

Economic Contributions of the Maryland Stem Cell Research Fund

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An Economic Assessment of the Maryland Stem Cell Research Fund

Executive Summary

Sage Policy Group, Inc. (Sage) analyzed the economic and fiscal benefits associated with the Maryland Stem Cell Research Fund (MSCRF). Established by the Maryland Stem Cell Research Act of 2006, the MSCRF has been supporting stem cell research with State support since 2007.

To date, the MSCRF has awarded approximately \$140 million in support of 400 Maryland-based research projects. While the MSCRF awarded \$15 million in its inaugural year and \$23 million in its sophomore season, funding levels have since fallen. In 2016, the MSCRF funded \$9.1 million of research, or less than half of its peak level. In 2018, funding is expected to decline to \$8.2 million.

Despite waning commitments, Maryland ranks sixth among all states in terms of financial commitments to stem cell-related research and in the top 5 in terms of industry presence. However, should current patterns of dwindling funding persist, this ranking will slide lower. This report uses IMPLAN economic modeling software, an industry standard, to estimate the economic and fiscal impacts generated by the MSCRF since 2007.

While total research funding has declined, the proportion allocated toward private firms has been surging in recent years. During MSCRF's early years, the lion's share of awards went to Johns Hopkins University affiliates. In 2016 and 2017, however, the share of money awarded to private companies rose dramatically. In 2017, private companies accounted for \$2.7 million in awards or 31.9 percent of total MSCRF funding.

It is important to note that the MSCRF is in its planting stage. It is seeding Maryland's economic environment with great researchers, impactful analysis, and promising therapies. However, the largest impacts occur during harvest season, when ideas are commercialized, creating larger companies and more employment opportunities in the process.

Key Analytical Findings

- The MSCRF has supported nearly 500 jobs directly since its inception;
- These direct jobs are associated with more than \$57 million in employee compensation;
- Once multiplier effects are considered, the MSCRF has supported more than 1,400 FTEs across Maryland;
- These 1,400+ jobs are associated with more than \$108 million in employee compensation;
- Business sales in Maryland have been bolstered by more than \$286 million as a result of the MSCRF, or by more than two times State contributions;
- The MSCRF has generated nearly \$9 million in additional tax revenues for State and local governments since inception.

Introduction

The Technology Development Corporation (TEDCO) commissioned Sage policy Group, Inc. (Sage) to conduct an economic and fiscal impact analysis of the Maryland Stem Cell Research Fund (MSCRF). The Maryland Stem Cell Research Act of 2006 established the MSCRF. The Fund's express purpose is to promote state-funded stem cell research and cures through grants and loans to public and private entities located throughout Maryland. While economic development represents a cornerstone objective of the MSCRF, the ultimate goal is to improve the human experience through the development of new medical strategies that utilize human stem cells for prevention, diagnosis, and treatment of human diseases and conditions.

Over its nine-year existence, the MSCRF has awarded approximately \$140 million dollars to more than 400 research projects. This funding has nurtured a budding stem cell industry within Maryland that ranks in the top five of all states. As of this writing, the Free State is home to 40 stem cell-based product companies and nearly 100 stem cell clinical trials,¹ all of which endeavor to contribute to the creation of life-saving technological advances.

This report assesses the economic and fiscal impacts contributed by the MSCRF since its inception along several dimensions—innovation, business formation, job creation, associated income, local business activity measured in business sales, and State-level fiscal impacts. This report also includes a comparative analysis of stem cell-related research funding across states. That comparison is rendered more difficult, however, by the fact that a number of states support stem cell research, but in the context of larger umbrella programs. Therefore, isolating the degree of support to stem cell research itself can be challenging.

Naturally, research funded by the MSCRF creates impacts that extend beyond economic and fiscal quantification. This report does not seek to assign dollar values to any impacts related to the development of new cures and treatments. In many instances, knowledge gleaned from stem cell research contributes to the overall body of knowledge that enters into the commercialization of new therapies. Attributing the contributions of stem cell research in those instances fairly and proportionately is complex. Moreover, much stem cell research remains in its infancy, and therefore has not yet led to commercial transactions that are easily quantifiable.

¹ Clinicaltrials.gov

I. Sources of Impact, Data, and Methodology

- Methods and Key Definitions

To quantify economic impacts, Sage used IMPLAN economic modeling software² and its embodied multipliers to generate estimates of employment, employee compensation, and output. Calculated employment impacts include both full- and part-time workers. Results are presented in the form of full-time equivalents (FTE), meaning that one job is the equivalent of one year of full-time employment. Labor income encompasses all forms of employment income including employee compensation (wages and benefits) and proprietor income (earnings of business owners). Output represents the sum of business sales (good and services) that occur as a result of the MSCRF's efforts and the activities of the companies and organizations they fund.

To conduct the fiscal portion of the analysis, Sage accessed publicly available information, including government-published tax rates and budgetary information. Some fiscal impacts were created implicitly within IMPLAN, which incorporates community-specific tax rates.

Economic impacts are presented in the form of **direct impacts** as well as in the form of secondary impacts. Direct impacts are generated by the activities of the MSCRF and the entities they fund. Secondary impacts can collectively be considered the multiplier effect, and can be segmented into two types of impacts –

indirect and **induced**. Indirect benefits are generated through the expanded volume of business-to-business transactions attributable to a larger local economy. For instance, increased spending by medical supply companies directly implicated in stem cell research activities may in turn lead to increased spending at office supply companies, local hotels, and local restaurants. Induced benefits are triggered when workers primarily or secondarily supported through enhanced economic activity spend their earnings in the local economy.

Exhibit 1: MSCRF Annual Grant funding

Fiscal Year	Funding(m)
2007	\$15.0
2008	\$23.0
2009	\$18.0
2010	\$12.4
2011	\$10.4
2012	\$12.4
2013	\$10.4
2014	\$10.2
2015	\$9.4
2016	\$9.1
2017	\$9.1
2018	\$8.2
Total	\$147.6

Source: MSCRF

² IMPLAN is the most commonly used econometric software for analyses of its type and has emerged as the industry standard for this type of quantification. The model is comprised of economic multipliers that reflect the statistical relationship between various local industries and the likelihood that certain goods and services will be sourced locally as opposed to outside the community. These multipliers are updated each year and Sage purchases model licenses on an annual basis. This study utilizes the most recent multipliers to date (2015).

To the extent that expenditures by businesses or consumers take place beyond Maryland’s boundaries, they are not considered in Sage’s impact estimates. Appendix A at the end of this report supplies additional detail regarding IMPLAN model workings and definitions.

- **Data Inputs**

The primary inputs used in this analysis are the grants funded by the MSCRF. Since the inception of its operations in 2007, the MSCRF has awarded nearly \$150 million to researchers working throughout Maryland. That funding peaked in 2008 at \$23 million. As reflected in Exhibit 1, funding levels have fluctuated over time and have tended to drift lower. The decline in funding since 2012 is a product of State budgetary dynamics and not a reflection of the MSCRF’s operational efficiency. The result is that less research is transpiring in Maryland than one might have predicted as of 2008. Exhibit 1 supplies more complete statistical detail.

Approximately 70 percent of grant funding has gone to Johns Hopkins University, a global medical research leader. The University of Maryland System³ has received more than 20 percent of MSCRF awards. Research institutions, a category which from 2007 to 2016 encompassed only the Kennedy Krieger Institute, but has since grown to include the Lieber Institute for Brain Development and the Hussman Institute for Autism, have accounted for approximately 4 percent of total funding.

Exhibit 2: Awards by Recipient

	JHU	Research Institutions ⁴	Private Companies	UMS	Private Hospitals	Total ⁵
2007	\$9,428,285	-	\$929,747	\$3,152,521	-	\$13,510,553
2008	\$17,302,827	\$827,887	-	\$4,563,236	-	\$22,693,950
2009	\$13,593,770	\$769,951	\$460,000	\$4,114,964	-	\$18,938,685
2010	\$7,410,243	\$230,000	\$229,880	\$3,836,135	-	\$11,706,258
2011	\$8,189,835	\$1,030,000	-	\$1,692,998	-	\$10,912,833
2012	\$7,863,409	\$230,000	\$690,000	\$2,777,629	-	\$11,561,038
2013	\$7,796,027	\$230,000	\$559,000	\$2,120,696	-	\$10,705,723
2014	\$6,055,780	-	\$506,431	\$2,640,000	\$223,779	\$9,425,990
2015	\$5,552,590	\$437,000	\$475,000	\$2,613,500	-	\$9,078,090
2016	\$5,818,069	\$801,875	\$1,216,325	\$570,000	-	\$8,406,269
2017	\$3,653,013	\$1,263,845	\$2,698,960	\$835,000	-	\$8,450,818
Total	\$92,663,848	\$5,820,558	\$7,765,343	\$28,916,679	\$223,779	\$135,166,427

Source: MSCRF

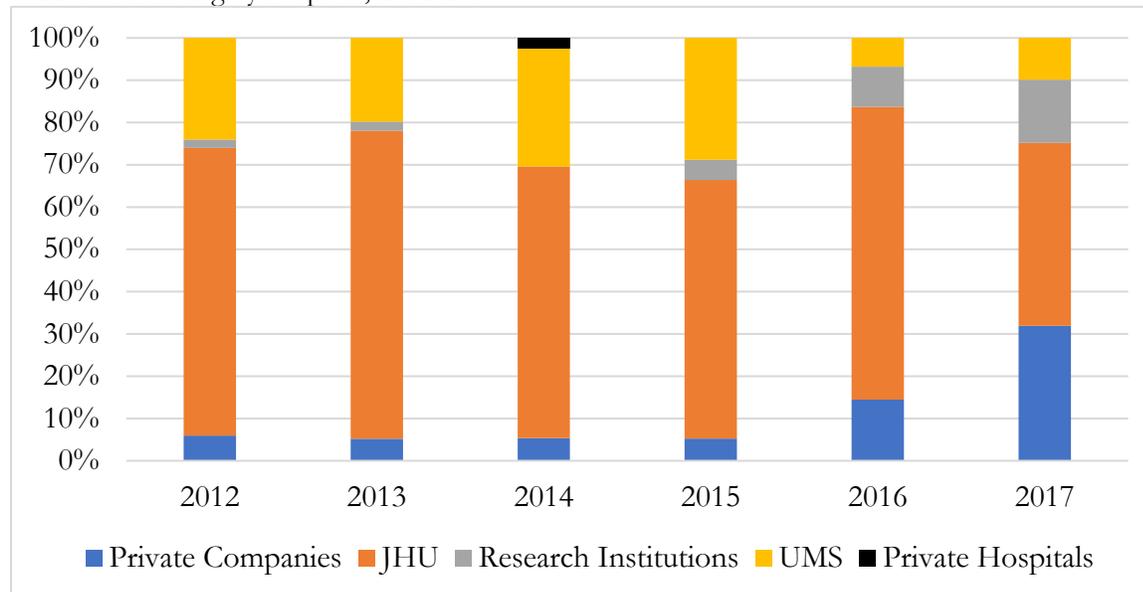
³ Includes University of Maryland, Baltimore, University of Maryland, Biotechnology Institute, and University of Maryland, College Park

⁴ Includes the Kennedy Krieger Institute, The Lieber Institute for Brain Development, and the Hussman Institute for Autism.

⁵ Totals are lower than aggregate funding levels because administrative costs are excluded.

The distribution of awards has changed dramatically over time, particularly in recent years. While Johns Hopkins and UMS received the vast majority of awards in prior years, in 2017, private companies received more than 30 percent of the MSCRF’s awards. Research institutions received 15 percent. Exhibit 3 supplies relevant detail. The blue portion of the bars represent share of MSCRF funding to private companies, while the grey-shaded area represents the research institution category.

Exhibit 3: Funding by recipient, 2012-2017



Source: MSCRF

- [The Central Importance of Commercialization](#)

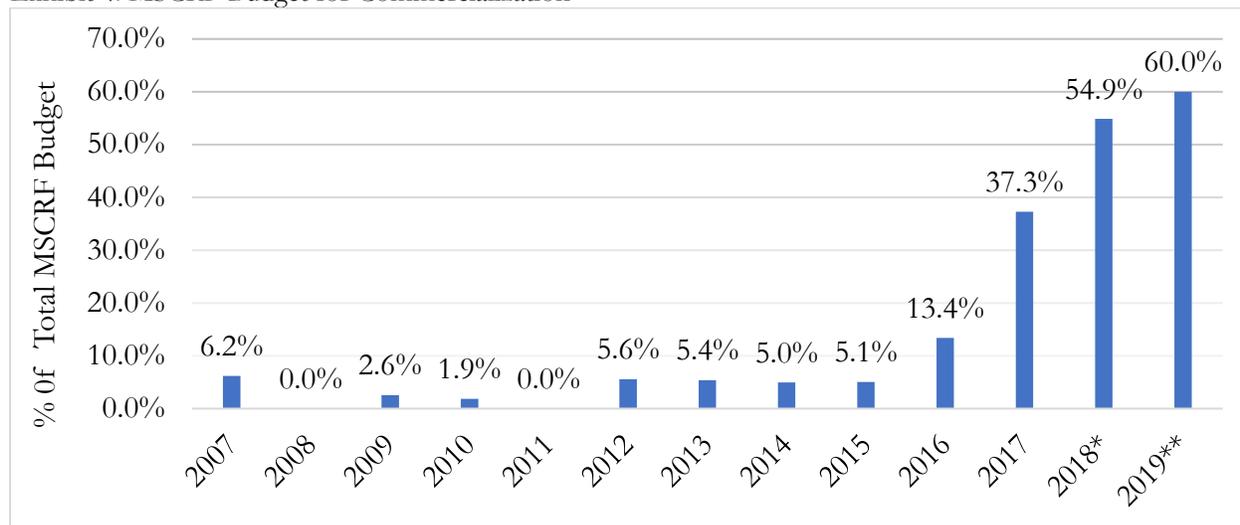
In the MSCRF’s inaugural year of 2007, commercialization — a category that includes awards to entities controlling intellectual property ready to advance into the marketplace, comprised just 6.2 percent of the total MSCRF funding budget. Through 2015, commercialization continued to represent approximately 5 percent of MSCRF’s budget.

In 2016, however, the share of the budget directed toward commercialization increased to 13.4 percent. In 2017 that figure climbed to 37.3 percent, an indication that a growing number of technologies are approaching a level of refinement that allows for commercial introduction. The harvest is about to begin. In 2018 and 2019, commercialization is projected to account for more than 50 percent of the MSCRF’s budget. Exhibit 4 provides summary detail.

The economic implications of this are simply enormous. A single successful technology or company can support thousands of jobs in Maryland. However, the State of Maryland has been reducing

funding for the MSCRF precisely at a moment when the potential for commercialization is ramping higher. That diminishes the chances that Maryland will benefit as fully from the commercialization of stem cell technologies as other states that have maintained a more robust commitment to research.

Exhibit 4: MSCRF Budget for Commercialization



Source: MSCRF

Exhibit 5 supplies a sample of companies that have explored funding from TEDCO/MSCRF. Many of these companies have successfully raised monies from other sources, including initial public offerings and Series A funding rounds. This provides these companies with greater resources to conduct R&D and commercialize technologies. The ongoing relationship these enterprises maintain with TEDCO/MSCRF means that these firms are more likely to maintain a significant share and perhaps all of their productivity activities in Maryland.

Exhibit 5: Sample of Companies Exploring Opportunities with TEDCO

Company Name	Stage	Field	Company Name	Stage	Field
3DBioWorks Inc	Applied	bioreactor	Longeveron LLC	Funded	Clinical trials
AgamiLife Inc	Engaged	storage	Maxcyte Inc	Funded	pre clinical
Cellth Systems, LLC	Engaged	pre clinical	3Dnatics Inc	Funded	drug discovery, service
Cellunova	Engaged	clinical	BioCardia	Funded	Clinical site in MD
Domicell LLC	Engaged	pre clinical	GlobalStem	Funded	Research product
Green Cross Cell	Engaged	clinical	Stem Cell Surgical, LLC	Funded	R&D
WindMiL	Engaged	clinical stage	Orgenesis, Inc	Funded	Pre clinical
LifeSprout	Funded	pre clinical	Phycin LLC	Funded	Research products
RoosterBio Inc	Funded	products	Propagenix Inc	Funded	Pre clinical
TissueGene Inc	Funded	stage 3 clinical	Seraxis Inc	Funded	Pre clinical

Source: MSCRF

II. Stem Cell Research Funding across States

Maryland is a Leader, but should be more of one

Over the past decade, the State of Maryland ranked sixth among U.S. states in terms of its financial commitment to stem cell research. This type of support helps explain the following rankings:

- Ernst and Young ranked Maryland 4th in the nation for its Core Biotechnology.
- JLL ranked suburban MD/Metro D.C. as the #6 market for Life Sciences.
- Genetic Engineering & Biotechnology News ranked Maryland/DC Metro #5 among U.S. Biopharma Clusters.

Home to the National Institutes of Health, the Food & Drug Administration, Fort Detrick, Johns Hopkins, the University of Maryland – College Park, the University of Maryland – Baltimore, UMBC, and other assets, it is not surprising that Maryland is a leading life sciences state. However, one might have expected even loftier rankings given Maryland’s unparalleled cluster of R&D assets. Many Marylanders would agree that the massive volumes of research and development that takes place statewide has yet to translate into a commensurate level of commercialization. Programs like the MSCRF are critical to taking Maryland to the next stage.

At least some of the economic implications are obvious. Jobs in the life sciences are extremely high-paying on average, which means that they support high living standards and also generate proportionately more income tax revenue for state and local governments in Maryland. Moreover, biotechnology as an industry is associated with elevated economic multiplier effects, a reflection of both capital- and human capital-intensity.

Exhibit 6: State Stem Cell Research Commitments

State	Commitment
California	\$3 Billion
Texas	\$3 Billion
Massachusetts	\$1 Billion
New York	\$660 Million
Connecticut	\$200 Million
Maryland	\$147 Million
Washington	\$100 Million
Minnesota	\$45 Million

Source: MSCRF

III. Economic and Fiscal Impacts

Based on Sage’s IMPLAN modeling, the MSCRF supported more than \$286 million in statewide economic activity from 2007 to 2017. This economic activity supported more than 1,400 jobs (FTEs). Those jobs were associated with more than \$108 million in employee compensation, meaning the average supporting worker earns more than \$77,000 in employee compensation per annum. Direct employee compensation per worker, which largely encompasses the researchers themselves, exceeds \$115,000/annum. Approximately 1.8 positions are created through multiplier effects for every 1 directly created job. Each dollar of grant funding creates more than \$2 in economic activity. Exhibit 7 supplies additional detail.

Again, to use an agrarian metaphor, these are the effects associated with the planting stage. Much of the research supported to date has been basic research, intended to increase the sum total of human knowledge. Increasingly, the MSCRF is supporting research that positions that knowledge to be commercialized. In other words, the economic impacts associated with the MSCRF are set to ramp higher, perhaps exponentially, if the State of Maryland commits adequate resources to the Fund and distances itself from the recently observed pattern of diminished support.

Exhibit 7: Economic Impacts generated by MSCRF, 2007-2017

	Jobs (FTEs)	Employee Compensation	Business sales
2017 Dollars			
Direct effects	495	\$57,091,212	\$146,180,487
Indirect effects	446	\$28,818,832	\$72,341,102
Induced effects	464	\$22,789,427	\$67,931,084
Total	1,405	\$108,699,471	\$286,452,673

Source: Sage, IMPLAN, MSCRF

Exhibit 8 reflects the fact that economic impacts have tended to correlate neatly with annual funding levels. That will change going forward as commercialization becomes more apparent. Commercial impacts can be massive, and that will serve to delink grant funding from economic impact. However, if the State of Maryland fails to support the MSCRF adequately, the efforts of the past may be squandered, with commercialization that would have otherwise transpired in Maryland taking place in other states.

Exhibit 8: Total Annual Economic Impacts*, 2007-2017

	Grant Funding	Jobs (FTEs)	Employee Compensation	Business sales
2007	\$13,510,553	150	\$11,617,115	\$30,614,259
2008	\$22,693,950	245	\$18,959,489	\$49,963,412
2009	\$18,938,685	206	\$15,966,322	\$42,075,601
2010	\$11,706,258	125	\$9,640,143	\$25,404,399
2011	\$10,912,833	113	\$8,721,136	\$22,982,564
2012	\$11,561,038	117	\$9,016,005	\$23,759,625
2013	\$10,705,723	107	\$8,267,226	\$21,786,388
2014	\$9,425,990	92	\$7,121,514	\$18,767,126
2015	\$9,078,090	88	\$6,822,403	\$17,978,888
2016	\$8,406,269	81	\$6,284,110	\$16,560,338
2017	\$8,450,818	81	\$6,284,009	\$16,560,072

Source: Sage, IMPLAN, MSCRF

*2017 Dollars

- **Fiscal Impacts**

Exhibit 9 supplies estimates of State-level fiscal impacts. In total, State and local tax revenues have been enhanced by nearly \$9 million due to the MSCRF’s grant funding activities. To estimate State and local income tax collections, the Sage study team computed effective income tax rates based on data supplied by the State of Maryland’s FY2016 Comprehensive Annual Financial Report. Sales tax augmentation totaled \$2.7 million and property tax collections were bolstered by \$2.6 million. Both of these estimates were generated directly as IMPLAN model outputs.

Exhibit 9: Fiscal Impacts by Year

	State Income Taxes	Local Income Taxes	Sales Tax	Property Taxes	Total
2007	\$239,828	\$144,343	\$288,731	\$276,093	\$948,995
2008	\$391,406	\$235,572	\$471,218	\$450,592	\$1,548,788
2009	\$329,614	\$198,382	\$396,826	\$379,456	\$1,304,278
2010	\$199,014	\$119,779	\$239,595	\$229,108	\$787,496
2011	\$180,042	\$108,360	\$216,754	\$207,267	\$712,423
2012	\$186,130	\$112,024	\$224,083	\$214,275	\$736,512
2013	\$170,672	\$102,720	\$205,473	\$196,479	\$675,344
2014	\$147,019	\$88,485	\$176,998	\$169,250	\$581,752
2015	\$140,844	\$84,769	\$169,563	\$162,141	\$557,317
2016	\$129,732	\$78,080	\$156,185	\$149,348	\$513,345
2017	\$129,729	\$78,079	\$156,182	\$149,346	\$513,336
Total	\$2,244,031	\$1,350,592	\$2,701,608	\$2,583,355	\$8,879,586

Source: Sage, IMPLAN, MSCRF

Conclusion

To date, the MSCRF has awarded approximately \$140 million in support of 400 Maryland-based research projects. One result has been the amassing of a body of knowledge that continues to migrate toward commercialization. Commercial impacts can be massive, with a single successful company able to support thousands of jobs. However, if the State of Maryland fails to support the MSCRF adequately, the efforts of the past may be squandered, with commercialization that would have otherwise transpired in Maryland taking place in other states.

In fact, State of Maryland support for stem cell research has been on the wane. While the MSCRF awarded \$15 million in its inaugural year and \$23 million in its sophomore season, funding levels have fallen since. In 2016, the MSCRF funded \$9.1 million of research, or less than half of its peak level. In 2018, MSCRF grant funding is expected to decline to \$8.2 million. Despite waning commitment, Maryland ranks sixth among all states in terms of financial commitments to stem cell-related research and in the top 5 in terms of industry presence.

To put the issue of commercialization into further context, it should be noted that in the MSCRF's inaugural year of 2007, commercialization — a category that includes awards to entities controlling intellectual property ready to advance into the marketplace, comprised just 6.2 percent of the total MSCRF funding budget. Through 2015, commercialization continued to represent approximately 5 percent of MSCRF's budget. In 2016, however, the share of the budget directed toward commercialization increased to 13.4 percent. In 2017 that figure climbed to 37.3 percent, an indication that a growing number of technologies is approaching a level of refinement that allows for commercial introduction. In 2018 and 2019, commercialization is projected to account for more than 50 percent of the MSCRF's budget. After many seasons of planting, the economic harvest is about to begin.

Despite diminished support and the fact that many technologies have yet to find their way to the marketplace, MSCRF economic impacts have already been consequential. Since its inception, the MSCRF has supported:

- more than 1,400 FTEs across Maryland once multiplier effects are fully considered;
- more than \$108 million in employee compensation;
- more than \$286 million in additional business sales statewide or by more than two times accumulated State contributions; and
- nearly \$9 million in additional tax revenues for Maryland's state and local governments..

Appendix A – IMPLAN

IMPLAN is an economic impact assessment software system. The system was originally developed and is now maintained by the Minnesota IMPLAN Group (MIG). It combines a set of extensive databases concerning economic factors, multipliers and demographic statistics with a highly refined and detailed system of modeling software. IMPLAN allows the user to develop local-level input-output models that can estimate the economic impact of new firms moving into an area as well as the impacts of professional sports teams, recreation and tourism, and residential development. The model accomplishes this by identifying direct impacts by sector, then developing a set of indirect and induced impacts by sector through the use of industry-specific multipliers, local purchase coefficients, income-to-output ratios, and other factors and relationships.

There are two major components to IMPLAN: data files and software. An impact analysis using IMPLAN starts by identifying expenditures in terms of the sectoring scheme for the model. Each spending category becomes a "group" of "events" in IMPLAN, where each event specifies the portion of activity allocated to a specific IMPLAN sector. Groups of events can then be used to run impact analysis individually or can be combined into a project consisting of several groups. Once the direct economic impacts have been identified, IMPLAN can calculate the indirect and induced impacts based on a set of multipliers and additional factors.

Economic benefits principally take the form of new employment opportunities, associated income and augmented business revenues. These economic benefits include both direct benefits, which are closely associated with the activities that will take place at the National Aquarium and secondary benefits that are associated with foreseeable and calculable multiplier effects.

Secondary benefits can be segmented into two types of impacts, indirect and induced. Indirect benefits are related to the business-to-business transactions that take place due to increased demand for goods and services that accompanies augmented investment and business operations. Impacted businesses sell everything from office furniture and copiers to computer and graphic design services. Induced benefits are created when workers directly or indirectly supported by increased economic activity spend their earnings in the local economy. Indirect and induced benefits together comprise total multiplier effects.

The hallmark of IMPLAN is the specificity of its economic datasets. The database includes information for five-hundred-and-twenty-eight different industries (generally at the three or four digit Standard Industrial Classification level), and twenty-one different economic variables. Along with these data files, national input-output structural matrices detail the interrelationships between and among these sectors. The database also contains a full schedule of Social Accounting Matrix (SAM) data. All of this data is available at the national, state, and county level.

Another strength of the IMPLAN system is its flexibility. It allows the user to augment any of the data or algorithmic relationships within each model in order to more precisely account for regional relationships. This includes inputting different output-to-income ratios for a given industry,

different wage rates, and different multipliers where appropriate. IMPLAN also provides the user with a choice of trade-flow assumptions, including the modification of regional purchase coefficients, which determine the mix of goods and services purchased locally with each dollar in each sector. Moreover, the system also allows the user to create custom impact analyses by entering changes in final demand. This flexibility is a critically important feature in terms of the Sage proposed approach. Sage is uniquely qualified to develop data and factors tailored to this project, and, where appropriate, overwrite the default data contained in the IMPLAN database.

A final advantage of IMPLAN is its credibility and acceptance within the profession. There are over five hundred active users of IMPLAN databases and software within the federal and state governments, universities, and among private sector consultants. The following list provides a sampling of IMPLAN users.

Sample of IMPLAN Users:

Academic Institutions

Alabama A&M University
Albany State University
Auburn University
Cornell University
Duke University
Iowa State University
Michigan Tech University
Ohio State
Penn State University
Portland State University
Purdue University
Stanford University
Texas A&M University
University of California – Berkeley
University of Wisconsin
University of Minnesota
Virginia Tech
West Virginia University
Marshall University/College of Business

Federal Government Agencies

Argonne National Lab
Fed. Emergency Man. Agency (FEMA)
US Dep't of Agriculture, Forest Service
US Dep't of Ag., Econ Research Service
US Dep't of Int., Bureau of Land Mgmt.
US Dep't of Int., Fish and Wildlife Serv.
US Dep't of Int., National Parks Service
US Army Corps of Engineers

State Government Agencies

MD Dep't of Natural Resources
Missouri Department of Economic Development
California Energy Commission
Florida Division of Forestry
Illinois Dep't of Natural Resources
New Mexico Department of Tourism
South Carolina Employment Security
Utah Department of Natural Resources
Wisconsin Department of Transportation

Private Consulting Firms

Coopers & Lybrand
Batelle Pacific NW Laboratories
Boise Cascade Corporation
Charles River Associates
CIC Research
BTG/Delta Research Division
Crestar Bank
Deloitte & Touche
Ernst & Young
Jack Faucett Associates
KPMG Peat Marwick
Price Waterhouse LLP
Sage Policy Group, Inc.
Economic Research Associates
American Economics Group, Inc.
L.E. Peabody Associates, Inc.
The Kalorama Consulting Group
West Virginia Research League