

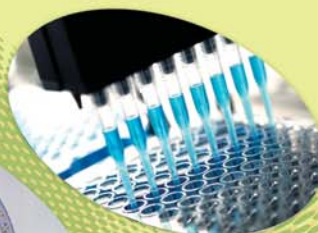
2012 Evidence and Opportunity: *Impacts of the Biosciences in North Carolina*



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North Carolina Biotechnology Center

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EXECUTIVE SUMMARY

This third biennial independent assessment of the economic impacts of bioscience industry development in North Carolina found that the state's industry not only withstood the toughest of economic times, but in the bottom-line measures of direct job creation, employment impacts and industry competitiveness, continued to advance through the severe recession and weak economic recovery.

These findings point to just what a remarkable success story bioscience industry development has been in North Carolina. In 1984, when just a few companies were applying the new advances in a fledgling field known as biotechnology, the State of North Carolina created the unique model of the North Carolina Biotechnology Center (NCBiotech) to be a catalyst and resource for sustaining economic development in this emerging field. The Center represented the world's first government-sponsored commitment to advancing biotechnology-based economic development with a focus on public-private partnerships and filling key gaps to ensure the growth of this industry in the state.

Few realized in 1984 just how transformative biotechnology would be and how it would open the door to more traditional bioscience industries to develop in North Carolina. Advances in biotechnology have reshaped all aspects of biomedical development from the way we study medicine, discover and develop therapeutics, and diagnose and treat diseases and medical conditions for both humans and animals. Furthermore, advances in biotechnology are having similar transformative impacts on agricultural biosciences for improving, protecting and enriching plants, as well as giving birth to a new industrial biotechnology sector generating bio-based fuels and specialty chemicals.

North Carolina is now among the largest states in bioscience industry development in the U.S. Today, the past distinctions between a biotechnology company and a pharmaceutical or medical products company have fallen away as biotechnology techniques and knowledge are being applied in all traditional bioscience industries.

Looking to the future, the prospects of continued advances in the biosciences look bright. As the National Research Council explains in its study *A New Biology for the 21st Century*, advances in the life sciences have the potential to contribute innovative and mutually reinforcing solutions to global-reaching, societal challenges related to food, environment, energy and health, and at the same time, serve as the basis for new industries that will anchor the economies of the future.¹ A recent OECD study of the bio-economy estimates that based on recognized advances in biological sciences with a high probability of reaching the market, it is expected by 2030 that these bioscience innovations could contribute up to 35 percent of the output of chemicals and other industrial products, 80 percent of pharmaceuticals and diagnostic production, and 50 percent of agricultural output worldwide.²

Below are the key findings from this third biennial assessment of the economic impacts of bioscience industry development on North Carolina and the contributions of NCBiotech. The methodology for measuring these economic impacts remains the same as in past years. In order to provide the most current industry employment data to develop economic impacts of the biosciences in 2012, the NCBiotech database of bioscience companies is used. This unique and North Carolina specific database involves ongoing tracking of individual firm employment in the state, including direct outreach to firms by NCBiotech staff. Up-to-date figures through the end of the second quarter were used in generating these results.

¹ National Research Council, *A New Biology for the 21st Century*, National Academy of Sciences, 2009.

² OECD, *The Bioeconomy to 2030*, 2009, page 199.

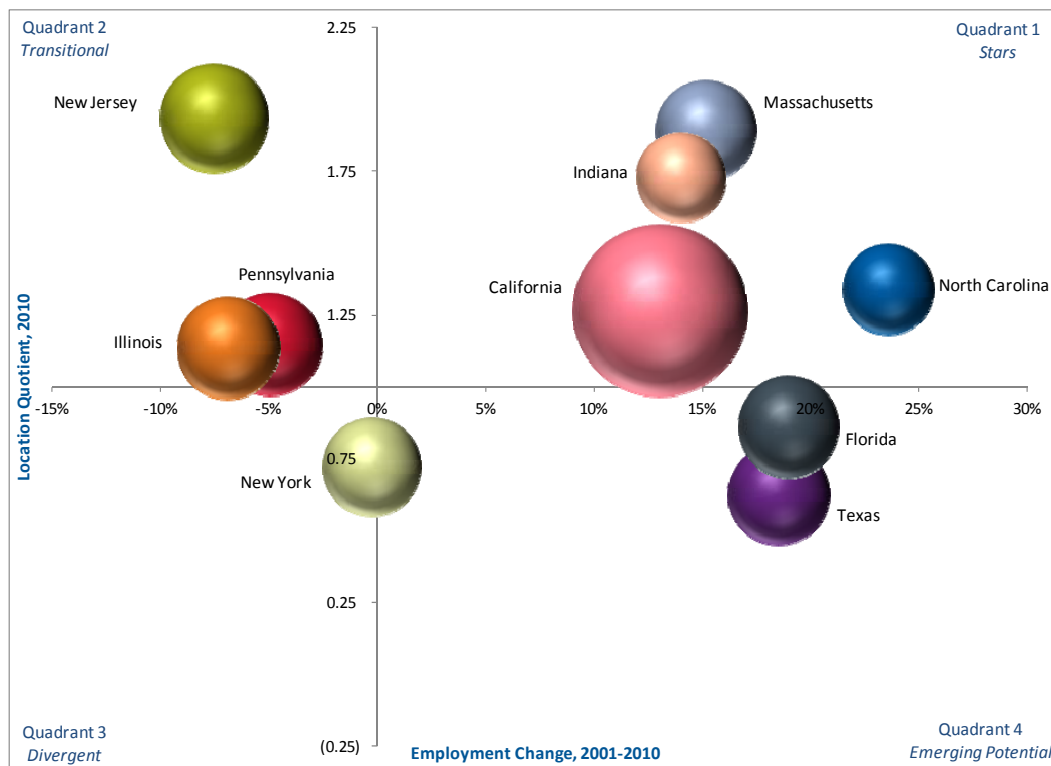
To compare North Carolina to other states, the report uses the Biotechnology Industry Organization's (BIO) definition of the bioscience industry that was developed jointly with Battelle based on selected North American Industry Classification System sectors and measured by industry employment levels reported in the Bureau of Labor Statistics Quarterly Census of Employment and Wages and maintained by IMPLAN. The latest year available for state by state comparisons is 2010. This BIO-Battelle definition was first developed in 2002, and given the changing nature of biological research and its commercial applications, was recently revised in 2012. The biggest change was adding bioscience-related distribution recognizing that the increasingly specialized approaches undertaken in the distribution of drugs, medical devices, and other bioscience-related products includes cold storage and highly-regulated product monitoring as well as new technology for distribution such as automated pharmaceutical distribution systems warrant its inclusion as a major industry subsector.

Competitive Strength Revealed: North Carolina Stands Strong in Bioscience Industry Growth over the Past Decade and Through the Recent Recession to Recovery Period

North Carolina stands out in its rapid growth in the biosciences over the past decade, even compared with national leaders in the sector. Figure ES-1 presents the current employment position for North Carolina and the other states ranked in the top 10 in terms of overall bioscience employment. **Among the ten largest bioscience employer states, North Carolina's 23.5 percent job growth since 2001 has been the fastest.** Since 2001, this translates into nearly 12,000 new jobs in the biosciences for North Carolinians, a total job gain surpassed only by California, Florida, and Texas, three much larger states.

Five of the ten largest bioscience employer states, including North Carolina, have a specialized concentration of employment (meets or exceeds a location quotient of 1.20 or at least 20 percent of the national average concentration of employment). These five states are: New Jersey (Location Quotient is 1.93), Massachusetts (LQ is 1.89), Indiana (LQ is 1.73), North Carolina (LQ is 1.34), and California (LQ is 1.26).

Figure ES-1: Total Bioscience Sector, Degree of Specialization, Employment Growth, and Size, Ten Largest U.S. Bioscience Employer States, 2001–2010

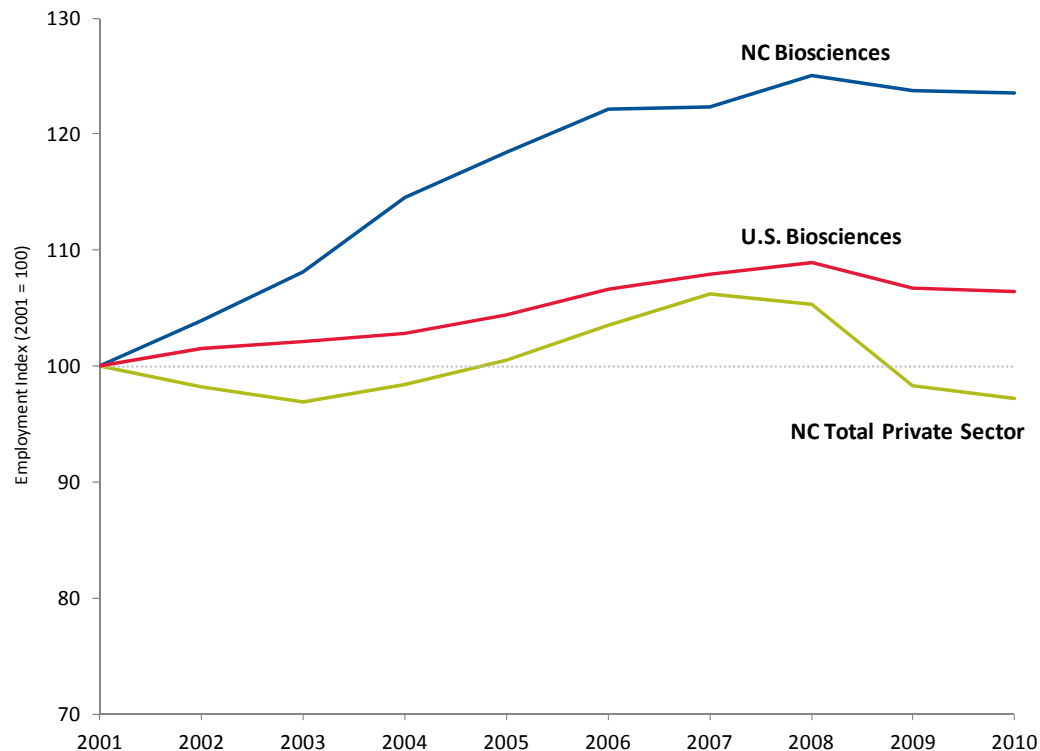


Another sign of the varied and robust nature of North Carolina's bioscience industry base is that it is just one of eleven states nationally with a specialized employment concentration in three or more of the five bioscience subsectors. It has a specialized location quotient in: drugs and pharmaceuticals (LQ is 2.34); research, testing, and medical labs (LQ is 1.39); and agricultural feedstock and chemicals (LQ is 1.20). Since 2001, four of the five major bioscience subsectors contributed to the state's substantial overall job growth with only the smallest sector, agricultural feedstock and chemicals, shedding jobs.

Bolstering the State's Economy In Tough Economic Times: Growth of North Carolina's Bioscience Industry through the Recession and Recovery even as the State's Overall Private Sector Declined Sharply

While bioscience industry employment in North Carolina held its own and even grew slightly through the recession and early years of recovery, private sector employment in North Carolina fell sharply. From a pre-recession high of 3.4 million jobs, private sector jobs fell to a low of 3.1 million in 2010. So, the bioscience industry has helped bolster the state's economy in tough economic times.

Figure ES-2: Employment Growth in North Carolina's Bioscience Sector, 2001–2010



Compared with other top bioscience states, from the economic peak in 2007 through the recession and initial year of recovery in 2010, North Carolina was just one of four states to have added employment. Two of the largest employer states—New Jersey and Pennsylvania—have seen significant job loss as a result of the recession. These states have been especially hard hit by declines in the drugs and pharmaceuticals subsector which has cut jobs in recent years.

Rising Statewide Total Employment Impacts as Bioscience Industry Cluster Development Intensifies: Continued Growth of North Carolina's Bioscience

Industry is Creating Deeper Connections and Higher Multiplier Impacts in the State

The growth of the bioscience industry cluster also boosts North Carolina's supply chains that support this industry. The result is that the total employment impact of each bioscience industry job in generating additional jobs in North Carolina is growing—in other words, with greater cluster development comes rising employment multipliers across North Carolina's economy. This benefit of increased agglomeration is reflected in the IMPLAN Input/Output models through its regional purchase coefficients. Table ES-1 provides the results over time of how direct bioscience jobs impact broader employment in North Carolina.

Of particular note is that the total employment impact of the bioscience industry in North Carolina rose an impressive 57,658 jobs or 32 percent from its level of 180,007 jobs in 2008 to 237,665 in 2012. Helping to drive this considerable rise in total employment impact of the bioscience industry in the state is the higher employment multiplier in North Carolina, so that each direct job in the bioscience industry in 2012 accounts for slightly more than 4 total jobs in the state compared to 3.4 jobs in 2008.

Table ES-1: Comparison of the Employment Impacts from the Economic Contribution of Biotechnology/Bioscience Sector to the North Carolina Economy, 2008, 2010 and 2012

Item	2012	2010	2008
Total Biotechnology Sector			
Direct Impact (Employment)	58,589	56,842	53,182
Indirect Impact (Employment)	84,654	84,494	64,913
Induced Impact (Employment)	94,422	84,487	61,913
Total Impact (Employment)	237,665	226,823	180,007
Total Employment Multiplier (Total Impact Divided by Direct Impact)	4.056	3.990	3.385

Source: Battelle analysis of NCBiotech data using IMPLAN.

As a result of local and national economic conditions, the sector's growth in employment did not translate into an increase in the value of the sector's output or revenues. In a recession, the level of output or sales per job declines reflecting the weaker economic conditions. Given the weak national recovery, output did not rise relative to employment as might be expected in the first year of a recovery. Therefore, it is not surprising that despite the rising level of direct employment in the biosciences, the industry's output generated fell from previous years. Moreover, this decline in post-recession output is not concentrated in the bioscience sector—it occurred across most sectors of the North Carolina economy and occurred nationally as well. Thus, these results are consistent with both overall state and national economic changes.

A Proven Bioscience Catalyst Continues to Generate Economic Dividends: North Carolina Biotechnology Center (NCBiotech) Continues to Have a Growing Impact on Bioscience Development and the North Carolina Economy Overall

Along with the growing employment base, the contributions of NCBiotech to the North Carolina economy have continued to rise, resulting in expanded state and local tax generation. The following tables present the total impacts on the state's economy from ongoing companies in 2012 (compared with previous years) who received loans from NCBiotech (Table ES-2) as well as the total impact of NCBiotech operations/programmatic spending on the state's economy (Table ES-3).

Table ES-2: The Economic Contribution of Currently Active Companies that Received Business Loans on the North Carolina Economy, 2008, 2010, 2012

Item	2012 Total Impact	2010 Total Impact	2008 Total Impact
Number of Companies	74	83	64
Output (\$M)	\$2,386	\$1,355	\$818
Employment (# of Jobs)	9,586	5,513	3,734
Labor Income (\$M)	\$608	\$303	\$193
State and Local Tax Revenues (\$M)	\$71	\$44	\$27

Source: Battelle analysis of NCBIotech data using IMPLAN.

Table ES-3: The Economic Contribution of NCBIotech Operational/Programmatic Spending on the North Carolina Economy, 2010 and 2012 Report (one year lag)

Item	2012 Report Total Impact	2010 Report Total Impact
Output (\$M)	\$39.4	\$35.9
Employment (# of Jobs)	256	239
Labor Income (\$M)	\$14.0	\$12.3
State and Local Tax Revenues (\$M)	\$1.7	\$1.6

* Data for 2008 are not included. The approach in 2008 was not comparable given that research spending was included, but excluded in future years so as not to double count.

Source: Battelle analysis of NCBIotech data using IMPLAN.



I. INTRODUCTION

In 2008, Battelle undertook a comprehensive assessment of the economic impacts of the biosciences in North Carolina and the specific impact contributions of the North Carolina Biotechnology Center. This report was followed up with a 2010 report that updated the status of the state bioscience sector and economic impact analysis of the prior report. This 2012 report updates these two earlier analyses with current data and examines the further progress made in North Carolina's economy through bioscience industry growth and investment.

The State of North Carolina was among the first U.S. states to recognize the groundbreaking economic development opportunities that modern biotechnology would bring. In 1984, the state developed a unique model for biotechnology and biosciences development, centered on the formation of the North Carolina Biotechnology Center (NCBiotech). NCBiotech represented the world's first government-sponsored commitment to targeted bioscience-based economic development. The state observed the nascent opportunities on biotech's horizon and stepped forward to initiate the long-term commitment of resources required to place North Carolina among the preeminent locations in the world for bioscience sector growth. As all three of the *Bioscience Impacts in North Carolina* reports show, the results achieved for North Carolina and its citizens have been significant and are a testimony to the foresight of the state and multiple stakeholder partners in committing to the Center's mission and to biotech, and more broadly the biosciences, as a signature for the North Carolina economy.

2012 Impact Update Methodology

This impact update project uses the same methodology utilized in the prior 2008 and 2010 reports. Battelle uses both quantitative and qualitative methods in its economic impact projects, with quantitative analytical techniques favored where facilitated by available data sources. For the analysis of the impact of the bioscience sector in North Carolina, Input/Output (I/O) analysis is used. This "gold standard" economic impact analysis technique is also used in calculating the current spending impacts of the Center.

This report presents an overview of the current position of North Carolina in the biosciences, with Battelle measuring the size of the bioscience economy in the state. The report also examines where North Carolina ranks among U.S. states in the biosciences and provides benchmark comparison to other leading states.

Using I/O analysis, Battelle details the overall economic impact of the bioscience sector on the State of North Carolina—presenting data on direct output and employment in the sector and the total, multiplier-based impacts generated across the economy by indirect and induced impacts. Because of the importance of science and technology research and development to progress in the bioscience sector, Battelle also examines the specific economic impact in the state from biotechnology, medical and other life-sciences research taking place at North Carolina institutions.

One of the key roles of NCBiotech is support for bioscience business commercialization in the state and the provision of capital and services to new and growing bioscience enterprises. NCBiotech has 74 currently active companies in its portfolio of businesses that have received business loans from the Center. NCBiotech also has worked with the State of North Carolina to facilitate the

recruitment into or expansion of 24 bioscience companies in the state from January 2008 through December 2012. The specific economic impact of the 74 companies that have received NCBiotech loans and the 24 companies the Center has assisted in their recruitment or expansion is measured herein.

In addition, economic impacts are generated directly by the Center through its operations and expenditures. Employing 85 personnel and with an annual budget of \$19.1 million³, NCBiotech generates significant expenditure impacts in the state through its ongoing operations. These Center expenditure impacts also are presented in this report.

About Battelle

The Battelle Technology Partnership Practice (TPP) is the technology-based economic development consulting arm of Battelle, the nation's largest non-profit R&D organization. Each year Battelle undertakes more than 4,500 projects for industry, higher education, the public sector, and other clients. In addition to these projects, Battelle manages and operates the Pacific Northwest National Laboratory and co-manages Brookhaven National Laboratory, Idaho National Laboratory, the National Renewable Energy Laboratory, Lawrence Livermore National Laboratory and Oak Ridge National Laboratory for the U.S. Department of Energy. Additional labs operated by Battelle include the National Biodefense Analysis and Countermeasures Center for the U.S. Department of Homeland Security and the United Kingdom's National Nuclear Laboratory.

Battelle's TPP has a national track record in identifying and designing comprehensive bioscience roadmaps and strategies across basic and translational research enhancement, technology development, new-venture development and business development. TPP has completed bioscience strategies for many states and regions including the States of Arizona, Colorado, Georgia, Iowa, Maryland, Michigan, Missouri, Mississippi and Nebraska and such regions as Central Indiana, Central Ohio, Memphis, Pittsburgh, Oklahoma City, St. Louis, Tucson, and Western Massachusetts. TPP also has considerable expertise in evaluating the economic impacts of bioscience and technology-based organizations and programs, including work for individual states, national bodies and organizations such as the Mayo Clinic, and more recently the economic impacts of the Human Genome Project.

Battelle TPP also is well known nationally for competitive benchmarking capabilities. In addition to conducting benchmarking in all of its technology roadmap and strategic planning engagements, since 2001, Battelle has partnered with the national Biotechnology Industry Organization (BIO) to assess the "state of the states" in biosciences and biotechnology in each of the 50 states. The initiative has been repeated for BIO in 2004, 2006, 2008, 2010 and 2012.

³ This comprises a conversion from fiscal year to a calendar year basis for the purpose of facilitating the input/output analysis.

II. THE NORTH CAROLINA BIOSCIENCE SECTOR: SIZE AND PERFORMANCE OF THE CLUSTER

The bioscience industry has proven to be a robust growth sector and reliable job generator in state and national economies across the world, even as developed economies seek to recover from the deep recession of the late 2000s. Increasingly, competition in the biosciences is global as many nations look to benefit economically by establishing a niche strength in this rapidly growing, high-wage industry. The sector has drawn much attention from national, state and regional economic development organizations given this track record, though as described in the previous section of the report, North Carolina has been ahead of this curve with a nearly 30 year history of focus on and dedicated resources to the sector.

The State of North Carolina had the foresight, more than a quarter of a century ago, to invest in the development of a bioscience cluster. Objective statistics herein show that this investment has paid off, many times over, in the growth of one of the most dynamic economic engines in the state. In this chapter of the report, Battelle examines the current size and scope of the bioscience sector in North Carolina.

Defining the Bioscience Industry in North Carolina

The bioscience sector in North Carolina is analyzed using two definitions of the sector—one based on the Center’s own database and the other based on Battelle/BIO’s national industry data on the biosciences (see sidebar)—that facilitates benchmarking of North Carolina against competing states.

Background to the Analysis

In this analysis of the size and impact of the bioscience industry on the State of North Carolina, Battelle conducted two complementary analyses (the same process used in both the 2008 and 2010 studies). Because a core mission of the North Carolina Biotechnology Center (NCBiotech) is to track the size and performance of the sector, the NCBiotech Library has developed its own database of bioscience companies operating in the State. As an industry, the biosciences cut across many sectors and are classified in a range of industry sectors. While the federal government’s official North American Industry Classification System (NAICS) has improved the availability of data on biotechnology and life sciences employment, there is no “official” definition of the biosciences. Thus, the NCBiotech Library has developed its own database of companies that it has identified as active in the bioscience sector. While these companies are concentrated in the traditional life sciences oriented sectors, such as pharmaceuticals, life sciences R&D, and health care, many of the State’s biotechnology companies are classified in a variety of other sectors ranging from chemicals, to engineering and agriculture. This database allows for North Carolina to track, and for Battelle to analyze, the size and impact of the sector using highly accurate, up to date sector information provided by the Center’s Library. Thus, the first analysis of the size and impact of the sector is based on the NCBiotech Library’s own database and information.

Because similar company-specific databases do not exist at the national, regional, or state level for comparison to the Center’s database, Battelle has also analyzed the size, growth and impact of this sector using its own definition of the bioscience sector based on national NAICS codes and available national and state-level employment data. In this analysis Battelle uses the same definitional structure used in the national bioscience report produced for the Biotechnology Industry Organization in the June 2012 report “State Bioscience Industry Development 2012.”

North Carolina Biotechnology Center Database-Based Definition

The NCBiotech Library provided Battelle with its database of bioscience companies and branch locations located in North Carolina. This regularly updated database contained information on the name, location, industry classification, employment and key operational information on 567 companies and branch locations. Because some companies have multiple locations, a total of 514 of these database records are used to track employment in the bioscience sector in the state.

As presented in Table 1, according to the Center's database, **there are 58,589 persons employed in the bioscience sector in North Carolina** (an increase of 5,377 jobs from the 53,212 reported in the 2008 impact report—representing a 10.1 percent increase).⁴ Bioscience employment is highly concentrated in two sectors—drugs and pharmaceuticals, with 21 percent of the companies and 40 percent of the employment, and research, testing, and medical laboratories⁵ which account for 59 percent of companies and 46 percent of employment. When combined, these two sectors account for 80 percent of companies and 86 percent of employment.

Table 1: Bioscience Sector Employment, 2012

Sector	2012 Number of Records	2012 Percent of Total	2012 Jobs	2012 Percent of Jobs Total
Total	514	100%	58,589	100%
Agricultural Feedstock & Chemicals	15	3%	1,750	3%
Drugs & Pharmaceuticals	107	21%	23,265	40%
Medical Devices & Equipment	32	6%	5,202	9%
Research, Testing, & Medical Laboratories	302	59%	26,801	46%
Other	58	11%	1,571	3%

Source: North Carolina Biotechnology Center Biotechnology Database and Battelle TPP.

⁴ NCBiotech updates its biotechnology database on a rolling basis so the employment number used here may differ from other Center reports as company information was updated.

⁵ Many early stage firms are classified as research and development entities rather than by the classification of the product or service they are developing.

Battelle/BIO Definition

Battelle's Technology Partnership Practice, in its work assisting in the strategic planning and development of life sciences industry initiatives for numerous states and its work with the Biotechnology Industry Organization (BIO) on its biennial state bioscience initiatives report, has developed a nationally recognized industry definition of the biosciences for comparing and tracking performance of the industry among states and regions. The definition goes beyond biotechnology research and development to include varied, but highly related industrial applications in the biosciences, while providing an available set of comparable employment metrics across all U.S. states and regions (thereby facilitating benchmarking).

The bioscience industry is unique. It represents a varied set of companies that span manufacturing, services, and research activities, requires a highly skilled workforce, and produces a broad range of products and services classified among 25 individual industries. Much more than other sectors, biotechnology and its associated biosciences are dynamic and evolve with the latest research and scientific discoveries with widespread impact on food, medicines, diagnostics, and industrial products. The common link among this diverse set of firms is an application of knowledge as to how living organisms function—and then using that knowledge to create useful and valued products.

The Battelle/BIO industry definition is used in this section of the report to present an overview of current levels and recent trends of bioscience economic activity in North Carolina. It is particularly important in this third biennial examination of the state's bioscience industry to note that **Battelle has recently re-examined how bioscience companies classify themselves within detailed industries as well as considered how the evolving nature of the industry is changing the range of companies involved in these activities. Following this evaluation, Battelle and BIO worked together to revise and update the industry definition of the biosciences for our 2012 report.⁶ This updated industry definition is used in this report and incorporates a few key refinements from previous reports:**

The Battelle/BIO Definition of the biosciences aligns well with the NCBiotech database and has been updated in the 2012 Battelle/BIO State Bioscience Industry Development report to include the following four major subsectors:

- *Agricultural Feedstock & Chemicals*
- *Drugs & Pharmaceuticals*
- *Medical Devices & Equipment*
- *Research, Testing, & Medical Labs*

As well as a new addition:

- *Bioscience-related Distribution*

- The first refinement is to cut out several detailed industries that have become more closely associated with the delivery of clinical services to patients than the development of new bioscience products. This includes three specific industries: ophthalmic goods manufacturing; dental labs; and diagnostic imaging centers. These changes impact both the medical device and research, testing, and medical labs subsectors.
- A second refinement involves the inclusion of a new fifth major subsector for the bioscience industry—bioscience-related distribution. This subsector increasingly utilizes specialized approaches such as cold storage and highly regulated product monitoring,

⁶ See Battelle/BIO *State Bioscience Industry Development 2012*, pages 3–4 and 35–36 for a detailed discussion of these changes/updates to the Battelle industry definition.

and new technologies for distribution such as automated pharmaceutical distribution systems. The subsector includes three detailed industries: one associated with biomedical equipment and device distribution; another with drug distribution; and a third with agbioscience-related distribution (including ag chemicals and seeds).

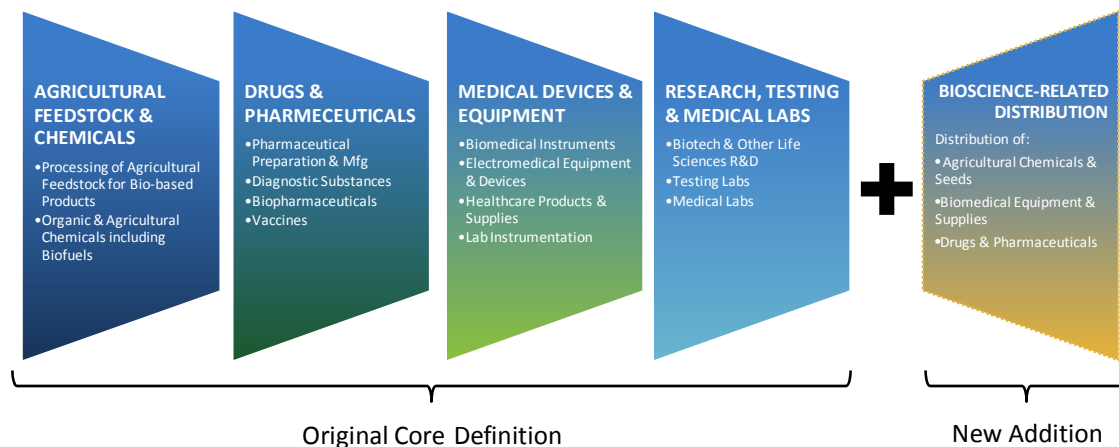
- The third refinement was to drop one detailed industry from the agricultural chemicals and feedstock subsector—all other basic organic chemicals manufacturing—which Battelle has seen become more of a catch-all for broad industrial chemicals and less focused in primarily bioscience-related organic and agricultural chemicals.

In addition to these changes, data for the research, testing, and medical labs subsector has been revised back over time to now include the newly released state-specific data from the Census Bureau's Economic Census. These data allow Battelle to make adjustments to isolate the bioscience-specific component activities of the R&D and testing labs industries.

Given these changes to the industry definition and data, Battelle/BIO industry employment data in this report are not fully comparable with those presented in prior reports for North Carolina. Battelle has, however, gone back in time to make these data comparable under the current data approach and methodology in order to have meaningful trend comparisons back to 2001.

The revised definition of the bioscience industry is depicted in Figure 1.

Figure 1: Revised Battelle/BIO Definition of the Bioscience Industry



The economic analysis presented here focuses not only on the sector at-large but also on its major subsectors. The analysis begins with a focus on North Carolina then goes on to highlight where North Carolina ranks in the subsectors nationally, and to compare the state's recent performance with that of other leading bioscience states as well as regional peers.

This section of the report provides comparisons with the national sector in order to provide context for the relative performance of the region. Labor market data in this analysis are for 2010, the most current annual data available (the previous impact report used 2008 data). Industry trends are examined over the ten years from 2001 through 2010.

The North American Industry Classification System (NAICS) is the official Federal government system for classifying establishments and their activities into the appropriate sectors. NAICS industries at the most detailed (6-digit) level were selected for this analysis and together make up the major sectors and subsectors. Using this system, 25 industries at the 6-digit level of detail were chosen. These detailed industries were aggregated up to the five major subsectors of the bioscience industry. A full list of bioscience NAICS codes used is shown in Table 2.

Four of the NAICS in the industry definition—testing laboratories (NAICS 541380); R&D in the physical, engineering, and life sciences (NAICS 54171); Drugs and Druggists’ Sundries Merchant Wholesalers (NAICS 424210); and Farm Supplies Merchant Wholesalers (NAICS 424910)—were adjusted in this analysis to include only the share of these industries directly engaged in biological or other life sciences activities. To isolate these relevant life science components, Battelle used information and data from the U.S. Census Bureau’s Economic Census. The database used for employment analysis relies on employers to classify themselves for records kept under each state’s unemployment insurance program. The data are dependent on both employer and state quality control measures and at times employers and government record-keepers may inappropriately classify themselves.

Table 2: The Bioscience Subsector Industries and NAICS Codes—Updated Definition

NAICS Code	Industry Description
Agricultural Feedstock & Chemicals	
311221	Wet corn milling
311222	Soybean processing
311223	Other oilseed processing
325193	Ethyl alcohol manufacturing
325221	Cellulosic organic fiber manufacturing
325311	Nitrogenous fertilizer manufacturing
325312	Phosphatic fertilizer manufacturing
325314	Fertilizer, mixing only, manufacturing
325320	Pesticide and other ag. chemical manufacturing
Drugs & Pharmaceuticals	
325411	Medicinal and botanical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Biological product (except diagnostic) manufacturing
Medical Devices & Equipment	
334510	Electromedical apparatus manufacturing
334516	Analytical laboratory instrument manufacturing
334517	Irradiation apparatus manufacturing
339112	Surgical and medical instrument manufacturing
339113	Surgical appliance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
Research, Testing, & Medical Laboratories	
54171*	R&D in the Physical, Engineering, & Life Sciences
541380*	Testing laboratories
621511	Medical laboratories
Bioscience-related Distribution	
423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
424210*	Drugs and Druggists' Sundries Merchant Wholesalers
424910*	Farm Supplies Merchant Wholesalers

*Includes only the portion of these industries engaged in biological or other life sciences activities.

Size of the North Carolina Bioscience Sector

Overview

North Carolina's bioscience industry remains large, diverse, highly specialized, and continues to grow despite the recent deep recession and the sluggish nascent recovery year that followed. State bioscience firms employ more than 62,000 in 2010 across over 2,500 individual business establishments⁷ (see Table 3). North Carolina's large employment base in the biosciences yields a high concentration of jobs in the state relative to the national average. The location quotient (LQ) for the biosciences in North Carolina is 1.34, meaning the state has a 34 percent greater concentration of bioscience jobs compared with the national average. An industry location quotient that exceeds 1.20 is typically referred to as a regionally "specialized" industry.

Table 3: North Carolina and U.S. Bioscience Employment Metrics, 2001–2010

Industry Subsector	2010 Establishments	Percent Change Estab, '01-10	2010 Employment	Percent Change Empl, '01-10	Percent Change Empl, '07-10	2010 Location Quotient
North Carolina						
Total Biosciences	2,509	41.4%	62,386	23.5%	1.0%	1.34
Agricultural Feedstock & Chemicals	43	-12.3%	2,540	-33.0%	-23.0%	1.20
Bioscience-related Distribution	1,229	17.5%	13,322	20.4%	-14.6%	1.04
Drugs & Pharmaceuticals	108	35.0%	20,120	7.1%	4.6%	2.34
Medical Devices & Equipment	175	42.3%	8,236	20.3%	12.0%	0.83
Research, Testing, & Medical Labs	954	100.3%	18,168	81.3%	11.4%	1.39
United States						
Total Biosciences	70,006	12.8%	1,605,533	6.4%	-1.4%	N/A
Agricultural Feedstock & Chemicals	1,760	2.2%	72,988	-5.9%	-5.5%	N/A
Bioscience-related Distribution	36,170	-1.1%	440,394	6.0%	-4.2%	N/A
Drugs & Pharmaceuticals	2,908	11.3%	296,759	-3.1%	-7.0%	N/A
Medical Devices & Equipment	6,957	11.7%	343,468	-0.3%	-0.8%	N/A
Research, Testing, & Medical Labs	22,212	48.9%	451,923	23.8%	6.1%	N/A

Note: Location quotients in bold red indicate a specialized industry employment concentration.

Source: Battelle analysis of Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) data from IMPLAN.

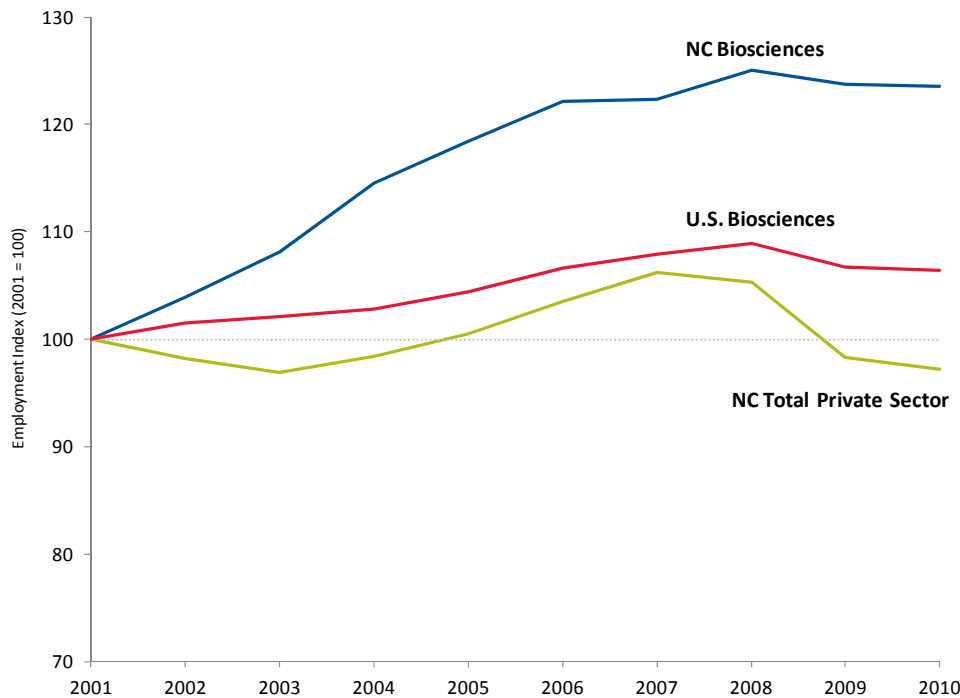
North Carolina is notably diverse in the biosciences with varied strengths—it is one of just eleven states along with Puerto Rico that has a specialized employment concentration in three or more of the five bioscience subsectors. It has a specialized location quotient (meets or exceeds 1.20) in: drugs and pharmaceuticals (LQ is 2.34); research, testing, and medical labs (LQ is 1.39); and agricultural feedstock and chemicals (LQ is 1.20). Since 2001, four of the five major bioscience subsectors contributed to the state's substantial overall job growth with only the smallest sector, agricultural feedstock and chemicals, shedding jobs.

The state has rapidly grown its bioscience sector over the decade; and while employment has leveled off since the economic peak in 2007, North Carolina has maintained its bioscience employment base during a time period in which the overall private sector has shed jobs. Bioscience

⁷ The term "establishment" used throughout this analysis is not synonymous with a "company." A firm or employer can have one or more establishments. An establishment is an economic unit, such as a farm, mine, factory, or store that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity for which a single industrial classification may be applied.

companies in North Carolina increased employment by 23.5 percent over the 2001 through 2010 period, well outpacing national bioscience industry growth over that same period (up 6.4 percent, see Figure 2). This strong job growth occurred despite net private sector job declines over the decade (down 2.8 percent overall). Total bioscience establishments have grown by a substantial 41.4 percent during this same nine-year period, outpacing the national growth in sector establishments.

Figure 2: Employment Growth in North Carolina's Bioscience Sector, 2001–2010



To understand the recent strong overall performance of the North Carolina bioscience sector, it is necessary to study the underlying composition and recent trends among its major components. The following discussion will focus on the five major subsectors of the state bioscience industry.

Employment in Major Bioscience Subsectors

In North Carolina, the composition of the bioscience sector is notably varied with several clear niche strengths (see Figure 3). Drugs and pharmaceuticals is largest among the subsectors with more than 20,000 employees accounting for about one in three state bioscience jobs. Research, testing, and medical labs, with its steady and rapid recent growth, now employs more than 18,000 or 29 percent of the sector. Bioscience-related distribution, with more than 13,000 jobs, accounts for 22 percent. Medical device and equipment manufacturing contributes 13 percent, and the agricultural feedstock and chemicals subsector contributes 4 percent.

National Employment Ranking Highlights: North Carolina*

- **Drugs & Pharmaceuticals:** 4th in employment among all U.S. states and Puerto Rico; 4th in LQ among all states.
- **Research, Testing, & Medical Labs:** 8th in employment among all U.S. states and Puerto Rico; 9th in LQ.
- **Bioscience-related Distribution:** 10th in employment among all states and Puerto Rico; 19th in LQ.
- **Agricultural Feedstock & Chemicals:** 11th in employment among all states and Puerto Rico; 16th in LQ.
- **Medical Devices & Equipment:** 18th in employment among all states and Puerto Rico; 23rd in LQ.

Source: Battelle/BIO *State Bioscience Industry Development, 2012*

*For reference, NC ranks 10th among all states in population and 10th in total private sector employment.

Figure 3: Employment Composition of the North Carolina Bioscience Sector, 2010

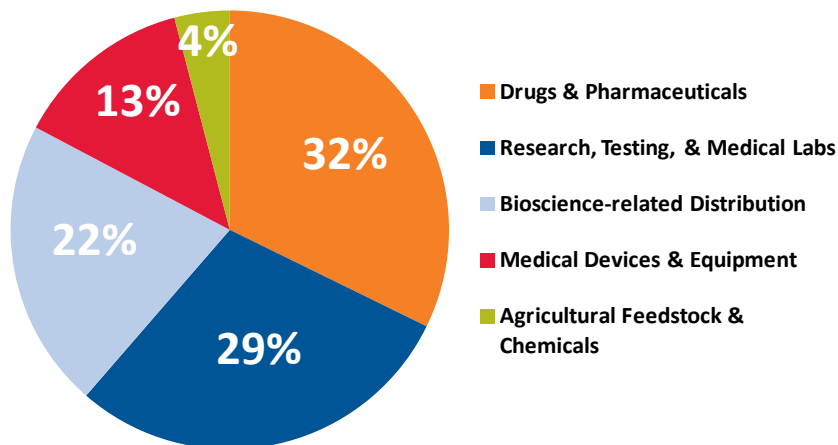
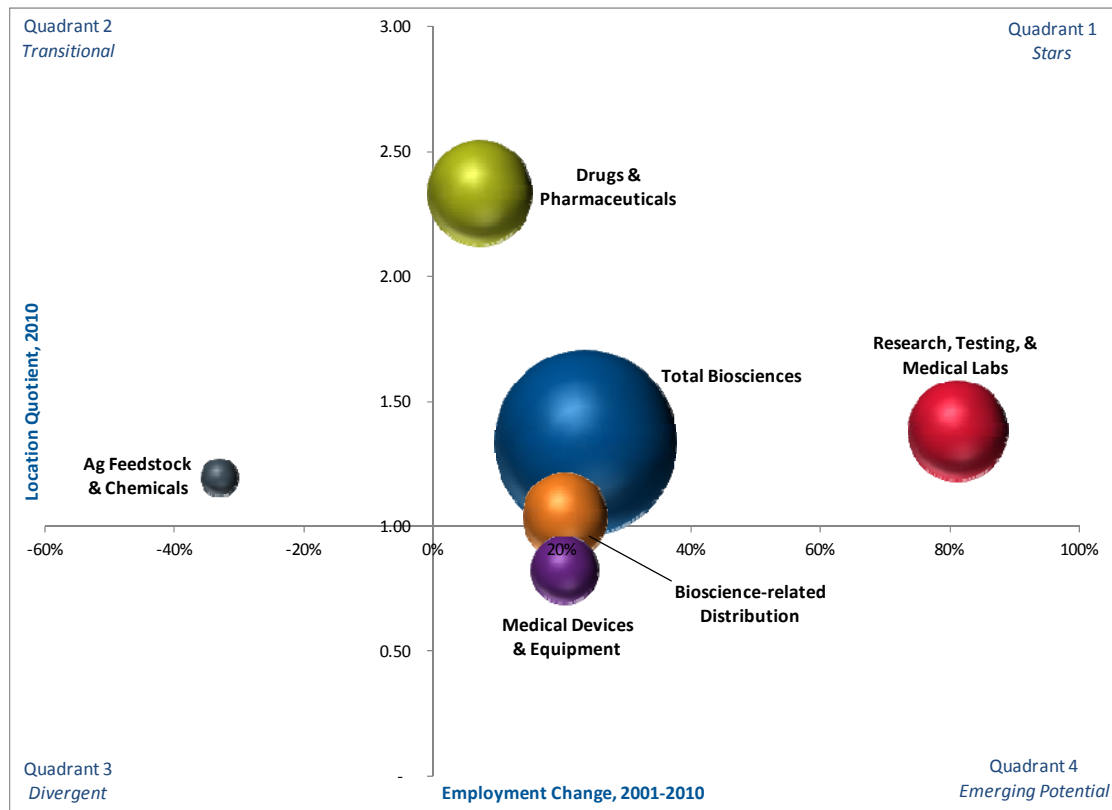


Figure 4 presents a useful snapshot of three key employment variables that track recent performance—employment size (size of bubble), relative employment concentration (LQ), and recent employment growth or decline. The quadrants in which the bubbles lie provide insight into relative performance of each industry subsector and allow for a general characterization based upon these variables.

Figure 4: North Carolina Bioscience Subsectors, Degree of Specialization, Employment Growth, and Size, 2001–2010



North Carolina has a large and highly specialized drugs and pharmaceuticals sector, and has reversed a declining employment trend. Pharmaceutical manufacturers operated 108 business establishments in the state, employing more than 20,000 in 2010. These establishments are typically the largest among the bioscience subsectors and with an average of 186 employees per establishment in North Carolina, are significantly larger than the average size in the U.S. (102 employees per establishment). Firms operating these establishments tend to be large, multinational concerns with large investments in R&D and manufacturing working to bring drugs to market.

Nationally, North Carolina ranked fourth among all states and Puerto Rico in drugs and pharmaceuticals employment in 2010. The subsector maintains a very high location quotient, which at 2.34 represents more than twice the national average concentration of drug and pharmaceutical industry jobs. Matching its ranking in employment levels, this high subsector LQ ranks North Carolina 4th among all U.S. states.

Despite job declines from 2003 through 2008 and a declining employment trend in the national subsector, drugs and pharmaceutical firms grew their North Carolina employment base by more than 1,500 jobs, or 8 percent, in 2009. This is especially impressive given it occurred during the end of the deep national recession. In 2010, the state maintained its subsector employment

Like the national drugs and pharmaceuticals sector, the largest detailed component industry in North Carolina is the broad pharmaceutical preparation manufacturing industry (NAICS 325412). This specialized component (LQ is 2.43) employs more than 15,000 in the state. Another key

component is the smaller but highly specialized (LQ is 5.90) biological product manufacturing industry, which employs more than 4,500.

Research, testing, and medical laboratories, second largest of the North Carolina bioscience subsectors, is large, specialized, and has nearly doubled its employment base since 2001. State employment reached 18,168 in 2010 and is highly concentrated compared with the national subsector. The location quotient for research, testing, and medical labs in North Carolina is 1.39, and is considered specialized. With 954 individual business establishments in North Carolina, firms in this subsector have doubled their statewide operations footprint since 2001. These results bode well for North Carolina, since it is the R&D sector that drives innovation and potential new business formation and technology commercialization.

As Figure 4 shows, employment growth in the state's research, testing, and medical laboratories subsector has been dramatic and is helping to drive the overall bioscience industry. Overall, the sector added more than 8,000 jobs, or 81 percent, in the most recent 9-year period. This rapid growth rate has exceeded even the fast-paced national subsector, which grew by 24 percent during this same period and has accounted for 9 of every 10 net new bioscience jobs created in the U.S. Employers in both the research and testing and medical labs components have increased employment and contributed to the overall impressive growth.

The research, testing, and medical labs subsector is unique among the biosciences. First, companies in this area are primarily focused on providing services, rather than production. Second, as these companies expand they may "graduate" out of this subsector and into a drugs and pharmaceuticals classification if new therapeutics are developed and approved. The R&D component of the subsector typically is made up of smaller firms engaged in cutting-edge research and new-product development that often drive the biopharmaceutical pipeline for the overall bioscience sector. In North Carolina, the biotech/bioscience R&D component accounts for more than 12,000 jobs or a majority 67 percent of the overall subsector. This share is comparable with that for the U.S. subsector where, on average, this R&D component industry accounts for 65 percent of jobs. North Carolina is highly specialized in this industry irrespective of the broader specialization when medical labs are included, with a location quotient of 1.41.

Clinical research organizations (CRO's) provide a range of clinical research and development services critical to supporting a vibrant, efficient biotechnology and drug development sector. These organizations play a key role in the entire spectrum of drug development from early stage development and recruiting for clinical trials, to laboratory services, to regulatory guidance and submission, and finally through to sales and marketing. North Carolina has a leading concentration of CRO firms, although it is not possible to determine exact employment figures for this set of companies from an "industry" perspective as they are typically embedded within the life sciences R&D industry or even sometimes coded outside of the Battelle industry definition in the much broader professional, scientific, and technical services industry (NAICS 5419) or as a specific unit within public or private hospitals or universities. To the extent these companies are captured within the life sciences R&D component industry, they contribute to the highly specialized industry.

The remaining component of the research, testing, and medical laboratories subsector in North Carolina is medical labs. Medical labs employ 6,000 in North Carolina, a specialized concentration of jobs with a LQ of 1.29. Medical lab facilities develop and provide an array of analytic and diagnostic services to patients.

The agricultural feedstock and chemicals subsector in North Carolina is sizable and specialized, but remains in transition after eight years of steady job declines. The state has 43

business establishments that employ more than 2,500 workers in 2010. Its location quotient is 1.20, signifying a specialized concentration relative to the national subsector. In recent years, however, the subsector has contracted with respect to jobs.

Subsector employment in North Carolina peaked in 2002 and has since declined by nearly 2,000 jobs or 44 percent. Overall since 2001, employment is down by one-third. In the national sector, U.S. firms employed nearly 73,000 in 2010 after weathering the ups and downs of the business cycle in recent years and resuming job growth in 2010. The national subsector has added jobs in five of the last six years, though the steep job losses in the depths of the recession in 2009 have not been offset by the recent gain.

Many of the component industries of the agricultural biosciences are reducing employment levels yet increasing value-added output as technology advances and key capital investments are boosting productivity. In a recently published report for Central Ohio, for example, Battelle found the agbioscience sector had greater value-added output per worker compared with the overall private sector, and although jobs had declined in the regional sector, output per worker had significantly increased. In North Carolina, this could be the case particularly as evidenced by the wage premiums paid to workers in this sector compared to both the overall state private sector and national industry averages where North Carolina agbioscience workers earn, on average, substantially more.

North Carolina's presence in the agricultural bioscience subsector is concentrated in agricultural chemicals where state firms employ more than 1,000 in two detailed industries—fertilizers and pesticides and other agricultural chemicals. Both of these industries have very high state specializations with location quotients of 5.55 and 2.61, respectively.

Steady hiring in U.S. ethanol production facilities has helped to drive some employment gain in the organic and agricultural chemicals component of the agbioscience subsector. Since 2001, the ethanol sector has increased employment by 200 percent nationally. North Carolina has little to no employment in this detailed sector as reported to and classified in the BLS data.

North Carolina's medical device and equipment subsector continues to emerge with steady job gains and a growing market share. Medical device manufacturers operated 185 establishments in North Carolina employing 8,236 in 2010. Since 2001, these employers have increased their payrolls by 20.3 percent compared with a 0.3 percent decline overall for the national sector during this same time period. While the national medical device subsector has contracted somewhat during the recent recession and post-recession period, North Carolina has been growing its subsector with average annual job gains of 3.9 percent from 2008 through 2010. North Carolina has increased jobs nearly every year since 2003 (the exception being 2007).

North Carolina's LQ in the medical device equipment subsector was 0.83 in 2010, indicating a relative concentration of jobs lower than the national average; however, the subsector can clearly be characterized as "emerging" given its recent growth and its gain in market share nationally. In North Carolina, the largest employers in the medical device subsector include manufacturers of surgical and medical instruments; surgical appliances and supplies; and electromedical apparatus.

The state's bioscience-related distribution subsector is sizable and well concentrated, though it has been affected by cyclical impacts and the recent recession. In North Carolina, key supply chain and innovative distribution companies in drugs, biomedical device and equipment, and agbioscience-related wholesale activities employed 13,322 in 2010 across 1,229 individual business establishments. Bioscience-related distribution has increased this employment base by

20 percent overall since 2001, though this includes a nearly 15 percent decline in employment since the economic peak in 2007. The actual decline came in 2009 and interrupted a streak of steady employment gains since 2003.

Bioscience Wages

North Carolina's bioscience workers, like those in the national sector, earn higher wages, on average, than their counterparts in most other major industries and the overall private sector. Comparisons of annual wages by industry provide insight into the relative demand for—and supply of—workers within a regional labor market. Specifically, wage premiums paid to workers in industries like the biosciences signal the strong demand for highly skilled and well-educated workers that drive the high-value innovation and commercialization in the sector.

Bioscience workers in North Carolina earned \$78,348 on average in 2010, or more than \$37,000 greater than the state's average private-sector worker (Table 4). This represents a 92 percent average wage premium for the skills and high-value-adding jobs in the industry. Not only are wages higher in the biosciences but they have grown at a faster rate compared with the overall private sector—since 2001, average bioscience wages have increased by 10 percent in North Carolina compared with 4 percent growth for the overall private sector.

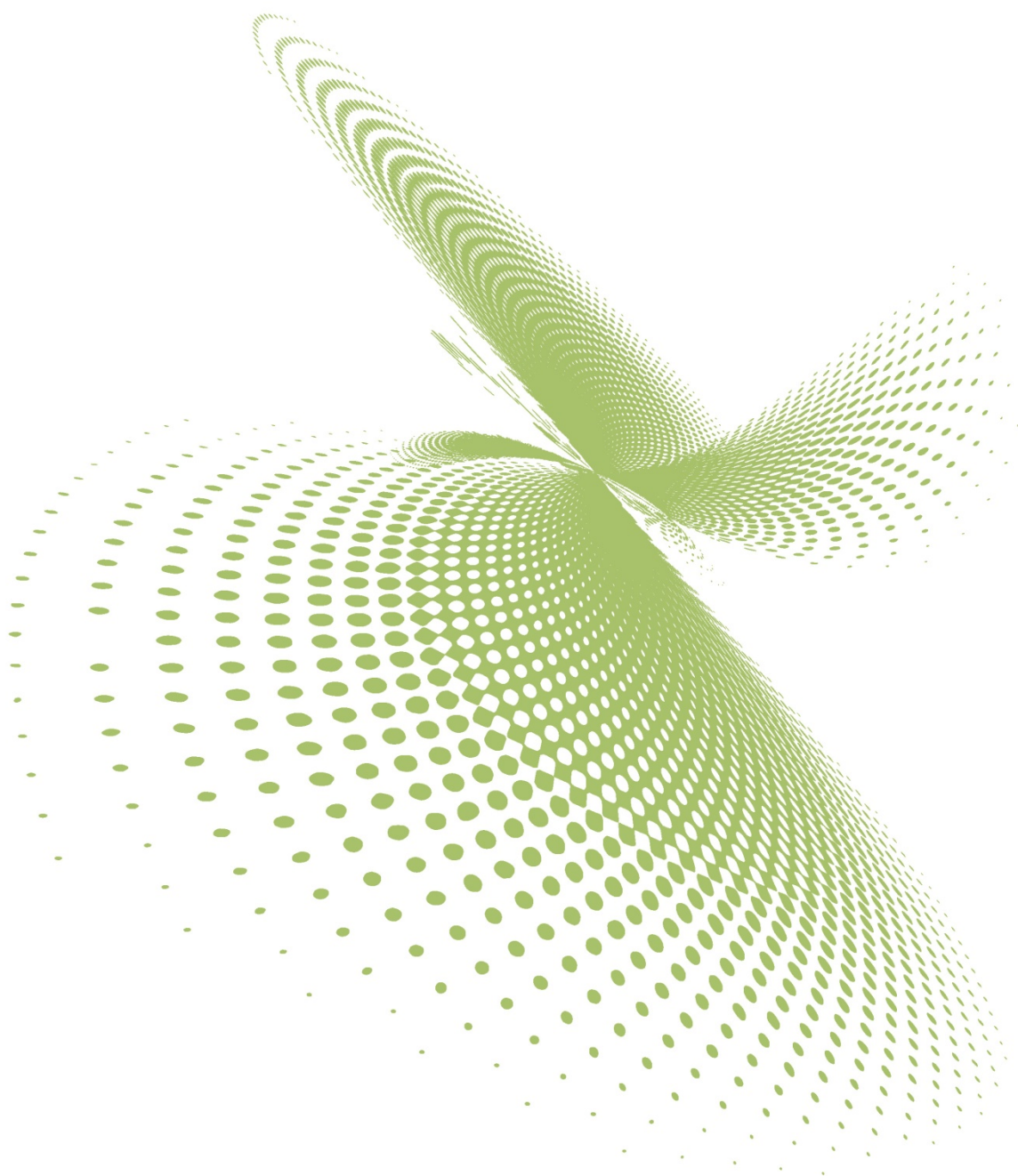
Within the sector, employees of drug and pharmaceutical manufacturers earn the highest wages—nearly \$90,000 in 2010. As Table 4 shows, most major bioscience subsectors pay more, on average, compared with other major industries in the state, including finance and insurance and information.

North Carolinians earn just below the national average wage in the biosciences, about 6 percent less than the \$82,697 earned nationally. Workers in North Carolina's agricultural feedstock and chemicals subsector earn more than their counterparts nationally—\$84,334 versus \$70,869, respectively.

Table 4: Average Annual Wages in North Carolina for Biosciences and Other Major Industries, 2010

Major Industries & Bioscience Subsectors	Avg. Annual Wages, 2010
Drugs & Pharmaceuticals	\$ 89,592
Management of companies and enterprises	\$ 85,249
Agricultural Feedstock & Chemicals	\$ 84,334
Research, Testing, & Medical Laboratories	\$ 80,595
Total Biosciences	\$ 78,348
Bioscience-related Distribution	\$ 72,289
Finance and insurance	\$ 72,053
Professional and technical services	\$ 65,180
Information	\$ 61,605
Medical Devices & Equipment	\$ 53,875
Total Private Sector	\$ 40,866
Transportation and warehousing	\$ 40,700
Construction	\$ 40,144
Health care and social assistance	\$ 39,562
Agriculture, forestry, fishing and hunting	\$ 28,170
Arts, entertainment, and recreation	\$ 27,688
Retail trade	\$ 24,653

Source: Battelle analysis of BLS, QCEW data from IMPLAN.



III. BENCHMARKING THE NORTH CAROLINA BIOSCIENCE SECTOR

Competitive Benchmarking: Comparing North Carolina with Other States

North Carolina's bioscience sector is large, highly ranked among all states, specialized in its concentration of jobs, and has grown by three and a half times the national growth rate. Despite its obvious broad strengths and recent accomplishments, however, it is useful to compare its competitive position relative to states competing for biotechnology and bioscience market share both regionally and nationally. The analysis in this section examines employment data and corresponding trends in the bioscience subsectors in North Carolina and two sets of benchmark states:

- 1) The top 10 states in the nation, of which North Carolina is one (as ranked by total bioscience employment)
- 2) Five southern/eastern seaboard states: Florida, Georgia, Maryland, South Carolina, and Virginia.

Comparing North Carolina to the Ten Largest Bioscience Employer States

North Carolina stands out in its rapid growth in the biosciences over the decade, even compared with national leaders in the sector. Figure 5 presents the current employment position for North Carolina and its fellow states ranked in the top 10 in terms of overall bioscience employment. **Among the ten largest bioscience employer states, North Carolina's 23.5 percent job growth since 2001 has been the fastest.** Since 2001, this translates into nearly 12,000 new jobs in the biosciences for North Carolinians, a total job gain surpassed only by California, Florida, and Texas, three much larger states.

Since the economic peak in 2007 and through the recession and first year of the economic recovery, North Carolina is one of just four of the largest ten bioscience employer states that have added jobs. These four states are: Texas (up 3.7 percent since 2007), Massachusetts (up 3.4 percent), California (up 2.2 percent), and North Carolina (up 1.0 percent). Two of the largest employer states—New Jersey and Pennsylvania—have seen significant job loss as a result of the recession, down 7.8 percent and 6.9 percent respectively. These states have been especially hard hit by declines in the drugs and pharmaceuticals subsector which has cut jobs in recent years.

Five of the ten largest bioscience employer states have a specialized concentration of employment including: New Jersey (LQ is 1.93), Massachusetts (LQ is 1.89), Indiana (LQ is 1.73), North Carolina (LQ is 1.34), and California (LQ is 1.26).

Figure 5: Total Bioscience Sector, Degree of Specialization, Employment Growth, and Size, Ten Largest U.S. Bioscience Employer States, 2001–2010

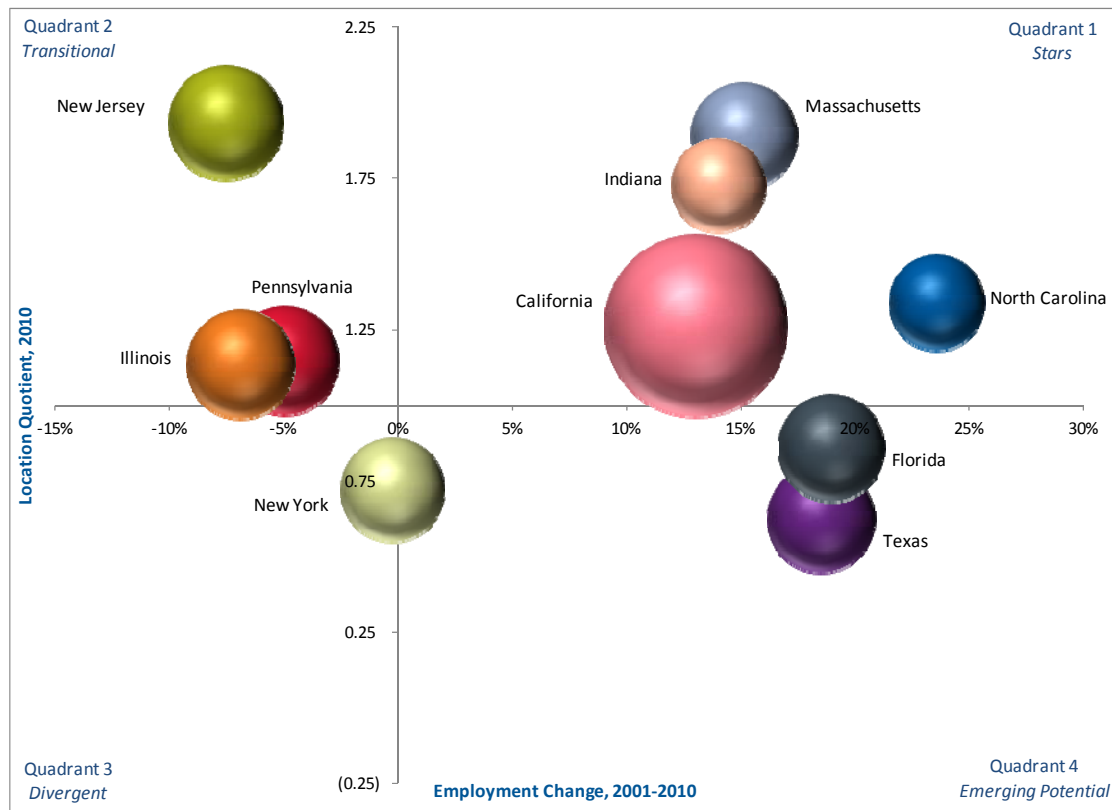


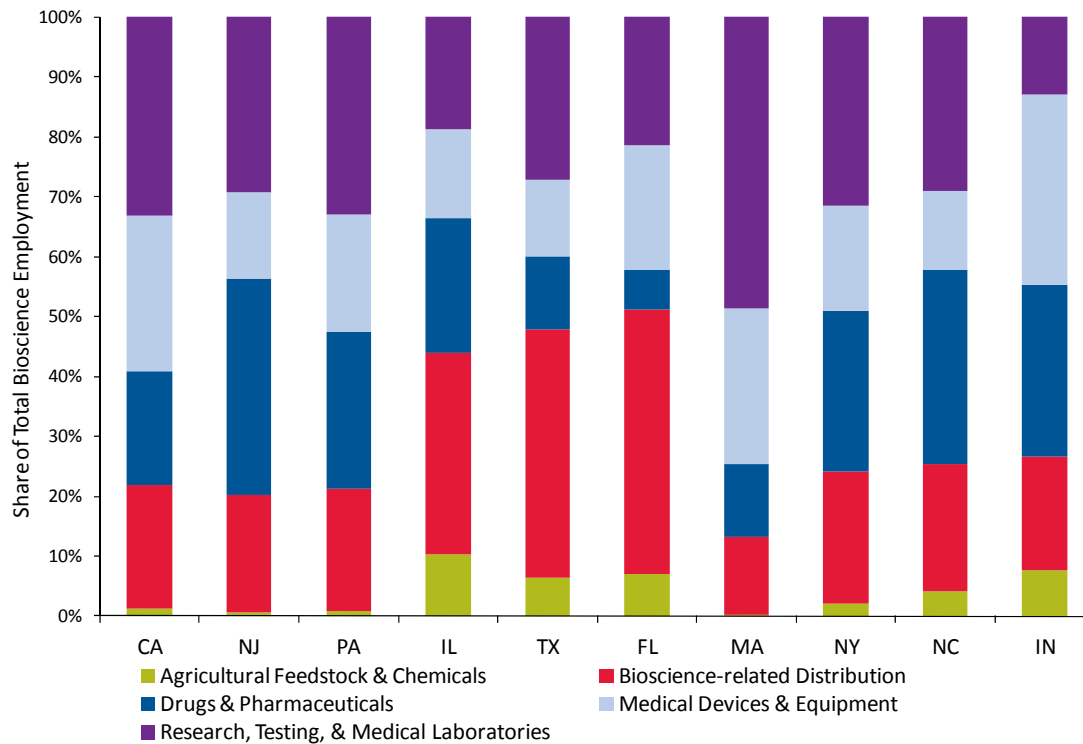
Table 5 presents the overview of total bioscience employment metrics illustrated in Figure 5 for North Carolina and the leading bioscience employer states. Figure 6 then shows the bioscience employment composition by subsector across the top 10 states.

Table 5: North Carolina and Leading Bioscience Employer States, Total Bioscience Employment Metrics, 2001–2010

State	2010 Establishments	Percent Change Estab, '01-10	2010 Employment	Percent Change Empl, '01-10	Percent Change Empl, '07-10	2010 Location Quotient
North Carolina	2,509	41.4%	62,386	23.5%	1.0%	1.34
California	7,468	18.6%	228,700	13.0%	2.2%	1.26
New Jersey	2,554	34.6%	91,167	-7.5%	-7.8%	1.93
Pennsylvania	2,240	-11.1%	81,796	-4.9%	-6.9%	1.15
Illinois	3,424	11.3%	79,961	-6.9%	-0.3%	1.14
Texas	4,459	30.5%	78,452	18.5%	3.7%	0.62
Florida	5,102	32.8%	78,062	18.9%	-1.1%	0.86
Massachusetts	1,979	8.4%	77,762	15.1%	3.4%	1.89
New York	2,948	13.7%	74,873	-0.3%	-2.9%	0.72
Indiana	2,030	33.4%	59,786	14.0%	-0.7%	1.73

Note: Location quotients in bold red indicate a specialized industry employment concentration.

Source: Battelle analysis of BLS, QCEW data from IMPLAN.

Figure 6: Composition of Bioscience Employment in the Top 10 Bioscience States, 2010


Comparing North Carolina to Southern/Eastern Seaboard States

Focusing the lens more closely on regional peers, Battelle also compared the performance of North Carolina against that of its neighboring states along the Southern/Eastern seaboard (Maryland, Virginia, South Carolina, Georgia and Florida). Against these regional benchmarks, North Carolina's bioscience industry stands out as one of the largest (second only to Florida, whose private sector employment base is twice as large) and fastest growing, as well as the only one with a specialized employment concentration in the sector.

Figure 7 presents the current employment volume, employment growth trend and degree of specialization for North Carolina and selected Southern/Eastern Seaboard states. With highly concentrated employment and strong job growth over the decade, North Carolina and Maryland rise to the "stars" quadrant of the chart denoting broad current strengths in the sector. Maryland has a 12 percent greater concentration in the biosciences compared with the national average concentration (LQ is 1.12). It has grown by 8.3 percent since 2001, just outpacing national bioscience job growth.

Regional strength and emergence is broadly evident in the position of all six states to the right of the vertical axis, indicating job growth. Though it has a smaller base relative to the others, South Carolina is emerging with a 45 percent growth rate since 2001.

Figure 7: Total Bioscience Sector, Degree of Specialization, Employment Growth, and Size, NC and Selected States, 2001–2010

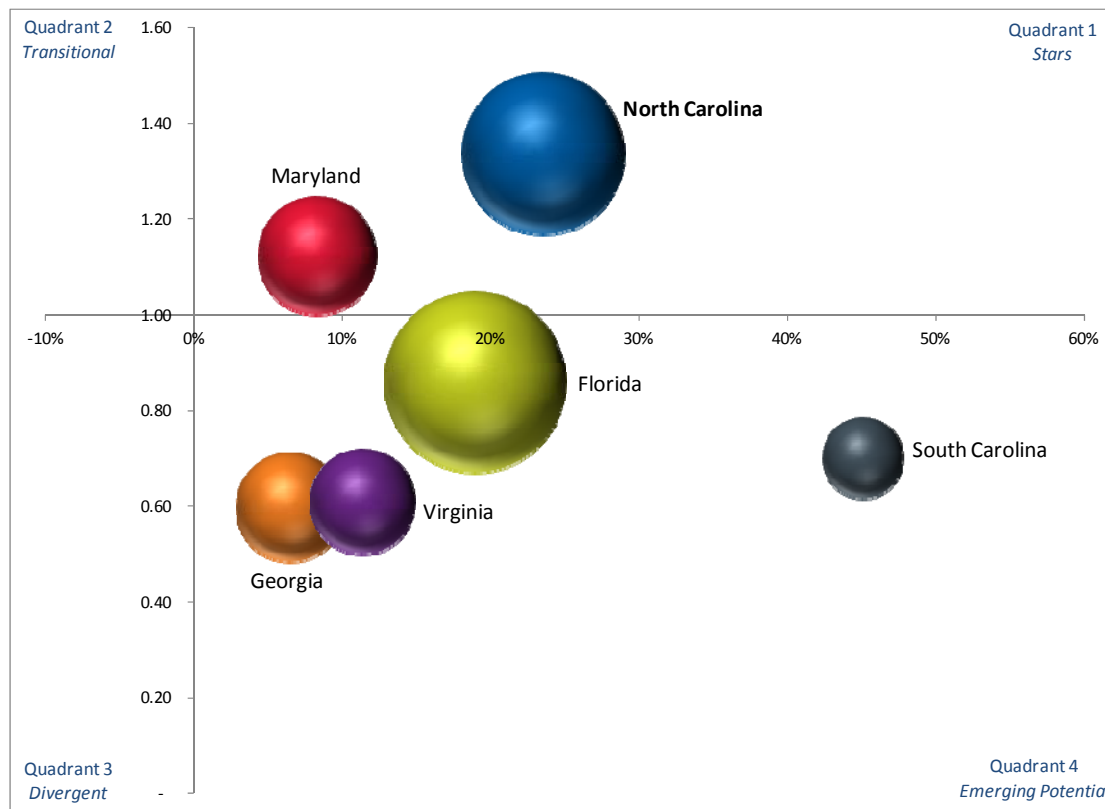


Table 6 presents the overview of total bioscience employment metrics illustrated in Figure 7. In addition, it shows the employment trend since the economic peak in 2007 and through the recession years to 2010. Since 2007, only Virginia and North Carolina have increased employment overall, rising 2.6 percent and 1.0 percent respectively. Among establishments, North Carolina has added business operations at a much greater rate than its regional peers since 2001 (up 41 percent).

Table 6: North Carolina and Comparison States, Total Bioscience Employment Metrics, 2001–2010

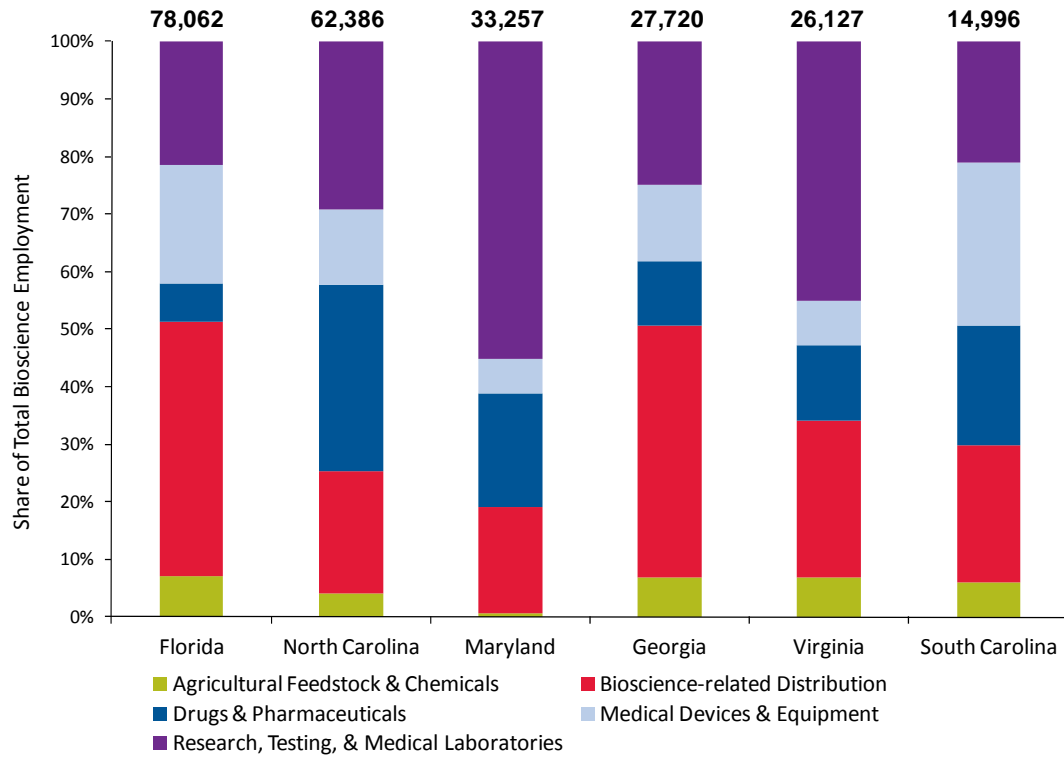
State	2010 Establishments	Percent Change Estab, '01-10	2010 Employment	Percent Change Empl, '01-10	Percent Change Empl, '07-10	2010 Location Quotient
North Carolina	2,509	41.4%	62,386	23.5%	1.0%	1.34
Florida	5,102	32.8%	78,062	18.9%	-1.1%	0.86
Maryland	1,842	8.5%	33,257	8.3%	-1.2%	1.12
Georgia	1,640	5.8%	27,720	6.5%	-1.8%	0.60
Virginia	1,321	8.5%	26,127	11.4%	2.6%	0.61
South Carolina	985	23.3%	14,996	45.1%	-3.4%	0.70

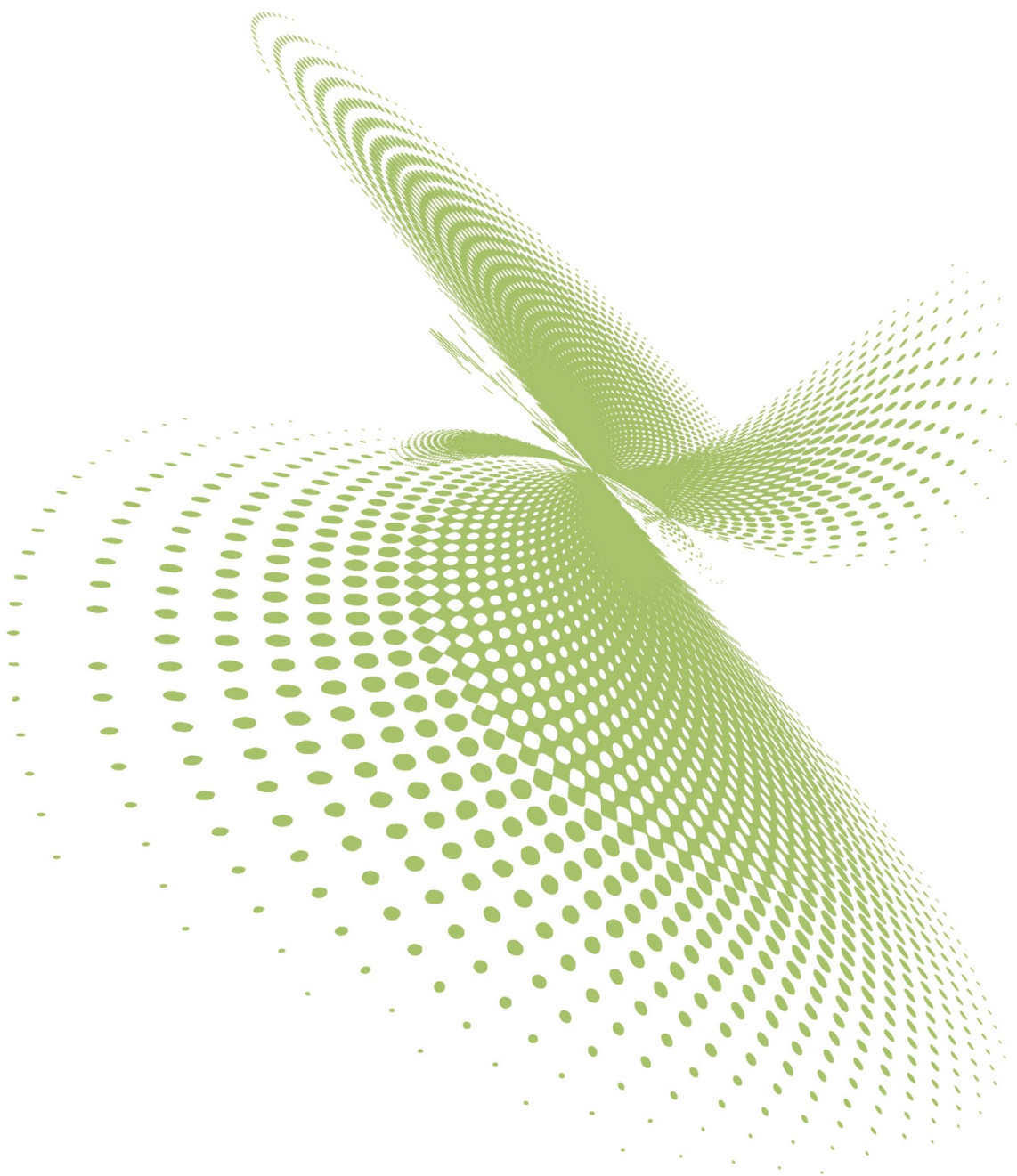
Note: Location quotients in bold red indicate a specialized industry employment concentration.

Source: Battelle analysis of BLS, QCEW data from IMPLAN.

While the size of each state sector varies, Figure 8 provides a snapshot of the niche industries and broad composition of each by subsector. North Carolina's specialized presence in drug and pharmaceutical production is apparent in the size of its dark blue bar. The state's large research, testing, and medical labs subsector is also evident, though not as large a component as in Maryland, where life sciences R&D plays a dominant role in its bioscience economy. Florida employs more in the biosciences but has much more of a focus and niche in bioscience-related distribution and in medical devices.

Figure 8: Composition of Bioscience Employment in NC and Selected States, 2010





IV. ECONOMIC IMPACT OF THE BIOSCIENCE INDUSTRY ON NORTH CAROLINA

Direct and Indirect Economic Impacts of the Bioscience Industry in North Carolina

The bioscience industry is more than simply a source of direct jobs; it has grown to become a critical, high-value driver of the North Carolina economy. The recent strong and continued growth of the bioscience industry in North Carolina is creating deeper and varied connections with other state sectors as it boosts the supply chains that support the industry and drives broad economic impacts across the North Carolina economy. Not only does the sector directly account for an estimated 1.1 percent of all jobs in the state;⁸ the bioscience sector impacts other sectors through its purchases of goods and services from other businesses and industries across the state and through the wages and salaries it pays its workers. These impacts are growing as evidenced through the greater multiplier impacts found in this industry update and profiled in this chapter.

Economic Impact Methodology

Using the information on the size and composition of the North Carolina bioscience sector described in the introduction and provided by NCBiotech, Battelle prepared an analysis of the economic impact of the industry on the State of North Carolina's economy using the IMPLAN input-output model.⁹ IMPLAN is one of the most widely used models in the nation, and can be used to analyze the impacts of companies, projects, or of entire industries. An input-output (I/O) analysis examines the relationships among businesses and among businesses and final consumers. I/O analysis is based on the use of multipliers, which describe the response of an economy to a change in demand or production. Multipliers measure the effects on an economy from a source of economic activity, in this case the jobs and activities of companies in the bioscience sector in North Carolina.

The economic activity generated in a state is greater than the simple total of spending associated with the event or activity being studied. This is because as this money is earned it is, in turn, spent, earned and re-spent by other businesses and workers in the regional economy through successive cycles of spending, earning and spending. However, the spending in each successive cycle is less than in the preceding cycle because a certain portion of spending "leaks" out of the economy in each round of spending. Leakages occur through purchases of goods or services from outside of the region and federal taxation. The IMPLAN multipliers used in this analysis capture the effects of these multiple rounds of spending.

This report measures the economic impact of the bioscience sector by focusing on three measures of economic impact:

- **Employment.** The total number of full and part time jobs in all industries; and
- **Output.** The total value of production or sales in all industries;

⁸ The U.S. Bureau of Economic Analysis state employment data is only available through 2011. Current employment was estimated based on this data projected to current levels based on recent growth trends from U.S. Bureau of Labor Statistics data.

⁹ See www.implan.com for a description of the model.

- **Labor Income.** Total employment income including wages and salaries, benefits, and self reported income earned by the workers holding the jobs created.¹⁰

Four measures of the economic activity and impact of the jobs supported by the bioscience sector are included:

- **Direct effects.** The change in economic activity being analyzed—in this case the business activities of the bioscience sector, including bioscience companies, academic research and the Center’s operations. For this analysis, Battelle used the employment data from the NCBiotech database and the IMPLAN model to estimate business activity based on these employment figures;
- **Indirect effects.** The changes in inter-industry purchases, for example the purchase of raw materials by a bioscience manufacturer, in response to the change in demand from the directly affected industries;
- **Induced effects.** The changes in spending from households as income and population increase due to changes in production; and
- **Total effects.** The combined total of direct, indirect and induced effects.

Economic Impacts of the Bioscience Industry—Based on the NCBiotech’s Database

The bioscience industry in North Carolina has total estimated revenues¹¹ of \$36.5 billion in 2012 and employs 58,589 workers earning an estimated \$6.1 billion in labor income (Table 11, Direct Impact column). The industry generates an additional \$11.9 billion in *Indirect Impacts* through its purchases of goods and services from other companies in the state, and \$10.6 billion in *Induced Impacts* through local spending by state residents employed in or impacted by the sector.¹² In aggregate, the bioscience sector in North Carolina generates \$59.0 billion in economic activity in the state, supports 237,665 jobs earning \$14.8 billion in labor income, and generates \$1.7 billion in state and local government revenues. The 237,665 jobs created or supported by the bioscience sector account for 4.5 percent of all employment in the state.

The economic impacts of the bioscience sector are also presented by major subsector in Table 7 with:

- The drugs and pharmaceutical subsector having the largest impact, generating \$41.3 billion in economic activity and supporting 140,548 jobs earning \$9.1 billion in labor income and generating \$1.1 billion in state and local government revenues; and
- The research, testing, and medical laboratories subsector having the second largest impact, generating \$8.5 billion in economic activity and supporting 64,529 jobs earning

¹⁰ In the previous reports, Battelle reported Employee Compensation. In this report, in order to be comparable to other research done in this area, the more broad Labor Income measure was used which includes self-reported and proprietor income.

¹¹ IMPLAN can estimate output or business volume based on employment. This was estimated based on biotechnology employment from the NCBiotech database.

¹² Because Battelle is analyzing the impact of an entire sector of the economy, estimated indirect and induced impacts were reduced by the share of total State biotechnology sector employment in each industry in the model that was included in the direct impacts. This adjustment was made in order to eliminate double counting of impacts. Many biotechnology firms purchase goods, services and production inputs from other biotechnology firms. Including these purchases in the indirect or induced effects estimated by IMPLAN would lead to double counting—as the activities of these companies were already included in the direct impacts.

\$3.8 billion in labor income and generating \$340 million in state and local government revenues.

Table 7: Economic Contribution of Bioscience Sector to the North Carolina Economy by Subsector, 2012

Item	Direct Impact	Indirect Impact	Induced Impact	Total Impact
<u>Total Bioscience Sector</u>				
Output (\$ M)	\$36,477	\$11,903	\$10,630	\$59,009
Employment (# of Jobs)	58,589	84,654	94,422	237,665
Labor Income (\$ M)	\$6,064	\$5,104	\$3,663	\$14,830
State and Local Tax Revenues (\$ M)	—	—	—	\$1,731
<u>Agricultural Feedstock & Chemicals</u>				
Output (\$ M)	\$3,073	\$965	\$620	\$4,658
Employment (# of Jobs)	1,750	6,207	5,504	13,461
Labor Income (\$ M)	\$268	\$379	\$214	\$861
State and Local Tax Revenues (\$ M)	—	—	—	\$127
<u>Drugs & Pharmaceuticals</u>				
Output (\$ M)	\$26,218	\$8,494	\$6,615	\$41,328
Employment (# of Jobs)	23,265	58,540	58,743	140,548
Labor Income (\$ M)	\$2,979	\$3,823	\$2,280	\$9,082
State and Local Tax Revenues (\$ M)	—	—	—	\$1,126
<u>Medical Devices & Equipment</u>				
Output (\$ M)	\$1,582	\$469	\$522	\$2,573
Employment (# of Jobs)	5,202	3,254	4,633	13,088
Labor Income (\$ M)	\$396	\$175	\$180	\$750
State and Local Tax Revenues (\$ M)	—	—	—	\$84
<u>Research, Testing, & Medical Laboratories</u>				
Output (\$ M)	\$4,305	\$1,542	\$2,629	\$8,476
Employment (# of Jobs)	26,801	14,353	23,374	64,529
Labor Income (\$ M)	\$2,288	\$596	\$906	\$3,790
State and Local Tax Revenues (\$ M)	—	—	—	\$340
<u>Other Biosciences</u>				
Output (\$ M)	\$1,298	\$432	\$244	\$1,974
Employment (# of Jobs)	1,571	2,299	2,168	6,038
Labor Income (\$ M)	\$132	\$130	\$84	\$347
State and Local Tax Revenues (\$ M)	—	—	—	\$53

Source: Battelle analysis of NCBiotech data using IMPLAN.

The growth of the bioscience industry cluster also boosts the supply chains in North Carolina supporting this industry. The result is that the total employment impact of each bioscience industry job in generating additional jobs in North Carolina is growing—in other words, with greater cluster development comes rising employment multipliers across North Carolina's economy. This benefit of increased agglomeration is reflected in the IMPLAN I/O models through its regional purchase coefficients. Table 8 below provides the results over time of how direct bioscience jobs impact broader employment in North Carolina.

Table 8: Comparison of the Employment Impacts from the Economic Contribution of Bioscience Sector to the North Carolina Economy, 2008, 2010 and 2012

Item	2012	2010	2008
Total Bioscience Sector			
Direct Impact (Employment)	58,589	56,842	53,182
Indirect Impact (Employment)	84,654	84,494	64,913
Induced Impact (Employment)	94,422	84,487	61,913
Total Impact (Employment)	237,665	226,823	180,007
Total Employment Multiplier (Total Impact Divided by Direct Impact)	4.056	3.990	3.385

Source: Battelle analysis of NCBiotech data using IMPLAN.

While bioscience sector employment in North Carolina continued to grow even through the recession, as a result of local and national economic conditions, this employment growth did not translate into an increase in the value of the sector's output or revenues. In a recession, the level of output or sales per job declines reflecting the weaker economic conditions. Given the weak national recovery, output did not rise relative to employment as might be expected in the first year of a recovery. Therefore, it is not surprising that despite the rising level of direct employment in the biosciences, the industry's output generated fell from previous years. Moreover, this decline in post-recession output is not concentrated in the bioscience sector—it occurred across most sectors of the North Carolina economy and occurred nationally as well. Thus, these results are consistent with both overall state and national economic changes.

The Economic Impact of Life Sciences R&D in North Carolina

North Carolina is not only a major center for bioscience industry employment, it is also a leading center for life sciences research and development. North Carolina had a total of almost \$1.9 billion in academic life sciences R&D expenditures in 2010 (up 29 percent from nearly \$1.5 billion in 2007). With its high concentration of nationally ranked medical schools, medical sciences is the largest area of academic research expenditures, accounting for 58 percent of 2010 life science R&D, followed by biological sciences at 29 percent (see Table 9).

Table 9: Life Sciences Research and Development Expenditures in North Carolina 2007 to 2010

	2007		2008		2009		2010	
Life Science Field	(\$1,000s)	%	(\$1,000s)	%	(\$1,000s)	%	(\$1,000s)	%
Agricultural Sciences	\$91,534	6%	\$103,380	7%	\$101,489	6%	\$98,236	5%
Bioengineering/ Biomedical Engineering	\$22,853	2%	\$22,374	1%	\$26,096	2%	\$29,437	2%
Biological Sciences	\$391,715	27%	\$509,952	34%	\$521,898	32%	\$548,853	29%
Medical Sciences	\$913,685	63%	\$834,304	55%	\$925,154	56%	\$1,095,961	58%
Other Life Sciences	\$41,767	3%	\$47,408	3%	\$72,513	4%	\$115,482	6%
Total	\$1,461,554	100%	\$1,517,418	100%	\$1,647,150	100%	\$1,887,969	100%

Source: Battelle analysis of NCBiotech data using IMPLAN.

North Carolina's academic life sciences research resources not only contribute to the state's competitive economic position in the biosciences through the development and commercialization of new technologies; as described above they contribute to the strength of the state's economy through their purchases of goods and services from other businesses and business sectors across the state economy. The impacts of the academic life sciences expenditures were estimated using the IMPLAN model.

The results of the analysis of the economic impact of academic life sciences research expenditures on the State of North Carolina are presented in Table 10 for overall expenditures and in Table 11 by research area. The \$1.9 billion in academic life science R&D expenditures directly creates an estimated 10,726 jobs with \$1.1 billion in labor income. Including multiplier effects, academic life science R&D expenditures generate nearly \$3.8 billion in economic activity in North Carolina (up from \$2.5 billion in 2008), support 28,479 jobs (versus 20,959 in 2008) earning an estimated \$1.7 billion in labor income. This also generated an estimated \$148.5 million in state and local tax revenues, up from \$106.3 million in 2008. Academic life science R&D expenditures generate an additional \$682.7 million in *Indirect Impacts* through purchases of goods and services from North Carolina suppliers and \$1.2 billion in *Induced Impacts* through local spending by the state residents employed in or impacted by the sector.

Table 10: 2010 Economic Impact of Life Science Research and Development Expenditures on the North Carolina Economy

Item	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output (\$)	\$1,887,969,024	\$682,696,981	\$1,222,506,759	\$3,793,172,764
Employment (# of Jobs)	10,726	6,629	11,124	28,479
Labor Income (\$ M)	\$1,052,016,416	\$263,781,479	\$415,582,089	\$1,731,379,984
State and Local Tax Revenues (\$ M)	–	–	–	\$148,520,397

Source: Battelle analysis of NCBiotech data using IMPLAN.

Table 11: 2010 Economic Impact of Life Sciences Research and Development Expenditures in North Carolina by Life Sciences Field

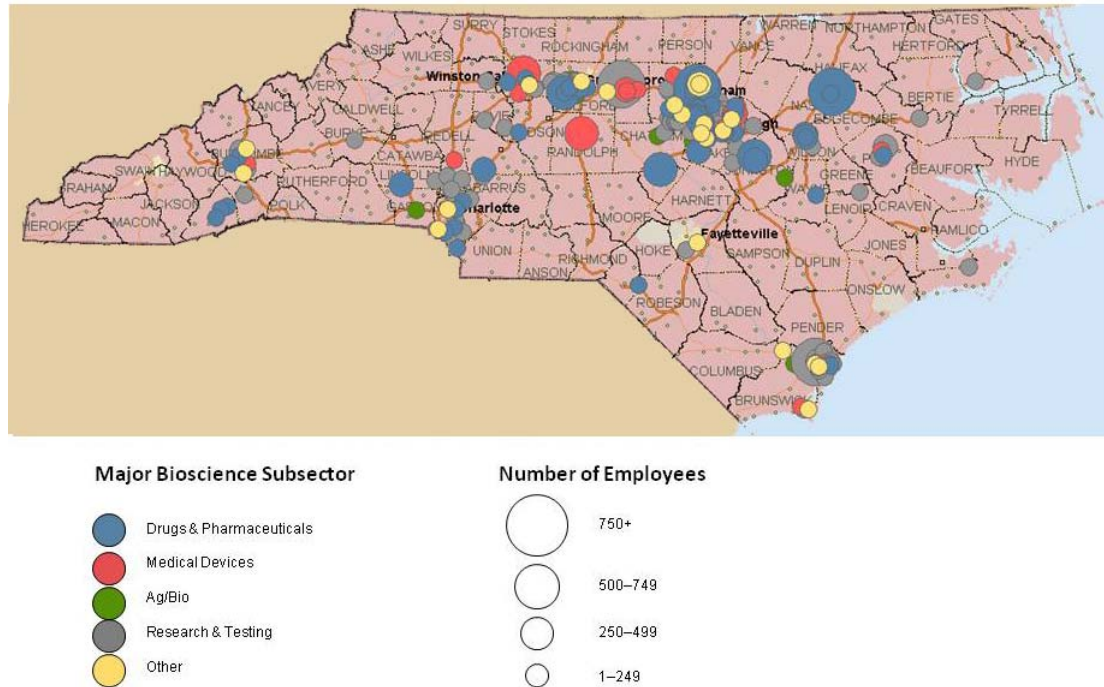
Life Science Field	Estimated		Total Impacts			
	Direct Impact (\$)	Estimated Direct Employment (# of Jobs)	Output (\$)	Employment (# of Jobs)	Employee Compensation (\$)	State and Local Government Revenues (\$)
Agricultural Sciences	\$98,236,000	558	\$197,368,770	1,482	\$90,088,261	\$7,727,907
Bioengineering/Biomedical Engineering	\$29,437,000	167	\$59,142,722	444	\$26,995,482	\$2,315,713
Biological Sciences	\$548,853,000	3,118	\$1,102,716,332	8,279	\$503,330,880	\$43,176,485
Medical Sciences	\$1,095,961,000	6,226	\$2,201,926,735	16,532	\$1,005,061,491	\$86,215,697
Other Life Sciences	\$115,482,000	656	\$232,018,204	1,742	\$105,903,870	\$9,084,594
Total	\$1,887,969,000	10,726	\$3,793,172,764	28,479	\$1,731,379,984	\$148,520,397

Source: Battelle analysis of NCBiotech data using IMPLAN.

Distribution of the Bioscience Industry in North Carolina

The bioscience sector in North Carolina not only serves a diverse set of markets that ranges from manufacturing to research and services, it also has a broad geographic footprint in the state. There is a broad representation of bioscience industries across the state, covering urban and rural areas alike. Figure 9 illustrates the distribution of bioscience industry operations across the state spanning the five major subsectors (color of the bubble) and the size of these operations by employment (size of the bubble).

Figure 9: Locations of North Carolina Bioscience Companies



V. INSTITUTIONAL EXPENDITURE AND FUNCTIONAL IMPACTS OF THE NORTH CAROLINA BIOTECHNOLOGY CENTER

Introduction

Accounting for the full, comprehensive institutional impacts of the work and mission of the North Carolina Biotechnology Center (NCBiotech) involves not only assessing those economic impacts that can be measured in a quantitative manner, but also acknowledging the functional impacts of the Center's activities, research, and outreach, and the important role they play in advancing both an industry and jobs that drive the state economy as well as biomedical and other bioscience-related R&D beneficial to society. This chapter first assesses the economic impacts of the Center's expenditures and then describes the key functional impacts it generates.

Battelle analyzed the economic impact of the operations of the Center in two areas:

- Business Loans and Recruitment/Expansion Assistance – includes the Center's loans made to support the growth, research, and operations of bioscience companies, as well as the assistance provided to facilitate company recruitment into or expansion within the state; and
- Operational Spending – includes the operating costs, wages and salaries of NCBiotech staff, R&D grants, statewide development efforts, various educational spending and other non-economic development related spending by the Center.

Data, Methodology, and Impact Measures Used to Estimate NCBiotech Impacts

The expenditure data used to estimate the economic impact associated with the Center's *programmatic spending* was based on the Fiscal 2011 and Fiscal 2012 annual report data provided by the Center and converted to calendar year 2011 spending. This spending was analyzed by spending area, using IMPLAN.

**Table 12: North Carolina Biotechnology Center Operating Budget for Calendar Year 2011⁽¹⁾
(Not Including Business Loans)**

Program Area/Year	2011
Total	\$19,104,490
Science and Technology Development	\$3,802,233
Statewide Development	\$1,632,826
Business and Technology Development	Analyzed Separately
Education and Training Grants	\$616,692
Hamner Conference Center	\$729,118
Library and Information Services	\$684,320
Centers of Innovation	\$1,819,508
AgBio Initiatives	\$148,441
Other Programs	\$994,426
Program Management	\$5,469,326
General and Administrative	\$3,207,602

(1) NCBiotech budgets were converted from Fiscal into Calendar years.

Source: NCBiotech.

The analysis of the economic impact of the Center's *business loans* was based on detailed loan portfolio data provided by NCBiotech. The economic impacts of the portfolio of business loans were calculated separately from the operational spending impacts because—especially for loans—these differ in their impact on the economy from operational spending. Operational spending represents a flow of money spent in an economy. Economic development spending, especially loans, represent a source of capital to the borrowing company, not an annual stream of spending. Furthermore, loans must be re-paid to the Center. As presented in Table 13, NCBiotech made a total of 9 loans for \$1.1 million in 2011 compared with 13 loans for \$1.2 million in 2009. Unlike in past reports, the economic impacts of these loans are not analyzed in terms of the impact of the recent loans provided, but rather in terms of the entire portfolio of loans provided over the operating history of NCBiotech.

Table 13: North Carolina Biotechnology Center Business Loans, 2009-2011

Loan	2009	2010	2011
Total Amount	\$1,185,000	\$1,881,257	\$1,131,003
Company Inception Loan	\$287,000	\$58,407	\$120,000
SBIR Bridge Loan			\$75,000
Small Business Research Loan	\$225,000	\$1,572,850	\$461,003
Strategic Growth Loan	\$673,000	\$250,000	\$475,000
Total Number	13	12	9
Company Inception Loan	8	2	4
SBIR Bridge Loan			1
Small Business Research Loan	2	9	2
Strategic Growth Loan	3	1	2

Source: NCBiotech.

The Economic Impact of NCBiotech on the Development of the North Carolina Bioscience Industry

The primary economic impact of NCBiotech is its contribution to the development of the North Carolina bioscience industry. Since its founding in 1984, the Center has focused on the development and promotion of the industry in North Carolina through its support of bioscience research, business development, education, and strategic policy. The Center's mission has been to promote the development of the sector by encouraging emerging applications of science, supporting capital formation, facilitating workforce training, and coordinating the implementation of the state's bioscience policy. Through its nearly thirty years of operations, NCBiotech has interacted with many of the emerging and leading companies that make up the ninth largest concentration of bioscience industry employment in the country.

NCBiotech has directly supported the development of the state's bioscience sector through its business loans program. While it is not possible to determine the extent to which the business loans provided by the Center generated new or facilitated the growth and expansion of existing bioscience companies; it is, however, possible to measure the economic impacts made by the companies that have received economic development assistance from the Center.

Since 1989, when the Center started to provide economic development assistance to companies, it has made business loans to 136 companies.¹³ Of the 136 companies receiving loans, 74 are currently active.¹⁴ Battelle estimated the economic impacts of these 74 companies. As presented in Table 14, these 74 companies had total employment of 2,169 and estimated revenues of \$1.45 billion. The impacts of these companies' operations were analyzed using the IMPLAN model.¹⁵ These 74 companies generate almost \$2.4 billion in economic activity in the state, create or support 9,586 jobs earning \$608 million in labor income, and generate an estimated \$71 million in state and local tax revenues (an amount that exceeds the annual funding for NCBiotech). Companies receiving business loans from the Center now account for 4 percent of the economic activity associated with the entire bioscience sector.

¹³ The 2008 first economic impact report and the 2010 updated economic impact report analyzed both business grants and loans. Because the grant programs were discontinued several years ago and are not a major focus of the Center's current economic development programs, they were dropped from this analysis. A total of 143 loans have been approved, but 7 of the companies never accessed the funding and were excluded from the analysis.

¹⁴ Some of these companies may have been acquired by other companies or have changed their name and, thus, may be active in some form. In cases where a company was known to be acquired the acquiring company was included.

¹⁵ See above description of the IMPLAN model and methodology used.

Table 14: The Economic Contribution of the 74 Currently Active Companies that Received Business Loans to the North Carolina Economy

Item	Direct Impact	Indirect Impact	Induced Impact	Total Impact
<u>Total Impact of Bioscience Sector</u>				
Output (\$M)	\$36,477	\$11,903	\$10,630	\$59,009
Employment (# of Jobs)	58,589	84,654	94,422	237,665
Labor Income (\$M)	\$6,064	\$5,104	\$3,663	\$14,830
State and Local Tax Revenues (\$M)	–	–	–	\$1,731
<u>Impact of the 74 Currently Active Companies that Received Economic Development Loans</u>				
Output (\$M)	\$1,450	\$496	\$439	\$2,386
Employment (# of Jobs)	2,169	3,515	3,902	9,586
Labor Income (\$M)	\$238	\$219	\$151	\$608
State and Local Tax Revenues (\$M)	–	–	–	\$71

Source: Battelle analysis of NCBiotech data using IMPLAN.

In addition to providing business loans to support company creation and early development, NCBiotech is also active in efforts to both recruit bioscience companies to North Carolina and also to facilitate the expansion of bioscience companies already located in the state. Data provided by NCBiotech regarding 24 key company recruitment or expansion projects that the Center has assisted with since January 2008 shows the potential to create a total of 1,752 jobs once they reach their projected employment levels. Once the companies involved in these 24 projects attain their full projected level of employment, they will generate just over \$2.0 billion in economic activity and support 7,824 jobs earning \$492 million in labor income and generate \$60 million in combined state and local government revenues. Of these 24 projects, four benefited from NCBiotech's recently created Economic Development Award (EDA) that provides performance-based funding support to communities engaged in specific bioscience company recruitments or expansions. The four companies are Medicago Inc., Aerocrine Inc., KeraNetics LLC, and Piedmont Pharmaceuticals. A total of \$300,000 in NCBiotech EDA funding was awarded to support recruitments or expansions involving these four companies with projected creation of 273 new jobs—for a direct investment of \$1,099 in EDA funding for each job created.

Table 15: The 2012 Economic Contribution of 24 Bioscience Companies that NCBiotech has Assisted in Expanding to or in the State since 2008 on the North Carolina Economy

Item	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output (\$ M)	\$1,244	\$418	\$356	\$2,018
Employment (# of Jobs)*	1,752	2,907	3,165	7,824
Labor Income (\$ M)	\$186	\$183	\$123	\$492
State and Local Tax Revenues (\$ M)	–	–	–	\$60

Source: Battelle analysis of NCBiotech data using IMPLAN.

As described above, NCBiotech has facilitated the growth and development of this sector both directly, through its economic development programs, and indirectly, through its research, education and general sector support strategies. The bioscience sector has become a vital industry for the state and a strong sector that continued to expand, even in the current economic downturn. Some measures of the economic contributions of the sector are as follows:

- Each Bioscience industry job directly generates:
 - \$622,600 in direct industry revenues;

- \$203,200 in indirect impacts through inter-industry purchases;
- \$181,400 in induced impacts through the increase in local incomes;
- For a total of \$1,007,200 in North Carolina economic activity per bioscience job;
- Each bioscience sector job generates \$29,500 in state and local government revenues (including multiplier effects); and
- Each bioscience sector job supports 1.4 indirect jobs in supplier companies and 1.6 induced effect jobs through local incomes for a total of 3 additional jobs per bioscience sector job.

The Economic Impact of NCBiotech Operations in 2011

A more focused analysis of just 2011 reveals the current economic impacts of the Center's operations for the year, while the results of its loans to industry will take years to play out. The operating budget and business loans data were analyzed using the IMPLAN model in order to estimate the economic impacts associated with each activity.¹⁶ The economic impacts of the NCBiotech calendar 2011 spending on the State of North Carolina are presented in Table 16. The Center's \$19.1 million in operational expenditures in 2011 increased economic activity in North Carolina by \$39.4 million, supported an estimated 256 jobs earning \$14.0 million in labor income, and generated nearly \$1.7 million in state and local tax revenues.

Table 16: The Economic Contribution of NCBiotech Operational Spending on the North Carolina Economy

Item	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output (\$)	\$19,104,490	\$9,667,037	\$10,663,624	\$39,435,151
Employment (# of Jobs)¹	85	75.7	95.4	256.1
Labor Income (\$)¹	\$7,073,173	\$3,266,587	\$3,643,060	\$13,982,820
State and Local Tax Revenues (\$)	–	–	–	\$1,666,421

(1) Direct Employment and Labor Income is for NCBiotech staff only - Jobs and Labor Income created by NCBiotech grants are included in indirect impacts.

Source: Battelle analysis of NCBiotech data using IMPLAN.

¹⁶ See discussion above for a description of IMPLAN and a discussion of the economic impact methodology.

The Functional Impacts and Activities of the Center in Building North Carolina's Bioscience Cluster

Beyond the expenditure impacts NCBiotech generates as an organization designed to foster growth of a major tech-based economic cluster for North Carolina, it is important to acknowledge the significant impacts and benefits generated in the state across the many functions and initiatives the Center supports. The Center's broad range of economic development initiatives, programs, and services lead to significant functional benefits and economic impacts for the State of North Carolina.

The mission of NCBiotech is:

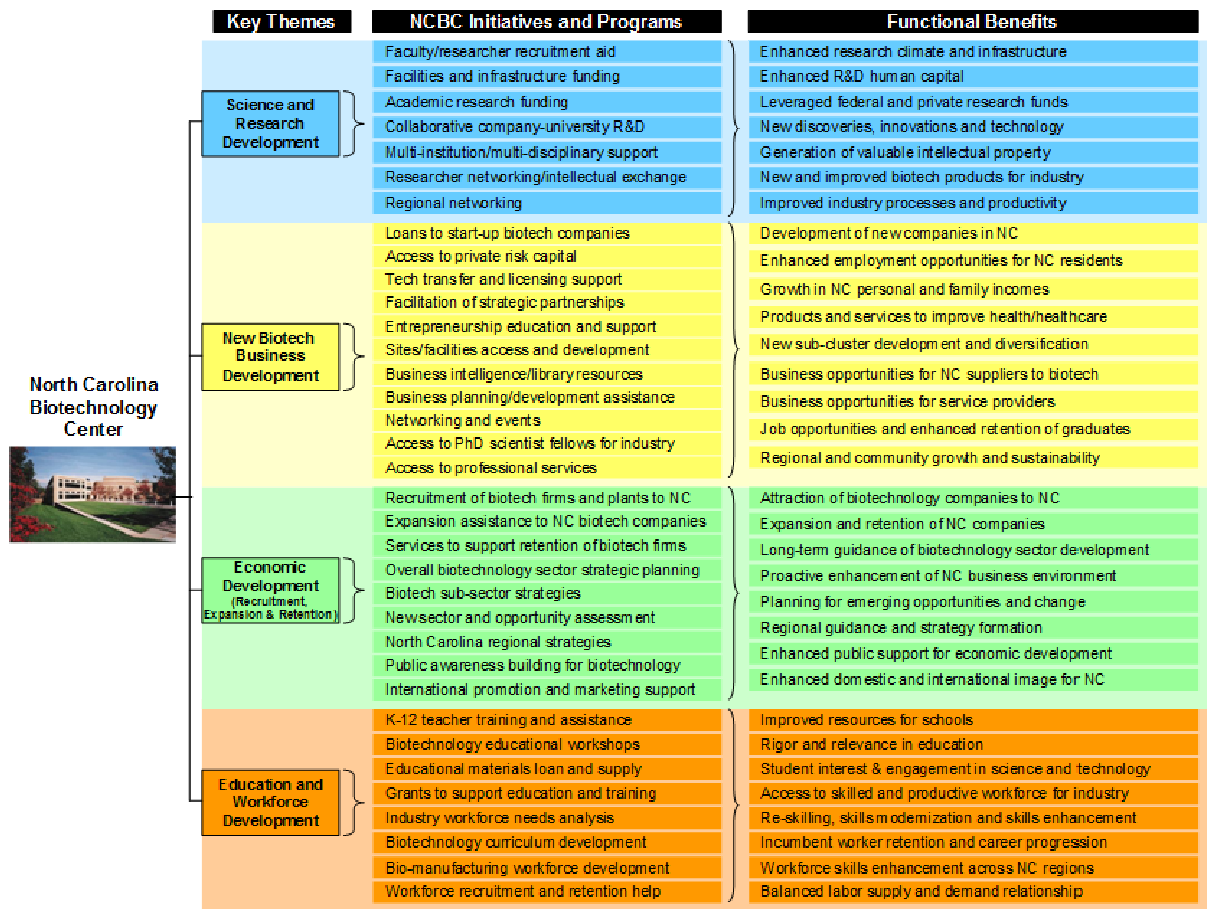
To provide long-term economic and societal benefits to North Carolina through support of biotechnology research, business, education and strategic policy statewide.

The Center addresses this mission via dedicated attention to six principal goals:

1. Strengthen North Carolina's academic and industrial biotechnology research capabilities.
2. Foster North Carolina's biotechnology industrial development.
3. Work with business, government and academia to move biotechnology from research to commercialization in North Carolina.
4. Inform North Carolinians about the science, applications, benefits and issues of biotechnology.
5. Enhance the teaching and workforce-training capabilities of North Carolina's educational institutions.
6. Establish North Carolina as a preeminent international location for the biotechnology industry.

The Center advances its mission and these goals through a comprehensive approach that addresses each key link in the tech-based economic development chain—from basic science, to applied R&D, to piloting and demonstration programs, technology transfer and new enterprise development, as well as education and workforce development, and addressing business recruitment, retention and expansion. The scope of services, initiatives, and programs provided by NCBiotech and their corresponding functional benefits is presented in Figure 10. The figure aligns these benefits under four primary program areas or themes including: science and research development; new business development; economic development (recruitment, retention, and expansion); and education and workforce development.

Figure 10: North Carolina Biotechnology Center Initiatives and Programs and their Functional Benefits for North Carolina



As the figure illustrates, the initiatives and programs of the Center are targeted towards achieving tangible functional results for the state. These results, in turn, lead to a wide range of economic impacts for North Carolina, including:

- **An enhanced science, creativity, innovation and knowledge base** in North Carolina in life sciences and disciplines related to biosciences and biotechnology
- **Growth in statewide economic output** (business volume) via direct impacts of biotech companies and the indirect impacts of the supply and service chain
- **Growth of specific North Carolina regions** through biotechnology
- **Diversification** and, through diversification, enhanced **sustainability** of the North Carolina economy
- **Enhanced education and skills** of North Carolinians
- **Gains in personal income** for North Carolinians via education and skills attainment and the higher than average wages paid within the biotechnology sector
- **Expansion of North Carolina state government revenues** via business taxes and personal taxes allocable to the operations of the biotechnology sector and its supply chain
- **An enhanced quality of life** generated for North Carolina through an improved employment climate

- **New and improved health care products** and services benefiting North Carolinians
- An **enhanced image and awareness of North Carolina** as a location for business activity in science and technology based enterprise, leading to positive spill-over effects in other technology sectors
- An **enhanced competitive position of North Carolina** in the increasingly competitive global marketplace, achieved through the production and sale of advanced biotechnology-based products and services.

These functional impacts combine with the expenditure and other quantifiable economic impacts to tell an impressive success story that began in 1984 and continues today with a leading, diversified, and rapidly growing bioscience industry in North Carolina.

Conclusion

The future remains bright for the biosciences as an industry, and it is expected to continue to be a reliable engine of economic growth with research and commercial breakthroughs expected across numerous applications from food and the environment to energy and health. The outlook for North Carolina's bioscience sector, meanwhile, continues to point upward as the state has demonstrated it can continue to grow rapidly and outpace its top tier bioscience counterparts in recent growth. NCBiotech has played a significant role in this success, and continues to help differentiate the state across a highly competitive national and global industry landscape. The Center's economic impacts and broad benefits to the state continue to expand, and after nearly 30 years in operation, it continues to build upon its legacy of proven results by rolling out new initiatives and preparing the North Carolina bioscience industry for the future.



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