An Economic Overview of the Science and Technology Sectors of Maine's Economy

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[2] EDA UMaine Staff Papers disseminate research and analysis conducted by members of the EDA Center at University of Maine. This report is a "preprint" that has not been peer reviewed.

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1. Introduction

In 2019 the State of Maine published their 10 year economic plan.[3] This roadmap document outlined a new approach to economic development, looking to enhance the synergies between new emerging sectors and the heritage industries of the past. Science and technological innovation was highlighted in the strategy as a key driving force in forging the economic direction of the state. This present report seeks to investigate the key STEM sectors in the State of Maine that will likely contribute to innovation and economic growth over the next 5 years. The focus of the study will be traditional macroeconomic measures such as employment and output but also labor based measures such as wages and qualifications. Forecasts using the EMSI modeling framework have been utilized to provide insights into the likely areas of increased labor demand in the future.

2. Technical Brief on Choice of Sectors

Key to completing this study is identifying the sectors that make up Maine's economy and those that are considered STEM. Building on the work of the 2019 10 year economic plan and its accompanying technical report t (Crawley and Hallowell 2020) as well as the Maine economic improvement Fund (MEIF) sectors were classified using the North American Industrial Classification System (NAICS). The use of NAICS codes is common for this type of report, however a considerable limitation is the fact that the codes are not updated regularly. This means that certain "new industries" such as 3D fabrication are not defined by a specific code. To elevate this issue this work constructs 7 sectors that comprise over 41 different industrial codes that allows us to capture, as best possible, the evolution of different sectors.

[3] https://www.maine.gov/decd/sites/maine.gov.decd/files/inline-files/DECD_120919_sm.pdf

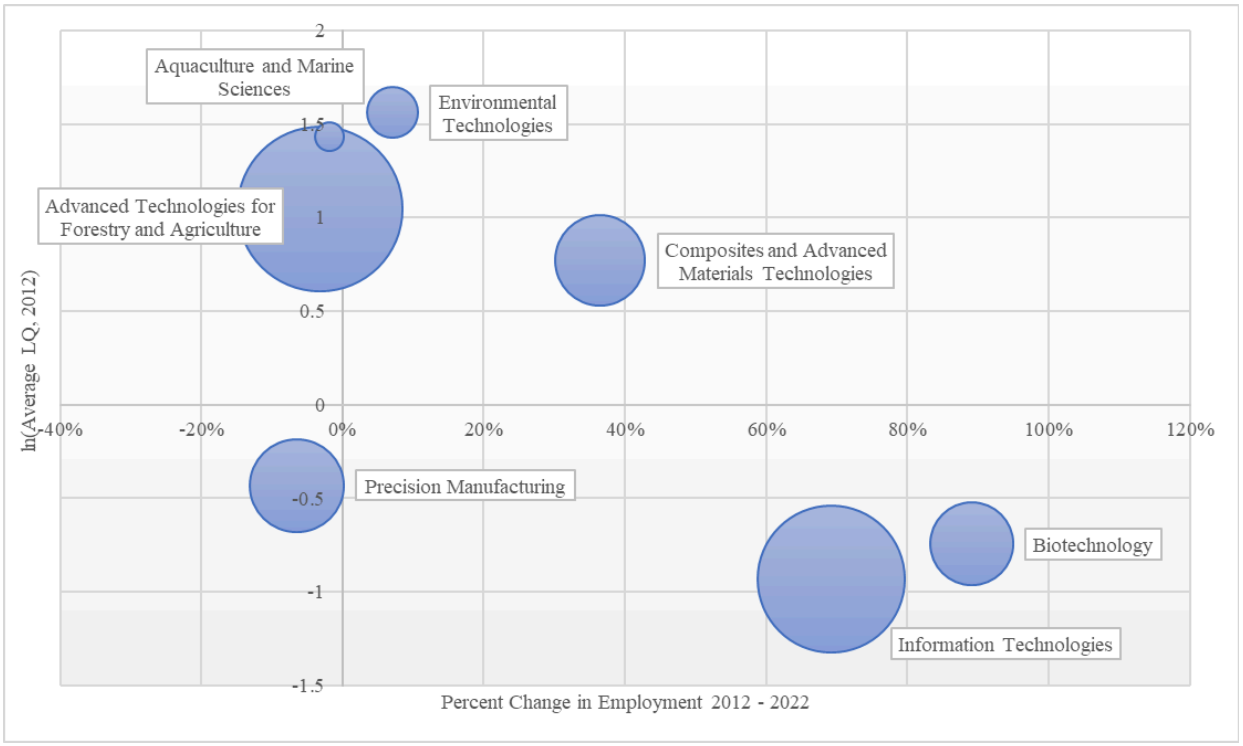
3. Historical Background of Sectors

The location quotient (LQ) is one measure of assessing the relative specialization of a particular sector within a region. The employment-based LQs calculated here examine the share of sector employment in Maine relative to the share of sector employment in the nation, where an LQ greater than 1 indicates the sector is more concentrated in the region than would be expected nationally. In Figure 1, the vertical axis shows the log of the sector's average LQ in 2012, the horizontal axis shows the percent change in sector employment between 2012 and 2022, and the size of the bubble represents the size of the sector in terms of 2022 employment.

It should be noted that while the LQ is a useful descriptive tool for understanding the relative concentration of an industry in a region, it is not indicative of high levels of, or growth in, employment.

- Composites and Advanced Manufacturing - concentrated and increasing employment
- Biotech & IT not as concentrated by growing
- AQ, AG and ET concentrated but did no show large changes in employment
- Precision manufacturing - not very concentrated and employment loss

Figure 1. Bubble Plot of Target Sector Location Quotients (LQs), 2012 -2022



Source: EMSI 2022 and author's calculations

These trends between 2012 and 2022 are summarized in Table 1, which shows number of jobs, average LQ, and Gross Regional Product (GRP) for each sector.

- Biotech - saw the largest percentage change in GRP across the period,
- Forestry & Ag - had the largest GRP but has been a decline in numbers of jobs (LQ dropped but still very specialized)
- The Information technology sector has seen the largest real increase in output going from $900 million in 2012 to now worth $1.9 billion
- Advanced Technology for Forestry and Agriculture employs the largest number of people with over 22,000.

Table 1. Trends in Target Sectors: 2012 - 2022

Target Sector	2012 Jobs	2022 Jobs	**% Change Jobs**	Average LQ 2012	Average LQ 2022	**% Change Average LQ**	2012 GRP	2022 GRP	**% Change GRP**
Advanced Technology for Forestry and Agriculture	23,323	22,586	**-3%**	2.84	2.61	**-8%**	$1.4 billion	$1.5 billion	**11%**
Aquaculture and Marine Sciences	715	702	**-2%**	4.19	5.02	**20%**	$31.9 million	$42.1 million	**32%**
Biotechnology	3,008	5,688	**89%**	0.48	0.75	**58%**	$290.5 million	$713.6 million	**146%**
Composites and Advanced Materials	4,999	6,822	**36%**	2.16	2.59	**20%**	$420.5 million	$616.4 million	**47%**
Environmental Technologies	2,025	2,168	**7%**	4.76	0.77	**-84%**	$133.6 million	$165.3 million	**25%**
Information Technologies	10,604	17,949	**69%**	0.39	0.50	**27%**	$903.6 million	$1.9 billion	**115%**
Precision Manufacturing	7,714	7,215	**-6%**	0.65	0.66	**1%**	$479.7 million	$517.1 million	**8%**

Source: EMSI 2022 and author's calculations

3.1 Employment Growth in Focus

To assess which sectors had the highest growth industries between 2012 and 2022, we calculated a standard employment growth rate and Birch Index (which considers the relative size of each sector by multiplying absolute job growth by relative job growth). In other words, an industry may have a very large growth rate but relatively low unemployment and as such, does not have as large of an impact on overall job growth. Table 2 shows the Birch Index and employment growth between 2012 and 2022 for our sectors of interest.

- Biotech had largest overall employment growth rate, but when taking into account relative size of each sector, the IT sector was the highest growth industry
- Both Advanced Technology for Forestry and Agriculture and Marine sciences saw decreases in employment, it must be noted these are modest declines in relative terms.

Table 2. Target Sector Employment Growth and Modified Birch Index, 2012 - 2022

Target Sector	Modified Birch Index	Modified Birch Index Rank	Employment Growth (%)	Employment Growth (%) Rank
Advanced Technology for Forestry and Agriculture	-714	7	-3%	6
Aquaculture and Marine Sciences	-13	5	-2%	5
Biotechnology	5,067	2	89%	1
Composites and Advanced Materials	2,487	3	36%	3
Environmental Technologies	153	4	7%	4
Information Technologies	12,432	1	69%	2
Precision Manufacturing	-467	6	-6%	7

Source: EMSI 2022 and author's calculations

4. Future Trends

To accomplish the goals of the State's Science and Technology plan it's important to understand how the sectors identified as STEM will perform in the future. To this end this report has utilized the EMSI model[4], calibrated with the sector breakdowns identified in section 1 to project performance out to 2028.

In Figure 2 the vertical axis shows the log of the sector's average LQ in 2022, the horizontal axis shows the percent change in sector employment between 2022 and 2028, and the size of the bubble represents the size of the sector in terms of 2028 projected employment.

- Composites and Advanced Manufacturing and Advanced Tech for For & Ag are still concentrated but only see modest employment growth
- AQ remains highly concentrated by doesn't see much employment growth
- Precision Man, Env Tech are not very concentrated but see modest employment growth
- Biotech and IT are not very concentrated but see large gains in employment.

[4] It must be noted that EMSI projections are based on national trends which are then regionalized based on the relative size and output of the industry in question. No Maine specific forecast data is available at this industrial level.

Figure 2. Bubble Plot of Projected Target Sector Location Quotients (LQs), 2022 - 2028

Source:EMSI 2022 and author's calculations

These projected trends between 2022 and 2029 are summarized in Table 3, which shows number of jobs, average LQ, and Gross Regional Product (GRP) for each sector.

- Biotech and IT - employment gains 13%
- Loss of employment in Aquaculture and Marine Sciences
- The other sectors show a relatively steady growth rate over this period
- The increase in LQ in the Composites and Advanced Material sector points to growth in its relative scale in Maine compared to the Nation.

Table 3. Projected Trends in Target Sectors: 2022 - 2028

Target Sector	2022 Jobs	2028 Jobs	**% Change Jobs**	Average LQ 2022	Average LQ 2028	**% Change Average LQ**
Advanced Technology for Forestry and Agriculture	22,586	23,117	**2%**	2.61	2.60	**-0.5%**
Aquaculture and Marine Sciences	702	682	**-3%**	5.02	5.03	**0.2%**
Biotechnology	5,688	6,407	**13%**	0.75	0.84	**12%**
Composites and Advanced Materials	6,822	6,952	**2%**	2.59	2.63	**2%**
Environmental Technologies	2,168	2,268	**5%**	0.77	0.76	**-1%**
Information Technologies	17,949	20,247	**13%**	0.50	0.52	**4%**
Precision Manufacturing	7,215	7,420	**3%**	0.66	0.69	**6%**

Source: EMSI 2022 and author's calculations

5. Labor Market

The number of STEM occupations, as we have defined for this report, increased by 2,902 from 2016 - 2021 (12.8%) outpacing the national growth rate of 7%. Regional job concentration per capita is 0.8 times the national job concentration - in other words, there are 20% fewer STEM occupations in this region than what we would expect to find in the average region. It is also possible to break down STEM occupations into resident and non resident workers to establish the number of net commuters. Net commuters is the difference between the occupational residents in a region and the occupational employment in a region. For a region in which more workers live than there are jobs in the region, net commuting is negative i.e. the net result is that workers commute out of the region for work [5].

[5] This is obtained through EMSI that uses the Census Bureau's LED LODES dataset.

Table 4. STEM Occupations by County, Net Commuters

County	2021 STEM Jobs	2021 STEM Resident Workers	2021 Net Commuters
Cumberland	9,626	8,121	1,505
York	2,950	4,486	(1,535)
Kennebec	2,502	2,292	209
Penobscot	2,065	1,650	415
Androscoggin	1,423	1,864	(441)
Hancock	1,283	932	350
Sagadahoc	1,060	932	128
Aroostook	631	552	78
Knox	471	405	66
Waldo	425	400	25
Somerset	402	547	(145)
Oxford	352	590	(238)
Lincoln	273	449	(176)
Washington	251	182	69
Franklin	208	280	(72)
Piscataquis	191	162	29

Source: EMSI 2022

- Cumberland County has the highest number of STEM jobs
- Piscataquis has the lowest number of STEM resident workers
- York has the largest number of Net commuters of any county.
- The counties around Cumberland show a clear core periphery pattern

Table 5 shows, for various STEM occupations in Maine, the number of jobs between 2012 and 2028, average annual earnings, and the number of hires in 2021.

- Only occupation to see negative percentage change is forest and conservation technicians (also had lowest average annual earnings)
- Four occupations projected to see greater than 100% increase by 2028
- Largest percentage increase is Computer and Information Research Scientists

Table 5. STEM Occupations, Number of Jobs: 2012 - 2028

Occupations	2012 Jobs	2022 Jobs	2028 Jobs	**% Change Jobs (2012 - 2028)**	2021 Hires	Avg. Annual Earnings
Computer and Information Analysts	1,761	2,717	2,858	**62%**	771	$80,901
Computer and Information Research Scientists	32	107	120	**274%**	35	$105,245
Computer Support Specialists	2,688	3,126	3,253	**21%**	995	$54,492
Database and Network Administrators and Architects	2,196	2,262	2,334	**6%**	631	$93,034
Software and Web Developers, Programmers, and Testers	3,584	4,805	5,432	**52%**	1,590	$87,895
Operations Research Analysts	250	367	406	**63%**	115	$73,427
Statisticians	69	131	159	**132%**	50	$67,995
Aerospace Engineers	92	131	143	**55%**	29	$116,639
Bioengineers and Biomedical Engineers	62	71	78	**27%**	25	$91,483
Civil Engineers	1,058	1,194	1,269	**20%**	339	$90,150
Computer Hardware Engineers	335	480	478	**43%**	112	$120,457
Electrical and Electronics Engineers	690	1,048	1,098	**59%**	241	$93,191
Industrial Engineers, Including Health and Safety	740	1,108	1,195	**61%**	325	$87,161

Marine Engineers and Naval Architects	131	400	395	**203%**	68	$95,909
Materials Engineers	80	103	107	**33%**	20	$101,296
Mechanical Engineers	731	1,201	1,244	**70%**	279	$91,507
Drafters	1,333	1,461	1,441	**8%**	559	$57,282
Engineering Technologists and Technicians, Except Drafters	2,212	2,381	2,401	**9%**	942	$69,907
Surveying and Mapping Technicians	283	316	321	**13%**	147	$47,806
Agricultural and Food Scientists	104	126	131	**26%**	72	$65,867
Biological Scientists	552	766	796	**44%**	295	$74,217
Conservation Scientists and Foresters	247	304	297	**20%**	107	$61,504
Medical Scientists	232	285	326	**40%**	114	$129,031
Chemists and Materials Scientists	207	418	473	**128%**	218	$75,105
Chemical Technicians	155	174	191	**23%**	97	$53,539
Environmental Science and Geoscience Technicians	131	161	167	**28%**	89	$51,407
Forest and Conservation Technicians	58	31	32	**(45%)**	18	$37,435
Miscellaneous Life, Physical, and Social Science Technicians	273	387	394	**44%**	253	$59,510

Source: EMSI 2022 and author's calculations

6. Conclusion

This report has laid out both the recent performance of STEM industries in terms of jobs and output as well as projections for the labor market. The importance of these sectors to the success of the Maine economy is easy to see if one is to reflect on the GRP of STEM industries. The relative wage levels of these sectors is also notable as they likely result in significant multiplier effects. One word of caution when assessing STEM industries and occupations is the uncertainty over new and emerging technologies. Formal economic classifications of industry take years to develop and often are only accounted for using NAICS codes once they are established. The approach of this report, as detailed in the introduction, has been to form our own classifications of sectors to account for the dynamism of STEM.

In addition to these caveats this report acknowledges the demographic challenges of the state of Maine as well as historic outmigration patterns of educated workers. Labor market supply changes are likely to persist and projections for future job growth are likely to be undermined by population dynamics.

Appendix

Appendix A. NAICS Linked to Priority Sectors

NAICS Code	NAICS Description
Biotechnology	
3254	Pharmaceutical and Medicine Mfg.
3391	Medical Equipment and Supplies Mfg.
541710	R&D in the Physical, Engineering, and Life Sciences
334510	Electro medical and Electrotherapeutic Apparatus Mfg.
334516	Analytical Laboratory Instrument Mfg.
334517	Irradiation Apparatus Mfg.
Composites and Advanced Materials Technologies	
3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Mfg.
336612	Boat Building
541330	Engineering Services
541690	Other Scientific and Technical Consulting Services
Environmental Technologies	
2213	Water, Sewage and Other Systems
5622	Waste Treatment and Disposal
5629	Remediation and Other Waste Management Services
54138	Testing Laboratories
221119	Other Electric Power Generation
541620	Environmental Consulting Services
Advanced Technologies for Forestry and Agriculture	
111	Crop Production
112	Animal Production
1151	Support Activities for Crop Production
113	Forestry and Logging

321	Wood Product Mfg.
322	Paper Mfg.
337	Furniture and Related Product Mfg.
1153	Support Activities for Forestry
Information Technologies	
5415	Computer Systems Design and Related Services
511210	Software Publishers
516110	Internet Publishing and Broadcasting
518111	Internet Service Providers
518112	Web Search Portals
518210	Data Processing, Hosting, and Related Services
334	Computer and Electronic Product Mfg.
541380	Testing Laboratories
541512	Computer Systems Design Services
54171	Research and Development in the Physical, Engineering and Life Sciences
541720	Research and Development in the Social Sciences and Humanities
Precision Manufacturing	
332	Fabricated Metal Product Mfg.
333	Machinery Mfg.
Aquaculture and Marine Sciences	
1125	Animal Aquaculture
311710	Seafood Product Preparation and Packaging

Source: Crawley and Hallowell (2020)

Appendix B. EMSI Data Sources

Category	Data Source
Occupations	Occupational Employment Statistics (QCEW and Non-QCEW Employees)
	American Community Survey (Self-Employed and Extended Proprietors)
	Occupational wage estimates are also affected by county-level Emsi earnings by industry
	Maine Department of Labor
Industry	Quarterly Census of Employment and Wages
	Supplemental estimates from County Business Patterns
	County Business Patterns
	BEA State and Local Personal Income Reports
	National Industry-Occupations Employment Matrix (NIOEM)
	Current Employment Statistics
	American Community Survey
	Projections for QCEW and Non-QCEW employees are informed by NIOEM and long-term industry projections published by individual states

Source: EMSI 2022