

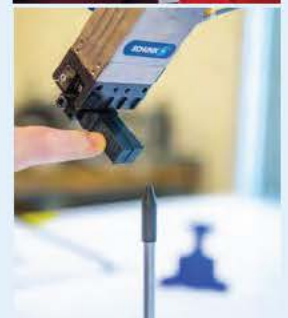
# MAINE STATE LEGISLATURE

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# MAINE ECONOMIC IMPROVEMENT FUND



## Annual Report FY2022 Presented to Maine State Legislature



A successful partnership among Maine's government, private sector and public universities to build Maine's economy and future workforce through research and development.





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In recognition of the unique role of public university research and development (R&D) in driving and diversifying private sector growth, 25 years ago our state's Legislature established the Maine Economic Improvement Fund (MEIF).

Through this targeted ongoing investment in commercially promising University of Maine System R&D, we've been able to build strategic statewide capacity to support hundreds of small businesses here to grow and create thousands of high-paying Maine jobs through new products and processes, while attracting new companies and opportunities to our state. Three-quarters of MEIF dollars are focused at the flagship University of Maine, which has expanded the external R&D funding it attracts annually to Maine from just \$25 million when MEIF was born from bipartisan legislative action in the 1990s to nearly \$150 million in 2022.

Today, university researchers are at work in our labs and field sites and in your districts helping our heritage industries — including farming, fishing, forestry and manufacturing — innovate for the future through new technologies and talent. At the same time, we are fostering the formation of promising new technologies, like clean energy and biomaterials development for applications ranging from health care to affordable home and highway construction.

We've also established world-class expertise essential to Maine's policymakers and always available to its people, including in climate science, rural public health and education, and most recently, forever chemicals like PFAS.

The hands-on engagement of students in all of our research activities — including undergraduates — distinguishes our state's public universities, and ensures our graduates are well-prepared to be leaders, problem-solvers and innovators in the Maine workforce and in our communities.

Given this incredible impact, it should come as no surprise that the private sector has consistently called for increasing Maine's economic competitiveness by boldly increasing public investment in UMS R&D through MEIF, which in 2022 had a 6:1 rate of return and accelerated UMaine's ascension to the top-tier of America's research universities by achieving R1 Carnegie Classification.

Doing so, they say — and our track record shows — will create more value-added Maine jobs and products, grow wages, catalyze private sector innovation and investment, and recruit and retain talent to our campuses and your communities — all while sustaining the state's abundant natural resources and special quality of life.

The University of Maine System is proud of what we have accomplished together with our students and business partners and your MEIF investment, including the success stories showcased in this year's reformatted annual report. We look forward to continuing to work with you to ensure we realize the full potential of public university R&D and of Maine's economy.

Thank you for your support,

Dannel Malloy  
Chancellor, University of Maine System

Joan Ferrini-Mundy  
Vice Chancellor for Research & Innovation, University of Maine System  
President, University of Maine and University of Maine at Machias

## MEIF Background

The Maine Economic Improvement Fund (MEIF) represents the ongoing commitment between the state, the private sector and our public universities, working together to advance research and economic development for the benefit of all Maine people.

Since the Maine Legislature established MEIF in 1997, MEIF has positioned the University of Maine System (UMS) at the center of statewide efforts to leverage economic development through targeted investment in university-based R&D. MEIF continues to be funded through an annual state appropriation to UMS.

These funds provided through state appropriation to the University of Maine System are dollars specifically directed to support university-based research, development and commercialization in the state's legislatively designated seven strategic technology areas:

- Advanced Technologies for Forestry and Agriculture
- Aquaculture and Marine Sciences
- Biotechnology
- Composites and Advanced Materials Technologies
- Environmental Technologies
- Information Technologies
- Precision Manufacturing

The University of Maine and the University of Southern Maine have well-established research, development and commercialization activities accounting for 97 percent of the MEIF activity. In 2009, the University of Maine System established the Small Campus Initiative Fund to promote seven-sector research and development activity at the other five UMS campuses and, as of 2013, Maine Maritime Academy (MMA).

## Role of MEIF

The role of MEIF is to support the solution of fundamental problems and discover new solutions, and to provide researchers at Maine's public universities with the investment necessary to:

- Create and sustain economic development and innovation
- Attract co-investment through external grants and contracts to support R&D activities in Maine's seven sectors
- Create new products, patents, technologies, companies and exciting job opportunities in Maine
- Build and equip modern laboratories with state-of-the-art equipment made available to students and companies
- Attract and retain world-class R&D talent

MEIF funds often provide the required match to acquire federal or private sector grants, and this investment in Maine's public university R&D helps faculty, staff and students successfully leverage tens of millions of dollars in grants and contracts annually.

MEIF directly supports faculty, grad students and staff who are working to make the universities more competitive for federal grants, expanding opportunities to support Maine companies and involve students in research learning and real applications of their education.

MEIF increasingly fosters university partnerships with business and industry through economic development collaborations, entrepreneur training programs, business incubators, technology accelerators, business research and other programs. These efforts lead to new Maine-based products, technologies, patents and spin-off businesses.

The University of Maine and the University of Southern Maine are the two universities with established research and graduate programs in the seven targeted research sectors and have received MEIF funds, with 76.6 percent to the University of Maine and 19 percent to the University of Southern Maine. In addition, 1.4 percent of MEIF funds are awarded to the University of Maine Machias and 3 percent to the other campuses and Maine Maritime Academy.

### Indicators of success show that Maine's MEIF investment is paying dividends by:

- Creating businesses and jobs, including the jobs of more than 500 faculty and staff, and nearly 1300 students working on MEIF-funded projects.
- Boosting Maine's economy by leveraging MEIF funds to bring federal and private-sector grants and contracts to Maine.
- Building capacity and expertise to help Maine companies solve problems and commercialize innovation.
- Generating new intellectual property and working to commercialize patents and innovations.
- Capitalizing on natural resources and core strengths by focusing R&D efforts on economic sectors where Maine can make real gains. University research personnel use MEIF resources to support the staff, equipment and facilities they need to successfully pursue and develop research projects.





This symbiotic relationship between the lab and industry is a differentiator for Maine, and **the perfect example of how industry, academia and the state can work together** to create nationally leading industries.”

Sean Sullivan  
Executive Director, Maine Brewers’ Guild

## Harnessing collective strengths for statewide impact

The Quality Control Collaboratory (QC2) Lab creates unique educational opportunities for University of Southern Maine science students through its quality control services to Maine’s growing craft beverage industry. QC2 supports this important economic sector while educating both students and the industry on the science of their craft. With QC2, not only do Maine brewers have a world-class lab to test their beers, but the lab is staffed by students who gain hands-on experience that yields real-world results. Coupled with an internship program, this helps Maine’s brewing industry develop a future workforce.

Rumford native Liza White knows the importance of paper mills to rural communities. As a UMaine undergraduate, she heard about associate professor Caitlin Howell’s research with Sappi North America to explore new, innovative uses of paper to meet biomedical needs. Finding next-gen products to help the pulp and paper industry was important to the first-generation university student from a Maine mill town. White plans to turn her years of industry-related R&D research as an undergraduate and now a Ph.D. student into a career when she graduates in 2025.

## Innovative technologies in a heritage industry

Sappi North America and UMaine biomedical engineer Caitlin Howell and her research partners are collaborating to link Maine’s strength in papermaking technology with the cutting-edge needs of the biotechnology industry. The result is “a new set of tools” for the bioscience sector and potential markets for a heritage industry. The paper-based innovations, which are lightweight and cost-effective, and can be rapidly mass produced, include a microfluidic water purification system, diagnostic microfluidic devices at the microdroplet scale, and surface contamination detection instruments.



Collaboration with UMaine on innovative, paper-based solutions brings **fresh insight, providing critical technical validation and access to market-demanded applications** that leverage the nanoscale texturing capability of Sappi’s Ultracast® paper manufacturing process.”

Mark Hittie  
Sappi Director of Release Business Strategy







Maine's land grant university has a long history of research to benefit the wild blueberry industry statewide. Now, a one-of-a-kind, three-acre research and education site has been established at UMaine. The new Wyman's Wild Blueberry Research and Innovation Center features plots controlled for genotype, akin to research traditionally conducted in orchards or row crops. The center will provide opportunities to develop innovative production techniques and the next generation of wild blueberry industry leaders.



Our collaboration with UMaine over the last two years has allowed Tanbark to **better understand the fiber processing we will need to meet our customer needs** and produce prototypes to enable us to move more quickly to market."

Melissa LaCasse  
CEO, Tanbark Molded Fiber Products

## Prototyping eco-friendly packaging

Tanbark Molded Fiber Products in North Yarmouth is a new company that is introducing packaging to replace plastic materials with innovative and custom solutions made from plant fiber, with a focus on Maine wood fiber. Tanbark reached out to UMaine and the Process Development Center (PDC) to access expertise and equipment for testing molded fiber recipes. In addition, PDC has helped support the growth of Portland's LaCasse & Weston, a producer of molded fiber machinery.



Having the hatchery seed is way more sustainable than wild seed, as well as the perks of selecting and introducing a new gold mussel to the markets. Can't wait to see **what's next for the whole Maine mussel industry** with hatchery seed."

Evan Young  
Owner, Blue Hill Bay Mussels LLC



## Sustainably growing for gold

Downeast Institute in Beals, the marine science field station for the University of Maine at Machias, has worked with Blue Hill Bay Mussels to develop methods to supplement Maine mussel farms with hatchery seed to maximize production, making the farms more resilient. Ropes can be seeded either with traditional blue mussels or the distinctive gold-striped mussels that Downeast Institute selectively bred to create a unique Maine product. Investment in hatchery-based mussel seed has had major implications for farms, allowing them to provide more product for a growing market without depleting the wild fishery.

In the past decade, the UMaine potato breeding program, in partnership with the Maine Potato Board, has released five new varieties — Easton, Sebec, Caribou Russet, Pinto Gold and Hamlin Russet — that had the competitive yield and quality attributes necessary to move them from the laboratory to market shelves. Nationally, varieties released by UMaine and its eastern regional collaborators were grown on 7,369 seed acres during 2021 with an approximate seed value of \$25.8 million and potential ware production value of \$239.4 million.





## MEIF Small Campus Initiative

The Small Campus Initiative (SCI) is an MEIF competitive grant program that helps to build capacity for research and development in the state at the Universities of Maine at Augusta, Farmington, Fort Kent, Machias and Presque Isle, and Maine Maritime Academy.

Funded projects:

- Statewide mapping of intertidal seaweeds using drones (MMA)
- ME MADE: Makerspaces for Abilities Driving Entrepreneurship (UMF)
- Using remote sensing data to assess forest health (UMFK)
- Applied R&D to promote shellfish aquaculture (UMaine Machias)
- Distributed machine learning approaches for big data analysis (UMPI)
- Modernization the medical laboratory technologist program (UMA)
- Developing the “next-generation environmental scientist” through eDNA community-based biomonitoring (MMA)
- Using high-frequency sensors to track water clarity and seasonal change in Maine lakes (UMF)
- Cybersecurity range and scenario builder (UMA)



Boldly increasing investment in University of Maine System R&D is **essential to achieving a vibrant and sustainable economy for Maine**, and consistent with the Growth Council’s long-standing recommendation to triple Maine’s R&D spending by 2030.”

Stephen Von Vogt  
Co-Chair, Maine Economic Growth Council

## Our goals:

### Generate co-investment

For every \$1 in MEIF funding, the University of Maine System leverages \$6 in co-investment for projects in the seven sectors.

### Establish and grow partnerships

University of Maine System R&D initiatives partner with Maine companies and communities to support the economy statewide.

### Focus on workforce development

MEIF project funds support undergraduate and graduate students in hands-on, real-world problem-solving in career pathways.

R1 — UMaine is in the top 146 of research universities nationwide	Maine spends 1% of GDP on R&D, compared to 3% nationwide and 4.8% in New England	“State government can double its investment in R&D annually without running out of viable projects.”  Making Maine Work (2022)
Maine ranks 44th of the 50 states for R&D spending as percent of GDP	MDF Measures of Growth has set a goal of Maine tripling its R&D spending by 2030	

# Progress in FY2022: Strategic Outcomes, Goals and Metrics

In December 2018, the University of Maine System Board of Trustees issued a Declaration of Strategic Priorities, the first of which is Advancing Workforce Readiness and Economic Development, with a priority action item: Strengthen research and economic development efforts to support Maine industries, and to foster business formation and expansion. The five-year University of Maine System Research and Development Plan was approved in the Spring of 2019 with three specific goals that drive the UMS research activities including the Maine Economic Improvement Funds.

**Goal One** – Make Maine the best state in the nation in which to live, work, and learn by 2030

**Goal Two** – Establish an innovation-driven Maine economy for the 21st century

This report addresses these goals. In addition, the University of Maine System reports R&D outcomes annually through the statutorily required survey of Maine R&D activity administered by the Maine Department of Economic and Community Development Office of Innovation (5 MSRA 13107).

The R&D Strategic Outcomes and related MEIF goals are:

## MEIF Metric 1: Increase Research Capacity and Activity

UMS maintains a sponsored programs grant and contracts effort growing greater than 3 percent annually on a three-year rolling average from a 2013 baseline of \$45 million and NSF-defined total research expenditures of \$45 million in the MEIF sectors. Activity from the seven MEIF sectors will account for 50 percent of the total R&D grants and contracts, with a 3 percent annual growth on a three-year rolling average. The utilization of MEIF funds will leverage other resources including grants and contracts from the federal government and the private sector increasing the impact of the State's investment.

**Goal Three** – Prepare the knowledge-and-innovation workforce for Maine

The the following metrics help measure the progress against these goals and recognize that MEIF activity is restricted to Maine's legislatively selected seven R&D sectors.

**UMS MEIF Metric 1** – Increase Research Capacity and Activity

**UMS MEIF Metric 2** – Support New Technologies, Licensing, and Commercialization

**UMS MEIF Metric 3** – Increase Economic Development Partnerships

**UMS Metric 4** – Support R&D Workforce Development

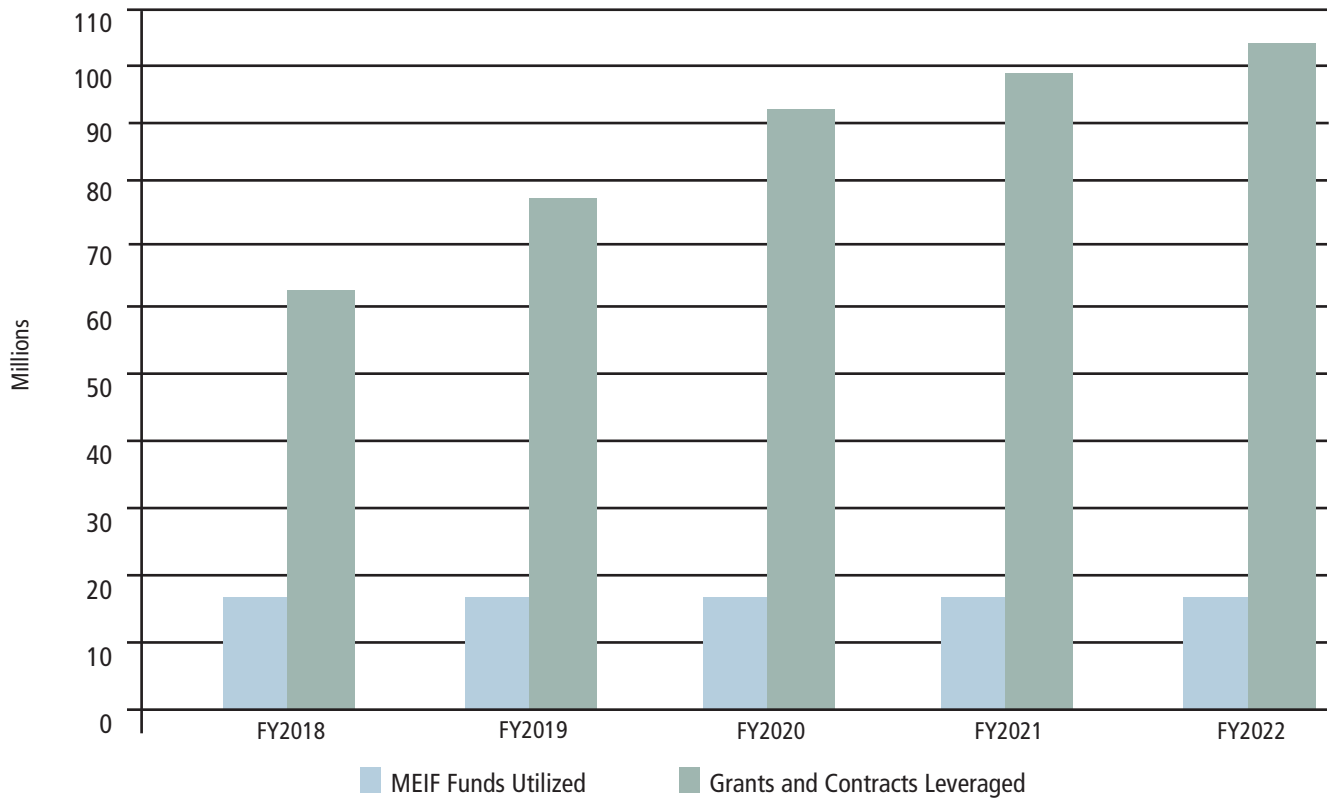
**Table 1**

<b>FY2022 Total Grants and Contracts (ALL Activity Inclusive)</b>	<b>Number of Proposals UM/UMM</b>	<b>Total Value UM/UMM</b>	<b>Number of Proposals USM</b>	<b>Total Value USM</b>	<b>Number of Proposals ALL</b>	<b>Total Value ALL</b>
Total Proposals Submitted	860	\$340,577,483	194	\$45,985,080	1,054	\$386,562,563
Total Proposals Awarded	673	\$111,714,024	139	\$44,055,328	812	\$155,769,352

### Grants and Contracts Awarded in MEIF Sectors Only

	<b>FY2018 MEIF Awards</b>	<b>FY2019 MEIF Awards</b>	<b>FY2020 MEIF Awards</b>	<b>FY2021 MEIF Awards</b>	<b>FY2022 Detail</b>		
	<b>UM/UMM MEIF Awards</b>				<b>UM/UMM MEIF Awards</b>	<b>USM MEIF Awards</b>	<b>Total USM MEIF Awards</b>
Aquaculture and Marine	16,032,068	8,084,961	8,698,761	10,773,253	14,785,311	1,842,250	\$16,627,560.880
Biotechnology	6,552,964	16,035,473	14,611,906	8,329,631	3,563,134	0	\$3,563,134.300
Composites	9,952,947	11,478,611	31,093,652	38,754,403	31,623,591	0	31,623,591.180
Cross Sector	3,034,812	21,301,337	2,783,430	5,659,119	19,056,121	1,029,650	20,085,771.350
Environmental Technologies	7,407,213	7,250,820	7,466,987	11,608,954	6,752,744	374,416	7,127,160.000
Forestry and Agriculture	10,685,631	9,598,475	17,624,566	15,611,749	13,268,251	133,948	13,402,198.710
Information Tech	5,582,266	951,594	7,069,113	6,686,372	6,999,513	670,953	7,670,466.260
Precision Manufacturing	3,099,123	1,870,527	3,077,779	1,158,472	2,454,483	3,314	2,457,797.200
<b>Total</b>	<b>\$62,347,023</b>	<b>\$76,571,798</b>	<b>\$92,426,194</b>	<b>\$98,581,953</b>	<b>\$98,503,149</b>	<b>\$4,054,531</b>	<b>\$102,557,680</b>
							<b>FY2021–FY2022 Increase 4%</b>

**Figure 1 FY2018-2022 MEIF Return on Investment 5.9:1 (UMS)**  
Tens of Millions Leveraged in Grants and Contracts (Five-Year Snapshot)





## MEIF Metric 2: Support New Technologies, Licensing, and Commercialization

UMS annual revenue from commercialization including intellectual property licensing from the MEIF sectors increases at least 10 percent annually on a three-year rolling average.

**Table 2**

MEIF Target 2 — Commercialization Activity	FY2018	FY2019	FY2020	FY2021	FY2022	Five-Year Average
Revenue from Commercialization	\$914,120	\$289,088	\$519,019	\$299,430	\$474,190	\$499,170
Rolling three year average	\$482,890	\$511,016	\$574,076	\$369,179	\$430,880	\$473,608
Number of Patents Filed (US/PCT)	20	17	16	23	16	18
Number of Patents Issued (US)	6	6	11	7	3	10
Number of License Agreements and License Options	9	11	8	4	2	7

**FY2021–FY2022 Change in Three-Year Average Revenue 17%**

In summary, three-year rolling average revenue from commercialization has shown an overall increase over the last decade, rebounding the last fiscal year from a pandemic-related decline in FY21. Commercialization relies on private companies utilizing UMS intellectual property to secure private investment to advance technology, products and services into markets. Maine continues to rank very low in comparison to other states for its industry R&D and innovation. This has been recognized by the state economic development agencies and is addressed in the 2020 Maine Economic Development Strategy. The pandemic has greatly impacted the startup and new venture community, yet activity is starting to return.

The timeline for commercialization of newly invented technology is hard to predict, but it is lengthy. U.S. patent applications take four to five years from initial application to issuance. Newly issued UMS patents reported above and detailed in Appendix 1 were filed four to five years ago. In addition, many UMS technologies fall into capital-intensive categories, such as transportation infrastructure, pulp and paper, sensors and biotechnology.

These sectors have longer timelines from lab to market at five to 10 years. UMS is focusing additional effort to accelerate commercialization with private-sector partners and other investment programs, such as the Maine Technology Institute and Maine Venture Fund.

## MEIF Metric 3: Increase Economic Development Partnerships

The UMS annual revenue from activities with business and industrial partners in the MEIF sectors continues to show the effects of reduced activity during the pandemic. Revenue in FY2022 was \$6,611,197, a decrease of approximately 31 percent. Companies continue to confront supply chain challenges and over the past several years have not prioritized research and development. We are already beginning to see a positive shift in these numbers for FY23 and expect this trend to continue.

**Table 3**

MEIF TARGET 3 — Business and Industry Contracts	FY2018	FY2019	FY2020	FY2021	FY2022
Revenue from Business and Industrial Contracts	\$6,339,260	\$7,211,422	\$10,876,661	\$9,581,790	\$6,611,197
Number of Business and Industrial Contracts	528	530	327	390	293

**FY2021–FY2022 Change in Revenue -31.00%**

## MEIF Metric 4: Support R&D Workforce Development

UMS shall maintain a concerted effort to involve faculty, staff and students participating in research, development and commercialization, and shall report annually the number of employees directly supported by MEIF funds and by grants and contracts in the MEIF sectors. As external funding is hard to predict, there is no specific numerical goal for employee count, but UMS shall report the annual number of faculty, staff and students to indicate trends and identify opportunities for growth.

In summary, state economic analysis predicts economic growth in Maine based on an available trained and educated workforce. Growth in the seven MEIF sectors is especially dependent on the available workforce. MEIF seven-sector projects at UMS rely on regular faculty and staff, as well as many “soft money” employees — those hired to work on specific grants and contracts, and paid by those grant and contract funds. UMS employees and students gain valuable on-the-job training and experience, and may then contribute to the employment base within these sectors after completion of the grants or graduation. Grant and contract revenue is a strong contribution to this workforce development. UMS counts employees involved in this activity, and will continue to pursue the growth in employment numbers related to growth in grant and contract activity. Non-student employees are tracked as full-time equivalents (FTEs) based on a 40-hour/52-week work year. Student employees, tracked by head count, generally work fewer than 20 hours per week during the academic year.

Grant and contract revenue also is an important source of funding for students’ salary, tuition and other types of support, allowing many research-active students to offset their cost of education while getting valuable skills and on-the-job experience, positioning them well to be leading contributors to Maine’s key growth sectors.

### Success and Strategic Impact

By investing MEIF funds in researchers, facilities and matching for grants, UMS has attracted more than \$432 million over the last five years (FY2018-2022) in federal and private-sector grants and contracts related to the seven strategic research areas. This funding directly results in Maine products and technologies, such as biofuels, pulp and paper products, biomaterials and bridges, new potato varieties, aquaculture technologies, offshore wind hulls, and software, which lead to improvements in Maine’s industries.

### Return on Investment

Each year, the power of the state’s MEIF appropriation is expanded by tens of millions of dollars in federal and private funds for important research, development and commercialization. The University of Maine, as the state’s land grant, sea grant, and space grant institution, utilizes its long-established research capacity and infrastructure to attract the majority of these external funds. Other UMS schools continue to build and partner within federal and private-sector grants and contracts.

### Developing Workforce and Creating Jobs

Five hundred plus full-time equivalent jobs are funded in Maine through the grants and contracts leveraged and expended related to MEIF. These positions include faculty, technicians and research staff. Currently, 1,297 graduate and undergraduate students are funded for their involvement in research, development and commercialization. This student involvement in research, development and commercialization projects is comparable to an internship and gives students great real-world experience as well as life-long networks and connections.

**Table 4-A FY2022**

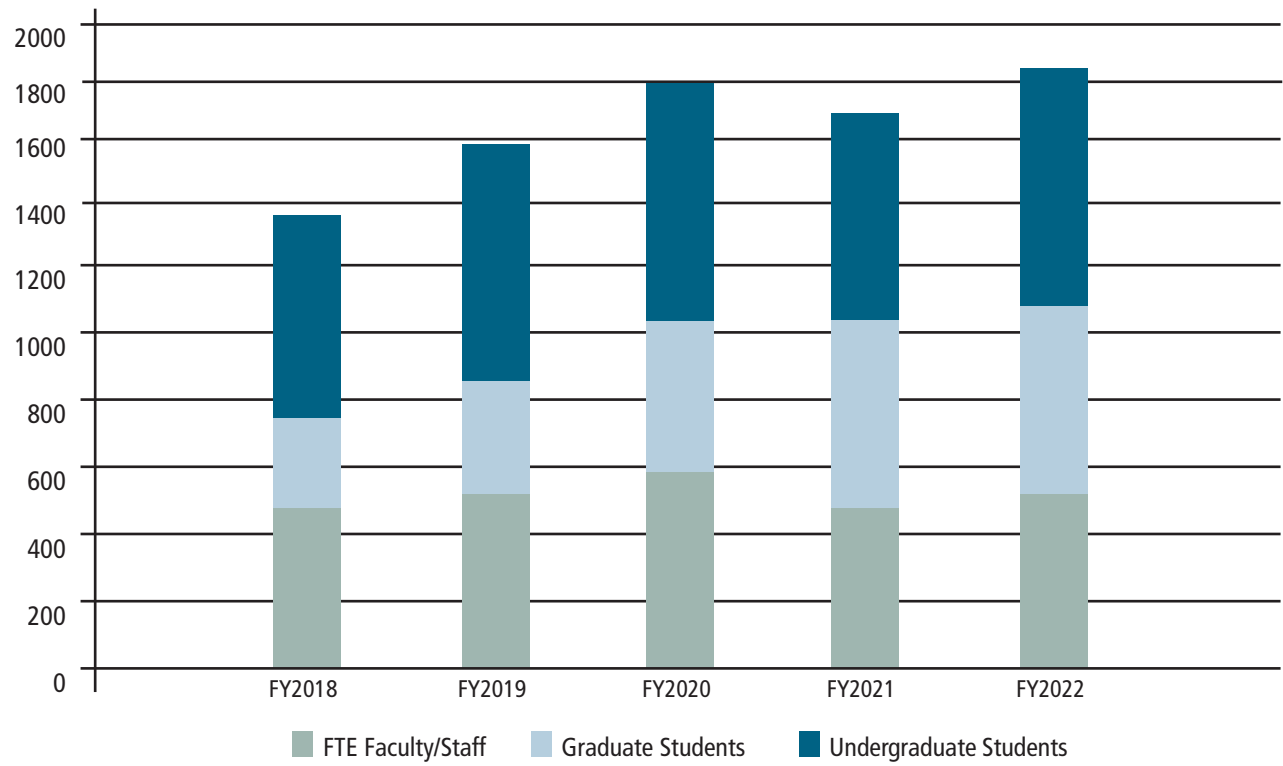
MEIF Target 4 — Workforce Development	Wages paid from MEIF	Wages paid from Grant/Contract	Totals
Number of faculty staff supported (FTE = Full Time Equivalent)	155	390	545
Number of Graduate students supported (headcount)	26	503	529
Number of Undergraduate students supported (headcount)	641	127	768

**Table 4-B**

Student costs from grants and contracts	FY2018	FY2019	FY2020	FY2021	FY2022
Student salaries and wages paid from grants and contracts	\$4,853,956	\$6,361,381	\$6,869,073	\$7,559,179	\$8,894,320
Student tuition paid by grants and contracts	795,339	916,618	1,384,425	\$1,306,089	\$1,344,309
Student fellowships/scholarships paid by grants and contracts	373,118	457,884	422,111	\$799,695	\$1,106,195
Student health insurance paid by grants and contracts	214,000	298,386	296,807	\$308,195	\$364,577
<b>Total soft money student support</b>	<b>\$6,264,840</b>	<b>\$6,236,413</b>	<b>\$8,034,269</b>	<b>\$9,973,158</b>	<b>\$11,709,401</b>

FY2021–FY2022 Change 17%

Figure2 MEIF Sector Workforce





### MEIF Small Campus Initiative

In 2009, the University of Maine System established the Small Campus Initiative Fund to promote seven-sector research and development activity at the other five UMS campuses and, as of 2013, Maine Maritime Academy (MMA).

**Table 5-A**

MEIF Small Campus Initiative Awards by Fiscal Year	FY2018	FY2019	FY2020	FY2021	FY2022
UM – Augusta	\$0	\$85,129	\$0	\$25,000	\$150,000
UM – Farmington	\$0	\$0	\$300,000	\$0	\$74,774
UM – Fort Kent	\$182,500	\$0	\$130,000	\$24,899	\$0
UM – Machias	\$300,000	\$300,000	\$0	\$250,000	\$175,000
UM – Presque Isle	\$182,500	\$0	\$0	\$168,474	\$0
Maine Maritime Academy	\$0	\$49,934	\$130,000	\$0	\$199,623
<b>Total Annual Awards</b>	<b>\$665,000</b>	<b>\$435,063</b>	<b>\$560,000</b>	<b>\$468,373</b>	<b>\$599,397</b>

**Table 5-B FY2022**

Title	PI(s)	Campus	Amount
Cyber Range Network Builder & Scenario Builder	Henry Felch	UMA	\$150,000
Using high-frequency sensors to track water clarity and seasonal change in Maine lakes	Rachel Hovel	UMF	\$74,774
Applied Research and Development to Foster Economic Growth in Maine's Shellfish Aquaculture Industry	Brian Beal	UMM	175,000
Growing the 'next-generation environmental scientist' by applying imaging flow cytometry and eDNA/qPCR technologies to community-based biomonitoring	Steven Baer	MMA	199,623
			<b>\$599,397</b>

- The Cyber Range Network Builder & Scenario Builder is evaluating the cybersecurity posture of Maine companies and organizations, modeling their networks, and providing training to help them defend against threats.
- Mountain lakes are an important natural laboratory to understand the factors underlying why Maine lake water clarity is changing. Using sensors and regular water sampling, researchers are collecting multiple parameters of high-frequency data from Maine mountain lakes to inform drivers of lake water clarity and training undergraduate students in skillsets essential to careers in environmental technology, including using state-of-the-art environmental sensors and coding to manage and analyze large datasets.
- To support the growth of shellfish aquaculture in Maine, researchers are investigating the efficacy of using multiple-trait genomic selection tools to create a strain of fast-growing eastern oysters and to develop hatchery methods to produce a consistent supply of cultured flat oyster seed that can be transferred to commercial hatcheries to supply Maine farmers.
- Using cutting-edge fluid imaging cytometry and qPCR instrumentation to contribute to biological monitoring in the Gulf of Maine while training the next generation of environmental scientists.

## Appendix 1 — University of Maine System Intellectual Property

Table A1-1

### University of Maine System — New Patent Applications Filed FY2022

Title	Application Type	Filing Date	Inventor	Campus
METHODS AND SYSTEMS FOR AUGMENTING AND/OR SIMULATING FLAVORS	PCT	7/23/21	Jonathan Roman Bland; Michael Gecawicz; R A Nimesha Ranasinghe; Meetha-Nesam James-Ravindran-Santhakumar	Orono
FLOATING WIND TURBINE PLATFORM	United States	7/23/21	Habib Joseph Dagher; Anthony M Viselli	Orono
CELLULOSE NANOFIBER (CNF) STABILIZED MEMBRANES AND METHODS OF MAKING THEREOF	United States	8/5/21	Michael D Mason ; Muhammad Radowan Hossen	Orono
SORTING OF POLY-DISPERSE PARTICLES	United States	9/7/21	Akm Bashir Khoda ; S M Abu Naser Shovon; Adeeb Ibne Alam; MD Ibrahim Khalil	Orono
SYSTEMS AND METHODS FOR DETERMINING WATER CONTENT IN A SAMPLE	PCT	9/13/21	Sfoog Hamad Saleh; Carl P Tripp	Orono
HEEL TANK DAMPER FOR FLOATING STRUCTURES	United States	9/27/21	Andrew Joseph Goupee; Habib Joseph Dagher; Anthony M Viselli; Christopher Keefer Allen; Richard Warren Kimball	Orono
ELECTRICALLY CONTROLLABLE SURGICAL TOOLS	United States	1/19/22	Robert Ecker; Mohsen Shahinpoor	Orono
FOLDABLE PHYSICAL STRUCTURES HAVING KINEMATIC CAPABILITY	United States	2/28/22	Anthony Michael Verzoni; Masoud Rais-Rohani	Orono
FOLDABLE THICK WALLED STRUCTURES	United States	2/28/22	Scott Tomlinson; Anthony Michael Verzoni; Masoud Rais-Rohani; Alexander James Cole	Orono
CEMENT COMPOSITIONS, AND METHODS THEREOF	PCT	3/11/22	Warda Ashraf; Hemant P Pendse	Orono
ACTIVE COLOR-CHANGING LIQUID CRYSTAL FILAMENT AND YARN	PCT	3/15/22	David Erb, Christopher Erb	Orono
ADJUNCTIVE TREATMENT OF MYCOBACTERIAL DISEASES	United States	3/22/22	Peter Woodruff ; Hyungjin Eoh; Ben Swarts	USM
CARBON ELECTRODE FOR PROTONIC CERAMIC ELECTROCHEMICAL CELLS	United States	5/18/22	Yingchao Yang, Min Wang	Orono
CONTINUOUS FORMING MACHINE	United States	5/27/22	William Glenn Davids; Roberto A Lopez-Anido; Cody Alexander Sheltra; Zane Dustin	Orono
DIGITAL MANUFACTURING FACILITY AND METHOD OF MANUFACTURING	United States	6/1/22	Habib Joseph Dagher	Orono
COMPOSITIONS AND METHODS FOR TOXIC SPECIES REMOVAL FROM FLUID	PCT	6/15/22	Islam H Hafez; Md Musfiquir Rahman	Orono
<b>Total 16</b>				

Table A1-2

University of Maine System — Patents Issued FY2022

Title	Country	Type	Patent Number	Issue Date
AF4124-7 Hamlin Russet	United States	Plant Variety	202100199	3/10/22
MOTION ABSORBING SYSTEM AND METHOD FOR A STRUCTURE	United States	CIP	11279452	3/22/22
METHOD OF ASSEMBLING A FLOATING WIND TURBINE PLATFORM	United States	Divisional	11352098	6/7/22
Total Issued				20
United States				3
International				17
The above table lists US Patents Only				



## Appendix 2 — Maine Economic Improvement Fund Financial History and Tables

Table A2-1

### A History of Legislative Actions on Appropriating State Research Funds

The following is a summary of the actions of the 118th–130th Maine Legislature with regard to appropriating research and development funds to the University of Maine System.

#### 118th LEGISLATURE

**March 26, 1997:** Governor signed into law the Economic Improvement Strategy (Chapter 24) that appropriated \$500,000 to UMS for research.

**April 1, 1998:** Governor signed into law the Economic Improvement Strategy (Chapter 643, Part LL, Sec. S-3) that appropriated \$4 million to UMS for research. These funds were allocated from the FY1998 year-end state surplus for use in FY1999.

#### 119th LEGISLATURE

**March 15, 1999:** Governor signed into law the Part I Current Services budget (Chapter 16) that appropriated \$4 million in 1999–2000 and 2000–01 to UMS on a “base budget” basis for research. This extends the one-time FY1999 \$4 million research appropriation that was funded from the FY1998 year-end state surplus.

**June 4, 1999:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 401) that appropriated an additional \$5.55 million in 1999–2000 and an additional \$50,000 in 2000–01 to UMS on a “base budget” basis for research.

**April 25, 2000:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 731) that appropriated \$300,000 in 2000–01 to UMS on a “base budget” basis for the Maine Patent Program.

#### 120th LEGISLATURE

**June 21, 2001:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 439) that appropriated an additional \$2 million in 2002–03 to UMS on a “base budget” basis for research.

**March 25, 2002:** Governor signed into law a deappropriation (Chapter 559) that reduced the FY2003 \$2 million Supplemental Appropriation by \$1 million.

**July 1, 2002:** Governor signed a Financial Order that curtailed the FY2003 \$2 million Supplemental Appropriation by an additional \$1 million. This eliminated the FY2003 increase of \$2 million for research, bringing the FY2003 research and development appropriation back to the FY2002 level of \$10.1 million.

**November 18, 2002:** Governor signed into law a Supplemental Appropriation budget (Chapter 714) that deappropriated the \$1 million curtailment that was signed July 1, 2002.

#### 121st LEGISLATURE

**March 27, 2003:** Governor signed into law the Part I Current Services budget (Chapter 20, Part RR) that appropriated \$100,000 in 2003–04 and 2004–05 on a “base budget” basis for research.

**January 30, 2004:** Governor signed into law a Supplemental Appropriation budget (Chapter 513, Part P, Sec. P-2) that includes a provision to transfer to MEIF up to \$2 million of any unbudgeted State revenue remaining at the close of FY2004. The full amount was subsequently transferred to UMS. This same Chapter 513, Part P, Sec. P-3 made the \$2 million part of the MEIF FY2005 base appropriation.

#### 122nd LEGISLATURE

**March 29, 2006:** Governor signed into law a Supplemental Appropriations budget (Chapter 519, Part A, Sec. A-1) that includes providing one-time funding of \$600,000 in FY2007 for the commercialization of research and development activity, and for the Gulf of Maine Ocean Observing System.

#### 123rd LEGISLATURE

**June 7, 2007:** Governor signed into law a budget (Chapter 240, Part A, Sec. A-68) that provides an increase of \$1.5 million in FY2008 and an additional \$1 million in FY2009 on a “base budget” basis for research.

#### 124th LEGISLATURE

**May 28, 2009:** Governor signed into law a budget (Chapter 213, Part A, Sec. A-67) that maintains the annual funding at the FY2009 level of \$14.7 million.

#### 125th LEGISLATURE

**June 15, 2011:** Governor signed into law a budget (Chapter 380) that maintains the annual funding at \$14.7 million. May 29, 2012: PUBLIC Law (Chapter 698) creates the formula funding for the Small Campus Initiative, reserving a percentage of MEIF exclusively for the five smaller campuses of the University of Maine System.

#### 126th LEGISLATURE

**June 10, 2013:** Governor signed into law (Chapter 225) an amendment to the MEIF statute to include Maine Maritime Academy as a MEIF-eligible small campus.

**June 26, 2013:** Legislature approved into law a budget (Chapter 368) that maintains the annual funding at \$14.7 million.

#### 127th LEGISLATURE

**June 30, 2015:** Legislature approved into law a budget (Chapter 267) that increases the annual funding by \$2.65 million in each year of the biennium.

#### 128th LEGISLATURE

**July 4, 2017:** Governor signs into law the state budget that maintains the annual funding at \$17.35 million.

#### 129th LEGISLATURE

**June 17, 2019:** Governor signs into law the state budget that maintains the annual funding at \$17.35 million.

#### 130th LEGISLATURE

**July 1, 2021:** Governor signs into law the state budget that maintains the annual funding at \$17.35 million.

**April 20, 2022:** Governor signs into law the state supplemental budget that increases annual MEIF funding by \$2 million to an annual total of \$19.35 million.

Table A2-2

## Legislative History of MEIF New Appropriations

<b>118th LEGISLATURE</b>	<b>FY98</b>	<b>FY99</b>	<b>Total 2-Year</b>
UM	\$400,000	\$400,000	\$3,200,000
USM	100,000	100,000	800,000
<b>Total</b>	<b>\$500,000</b>	<b>\$500,000</b>	<b>\$4,000,000</b>
<b>119th LEGISLATURE</b>	<b>FY00</b>	<b>FY01</b>	<b>Total 2-Year</b>
UM	\$4,440,000	\$40,000	\$4,480,000
USM	1,110,000	10,000	1,120,000
<b>Total</b>	<b>\$5,550,000</b>	<b>\$50,000</b>	<b>\$5,600,000</b>
<b>120th LEGISLATURE</b>	<b>FY02</b>	<b>FY03</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>121st LEGISLATURE</b>	<b>FY04</b>	<b>FY05</b>	<b>Total 2-Year</b>
UM	\$80,000	\$1,600,000	\$1,680,000
USM	20,000	400,000	420,000
<b>Total</b>	<b>\$100,000</b>	<b>\$2,000,000</b>	<b>\$2,100,000</b>
<b>122nd LEGISLATURE</b>	<b>FY06</b>	<b>FY07</b>	<b>Total 2-Year</b>
UM	\$0	\$540,000	\$540,000
USM	0	60,000	60,000
<b>Total</b>	<b>\$0</b>	<b>\$600,000</b>	<b>\$600,000</b>
*One-time funding			
<b>123rd LEGISLATURE</b>	<b>FY08</b>	<b>FY09</b>	<b>Total 2-Year</b>
UM	\$1,200,000	\$720,000	\$1,920,000
USM	300,000	180,000	480,000
INITIATIVES	0	100,000	100,000
<b>Total</b>	<b>\$1,500,000</b>	<b>\$1,000,000</b>	<b>\$2,500,000</b>
<b>124th LEGISLATURE</b>	<b>FY10</b>	<b>FY11</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
INITIATIVES	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>125th LEGISLATURE</b>	<b>FY12</b>	<b>FY13</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
INITIATIVES	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

<b>126th LEGISLATURE</b>	<b>FY14</b>	<b>FY15</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
INITIATIVES	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>127th LEGISLATURE</b>	<b>FY16</b>	<b>FY17</b>	<b>Total 2-Year</b>
UM	\$2,056,400	\$0	\$2,056,400
USM	514,100	0	514,100
INITIATIVES	79,500	0	79,500
<b>Total</b>	<b>\$2,650,000</b>	<b>\$0</b>	<b>\$2,650,000</b>
<b>128th LEGISLATURE</b>	<b>FY18</b>	<b>FY19</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
INITIATIVES	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>129th LEGISLATURE</b>	<b>FY20</b>	<b>FY21</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
INITIATIVES	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>130th LEGISLATURE</b>	<b>FY22</b>	<b>FY23</b>	<b>Total 2-Year</b>
UM	\$0	\$0	\$0
USM	0	0	0
INITIATIVES	0	2,000,000	2,000,000
<b>Total</b>	<b>\$0</b>	<b>\$2,000,000</b>	<b>\$2,000,000</b>

#### **Total Yearly Research Appropriations for FY2022**

UM	\$13,263,600
USM	3,315,900
UMM	250,000
UMFK	0
UMA	0
UMPI	0
UMS	520,500
MMA	0
<b>Total</b>	<b>\$17,350,000</b>

<b>Small Campus Initiatives</b>	<b>S.C. Initiatives</b>
University of Maine at Augusta	UMA
University of Maine at Farmington	UMF
University of Maine at Fort Kent	UMFK
University of Maine at Machias	UMM
University of Maine at Presque Isle	UMPI
Maine Maritime Academy	MMA



Table A2-3 Maine Economic Improvement Fund

## Utilization of FY2022 Operating Research Appropriation by Targeted Research Areas

Targeted Research Area	Source of R&D Funds						Utilization of R&D Funds				Balance
	FY2022 R&D Initial Base Budget	Unused R&D Funds from Prior Years As Reported	Adjustment to Prior Years Unused R&D Funds	Adjusted Unused R&D Funds from Prior Years	FY2022 R&D Funding Transfers	FY2022 Total R&D Funds Available	FY2022 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2023 <sup>1</sup>
Adv. Technology Forestry & Agriculture	\$1,810,262	\$(798,995)	\$-	\$(798,995)	\$-	\$1,011,267	\$2,531,001	\$122,728	\$(1,062,155)	\$1,591,574	\$(580,307)
Aquaculture & Marine Science	2,499,453	(892,904)	-	(892,904)	-	1,606,549	2,874,755	615,614	(1,366,959)	2,096,410	(489,861)
Biotechnology	1,357,411	(814,316)	-	(814,316)	-	543,095	1,642,960	284,507	(593,587)	1,333,880	(790,785)
Composites	1,541,320	66,559	-	66,559	-	1,607,879	2,361,793	753,363	(1,151,451)	1,963,705	(355,826)
Environmental	1,589,518	(175,715)	-	(175,715)	-	1,413,803	2,244,280	244,197	(949,900)	1,538,577	(124,774)
Information Technology	1,471,246	(580,300)	-	(580,300)	-	890,946	2,319,356	54,948	(812,745)	1,561,559	(670,613)
Precision Manufacturing	1,586,896	446,253	-	446,253	-	2,033,149	2,125,149	39,732	(805,791)	1,359,090	674,059
Cross Sector	1,407,494	(74,137)	-	(74,137)	-	1,333,357	1,472,633	182,937	(533,661)	1,121,909	211,448
<b>Total State Funding</b>	<b>\$13,263,600</b>	<b>\$(2,823,555)</b>	<b>\$-</b>	<b>\$(2,823,555)</b>	<b>\$-</b>	<b>\$10,440,045</b>	<b>\$17,544,927</b>	<b>\$2,298,026</b>	<b>\$(7,276,249)</b>	<b>\$12,566,704</b>	<b>\$(2,126,659)</b>
UM Cost Sharing Funding <sup>2</sup>	-	-	-	-	-	-	-	-	7,276,249	7,276,249	(7,276,249)
<b>Total Funding</b>	<b>\$13,263,600</b>	<b>\$(2,823,555)</b>	<b>\$-</b>	<b>\$(2,823,555)</b>	<b>\$-</b>	<b>\$10,440,045</b>	<b>\$17,544,927</b>	<b>\$2,298,026</b>	<b>\$-</b>	<b>\$19,842,953</b>	<b>\$(9,402,908)</b>

<sup>1</sup>Includes year-end equipment carry-over funds (equipment ordered, not received, and not paid).

<sup>2</sup>Salary and benefits from University.

Targeted Research Area	Source of R&D Funds						Utilization of R&D Funds				Balance
	FY2022 R&D Initial Base Budget	Unused R&D Funds from Prior Years As Reported	Adjustment to Prior Years Unused R&D Funds	Adjusted Unused R&D Funds from Prior Years	FY2022 R&D Funding Transfers <sup>3</sup>	FY2022 Total R&D Funds Available	FY2022 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2023 <sup>1,2</sup>
Forestry & Agriculture	\$510,760	\$150,611	\$-	\$150,611	\$-	\$661,371	\$480,482	\$85,022	\$-	\$565,504	\$95,867
Aquaculture & Marine	348,563	346,080	-	346,080	8,575	703,218	430,903	-	-	430,903	272,315
Biotechnology	227,920	39,534	-	39,534	10,174	277,628	245,488	-	-	245,488	32,140
Composites	50,000	(21,059)	-	(21,059)	29,325	58,266	57,211	-	-	57,211	1,055
Environmental	100,000	23,841	-	23,841	-	123,841	20,664	-	-	20,664	103,177
Information Technology	524,253	282,516	-	282,516	90	806,859	453,074	72,281	-	525,355	281,504
Precision Manufacturing	100,000	(74)	-	(74)	30	99,956	20,207	20,000	-	40,207	59,749
Cross Sector	1,454,404	431,687	-	431,687	-	1,886,091	1,169,916	-	-	1,169,916	716,175
Unassigned	-	267,440	-	267,440	(48,194)	219,246	-	-	-	-	219,246
<b>Total State Funding</b>	<b>\$3,315,900</b>	<b>\$1,520,576</b>	<b>\$-</b>	<b>\$1,520,576</b>	<b>\$-</b>	<b>\$4,836,476</b>	<b>\$2,877,945</b>	<b>\$177,303</b>	<b>\$-</b>	<b>\$3,055,248</b>	<b>\$1,781,228</b>

<sup>1</sup>Includes year-end equipment carry-over funds (equipment ordered, not received, and not paid).

<sup>2</sup>At USM, projects are funded on a year to year basis with renewals contingent on performance. A majority of the unused funds carried forward into FY23 are committed to multi year projects.

<sup>3</sup>Transfers for current year funding of USM R&D programs and awards from "Unassigned". UM base budgets the MEIF appropriation by sector and thus does not use funding transfers.

Table A2-4 Maine Economic Improvement Fund

## FY2022 Summary Utilization of Operating Research Appropriation by University

Targeted Research Area	Source of R&D Funds					Utilization of R&D Funds				Balance	
	FY2022 R&D Initial Base Budget	Unused R&D Funds from Prior Years As Reported	Adjustment to Prior Years Unused R&D Funds	Adjusted Unused R&D Funds from Prior Years	FY2022 R&D Funding Transfers <sup>3</sup>	FY2022 Total R&D Funds Available	FY2022 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts <sup>2</sup>	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2023 <sup>1</sup>
UMAINE	\$13,263,600	\$(2,823,555)	\$-	\$(2,823,555)	\$-	\$10,440,045	\$17,544,927	\$2,298,026	\$(7,276,249)	\$12,566,704	\$(2,126,659)
USM	3,315,900	1,520,576	-	1,520,576	-	4,836,476	2,877,945	177,303	-	3,055,248	1,781,228
UMM	250,000	285,521	(1)	285,520	139,480	675,000	500,000	-	-	500,000	175,000
UMFK	-	37,367	-	37,367	(2,206)	35,161	15,378	-	-	15,378	19,783
UMPI	-	168,483	-	168,483	-	168,483	88,094	-	-	88,094	80,389
UMA	-	25,001	(1)	25,000	149,512	174,512	24,512	-	-	24,512	150,000
UMF	-	152,002	(1)	152,001	72,034	224,035	58,070	-	-	58,070	165,965
UMS	520,500	44,298	-	44,298	(558,443)	6,355	-	-	-	-	6,355
MMA	-	137,483	(1)	137,482	199,623	337,105	78,806	-	-	78,806	258,299
<b>Total State Funding</b>	<b>\$17,350,000</b>	<b>\$(452,824)</b>	<b>\$(4)</b>	<b>\$(452,828)</b>	<b>\$-</b>	<b>\$16,897,172</b>	<b>\$21,187,732</b>	<b>\$2,475,329</b>	<b>\$(7,276,249)</b>	<b>\$16,386,812</b>	<b>\$(510,360)</b>

Includes year-end equipment carry-over funds (equipment ordered, not received, and not paid).

<sup>2</sup>UM Cost Sharing.

<sup>3</sup>Inter-unit R&D funding transfers related to FY2022 MMA and Small Campus Initiative (SCI) awards.

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