$783,145*	*$987,601*	*$817,618*
Induced effects	*$503,823*	*$464,692*	*$613,420*	*$556,861*	*$498,228*	*$527,413*	*$475,872*
Total effects	*$2,311,468*	*$2,203,851*	*$2,310,128*	*$2,259,422*	*$2,240,281*	*$2,476,290*	*$2,270,862*
Multiplier[1]	*1.9–2.4*	*1.7–2.2*	*1.7–2.4*	*1.8–2.4*	*1.8–2.3*	*2.0–2.6*	*1.8–2.3*

[1] The multiplier is reported as the range from the Type I to Type II multiplier values. The Type I multiplier is calculated as the sum of the direct and indirect effects divided by the direct effects. Type II multipliers equal the sum of all effects divided by the direct effect. For reasons presented in the discussion the Type I multiplier should be interpreted as a lower bound and the Type II multiplier as an upper bound.

retail trade establishments ranging as wide as building material wholesalers and "big box" retailers to local farm and feed stores, garden centers, and hardware stores. Across all projects, impacts from $1 million invested in forest and watershed projects result in more than $300,000 in wholesale and retail trade activity (about 2.2 jobs), ranging from about $250,000 for riparian projects to more than $450,000 for upland projects. Purchases from wholesale and retail establishments supply project managers and contractors with the vast array of materials and supplies, from erosion cloth to metal hardware to office supplies. Other economic sectors are less affected, but nonetheless important in accomplishing forest and watershed restoration goals, include goods and services from forest and native plant nurseries, cattle ranches, government enterprises, air transportation for projects that involve helicopter placement of large, woody debris, employment services, and professional services (insurance brokers, accountants).

Discussion and Conclusion

We examined data collected from contractors and grant recipients to estimate the employment and economic output effects of public investments in forest and watershed restoration. We found that forest and watershed restoration contracting leads to between 15.7 and 23.8 jobs per $1 million of public investment and results in an additional 1.4 to 2.4 times the amount of economic activity as every public dollar cycles through Oregon's economy. In general, labor-intensive contracting creates more jobs and less overall economic activity, whereas equipment-intensive contracting creates fewer jobs and more overall economic activity.

We also investigated the impact of restoration grants to examine how different types of contracting combine with other grant spending on projects to create economic impacts for six types of projects. On average, we found every $1 million of public investment in forest and watershed restoration projects supports 16.7 jobs in Oregon, ranging from 14.7 to 23.1 jobs per $1 million for in-stream and riparian projects, respectively. We also find that every dollar of public investment in forest and watershed restoration is multiplied in economic activity between 1.7 and 2.6 times as it cycles through Oregon's economy.

In Oregon, forest and watershed restoration makes up only a fraction of economic activity in natural resource sectors. Payroll for forestry, fishing, agriculture, and supporting activities in 2007 alone was nearly $450 million.[2] In comparison, the value of restoration investments in Oregon between 1995 and 2007 was slightly greater than $500 million.[3] Nonetheless, our analysis of the Oregon Plan for Salmon and Watersheds suggests that about 230 jobs are created per year from Oregon plan investments. If distributed evenly across the state, this equates to nearly seven jobs per county per year, or potentially one to two small businesses per county.

COMPARISONS TO OTHER IMPACT STUDIES

Our study suggests that forest and watershed restoration have a similar impact on employment as other public investment in infrastructure.[4] Heintz et al. examine the national employment affects of public investments in a variety of infrastructure categories including those they

Table 4. Effects of Oregon Plan for Salmon and Watersheds and OWEB restoration investments, 1997–2009 (in 2005 dollars)

	Percent of OWEB investment	Investment by project type ($)	Employment effect (jobs per million)	Economic output effect ($)	Total employment (jobs)	Total output ($)
In-stream projects	*23*	*38,065,297*	*14.7*	*2,203,851*	*560*	*83,890,242*
Riparian projects	*12*	*20,126,701*	*21.1*	*2,317,932*	*425*	*46,652,324*
Wetland projects	*5*	*8,408,327*	*17.4*	*2,268,221*	*146*	*19,071,943*
Fish passage projects	*27*	*45,252,542*	*15.2*	*2,240,347*	*688*	*101,381,397*
Forest projects	*28*	*46,854,286*	*15.0*	*2,476,290*	*703*	*116,024,799*
Other projects	*6*	*9,785,230*	*14.7*	*2,270,862*	*144*	*22,220,906*
Total	*100*	*168,492,382*			*2,666*	*389,241,611*
Total investment (aggregate model)		*168,492,382*	*16.0*	*2,312,753*	*2,696*	*389,681,261*

refer to as green infrastructure, such as investments in solar and wind power, water projects, and mass transit.[5] Heintz et al. define water projects from the perspective of drinking and wastewater treatment, and civil engineering around dams and other water management projects rather than through the lens of restoration. They estimate that per $1 million of public investment in infrastructure, total employment impacts range from 14.5 to 23.8 jobs, and that $1 million of public investment in green infrastructure results in total employment impacts of 14.8 jobs for wind power, 15.8 jobs for solar power, 19.8 jobs for water projects, and 22.8 jobs for mass transit.

Bivens and others have derived employment multipliers for broad economic sectors, such as manufacturing, business services, and agriculture, forestry, and fisheries.[6] Bivens explains that, although manufacturing creates fewer jobs per $1 million of demand in that sector, each job in manufacturing supports employment in other parts of the economy than do service jobs or jobs in agriculture, forestry, and fisheries. The authors ascribe this pattern to the generally higher wages in manufacturing and the greater proportion of spending in manufacturing on equipment and materials than labor. We find the same pattern within forest and watershed restoration contracting. Employment multipliers tend to be greatest in equipment-intensive contracting and least in labor-intensive and technical contracting, where labor requirements are greater. This pattern indicates that programs supporting forest and watershed restoration will affect a broader sweep of the economy through equipment-intensive contracting.

In natural resource contexts, many studies have examined the employment and economic effects of declines in the federal timber program.[7] Other studies have examined the economic impacts of individual projects. For example, Hjerpe and Kim examined the economic effects of a hazardous-fuels reduction stewardship contract implemented on five Arizona national forests and found employment effects typically in the range of 15.4–16.5 jobs per million.[8] Wagner and Shropshire studied the nearly $20 million Silver Bow Mine tailings restoration project, estimating that each $1 million in restoration funding resulted in 31.5 jobs, mostly temporary and requiring relatively little specialization.[9] Fewer studies have examined a program of ecological restoration funding. For example, Baker examined the socioeconomic impact of a program of natural resource restoration in Humboldt County, California, from 1995 to 2002 and found that in 2002 $14.5 million were invested in Humboldt County and resulted in 300 direct jobs (210 FTE).[10] Of these jobs, 240 were private sector (e.g., labor and equipment contractors, technical consultants, local nonprofits), forty-five were public sector jobs, and fifteen were with local tribal governments. Noting the importance of forest and watershed restoration to Humboldt County, Baker reported that the restoration work done in Humboldt County in 2002 was more than twice the value of commercial fishery landings and greater than some agricultural commodities for the county. Although we have already noted that Oregon's restoration economy does not approach the size of the traditional natural resource economy, we find that restoration work, especially a sustained program of restoration work, does confer significant benefits to Oregon's economy, much of which accrue to rural areas in need of economic development opportunities.

CHALLENGES AND OPPORTUNITIES

One of the main challenges of quantifying the economic impact of forest and watershed restoration work in Oregon is that funding for projects is often developed through many different sources that project managers must cobble together to finance a complete project. For example, a watershed council may receive partial funding from the Oregon Watershed Enhancement Board to implement a restoration project. Other funding for implementing the project may come from the federal government, private philanthropy, or a landowner. The design of the project may be paid through yet another grant for technical assistance or partially donated by a federal agency represented on the watershed council board that has a commitment to support such projects. The coordination of the entire project may be subsidized by other operational grants designed to keep the project manager's organization solvent (in the context of resources readily available for project implementation) without supporting the business of restoration. Each of these additional sources of funding tends to increase resources for forest and watershed restoration. In fact, our data showed that, on average, for every dollar of OWEB investment, grant award recipients raised an additional $1.48 from other sources, indicating that OWEB project funding consti-

tutes only 40 percent of total funding. When investigating the economic impact of only OWEB funding, this leverage creates potential misunderstandings of how the other funding components are spent. We tried to minimize this problem by only examining projects where OWEB funding constituted the majority of project funding. Nonetheless, from our experience, different grant programs, different agreements, and different sources of funding tend to have different stipulations about how the funds are spent. Some pay only for supplies and contracted materials; some refuse to pay for overhead; others pay only for project management or refuse to allow subawards.

In this context, we believe that it is unlikely that total project costs are allocated equally among funding sources. Although OWEB funding is relatively flexible, grant recipients may well strategically decide what to charge to OWEB based on the limitations of other funding sources. For example, if labor costs are subsidized by another source of funding, those costs may appear relatively low for a given amount of restoration funding. The effect of this partial accounting may inadvertently minimize the labor impact in project management while inflating the multiplier for a given project type because the direct effects for project management are subsidized by other sources that haven't been taken into account.

Our model reflects the economic impact of forest and watershed restoration on Oregon's economy. Consequently, the model reflects an urban bias due primarily to the central tendency of the model to reflect urban wages and skills. Much of the work of forest and watershed restoration, arguably most, is rural work done by rural people. To understand the impact of the statewide model on work that is largely rural, future research will be needed to modify the model specific to smaller subregions. For example, in Oregon the differences in economic resources available on each side of the Cascade Range, separating eastern from western Oregon, may result in very different outcomes for public investments in forest and watershed restoration east and west of the mountains. In addition, future research may address the local effects of forest and watershed restoration by focusing on the county level and using measures of urban influence or other typological descriptors to examine how urban or other economic structural differences influence economic impacts.

Endnotes

1 *For a discussion of when watershed councils decide to use contractors, see. Fraser McDonald, Cassandra Moseley, Emily Jane Davis, Max Nielsen-Pincus, Autumn Ellison,* Mobilizing Human Resources for Watershed Restoration*, EWP working paper #22, http://ewp.uoregon.edu/publications*

2 *US Bureau of the Census, County Business Patterns. Available online [URL]:* ***http://www.census.gov/*** *(accessed April 5, 2010).*

3 *Oregon Watershed Enhancement Board, Oregon Plan biennial report 2007-2009 (Salem, Oregon: Oregon Watershed Enhancement Board, 2008).*

4 *When comparing our results with other studies, differences may arise from a number of different sources. Comparing results from one state to another or from one state to a county or the nation will by definition create different results from the same impacts due to the different scales and structures of the compared economies (Shaffer et al. 2004). For example employment impacts of most activities will be greater at the national scale than at the state scale, and the state scale will be greater than at the county scale. A second challenge of comparison from one study to another arises from differences in assumptions (both explicit and implicit) made by different researchers, such as how to quantify induced impacts. The results of any given study may be, therefore, as much a result of the author's assumptions about the impacts as the actual impacts the study measures. R.E. Shaffer, S.C. Deller, and D. Marcouiller.* Community economics: Linking theory and practice *(Oxford, England: Blackwell Professional Publishing, 2004).*

5 *J. Heintz, R. Pollen, and H. Garrett-Peltier,* How infrastructure investments support the US economy: Employment, productivity, and growth *(Amherst, MA: Political Economy Research Institute. University of Massachusetts Amherst 2009).*

6 *J. Bivens,* Updated employment multipliers for the US economy *(2003). Working paper No. 268. (Washington, D.C.: Economic Policy Institute 2003); see also, D. Baker and T. Lee,* Employment multipliers for the US economy*, Working paper. (Washington, D.C.: Economic Policy Institute, 1993).*

7 *See for example, M. H. Robinson, C.W. McKetta, and S.S. Peterson.* A study of the effects of changing federal timber policies on rural communities of northcentral Idaho: An economic impact assessment *(Moscow, ID: University of Idaho, 1996).*

8 *Hjerpe, E.E. and Y.-S. Kim.* Economic impacts of southwestern national forest fuels reduction *(pp. 311-316, Journal of Forestry, September 2008).*

9 *Wagner, B. and R. Shropshire.* An estimation of the economic impacts of restoration in Montana *(Helena, MT: Department of Natural Resources and Conservation and Montana Department of Labor and Industry, 2009).*

10 *Baker, M.* Socioeconomic characteristics of the natural resource restoration system in Humboldt County, California *(Taylorsville, CA: Forest Community Research, 2004).*

Technical Appendix

Data and Methods

This appendix provides technical details related to information reported in the body of this paper. In this appendix, we report methodological information on our use of Minnesota IMPLAN Group (MIG) data, our empirical data collection procedures, the output per worker ratios used to calculate direct effects, and the production functions used in the economic impact models.

IMPLAN DATA

MIG data are calibrated to national and local data from a number of sources. National input-output matrices are developed by the U.S. Bureau of Economic Analysis (BEA) every five years using data collected from the U.S. Census Bureau's Economic Census and other programs of the census and other federal agencies. MIG data is calibrated to the BEA national input-output matrices and updated with data from a number of sources, including the U.S. Bureau of Labor Statistics, the U.S. Census Bureau, and the BEA. MIG estimates county- and state-level input-output matrices using the national input-output matrices and local employment, wages, government expenditures, margins, and other data. All national and local data are classified according to IMPLAN's industrial sectoring scheme, which has its origin in several federal economic sectoring systems. We use the 2008 MIG state and county dataset for Oregon, adjusted to 2005 dollars.[1]

GRANTS AND RESTORATION CONTRACTOR SURVEY DATA

To develop ecological restoration–specific production functions, we used data from three empirical sources: fiscal data from a sample of Oregon Watershed Enhancement Board (OWEB) restoration grants; a survey of business owners and managers whose businesses contract for ecological restoration work; and a survey of coordinators for Oregon watershed councils that received OWEB grants to manage ecological restoration projects.

Grants Data

We collected fiscal data from a stratified random sample of grants awarded by the OWEB. First, we describe the sampling procedure and then describe the process for extracting data from the sample of grants. A sample frame for OWEB grants was developed from two databases supplied by OWEB: the Oregon Watershed Restoration Inventory (OWRI) and the OWEB Grant Management System (OGMS). OWRI tracks watershed restoration projects across the state of Oregon. OWRI reporting is mandatory for OWEB grant recipients and voluntary for other projects that address Oregon plan restoration objectives. OWRI reports include a variety of information about individual restoration projects, including project partners, grant information, project funding, project location, ecological objectives, and restoration actions. OWEB compiles OGMS data to track grant awards. OWRI reports are generally submitted following the completion of a restoration project. OGMS data are recorded when OWEB receives a grant application (i.e., prior to the start of the project). OGMS data include general project data (i.e., recipient, project name), award dates, the county hosting the project, OWEB award amount, award funds distributed by OWEB to date, outstanding receipts, the project status (i.e., pending, open, monitoring, completed), and a brief project description. We obtained OWRI data on February 12, 2009, with assistance from the OWEB reporting specialist. We compiled OGMS data for calendar years 2002–8 on July 28, 2009, through the OGMS web interface (apps2.wrd.state.or.us/apps/oweb/fiscal/default.aspx).

To develop the sample frame for OWEB restoration grants, we merged the data reported in both the OWRI and OGMS based on the unique grant numbers assigned to each project in OGMS and reported in OWRI. The sample frame therefore represents OWEB grant-funded projects awarded between calendar years 2002 and 2008. A total of 2,601 grant projects are recorded in OGMS (2002–8). OWRI reports a total of 1,856 grant projects (1998–2008). OWRI reporting is lagged behind OGMS because OWRI reports are generally filed when a project is completed. A total of 1,457 grant projects are recorded in both data sets. After merging the two datasets based on the grant number, grant projects were classified by the dominant activity using the sum-of-cash funding and in-kind contributions by activity type reported in OWRI. A total of eight activity types are recorded in OWRI: combined (i.e., a project with multiple activities and no

dominant activity), fish passage and screening, in-stream, riparian, road, upland, urban, and wetland (includes estuarine projects).

We summarized the sample frame by describing the number of restoration projects by dominant activity, and include averages for OWEB funds invested, other leveraged cash, and in-kind contributions reported in the OWRI database (Table A1). We also summarized total average cost per project by dominant activity and calculated leverage ratios measuring the amount of cash and in-kind leverage relative to OWEB's investment. Finally, we also report the maximum project cost by dominant activity type to give a sense of the scope of restoration projects in each category.

To gather the final sample, we selected only grants for which OWEB had paid at least 50 percent of total cash project costs. The objective of this criterion is to limit our analysis to only those projects where we would have access to greater than 50 percent of the financial data. In the sample frame, restoration grants average from 30 percent OWEB funding for road projects to 74 percent for riparian projects (combined, 73 percent; in stream, 66 percent; upland, 65 percent; wetland, 65 percent, fish passage and screening, 59 percent). After we applied all criteria to the sample frame, only one project was classified as *urban* and seven classified as *road*. We excluded these projects from the sample frame. We then randomly selected twenty grants per project type. Both the *combined* and *wetland* project type strata had less than twenty grants left after we applied the 50 percent OWEB project-funding cutoff. We selected all grants that met the sampling criteria for these two strata, which resulted in sample sizes of fifteen and fourteen, respectively.

The final sample included 109 restoration grants. This sample represents OWEB restoration grant projects for which an OWRI form was completed prior to February 12, 2009, and for which an OWEB restoration grant was awarded on or after January 1, 2002. Only projects for which OWEB funding was greater than 50 percent of the project expenses are included.

We manually collected grant fiscal data from OWEB archive file folders and scanned them electronically. We then recorded information from all invoices paid by OWEB that were included in the grant fiscal archive. Specifically, we recorded the vendor name, address, and contact information, the total amount of the invoice paid by OWEB. We then classified the bill of goods represented on the invoice to the best that it was interpretable. Finally, we assigned a six-digit North American Industrial Classification System code to each invoice based on the vendor name and the transaction represented by the invoice. A total of ten grants in the sample, evenly distributed among the project types, were not classified due to the inability to decipher the scanned documents and other issues with the files.

Restoration Contractors Survey

We surveyed business owners and managers of businesses that contract with OWEB grantees and federal land management agencies in Oregon about their factors of production when engaged in restoration work. For contractors that worked with OWEB grantees, our sample included all 248 contractors identified as vendors (services that require either technical, equipment, or labor

Table A1. Summary of sampling frame grant finances by grant type and dominant activity

Project Types	N	Proportion of Projects	Average OWEB Funds	Average Other Cash	Average Total Cash	Average In-Kind	Average Total Project	Maximum Cost	Cash Leverage	Total Leverage
Combined	*23*	*3%*	*$48,629*	*$99,448*	*$148,077*	*$36,394*	*$184,471*	*$1,673,311*	*3.05*	*3.79*
Fish Passage	*106*	*27%*	*$87,736*	*$169,861*	*$257,597*	*$19,114*	*$276,711*	*$1,685,854*	*2.94*	*3.15*
In-stream	*97*	*23%*	*$80,649*	*$90,865*	*$171,514*	*$57,693*	*$229,208*	*$1,220,316*	*2.13*	*2.84*
Riparian	*67*	*12%*	*$61,736*	*$16,120*	*$77,856*	*$27,368*	*$105,224*	*$416,666*	*1.26*	*1.70*
Road	*22*	*2%*	*$38,818*	*$309,540*	*$348,359*	*$148,243*	*$496,601*	*$533,422*	*8.97*	*12.79*
Upland	*110*	*28%*	*$87,539*	*$113,196*	*$200,734*	*$35,607*	*$236,341*	*$3,250,629*	*2.29*	*2.70*
Urban	*1*	*0%*	*$38,544*	*$9,012*	*$47,556*	*$2,541*	*$50,097*	*$47,556*	*1.23*	*1.30*
Wetland	*21*	*5%*	*$82,287*	*$87,129*	*$169,417*	*$30,437*	*$199,853*	*$1,028,512*	*2.06*	*2.43*
All Restoration Grants	***447***	***100%***	***$77,467***	***$114,735***	***$192,202***	***$40,521***	***$232,723***	***$3,250,629***	***2.48***	***3.00***

from the above sample of OWEB grants). When pursuing contact information, we determined that fifty of the sampled vendors had gone out of business and were thus excluded from the sample.

To develop a sample of federal contractors, we developed a sample frame of 1,350 contractors from the Federal Procurement Data System (FPDS), a database of federal contracting. We queried the FPDS for all contractors working for federal land-management agencies in Oregon between the 2002 and 2008 federal fiscal years. We then stratified contractors by service codes to develop a stratified random sample of contractors engaged primarily in forest thinning work, other equipment-intensive work such as road construction and maintenance, and other forestry-related activities (Table A2). Within each service code group, we then eliminated all contracts with businesses that were classified as retail, wholesale, manufacturing, or other nonpertinent economic sectors, and all vendors that received less than $2,500 in contracts during the study period. Our final sample size was 220 businesses that had received contracts from federal land-management agencies in Oregon between 2002 and 2008 to perform services related to forest and watershed management and restoration work.

We provided businesses owners and managers three options for participation in this study: phone, mail, or Internet survey, but encouraged a telephone interview. We attempted to contact all business owners and managers over the phone to ask them to participate. Businesses that we were not able to contact over the phone within three attempts were sent a paper version of the questionnaire, with our telephone numbers and a link to an Internet version printed on the cover. We asked respondents information about the business they own or manage including the major type of work they perform and the type of restoration work they typically do. We then asked respondents to describe their expenditure patterns when working on restoration projects including costs for labor, capital, materials and supplies, administrative and other expenses including profit. We asked respondents to report the proportion of labor expenses that are typically hired locally (i.e., within the county of work) and the proportion of nonlabor expenses typically purchased locally and from a manufacturer or producer versus a retailer or wholesaler. All responses were entered into an Internet survey collector (www.surveymonkey.com). The telephone interviewer entered notes into the online collector during the interview.

Nearly all participants were interviewed over the phone. Approximately 6 percent of respondents completed the questionnaire over the Internet, and 10 percent filled out a paper version via the mail. A total of 190 businesses owners and managers were interviewed, with 101 originating from the FPDS sample, seventy-nine originating from OWEB grant invoices, and six that occurred in both sampling frames, for response rates of 49 percent and 45 percent, respectively. We then summarized the data by typical work types, from which we developed work type production functions.

IMPACT MODELS

To measure the impact of forest and watershed restoration on Oregon's economy, we developed production functions for each of the four contracting types discussed in the working paper and project management for each type of project. Production functions for each of the contractor types and project management consist of labor costs (i.e., direct effects) and a suite of nonlabor costs (i.e., indirect effects) derived from the survey of restoration business owners and managers (e.g., equipment, equipment repair,

Table A2. Federal contractor stratified sample frame and sample

Group Description	*Eligible Vendors after Eliminations*	*Average Contract (in Dollars)*	*Median Contract (in Dollars)*	*Sample Size*
Other Forestry-related Activities	*665*	*114,801*	*28,983*	*80*
Thinning	*167*	*859,763*	*144,000*	*60*
Construction and Maintenance (Roads)	*518*	*209,220*	*78,581*	*80*
Total	*1350*	*242,748*	*50,000*	*220*

various materials and supplies, and indirect administrative costs) and, for project management, the grants data. The impact of each type of contracting type and project type was then further divided into three separate parts: direct, indirect, and induced effects.

For direct effects, we matched each work type with the economic sectors from which the businesses that do each work type typically come using the IMPLAN 440 and related North American Industry Classification System (NAICS) sectoring schemes. By contrast, for indirect effects, the production functions we developed represent the factors of production for doing restoration work rather than the factors of production typically involved in each IMPLAN sector. The result of these two components are direct effects that reflect the wages and output per worker of the sectors from which restoration contractors and project managers typically come and indirect effects that reflect the factors of production specific to restoration work. We developed induced effects by inputting employee compensation in each direct sector as a labor income impact in IMPLAN 3.0, and combining those results with the induced effects produced through household spending resulting from the indirect effects. Impact models were then created for each of the contracted work types individually and then combined with project management in proportions appropriate to each project type to construct project type effects.

Production Functions

We created production functions from the grants data, the restoration business owners and managers' survey, and the watershed council surveys. Production functions consist of two components: labor coefficients and nonlabor coefficients. For contracting, labor coefficients were derived from a survey question that asked respondents to estimate, for the types of forest or watershed restoration work that they commonly do, the portion of every contract dollar they spend on labor costs. For project management, we derived labor costs from grant invoices paid by OWEB for the grant recipient's direct labor. For contractors, we derived nonlabor coefficients from the survey of business owners and managers' survey from a question that asked respondents to estimate the proportion of every contract dollar they spend on a variety of expense categories (e.g., equipment, maintenance and repair, fuel, live plant materials) for the types of forest or watershed restoration work that they commonly do. For project management, we derived nonlabor coefficients from grant expenditure data for materials and supplies, equipment, overhead, and other purchases. We constrained all labor and nonlabor coefficients to sum-to-one by dividing each coefficient by the sum of all coefficients (occasionally the sum of survey-derived coefficients could not be constrained, representing incomplete or inaccurate reporting; however, the degree of error was typically less than 5 percent). For each labor and nonlabor coefficient, we used the grants data to assign an Oregon purchase coefficient to represent the proportion of expenditures made from Oregon-based vendors. Production functions for each contracting type and project type represent the factors of production needed to generate one unit of output for contracting and projects, respectively (Tables A4 and A5). Based on the production functions for contractor and project types, we constructed impact models to estimate the direct, indirect, and induced effects of $1 million (in 2005 dollars) input to each contracting type and project type.

Direct Effects

We calculated the direct effects using the following IMPLAN and NAICS sectors to represent each work type:

1. Project management
    - Sector 424 – Grantmaking, giving, and other social organizations
        - NAICS 813312 – Environment, conservation, and wildlife organizations
    - Sector 432 – Local government enterprises
        - Census of government – Local government natural resource functions

2. Technical planning and design
    - Sector 369 – Architectural, engineering, and related services
        - NAICS 541320 – Landscape architectural services
        - NAICS 541330 – Engineering services
    - Sector 375 – Environmental and other technical consulting services
        - NAICS 541620 – Environmental consulting services

3. Equipment – watershed
    - Sector 36 – Other nonresidential construction
        - NAICS 237110 – Water and sewer line and related structures construction
        - NAICS 237310 – Highway, street, and bridge construction
        - NAICS 237990 – Other heavy and civil engineering construction
        - NAICS 238110 – Poured concrete foundation and structure contractors
        - NAICS 238910 – Site preparation contractors

4. Equipment – forestry
    - Sector 16 – Logging
        - NAICS 113310 – Logging

5. Labor-intensive
    - Sector 19 – Support activities for forestry
        - NAICS 115310 – Support activities for forestry

We obtained average payroll data for each NAICS code from several programs of the U.S. Department of Commerce's Census Bureau. First, for all nongovernmental and nonagricultural sectors (including natural resources), we obtained data from the U.S. Economic Census (2007), a quinquennial census of business activities. Second, for natural resource sectors (i.e., logging and support activities for forestry), we obtained data from County Business Patterns (2007), an annual survey of business employment and payroll. Third, for governmental data, we obtained data from the Census of Government (2007), a quinquennial census of government functions.

To calculate direct effects, we set output-per-worker ratios for each direct effect equal to the labor costs associated with each contract type and project management divided by the weighted average worker payroll costs for the detailed NAICS sectors represented in each contract and project type. IMPLAN measures economic output simply as total sales for service sectors. Because each of our contract types is treated as a subcontracted service, the direct effect on economic output for each impact model is the total input ($1 million) multiplied by the proportion of the total impact allocated to each contract type. For example, if the production coefficient for labor-intensive contracting is 0.10, the direct impact of labor-intensive contracting is $100,000. For the purposes of comparison, our contractor models are built on the assumption that all contracting is done with businesses located in Oregon and that those businesses hire workers who reside in Oregon. Although this assumption pushes the bounds of reality, its utility is in understanding and comparing the production structure of each contractor type. That is, it allows us to understand the factors of production internal to each contractor type rather than the effects of decisions made by those who let contracts. This forced IMPLAN 3.0 to derive direct effects based on our survey and grants data rather than based on the output-per-worker ratios of the national input-output matrices.

Indirect Effects

We derived indirect effects using the nonlabor portion of the production function for each contracting type and project management. Indirect effects reflect the expenditure patterns for goods and services demanded by contractors and project managers. For each project type we combined the contracting and project management production functions in the proportions represented in the grant expenditure dataset (Table 1). Thus, as a model, the approach worked by conceptualizing the project manager as a general contractor, with the four contracting types serving a role akin to subcontractors. Therefore, the proportion of the project cost used for the project manager's labor, materials, and administrative costs stays with the project management production function and the remainder is assigned to the other four production functions in the proportions represented in the grant expenditure data. For example, in the aggregate model an influx of $1 million is used to calculate labor, material, and administrative costs for the project manager (55 percent); the remaining costs are then allocated to technical planning and design (4 percent), equipment—construction (34 percent), equipment—forestry (5 percent), and labor-intensive (2 percent) work.

When estimating project impacts, we allow the project manager production function to vary to reflect a different bill of goods and services needed for each project type. However, we hold the other four work type production functions constant under the assumption that productiv-

ity for subcontracted work is static and varies only in the amount of subcontracted work rather than in the factors of production. That is, we assumed that labor-intensive contracting uses the same factors of production whether the project is an in-stream project or a riparian project. Prior to running the models, we used the grants data to calculate the proportion of expenditure from each sector that is purchased in Oregon, and then constrained the inputs to the proportion of in-state purchases by sector. We used IMPLAN 3.0 to run the indirect-effects models both by contracting type and by project type through our model of Oregon's economy.

Induced Effects

We calculated induced effects using labor income from the production function for each work type as a separate impact in IMPLAN 3.0. For each contract type, we calculated labor income as the labor coefficient in the production function multiplied by the total input. For each project type, we calculated the labor income as the sum of the products of each respective contract type and project management labor coefficients multiplied by each respective input (Table 1). We then scaled labor income by the local purchase ratio for each activity to account for only those effects resulting from increased employment in Oregon. The result is the effect on Oregon's economy from an increase in consumer spending that is produced by payroll increases in the directly and indirectly affected sectors.

Supplemental Results

For economists and other technical users, understanding employee compensation is often of interest because wages can help provide a reality check for the results. If the model produces results that require implausible wages, the model should be examined skeptically. We provide employee compensation data for those users interested in more model details.

Value-added is a measure of the difference between the cost of the goods required to produce a product and the sale price of that product. Value-added consists of profits, employee compensation, taxes, and interest. IMPLAN 3.0 produces results for value-added as total value-added or by any of its components. IMPLAN defines employee compensation as gross industry-paid wages and salaries plus taxable benefits. We estimated average employee compensation values for each contract type and project type by dividing the total employee compensation resulting from our impact model by the total employment resulting from the impact.

In general, average employee compensation is greatest for direct effects and least for induced effects. This

Table A3. Average employee compensation by contract type (panel A) and by project type (panel B)

A. Contract Type	*Direct Compensation (in Dollars)*	*Indirect Compensation (in Dollars)*	*Induced Compensation (in Dollars)*
Labor Intensive	*31,028*	*30,759*	*28,010*
Equipment Intensive—Watershed	*47,138*	*42,262*	*28,739*
Equipment Intensive—Forestry	*37,100*	*47,452*	*30,219*
Technical Planning and Design	*53,617*	*25,862*	*22,824*
B. Project Type			
All Projects (Aggregate)	*39,880*	*37,607*	*30,227*
In-stream	*44,063*	*34,634*	*30,652*
Riparian	*34,781*	*28,891*	*29,770*
Wetland	*42,369*	*35,057*	*30,199*
Fish Passage	*42,812*	*39,586*	*30,001*
Upland	*39,575*	*45,513*	*34,760*
Other	*38,457*	*43,080*	*30,659*

follows a plausible pattern, as induced effects tend to be focused on retail service jobs, while our direct effects tend to require more skilled and trained workers (Table A3). In two impact models (upland and other project types), average indirect compensation is greater than average direct compensation. Average direct employee compensation also follows a plausible pattern when different impact models are compared. Labor-intensive contracting provides the lowest wages and benefits, while technical planning and design contracts provide the highest wage and benefit jobs. In-stream, wetland, and fish passage projects provide the highest average direct wages while riparian project provide the lowest average direct wages.

Production Function—Contractor and Project Types

Table A4. Production functions for each contracting type

IMPLAN Sector	Coefficient Description		Coefficient	Retail and Wholesale Coefficient
A. Labor Intensive (n=24)				
5001	Labor		0.623	-
3015	Forest, timber, and forest nursery products		0.014	-
3319	Equipment		0.101	0.101
3319	Steel products from purchased steel		0.015	0.015
3323	Equipment repair		0.044	0.044
3323	Dimension lumber and preserved wood products		0.0003	0.0003
3323	Other retail services—Building material and garden supply		0.004	0.004
3326	Retail services—Gasoline stations		0.141	0.141
3358	Insurance agencies, brokerages, and related services		0.029	-
3368	Accounting, tax preparation, bookkeeping, and payroll services		0.029	-
		Total	**1.000**	0.305
B. Equipment—Watershed (n=43)				
5001	Labor		0.365	-
3015	Forest, timber, and forest nursery products		0.037	0.007
3025	Natural stone		0.033	0.005
3095	Dimension lumber and preserved wood products		0.025	0.018
3161	Ready-mix concrete		0.015	-
3171	Steel products from purchased steel		0.012	0.008
3319	Equipment		0.154	0.154
3319	Fuel		0.123	0.123
3323	Other retail services—Building material and garden supply		0.022	0.022
3358	Insurance agencies, brokerages, and related services		0.046	-
3365	Commercial and industrial machinery and equipment rental and leasing services		0.027	-
3368	Accounting, tax preparation, bookkeeping, and payroll services		0.046	-
3417	Commercial and industrial machinery and equipment repairs and maintenance		0.095	-
		Total	**1.000**	**0.338**
C. Equipment—Forestry (n=25)				
5001	Labor		0.368	-
3319	Equipment		0.207	0.207
3319	Fuel		0.161	0.161
3323	Steel products from purchased steel		0.033	0.033
3323	Other retail services—Building material and garden supply		0.009	0.009
3358	Insurance agencies, brokerages, and related services		0.031	-
3365	Commercial and industrial machinery and equipment rental and leasing services		0.037	-
3368	Accounting, tax preparation, bookkeeping, and payroll services		0.031	-
3417	Commercial and industrial machinery and equipment repairs and maintenance		0.122	-
		Total	**1.000**	**0.410**

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Table A4. Production functions for each contracting type

IMPLAN Sector	Coefficient Description	Coefficient	Retail and Wholesale Coefficient
D. Technical planning and design (n=38)			
5001	Labor	0.671	-
3015	Forest, timber, and forest nursery products	0.019	-
3025	Natural stone	0.001	0.001
3095	Dimension lumber and preserved wood products	0.003	0.002
3319	Equipment	0.075	0.075
3329	Other retail services—General merchandise	0.064	0.064
3323	Steel products from purchased steel	0.019	-
3323	Concrete products	0.002	0.002
3326	Retail services—Gasoline stations	0.086	0.086
3358	Insurance agencies, brokerages, and related services	0.019	-
3368	Accounting, tax preparation, bookkeeping, and payroll services	0.019	-
3416	Electronic and precision equipment repairs and maintenance	0.022	-
	Total	***1.000***	***0.229***

Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
All Forest and Watershed Restoration (Aggregate Model, n=99)			
5001	Labor	0.0870	1.00
-	Labor-intensive contracting	0.0200	0.93
-	Equipment-intensive—Watershed contracting	0.3400	0.96
-	Equipment-intensive—Forestry contracting	0.0500	1.00
-	Technical planning and design Contracting	0.0400	0.75
3006	Greenhouse, nursery, and floriculture products	0.0103	0.90
3010	All other crop farming products	0.0015	1.00
3011	Cattle from ranches and farms	0.0137	1.00
3014	Animal products, except cattle, poultry, and eggs	0.0034	1.00
3015	Forest, timber, and forest nursery products	0.0069	1.00
3018	Wild game products, pelts, and furs	0.0018	1.00
3025	Natural stone	0.0023	1.00
3026	Sand, gravel, clay, and ceramic and refractory minerals	0.0001	0.43
3031	Electricity and distribution services	0.0014	1.00
3033	Water, sewage treatment, and other utility services	0.0260	1.00
3095	Dimension lumber and preserved wood products	0.0002	1.00
3099	Wood windows and doors and millwork	0.0011	0.00
3102	Prefabricated wood buildings	0.0001	0.00
3113	Printed materials	0.0003	0.98
3114	Printing support services	<0.0001	1.00
3144	Plastics pipes and pipe fittings	0.0005	1.00
3149	Other plastics products	0.0001	1.00
3160	Cement	0.0005	0.08
3161	Ready-mix concrete	0.0032	1.00
3163	Other concrete products	0.0011	0.35
3167	Ground or treated mineral and earth products	0.0002	1.00
3170	Iron and steel and ferroalloy products	0.0019	1.00
3186	Plates and fabricated structural products	0.0128	0.22
3187	Ornamental and architectural metal products	0.0076	0.29
3193	Hardware	0.0001	0.00
3195	Machined products	<0.0001	1.00
3198	Valves and fittings other than plumbing	<0.0001	1.00

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Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
3199	Plumbing fixture fittings and trims	0.0001	1.00
3222	Turbines and turbine generator set units	<0.0001	0.00
3299	Institutional furniture	0.0002	1.00
3314	Signs	0.0002	0.75
3319	Wholesale trade distribution services	0.0909	0.80
3320	Retail services—Motor vehicle and parts	0.0007	1.00
3322	Retail services—Electronics and appliances	0.0000	0.52
3323	Retail services—Building material and garden supply	0.0609	0.99
3325	Retail services—Health and personal care	<0.0001	1.00
3326	Retail services—Gasoline stations	0.0005	1.00
3328	Retail services—Sporting goods, hobbies, books, and music	<0.0001	0.68
3329	Retail services—General merchandise	0.0010	1.00
3330	Retail services—Miscellaneous	0.0015	0.97
3332	Air transportation services	0.0261	1.00
3335	Truck transportation services	0.0035	0.88
3338	Scenic and sightseeing transportation services and support activities for transportation	0.0014	1.00
3339	Couriers and messengers services	<0.0001	1.00
3340	Warehousing and storage services	0.0001	0.00
3341	Newspapers	<0.0001	1.00
3346	Motion pictures and videos	0.0002	1.00
3348	Radio and television entertainment	<0.0001	1.00
3351	Telecommunications	0.0001	0.79
3356	Securities, commodity contracts, investments, and related services	0.0001	0.00
3362	Automotive equipment rental and leasing services	0.0016	0.08
3363	General and consumer goods rental services, except video tapes and discs	0.0004	1.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0079	1.00
3376	Scientific research and development services	0.0005	1.00
3377	Advertising and related services	<0.0001	1.00
3384	Office administrative services	0.0018	1.00
3382	Employment services	0.0241	1.00
3386	Business support services	<0.0001	0.00
3387	Investigation and security services	<0.0001	1.00
3388	Services to buildings and dwellings	0.0054	1.00
3389	Other support services	0.0007	1.00
3390	Waste management and remediation services	0.0012	1.00
3391	Elementary and secondary education from private schools	0.0038	0.09
3392	Education from private junior colleges, colleges, universities, and professional schools	0.0025	1.00
3400	Individual and family services	<0.0001	1.00
3401	Community food, housing, and other relief services, including rehabilitation services	0.0065	1.00
3413	Restaurant, bar, and drinking place services	<0.0001	1.00
3414	Automotive repair and maintenance services, except car washes	0.0038	1.00
3416	Electronic and precision equipment repairs and maintenance	0.0008	1.00
3417	Commercial and industrial machinery and equipment repairs and maintenance	0.0021	1.00
3418	Personal and household goods repairs and maintenance	0.0001	0.43
3422	Other personal services	<0.0001	0.79
3424	Grant-making, giving, and social advocacy services	0.0341	0.93
3427	U.S. Postal Service delivery services	0.0002	1.00
3429	Products and services of federal government enterprises (except electric utilities)	0.0308	0.23
3432	Products and services of state and local government enterprises (except electric utilities)	0.0310	0.99
	Aggregate Model Project Management Total	**0.5500**	**0.86**
	Aggregate Model Total	**1.0000**	**0.90**

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Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
In-stream Restoration Projects (n=19)			
5001	Labor	0.1120	1.00
-	Labor-intensive contracting	0.0100	1.00
-	Equipment-intensive—Watershed contracting	0.4300	1.00
-	Equipment-intensive—Forestry contracting	0.0400	1.00
-	Technical planning and design	0.0200	0.75
3006	Greenhouse, nursery, and floriculture products	0.0001	1.00
3011	Cattle from ranches and farms	0.0567	1.00
3014	Animal products, except cattle, poultry, and eggs	0.0067	1.00
3015	Forest, timber, and forest nursery products	0.0093	1.00
3113	Printed materials	<0.0001	1.00
3167	Ground or treated mineral and earth products	0.0012	1.00
3186	Plates and fabricated structural products	0.0148	0.00
3299	Institutional furniture	0.0009	1.00
3319	Wholesale trade distribution services	0.0052	1.00
3322	Retail services—Electronics and appliances	0.0001	0.35
3323	Retail services—Building material and garden supply	0.0054	0.79
3325	Retail services—Health and personal care	<0.0001	1.00
3326	Retail services—Gasoline stations	0.0006	1.00
3329	Retail services—General merchandise	<0.0001	1.00
3330	Retail services—Miscellaneous	0.0014	1.00
3332	Air transportation services	0.1535	1.00
3335	Truck transportation services	0.0100	1.00
3340	Warehousing and storage services	0.0005	0.00
3346	Motion pictures and videos	0.0011	1.00
3348	Radio and television entertainment	<0.0001	1.00
3351	Telecommunications	0.0001	1.00
3362	Automotive equipment rental and leasing services	0.0086	0.00
3363	General and consumer goods rental services, except video tapes and discs	0.0015	1.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0101	1.00
3368	Accounting, tax preparation, bookkeeping, and payroll services	0.0001	1.00
3388	Services to buildings and dwellings	0.0024	1.00
3424	Grant-making, giving, and social advocacy services	0.0039	1.00
3429	Products and services of federal government enterprises (except electric utilities)	0.0912	0.00
3432	Products and services of state and local government enterprises (except electric utilities)	0.0009	1.00
	In-stream Project Management Total	***0.4984***	***0.77***
	In-stream Projects Total	***1.0000***	***0.88***
Riparian Projects (n=18)			
5001	Labor	0.2640	1.00
-	Labor-intensive contracting	0.0200	1.00
-	Equipment-intensive—Watershed contracting	0.3400	1.00
-	Equipment-intensive—Forestry contracting	<0.0001	-
-	Technical planning and design	0.0400	1.00
3006	Greenhouse, nursery, and floriculture products	0.0372	0.94
3010	All other crop farming products	0.0028	1.00
3015	Forest, timber, and forest nursery products	0.0059	1.00
3025	Natural stone	0.0013	1.00
3031	Electricity, and distribution services	0.0019	1.00
3099	Wood windows and doors and millwork	0.0075	0.00

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Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
3113	Printed materials	0.0018	0.98
3114	Printing support services	<0.0001	1.00
3149	Other plastics products	0.0010	1.00
3186	Plates and fabricated structural products	<0.0001	1.00
3195	Machined products	0.0002	1.00
3314	Signs	0.0006	1.00
3319	Wholesale trade distribution services	0.1011	0.99
3320	Retail services—Motor vehicle and parts	0.0040	1.00
3323	Retail services—Building material and garden supply	0.0675	0.97
3325	Retail services—Health and personal care	<0.0001	1.00
3326	Retail services—Gasoline stations	0.0020	1.00
3328	Retail services—Sporting goods, hobbies, books, and music	0.0002	0.68
3329	Retail services—General merchandise	0.0003	1.00
3330	Retail services—Miscellaneous	0.0060	0.99
3341	Newspapers	0.0001	1.00
3351	Telecommunications	0.0003	1.00
3356	Securities, commodity contracts, investments, and related services	0.0004	0.00
3363	General and consumer goods rental services, except video tapes and discs	0.0010	1.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0015	1.00
3374	Management, scientific, and technical consulting services	0.0016	1.00
3377	Advertising and related services	0.0002	1.00
3382	Employment services	0.1461	1.00
3388	Services to buildings and dwellings	0.0316	1.00
3390	Waste management and remediation services	0.0075	1.00
3391	Elementary and secondary education from private schools	0.0239	0.04
3392	Education from private junior colleges, colleges, universities, and professional schools	0.0118	1.00
3413	Restaurant, bar, and drinking place services	0.0001	1.00
3416	Electronic and precision equipment repairs and maintenance	0.0050	1.00
3417	Commercial and industrial machinery and equipment repairs and maintenance	0.0002	1.00
3418	Personal and household goods repairs and maintenance	0.0005	0.43
3424	Grant-making, giving, and social advocacy services	0.0541	1.00
3427	U.S. Postal Service delivery services	<0.0001	1.00
3432	Products and services of state and local government enterprises (except electric utilities)	0.0098	1.00
	Riparian Project Management Total	**0.8013**	**0.95**
	Riparian Projects Total	**1.0000**	**0.95**
Fish Passage Projects (n=19)			
5001	Labor	0.0680	1.00
-	Labor-intensive contracting	0.0003	1.00
-	Equipment-intensive—Watershed contracting	0.5900	0.94
-	Equipment-intensive—Forestry contracting	0.0500	0.00
-	Technical planning and design	0.0300	1.00
3006	Greenhouse, nursery, and floriculture products	<0.0001	1.00
3011	Cattle from ranches and farms	0.0099	1.00
3014	Animal products, except cattle, poultry, and eggs	0.0110	1.00
3018	Wild game products, pelts, and furs	0.0089	1.00
3025	Natural stone	0.0016	1.00
3033	Water, sewage treatment, and other utility services	<0.0001	1.00
3161	Ready-mix concrete	0.0039	1.00
3170	Iron and steel and ferroalloy products	0.0094	1.00
3186	Plates and fabricated structural products	0.0419	0.27

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Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
3187	Ornamental and architectural metal products	0.0367	0.29
3198	Valves and fittings other than plumbing	<0.0001	1.00
3199	Plumbing fixture fittings and trims	0.0006	1.00
3314	Signs	0.0001	1.00
3319	Wholesale trade distribution services	0.0281	0.77
3320	Retail services—Motor vehicle and parts	0.0001	1.00
3323	Retail services—Building material and garden supply	0.0054	1.00
3326	Retail services—Gasoline stations	<0.0001	1.00
3329	Retail services—General merchandise	<0.0001	1.00
3330	Retail services—Miscellaneous	0.0007	1.00
3335	Truck transportation services	0.0056	0.65
3341	Newspapers	0.0001	1.00
3362	Automotive equipment rental and leasing services	0.0006	1.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0150	1.00
3374	Management, scientific, and technical consulting services	0.0040	1.00
3384	Office administrative services	0.0085	1.00
3382	Employment services	0.0012	1.00
3388	Services to buildings and dwellings	0.0002	1.00
3390	Waste management and remediation services	0.0001	1.00
3391	Elementary and secondary education from private schools	0.0006	1.00
3416	Electronic and precision equipment repairs and maintenance	<0.0001	1.00
3417	Commercial and industrial machinery and equipment repairs and maintenance	0.0007	1.00
3424	Grant-making, giving, and social advocacy services	0.0106	1.00
3427	U.S. Postal Service delivery services	0.0007	1.00
3432	Products and services of state and local government enterprises (except electric utilities)	0.0527	1.00
	Fish Passage Project Management Total	***0.3272***	***0.80***
	Fish Passage Projects Total	***1.0000***	***0.85***
Wetland Projects (n=11)			
5001	Labor	0.0800	1.00
-	Labor-intensive contracting	0.0125	1.00
-	Equipment-intensive—Watershed contracting	0.6120	0.94
-	Equipment-intensive—Forestry contracting	0.0078	0.00
-	Technical planning and design	0.0590	1.00
3006	Greenhouse, nursery, and floriculture products	0.0138	1.00
3010	All other crop farming products	0.0062	1.00
3015	Forest, timber, and forest nursery products	0.0096	1.00
3026	Sand, gravel, clay, and ceramic and refractory minerals	0.0003	1.00
3160	Cement	0.0040	0.08
3319	Wholesale trade distribution services	0.0622	0.37
3320	Retail services—Motor vehicle and parts	<0.0001	1.00
3323	Retail services—Building material and garden supply	0.0064	1.00
3326	Retail services—Gasoline stations	0.0003	1.00
3329	Retail services—General merchandise	0.0002	1.00
3330	Retail services—Miscellaneous	0.0008	0.76
3335	Truck transportation services	0.0003	1.00
3339	Couriers and messengers services	<0.0001	1.00
3362	Automotive equipment rental and leasing services	0.0001	1.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0005	1.00
3368	Accounting, tax preparation, bookkeeping, and payroll services	0.0012	1.00
3376	Scientific research and development services	0.0034	1.00

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Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
3384	Office administrative services	0.0001	1.00
3382	Employment services	0.0118	1.00
3386	Business support services	0.0001	0.00
3387	Investigation and security services	<0.0001	1.00
3389	Other support services	0.0015	1.00
3391	Elementary and secondary education from private schools	0.0004	1.00
3401	Community food, housing, and other relief services, including rehabilitation services	0.0478	1.00
3422	Other personal services	<0.0001	0.00
3424	Grant-making, giving, and social advocacy services	0.0402	0.75
3429	Products and services of federal government enterprises (except electric utilities)	0.0001	0.00
3432	Products and services of state and local government enterprises (except electric utilities)	0.0237	1.00
	Wetland Project Management Total	**0.3151**	**0.83**
	Wetland Projects Total	**1.0000**	**0.91**
Upland Projects (n=20)			
5001	Labor	0.0650	1.00
-	Labor-intensive contracting	0.0233	1.00
-	Equipment-intensive—Watershed contracting	0.1432	0.86
-	Equipment-intensive—Forestry contracting	0.1435	1.00
-	Technical planning and design	0.0734	1.00
3006	Greenhouse, nursery, and floriculture products	0.0004	1.00
3010	All other crop farming products	0.0011	1.00
3011	Cattle from ranches and farms	0.0075	1.00
3015	Forest, timber, and forest nursery products	0.0129	1.00
3026	Sand, gravel, clay, and ceramic and refractory minerals	0.0002	0.00
3033	Water, sewage treatment, and other utility services	0.1068	1.00
3095	Dimension lumber and preserved wood products	0.0009	1.00
3102	Prefabricated wood buildings	0.0004	0.00
3144	Plastics pipes and pipe fittings	0.0022	1.00
3161	Ready-mix concrete	0.0093	1.00
3163	Other concrete products	0.0028	0.00
3186	Plates and fabricated structural products	0.0068	0.30
3193	Hardware	0.0003	0.00
3314	Signs	0.0002	0.00
3319	Wholesale trade distribution services	0.1429	0.67
3320	Retail services—Motor vehicle and parts	0.0004	1.00
3323	Retail services—Building material and garden supply	0.1858	1.00
3329	Retail services—General merchandise	0.0031	1.00
3335	Truck transportation services	0.0019	1.00
3346	Motion pictures and videos	0.0002	1.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0077	1.00
3392	Education from private junior colleges, colleges, universities, and professional schools	0.0014	1.00
3417	Commercial and industrial machinery and equipment repairs and maintenance	0.0079	1.00
3424	Grant-making, giving, and social advocacy services	0.0015	1.00
3429	Products and services of federal government enterprises (except electric utilities)	0.0290	1.00
3432	Products and services of state and local government enterprises (except electric utilities)	0.0175	1.00
	Upland Project Management Total	**0.6161**	**0.92**
	Upland Projects Total	**1.0000**	**0.92**

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Table A5. Production functions for each project type

IMPLAN Sector	Coefficient Description	Production Coefficient	Instate Purchase Coefficient
Other Projects (n=12)			
5001	Labor	0.1090	1.00
-	Labor-intensive contracting	0.0531	1.00
-	Equipment-intensive—Watershed contracting	0.1666	0.86
-	Equipment-intensive—Forestry contracting	0.0082	1.00
-	Technical planning and design	0.0731	1.00
3006	Greenhouse, nursery, and floriculture products	0.0286	0.74
3011	Cattle from ranches and farms	0.0024	1.00
3025	Natural stone	0.0192	1.00
3031	Electricity, and distribution services	0.0114	1.00
3095	Dimension lumber and preserved wood products	0.0001	1.00
3113	Printed materials	0.0005	1.00
3161	Ready-mix concrete	0.0014	1.00
3163	Other concrete products	0.0039	1.00
3222	Turbines and turbine generator set units	0.0005	0.00
3319	Wholesale trade distribution services	0.2743	0.99
3320	Retail services—Motor vehicle and parts	0.0002	1.00
3322	Retail services—Electronics and appliances	0.0001	1.00
3323	Retail services—Building material and garden supply	0.0263	1.00
3326	Retail services—Gasoline stations	0.0002	1.00
3329	Retail services—General merchandise	0.0021	1.00
3330	Retail services—Miscellaneous	0.0008	1.00
3335	Truck transportation services	0.0015	1.00
3338	Scenic and sightseeing transportation services and support activities for transportation	0.0144	1.00
3339	Couriers and messengers services	<0.0001	1.00
3351	Telecommunications	0.0002	0.00
3365	Commercial and industrial machinery and equipment rental and leasing services	0.0098	1.00
3388	Services to buildings and dwellings	0.0018	1.00
3389	Other support services	0.0055	1.00
3392	Education from private junior colleges, colleges, universities, and professional schools	0.0039	1.00
3400	Individual and family services	0.0004	1.00
3414	Automotive repair and maintenance services, except car washes	0.0403	1.00
3422	Other personal services	0.0001	1.00
3424	Grant-making, giving, and social advocacy services	0.0115	1.00
3427	U.S. Postal Service delivery services	0.0001	1.00
3429	Products and services of federal government enterprises (except electric utilities)	0.0879	0.00
3432	Products and services of state and local government enterprises (except electric utilities)	0.0482	0.92
	Other Project Management Total	***0.7067***	***0.85***
	Other Projects Total	***1.0000***	***0.88***

Endnotes

1 For more information on MIG data, please refer to the MIG Data Guide (MIG 2004)