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## Maine Economic Improvement Fund Annual Report, FY2009

University of Maine System

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# **BUILDING OUR STATE'S ECONOMY**

## THROUGH RESEARCH, DEVELOPMENT, & JOBS



MAINE ECONOMIC  
IMPROVEMENT FUND

Annual Report 2009

UNIVERSITY OF MAINE SYSTEM





## STATE FUNDED RESEARCH ANNUAL REPORT DECEMBER 2009

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\* The narratives provided demonstrate the breadth and diversity of research conducted at UMaine and USM in FY09. While there are many stories to tell, these narratives highlight the significant ways that R&D activity spurs innovation, job creation and economic development in Maine.

### December 2009

One of Maine's smartest and most successful public investments began in 1997, with the creation of the Maine Economic Improvement Fund (MEIF). Funded through an annual State appropriation and periodically augmented through voter-approved bond referenda, MEIF provides university-based researchers with the capital necessary to leverage federal and private sector research grants and contracts. Those grants and contracts, in turn, create and sustain economic development through new jobs, products, technologies, companies, and opportunities.

During FY09, the University of Maine System (UMS) received \$14.7 million in MEIF funding. That FY09 MEIF appropriation helped university faculty and students successfully leverage nearly \$58 million in grants and contracts. As stipulated in Maine law, the University of Maine System directs MEIF dollars specifically to support university-based research in seven designated strategic research areas:

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

In FY09, the two UMS universities with graduate programs in some or all of those seven targeted research areas received MEIF funds: the University of Maine (UMaine) and the University of Southern Maine (USM). UMaine and USM use MEIF resources to support the personnel and facilities they need to pursue successfully research projects. In some instances, the funds provide required matching funds; in other instances, the funds are used to purchase equipment or renovate facilities so make the universities eligible or competitive for federal or private sector funding.

Though both universities are engaged in MEIF-related research, their roles as research universities differ:

UMaine uses MEIF funding to expand its longstanding role as Maine's designated research university. UMaine is heavily involved in basic and applied research, with a wide array of research facilities and resources on its Orono campus as well as at off-campus research sites located around the state. UMaine's extensive research infrastructure, accumulated over many decades, has enabled it to successfully pursue federal and private grants and contracts.

USM primarily uses MEIF funds to help build an infrastructure sufficient to compete successfully for research grants and contracts. Though it has several areas of distinction, USM's role as a research institution is relatively young and has not developed the assortment of research facilities that has been developed, over decades, at UMaine. Through MEIF, the University System is attempting to enhance USM's research capacity to better serve the needs and opportunities of southern Maine. For that reason, MEIF allocations to USM have been focused on improving and expanding its research infrastructure.

New this year, in addition to UMaine and USM, several other System campuses received research funding as part of the MEIF Small Campus Initiative. For more information on those projects, see page 27.

This document focuses specifically on MEIF-funded research taking place at UMaine, USM, and the four specific projects at campuses that were awarded Small Campus Initiative MEIF funds. Other University System reports, notably its annual report on sponsored research, address the much broader scholarly activity taking place each year across all seven UMS institutions.

### MEIF in 2009

#### SUCCESS:

By leveraging MEIF funds, UMaine and USM have attracted a combined \$58 million in federal and private-sector grants and contracts related to the seven strategic research areas.

#### RETURN ON INVESTMENT:

Using its long-established research capacity, UMaine used \$15.7 million in MEIF funds to attract \$50.8 million in federal and private-sector research funds. USM continued to build its research capacity, using \$2.8 million in MEIF funds to leverage an additional \$7.2 million in federal and private-sector grants and contracts.

#### STRATEGIC IMPACT:

In 2009, \$76 million was invested in university-based research and development related to the MEIF-targeted areas. The amount represents the combined total of grants and contracts received, and the MEIF funds drawn down to leverage them.

#### CREATING JOBS:

In 2009, 543 full-time equivalent (FTE) positions were funded in Maine through the funds leveraged and expended related to MEIF.

**TABLE 1**

	UMaine Funds	USM Funds	Total Funds
MEIF Funds Used	\$15,655,032	\$ 2,813,968	\$18,469,000 <sup>1</sup>
Grants & Contracts Leveraged <sup>2</sup>	50,781,609	7,207,061	57,988,670
<b>Total Funds</b>	<b>\$66,436,641</b>	<b>\$10,021,029</b>	<b>\$76,457,670</b>

<sup>1</sup>Includes prior year funds carried forward.

<sup>2</sup>"Grants and contracts leveraged" is based on awards and includes multi-year awards

### GRANTS AND CONTRACTS:

#### The Return on Investment in University-based Research

Total new dollars (MEIF + all grants) available for R&D expenditures were \$75,658,933 in FY09. UMaine used \$12,013,784 in MEIF funds to leverage \$50,781,609 in external grants and contracts specifically in the State's seven targeted sectors (see table below).

**TABLE 2**

#### MEIF Leveraged New FY09 External R&D Grants and Contracts in the Seven Sectors

Dollars/Sector

State Technology Sectors	Amount
Forestry and Agriculture	\$13,730,001
Aquaculture and Marine Sciences	\$9,688,644
Biotechnology	\$3,442,507
Composite Materials	\$5,368,397
Environmental Technologies	\$6,485,164
Information Technologies	\$10,518,540
Precision Manufacturing	\$186,478
Cross Sectors	\$1,361,878
<b>Total Grants/Contracts/Gifts Leveraged</b>	<b>\$50,781,609</b>

The increase in R&D infrastructure and activity has enhanced UMaine's capacity to spur industrial growth, with industry contracts for FY09 totaling \$3,067,213.

UMaine submitted a total of 677 proposals during FY09, involving 394 faculty and professional staff from 55 departments or units as principal investigators or co-investigators. A total of \$272.6 million was requested from external sponsors, up from \$217 million in the previous year. UMaine faculty and staff produced more than 3,500 publications in FY09, including papers, books, book chapters, and technical reports.

### POSITIONS LEVERAGED

In FY09, 448 job positions at UMaine were created and/or supported as a result of MEIF funds and external grants and contracts. This includes positions directly supported by MEIF funds, and people paid through R&D grants and contracts leveraged from the MEIF funds.

### FACILITIES AND EQUIPMENT

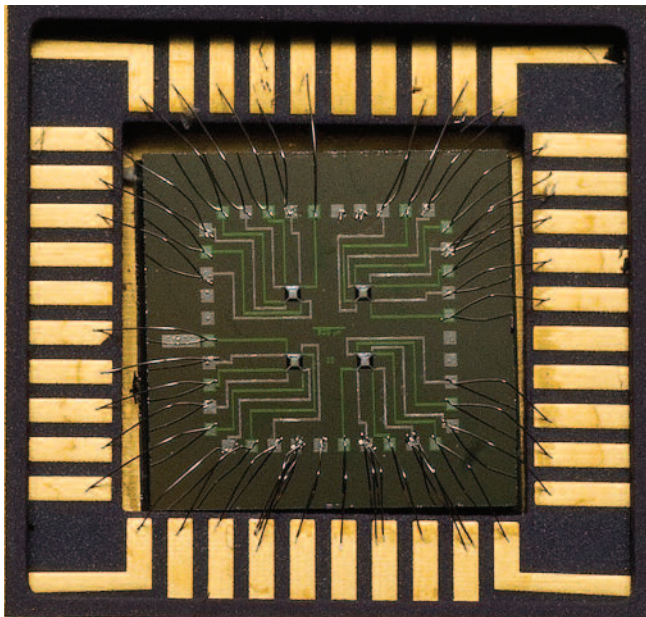
UMaine continues to expand and develop state-of-the-art research facilities to support the targeted technologies.

- More than \$2.2 million in new equipment was procured in FY09 to support UMaine R&D activity. Major purchases (greater than \$50,000) through various FY09 grants included more than 20 pieces of scientific equipment. This equipment outfits labs throughout the university.
- Planning, designing, and construction began on numerous facilities that were subjects of proposals to the R&D bond competition.

### INCREASED STUDENT INVOLVEMENT IN RESEARCH

Undergraduate and graduate students continue to play a major role in the MEIF research programs at UMaine. While graduate research assistants typically are funded (salaries and tuition) on external grants and contracts, an increasing number of undergraduates also are being paid to work in labs on grant-funded projects.





## TECHNOLOGY TRANSFER AND COMMERCIALIZATION

UMaine continues its technology transfer and commercialization program. The University's total patent portfolio now contains more than 80 U.S. patents, U.S. patent applications, and international patents.

In FY09 UMaine filed 23 new patent applications. Three new U.S. patents were issued and two were published by the U.S. Patent and Trademark Office (USPTO).

### U.S. Patent Applications Issued in FY09

- **U.S. 7,403,867** Spectroscopy Instrument Using Broadband Modulation and Statistical Estimation Techniques to Account for Component Artifacts
- **U.S. 7,416,368** Sheet Piling Panels with Elongated Voids
- **U.S. 7,547,470** Multifunctional Reinforcement System for Wood Composite Panels

### U.S. Patent Applications published by USPTO during FY09

- Monolithic Spiral Coil Acoustic Transduction Sensor (application #20080156098)
- Recovery of Acetic Acid from Wood Extracts (application #2009059228)

### New U.S. Patent Applications filed by UMaine during FY09

- Marine Aquaculture System
- Worm Reactor
- Blast Resistant ISO Container II
- Composite Construction Members and Method of Making
- Fire Resistant Paint
- Coated Wood Products for Ballistic Resistance
- Netforms Prefabricated Sectional Roofing System
- Thermoplastic Composites Containing Lignocellulosic Materials - CIP
- Composite Construction Members and Method of Making
- Composite Reinforced Oriented Strand Board
- Nanoscale Imaging of Molecular Positions and Anisotropies
- Container Security System with Conductive Grids & Bypass Resistors
- A Novel Method for Determining Constitutive Relationships in Compressible Cakes
- Combinatorial Cell Microenvironment Generator
- Riveted Composite Panelized System For Air Cargo Containers
- A Novel Membrane Electrode Assembly for Fuel Cells Having a Nanocomposite Catalyst Layer
- Slip Method for Prestressing Beams with Bonded Tendons







UMaine Engineers without Borders members, front: Mike Parker and faculty advisor Jean MacRae; back, left to right, Kelly McGuirl, Lee Rand and Liz Zelnic.

### TECH-BASED START-UP COMPANIES

**T**here were two new tech-based start-up companies formed to commercialize UMaine patent-pending technology during FY09.

**Advanced Infrastructure Technologies, LLC**, a start-up company commercializing "Bridge in a Backpack" technology developed at AEWC Advanced Structures & Composites Center. AIT moved into the Target Technology Incubator in Orono. The company plans to manufacture the composite bridge formwork kits in Maine and complete in-field installations throughout the country.

**Environetix, LLC**, a UMaine spin-off company from the Laboratory of Surface Science and Technology (LASST) is specializing in sensors resistant to extreme high temperatures. This company is commercializing UMaine patented and patent pending technology.

### UMAINE STUDENT START-UPS

#### Engineers Without Borders

This UMaine student group currently is working with the community of Dulce Vivir in Western Honduras to improve their sanitation system, a project they will continue for another two years.

Team members: 4 officers, many others involved

#### ERP Plugins

ERP is a small software development company working to build a suite of computer software programs aimed at strategically fulfilling the business process needs of large enterprises. The company was founded by a computer science graduate student and includes a communications and journalism undergraduate.

Team members: 2

#### Flannel Magazine

Flannel is a semi-monthly publication dedicated to Maine arts and culture that started out as a class project by a new media student. It includes photos, drawings, articles, and interviews with Maine artists. The magazine's creator has partnered with another new media student to produce the magazine.

Team members: 2

#### Market My Menu

This company, started by a business and computer science student, provides a Web site solution that allows restaurant owners an exciting new way to create their online presence with the ability to track their customer base and distribute promotional items (specials, newsletters, and coupons). Market My Menu received an MTI seed grant and a Libra Future Fund grant to fund the purchase of a server to host their system and to promote their products at the Maine Restaurant Association annual trade show. They launched their product in FY09 and have started to get customers.

Team members: 2

#### Scene Box Productions

Scene Box is a video production company specializing in filming events in and around Maine. The company was started by two new media students at UMaine who are preparing to graduate in May '10.

Team members: 2

### BUSINESS INCUBATION

**T**he University of Maine is a partner in the operation of two of the State's Advanced Technology Development Centers or "business incubators." The Target Technology Incubator in Orono provides both physical space and business counseling services to technology companies. The center is beginning its eighth year. The Maine Aquaculture Innovation Center operates aquaculture and marine science incubators at both the UMaine Center for Cooperative Aquaculture Research in Franklin, Maine and at the UMaine Darling Marine Center in Walpole, Maine.

#### The Target Technology Incubator

**T**he Target Technology Incubator currently has eight tenant companies and three new companies. Combined, tenant companies raised more than \$3 million in investment capital and research grants in FY09.

- Stillwater Scientific Instruments**  
 (SSI) Stillwater Scientific Instruments is developing a device that dramatically decreases the time it takes to analyze chemical compounds in the laboratory. This device, a component of mass spectrometers, will be sold to laboratory equipment manufacturers. Mass spectrometers are sold primarily in the biomedical and pharmaceutical industries, as well as environmental fields in which complex chemical mixtures must be accurately identified.
- Intelligent Spatial Technologies (IST)**  
 IST is a University of Maine spin-off company formed to commercialize the technology developed by the National Center for Geographic Information and Analysis. IST has developed technology that provides the user with information about their surroundings. By knowing where someone is and what direction they are facing, a handheld device instantly provides relevant information about nearby geographic objects.
- Angel Secure Networks**  
 Angel Secure Networks provides software and process engineering services for protecting very high value data against the risk of compromise by trusted insiders as well as outside pirates. The company's focus is on national security. The company also partners with UMaine's Supercomputer program to further its development and commercialization activities.
- Maine Secure Composites**  
 Maine Secure Composites, affiliated with UMaine's AEWC Advanced Structures & Composites Center, researches and develops secure composite materials for use in homeland security and by the U.S. military. It is currently focusing on secure shipping containers with embedded sensors that will detect tampering and is funded by the U.S. Department of Homeland Security.
- Milcord ME**  
 Milcord ME is developing geospatial solutions through government-funded advanced technology development programs based on research conducted through UMaine's Department of Spatial Information Science and Engineering.
- versionZero**  
 Nathan Hankla started versionZero, a new media development company, when he was a graduate student at the University of Maine. He now has clients in New York City and throughout the state of Maine. He was hired to redesign the Web site for the Bangor Region Chamber of Commerce and has worked with UMaine departments to develop marketing and trade show materials, including the Forest Bioproducts Research Initiative.
- Knife Edge Productions**  
 A digital video company founded by two UMaine graduates: Nathan Hankla and Sheridan Kelley. Knife Edge combines the latest video hardware and software with artistic talents and innovative visions.
- Zeomatrix LLC**  
 Zeomatrix is a UMaine spin-off engaged in designing, testing, and producing catalysts for environmental remediation of animal waste odor and decontamination of toxic chemical agents. It is commercializing UMaine patent pending technology.



## NEW TENANTS FY09

- Advanced Infrastructure Technologies, LLC**  
 Advanced Infrastructure Technologies, LLC will attempt to commercialize the composite bridge construction technology, called "Bridge in a Backpack," developed at UMaine's AEWC Advanced Structures & Composites Center. The technology involves hollow composite tubes that can be shipped in a bag to any construction site, inflated at the site, bent to any shape to fit the geometry of the site and infused with a resin to become rigid overnight. In its first year, the company expects to construct as many as six bridges in Maine, working with the Maine Department of Transportation, local contractors, and engineering firms.
- Clemas International, Ltd.**  
 Clemas International, Ltd. is a new monetizing innovation investment firm with offices in Orono, Maine. Clemas identifies commercially viable technologies, develops customized financial solutions, and commercializes the intellectual capital and intellectual property portfolios of academic, creative, corporate, financial, nonprofit, and government institutions. Clemas is a proactive partner to organizations confronting an abundance of intellectual property, scarcity of financial capital, and no clear pathway to commercialization. Clemas provides institutional investor access, time and strategic support frequently creating new venture development thereby leading to asset monetization.
- Forest Research**  
 Forest Research is a start-up company focusing on economic research of forest-based products and services, including biofuels, biomass, and carbon sequestration.

### TARGET AFFILIATES PROGRAM

Target's Affiliates Program allows companies that are not tenants to benefit from many of the services and resources available at the Center. Affiliates include existing technology companies, start-up companies, and University researchers commercializing new technologies.

- Just Enough, LLC, d.b.a. GudMuse (information technologies)
- Mainely Sensors (UMaine patents in precision manufacturing)
- Tirranna (information technologies)
- Environetix, LLC (precision manufacturing)

### The Center for Cooperative Aquaculture Research at Franklin

The Franklin center provides on-site space for start-up aquaculture businesses. FY09 has seen the beginning of significant incubator space expansion and fit-out through grants from the 2009 Maine Technology Asset Fund (R&D Bond). In addition, the Maine Aquaculture Innovation Center has expanded incubator resources at the Darling Marine Center in Walpole, Maine through grants from the Maine Technology Asset Fund.



### Aquaculture Business Incubation Clients in FY09

- Maine Halibut
- Friendship International
- Great Bay Aquaculture
- Little Pearl, LLC
- Sea and Reef Aquaculture, LLC

### ECONOMIC DEVELOPMENT PARTNERSHIPS

#### Moving R&D into Maine's Economy

UMaine works with several economic development organizations and municipalities to package real estate, programs, and services necessary to support incubator graduate companies and spin-off companies that do not need incubator space. Specific projects are in the planning stages with the Bangor Regional Development Alliance, the North Star Alliance (for composites, boat building, and the marine trades), the Economic Development Council of Maine, and many of Maine's trade associations and professional organizations.

In addition, the University of Maine had R&D contracts with more than 190 companies throughout the state. UMaine often supports companies on their Maine Technology Institute (MTI) funded grants. One third of FY09 MTI-funded projects involved collaborations with UMaine programs. UMaine researchers support the Maine Technology Institute by serving on its board of directors, the technology boards, and proposal review committees.

#### The 2007 R&D Bond — Maine Technology Asset Fund

In November of 2007, Maine voters approved a \$50 million R&D bond to support research development and commercialization at Maine's universities, nonprofit institutions, and private companies. A program called the Maine Technology Asset Fund was created by the Maine Technology Institute to administer the funds and make competitive grant awards to Maine applicants working on technologies within the state's seven designated sectors (MEIF sectors). This new process replaced previous R&D bond funds and required UMS institutions to compete through a peer-reviewed grant process. The funds can be used for standard bond expenses such as equipment, buildings, and lab renovations. Proposals were required to be collaborative in nature, and partnering with complementary organizations and companies. There were two rounds of funding for this program. The second competitive round was completed in June of 2009.

The University of Maine had four successful proposals and was a major partner on four additional projects.

## The 2007 R&D Bond – Maine Technology Asset Fund Round 2 Projects at UMaine:

Program	Project Title	Project Location	Award Amount
Process Development Center, Chemical and Biological Engineering Department, University of Maine	PDC Infrastructure Improvements for Advance Pulp and Paper R&D	Orono	\$1,083,197
New Media Program, University of Maine	Innovative Industries Initiative – New Media Research, Innovation, and Commercialization Center	Orono	\$3,690,000
School of Marine Sciences, University of Maine	Maine Center for Autonomous Marine Survey (MCAMS)	Orono	\$1,283,822
Department of Physics, University of Maine	Strengthening Biotechnology & Supporting STEM in Maine	Orono	\$883,160
<b>Company &amp; UMaine Partnership</b>			
Hodgdon Defense Composites, includes UMaine AEWC	A World Class Composites Shipyard & 21st Century Manufacturing Complex	Boothbay Harbor	\$3,874,719
Maine Aquaculture Innovation Center & the UMaine Darling Marine Center	Improvements to Maine's Aquaculture Business Incubation Infrastructure at DMC	Walpole	\$213,900
Maine Institute for Human Genetics and Health, includes UMaine Biochemistry, Microbiology, and Molecular Biology, among others	Maine Regional Flow Cytometry Collaborative	Bangor & Orono	\$1,247,875
Dielectric Communications (Div. of SPX Corp.) with UMaine Electrical and Computer Engineering Department	A New Design for Universal Rural Wireless Connectivity to Fixed and Mobile Users	Raymond & Orono	\$2,200,000

### UNIVERSITY OF MAINE FY09 HIGHLIGHTS

Total new R&D funding in FY09 was \$75 million. Of that amount, MEIF funds accounted for \$12 million which was leveraged to bring in an additional \$50.7 million in external grants – exclusively in the seven target sectors.

- A total of 677 new proposals were submitted involving 394 researchers and 55 departments, with \$272.6 million requested from external sponsors.
- More than 3,000 publications, papers, and presentations were produced by faculty and staff.
- UMaine leveraged \$50.7 million in external grants and contracts, specifically for the seven technology sectors.
- Over 543 job positions were created and/or supported through external grants and contracts.
- A total of \$2.2 million in new major equipment was secured to outfit labs throughout the university.
- A total of 17 new patent applications were filed, and three new U.S. patents were issued.
- The Target Technology Incubator housed 11 tenants companies, supported four affiliate companies, and provided referrals or counseling to more than 200 walk-in companies and individuals.
- UMaine-affiliated aquaculture incubators in Franklin and Walpole supported five companies moving toward full-scale commercialization.

### GRANTS AND CONTRACTS:

#### The Return on Investment in University-based Research

The University of Southern Maine invested \$2.8 million in state MEIF funding to leverage \$7.2 million in R&D awards from federal and private sector sources, a strong showing in a difficult economy and the highest R&D activity level to date for the campus. Total grant and contract activity at USM gained 6 percent over the past year, reaching \$45 million in awards for 2009 and rebounding from two years of declining federal support.

### POSITIONS LEVERAGED

In FY09, MEIF dollars and the R&D grants and contracts those funds generated supported 95 full-time equivalency positions, including faculty, technical staff, and students. Once again for this year's MEIF report, USM has focused attention on faculty-student collaborations in research.

USM stories showcase the work of scientists in action, and the development of Maine's workforce and its economy through university-based research and the productive engagement of students at all levels in Maine's research enterprise.



Matthew Bampton and Mark Swanson prepare to start a GPS survey of fault structures on Hall Island in Muscongus Bay as part of their NSF Research Experience for Undergraduates program.

### SPOTLIGHT ON STUDENT RESEARCH

Building resumes, advancing careers

*A combination of MEIF support, fellowships, and grant funding has added up to career-building successes for many USM students.*

In USM's graduate program of Biological Sciences, Associate Professor Lisa Moore mentors students in her lab, in remote corners of Maine, and beyond.

Karoline Perry started as an undergraduate in the Moore lab, first volunteering, then getting independent research credit, then getting paid on an NSF grant. With Moore's guidance, Perry is now completing a M.S. degree in Biology and has been accepted to be a Science Corps fellow in USM's National Science Foundation GK-12 program. As a Mainer, Karoline has a special connection with the high school students she interacts with, and her enthusiasm for microbiology generates enthusiasm among the students. An active researcher, her NASA-funded project is also Maine-based: studying the physiology and phylogeny of novel microbes she isolated from a unique copper/zinc mining site along the coast of Maine.

Also in the Moore lab, graduate students Kate Callnan and Heather Anne Wright were able to go on an oceanographic research trip to the Patagonia Shelf region in the southern Atlantic Ocean off the coast South America in Dec 2008. On this cruise, they collected samples to examine the picoplankton population distributions as well as the response of picoplankton to ocean acidification in on-deck incubation studies. Their work was part of a larger project led by chief scientist William "Barney" Balch of Bigelow Laboratory for Ocean Sciences, which looked at ocean acidification, one of the symptoms of global climate change. The trip was funded by an NSF Small Grant for Exploratory Research.



Students standing by their presentations at the Thinking Matters Symposium.

### Seventh Annual Student Research Symposium

The prevalence of cancer in East Poland, Maine, the use of music to improve the memory of those who have suffered a traumatic brain injury, and the toxicity of lunar dust were among the more than 225 projects presented at "Thinking Matters," USM's annual showcase of original student research.

The daylong celebration of research included a two-hour display of research projects on the main floor of USM's Sullivan Gym, Portland. USM faculty and research staff founded Thinking Matters in 2003 to promote opportunities for USM students to participate in student-faculty research collaborations and to hold an annual event showcasing the results of these efforts. Since then, students and faculty from Southern Maine Community College also have participated.

### Summer Undergrad Research Fellowship

'SURF's up' at USM each summer, when eight students and their faculty mentors take part in the Summer Undergraduate Research Fellowship (SURF) program.

Competitively awarded, each fellowship offers the student-faculty pair a \$2,600 award, enabling them to take a more in-depth look at a subject that interests them and to share their findings with others in group presentations.

2009 fellowship recipients included students in Biology, Physics, Political Science, Geography-Anthropology, Chemistry, and Psychology. Jefferson Gaynor completed his project "Characterization and Analysis of an Extremophile Community by Polymerase Chain Reaction Denaturing Gradient Gel Electrophoresis" under the guidance of Associate Professor Monroe Duboise. An undergraduate student in Biology, Jefferson found the SURF program experience provided a unique and valuable opportunity to develop research interests, acquire new skills, and build professional relationships. He noted that the design and completion of a supported, independent project has been an extremely rewarding experience that will greatly aid his future career decisions.





Micro-vials of cell samples being prepared for analysis.

### Building Maine's Biomed Work Force

USM students in the Applied Medical Sciences Department are receiving rare opportunities to collaborate with professors and researchers on groundbreaking research that is providing the region's biotech industry and biomedical community with valuable knowledge, commercial products, and an experienced workforce.

Many of the students in Dr. Ah-Kau Ng's laboratory have held internships or part-time employment at IDEXX Laboratories, MBS, Binax, and other organizations where they have conducted their theses and often found long-term employment. Since the beginning of the applied immunology graduate program in 1987 the focus has been on work force development for the biotech industry and biomedical community in Maine.

Examples of projects that students have worked on include finding a biomarker for cancer. With support from the National Institutes of Health, the Maine Cancer Foundation, and USM Faculty Senate Research Award, Ng's lab, together with collaborators at Maine Medical Center, has already developed several antibodies to osteopontin—all commercially available via MBS in Portland—which have potential in cancer diagnosis and therapy.

## UNIVERSITY OF SOUTHERN MAINE FY09 HIGHLIGHTS

- USM's R&D activity exceeded \$10 million in FY09, surpassing last year's totals by \$1.5 million. This amount includes \$2.9 million in state MEIF allocation and \$7.2 million in new grant awards from federal and private sector sources.
- Total proposal submissions at USM increased from 249 last year to 259 this year, with total funds requested at \$76 million. R&D projects constituted over \$25 million of external funding requests.
- Overall grant and contract activity at USM increased 6 percent in 2009 over the previous year, with \$45 million in new awards, reflecting a turnaround in funding trends and the declining economy of the past two years.
- R&D projects at USM continued to make significant gains in leveraged funding, increasing federal grant and contract expenditures for R&D activity over 25 percent in 2009.
- As a result of increased grant activity, MEIF and R&D projects supported 95 full-time positions in 2009, an increase of 7 positions over the prior year.



### What's in the Water?

Calculating the amount of chlorophyll in the Gulf of Maine is the focus of research by UMaine doctoral candidate Michael Sauer.

Sauer, who is based at UMaine's Darling Marine Center in Walpole, Maine, has received a \$30,000 NASA Earth and Space Science Fellowship to create a more accurate calculation of the amount of chlorophyll in the water. He is using optical equipment, sensors, and data from Gulf of Maine Ocean Observing System buoys to compile information about temperature, salinity and light absorption in the water column.

Algorithms used for NASA satellite chlorophyll imagery are based on the open ocean, where phytoplankton is the primary ocean color source. However, the current method of measuring chlorophyll from satellite images can't discern it from colored, dissolved organic matter (clear, yellowish-brown river water). Misinterpreting the color of the ocean results in misunderstanding the health of the ocean ecosystem.

Sauer was one of two UMaine graduate students to receive NASA fellowships last year. Oceanography doctoral candidate Margaret Estapa is studying the release of carbon from mud delivered from the Mississippi River to areas along the Gulf Coast.

### Tapping the Tides

Using a \$951,500 federal appropriation, UMaine researchers have teamed up with colleagues at Maine Maritime Academy (MMA) and Portland-based Ocean Renewable Power Company (ORPC) LLC and others to assess current prototypes and models of turbines that can be submerged in the ocean to produce power using tidal currents. The researchers also will evaluate the potential environmental impact of harnessing tidal energy off the coast of Eastport in the Western Passage of Passamaquoddy Bay.

UMaine oceanography professor Huijie Xue is an expert in oceanographic computer modeling, which is key to understanding how much energy is produced by ocean currents.

The impact on the ocean environment and how to lessen that effect is another issue researchers, including UMaine fish biologist Gayle Zydlewski with the School of Marine Sciences, are working to understand.

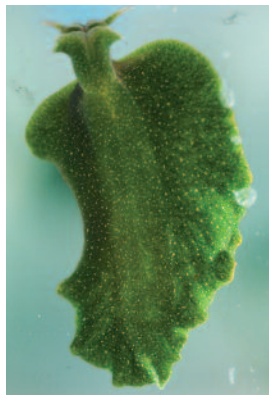
MMA and ORPC bring specialized skills and knowledge that will allow the research and turbine development to advance efficiently and safely, serving the state's economy and the environment.

Throughout the summer, ORPC conducted in-water testing of the commercial design of its generator unit, which has turbines made of a composite material developed by U.S. Windblade LLC of Bath, and a composite structural frame made by Harbor Technologies LLC of Brunswick—two companies with ties to UMaine's AEWCA Advanced Structures & Composites Center.





### Solar-powered Slugs



Since 1987, UMaine biochemistry professor Mary Rumpho-Kennedy has been studying *Elysia chlorotica*—a tiny “solar-powered” sea slug found in saltwater marshes along the East Coast. Her recent research offers insight into the potential for evolution of photosynthesis in an animal through symbiosis and gene transfer.

This sea slug looks and acts like a leaf and reacts to sunlight in much the same way as a plant, opening up when exposed to sunlight.

Sea slugs suck out the cellular contents of their algal prey and retain the green chloroplasts in cells lining their digestive gut. This DNA, if not digested, may be either taken up freely floating by cells lining the gut or transferred by some type of vector, possibly a virus. The foreign DNA then becomes part of the animal nuclear DNA, transferring genetic information from the algal nucleus to the sea slug.

With this special type of symbiosis, sea slugs never need to eat again. Instead, they survive for months on sunlight and air—just like a plant—by carrying out photosynthesis.

Rumpho-Kennedy ultimately hopes to discover how the sea slug is able to get the algal DNA into its system and make it work, determine the minimal requirements for photosynthesis, and understand how the foreign material avoids destruction in the sea slug.

### Searching for Solutions

Students in UMaine’s Graduate School of Biomedical Sciences (GSBS) collaborate with more than 80 world-class researchers from UMaine and six partners—The Jackson Laboratory; Mount Desert Island Biological Laboratory; Maine Medical Center Research Institute; University of New England; Maine Institute of Human Genetics & Health; and University of Southern Maine.

The springboard for GSBS was a research triangle—UMaine, The Jackson Laboratory and Maine Medical Center Research Institute—that offered the state’s first Functional Genomics Ph.D. Program, funded in 2002 by a \$2.6 million National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship (IGERT) grant.

Initial funding for GSBS student support came from the Maine Legislature using scholarship funding from the racino revenues, followed by two years of funding through the Maine Economic Improvement Fund. Funding for the next two years was appropriated by the Legislature as a result of the enhanced Federal Medical Assistance Percentage provided in the 2009 American Recovery and Reinvestment Act.

The program provides up to two years of financial support for students, including \$23,000 in stipends, tuition and fees, and health insurance. After their first two years in the program, students complete their education and research at UMaine or a partner institution. The final years are typically supported by external grants from agencies such as NSF or the National Institutes of Health.

### Detecting Breast Cancer With Geometry

UMaine assistant professor of mathematics Andre Khalil recently received a grant of more than \$73,000 from the Maine Cancer Foundation to build on initial research done by his colleagues in France—Pierre Kestener and Alain Arneodo—concerning use of wavelet-based image analysis to detect tumors and improve early detection of breast cancer.

The Two-Dimensional Wavelet-Transform Modulus Maxima method detects the difference between dense and fatty breast tissue, and reveals microcalcifications. The technology also may be able to discriminate between benign and malignant breast tumors.

Khalil will use the wavelet technology to analyze more than 3,000 images in the online Digital Database for Screening Mammography, maintained by the University of South Florida.

Based on Kestener’s research, Khalil hypothesizes that the software can detect a benign tumor based on its geometry, possibly even before it could be seen by a radiologist. It’s believed that benign tumors are fairly typical in shape—a circle or square. It is when the tumor has a more complex fractal or branch-like structure that it is more likely to become more invasive and, thus, malignant.



### Relating Competition and Conservation

Five UMaine professors have joined forces under the leadership of principal investigator James Wilson, professor of marine sciences, to gain a better understanding of the relationship between competition in the fishing industry and conservation.

The project is funded by an approximately \$1 million grant from the National Science Foundation. Researchers will look at the way competition among fishermen leads to private incentives and informal social arrangements that are—or aren't—consistent with conservation of the resource.

These informal arrangements and incentives are important because they can help explain to what extent private interests might reinforce or impair ongoing resource management and, consequently, the sustainability of coupled human and natural systems.

Looking at three Gulf of Maine fisheries—sea urchins, lobster, and cod—researchers will use a computer modeling program to mimic the way those in the fishing industry use their experience to refine their knowledge about their natural and social environment.

Each fishery will be modeled using a biophysical simulator of the natural system and a tightly integrated multi-agent learning classifier system that simulates the learning and interactions of fishermen. The design of each model will be based in part on extensive interviews with fishermen about their knowledge of the dynamics of the fisheries in which they work.



### Bridge-in-a-Backpack

Created by researchers at the UMaine's AEWCC Advanced Structures & Composites Center, the "Bridge in a Backpack" is going commercial.

An investment team coordinated by Brit E. Svoboda has formed a new Maine company, Advanced Infrastructure Technologies (AIT), located at UMaine's Target Technology Incubator.

The lightweight corrosion resistant system for short to medium span bridge construction not only has appeal for those in the transportation industry, but also for military applications.

The arches are easily transportable, rapidly deployable and do not require the heavy equipment or large crews needed to handle the weight of traditional construction materials.

Two Maine bridges have been rebuilt using the "Bridge in a Backpack" technology: the Neal Bridge in Pittsfield and the McGee Bridge in North Anson. Six more of these arch bridges will be constructed in Maine over the next two years.

In time, the company plans to design and kit these bridges in Maine, and ship them around the country. After an initial incubation of 5 years, the company sees a growth potential to over 100 jobs. These employees will include engineers, technicians, manufacturing, and sales/marketing personnel.

### Offshore Wind

Habib Dagher, director of UMaine's AEWCC Advanced Structures & Composites Center, is collaborating with companies on the design, manufacture, and testing of floating wind turbine technology off the Maine coast in waters 60–900 meters deep. The turbines would feature 300-foot towers with 200-foot blades prototyped, manufactured, and tested by AEWCC researchers.

AEWCC currently is working to open an advanced wind blade prototyping facility, where full-scale trial blades can be designed, fabricated, and tested under one roof. Funding for the facility came from the Maine Technology Institute, which in 2008 awarded nearly \$5 million to two AEWCC initiatives focused on the renewable energy and transportation industries. The allocations were made possible by a \$50 million Maine Technology Asset Fund R&D bond Maine voters approved in 2007.

As defined by Dagher, the current sustainable energy plan for the state is to generate 5 gigawatts of offshore wind in the next 10–20 years by installing 1,000 five-megawatt wind turbines in the Gulf of Maine.

Within 50 nautical miles of Maine's coast is the potential to produce 149,000 megawatts of power using offshore wind—the equivalent of 40 nuclear power plants.



Habib Dagher

### Sustainable Society

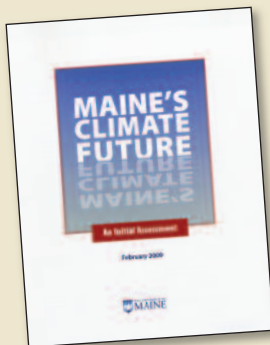
With a \$20 million grant, Maine is positioned to become a leader in addressing sustainability challenges. The five-year grant from the National Science Foundation's Experimental Program to Stimulate Competitive Research will be coupled with a \$1 million match each year from the Maine Economic Improvement Fund. UMaine and all collaborating partners will also contribute an additional \$1 million per year of in-kind support in the form of faculty salaries and use of research facilities.

Led by UMaine's Senator George J. Mitchell Center, core research teams from UMaine and USM, as well as government and industry stakeholders, will be brought together to improve the science and practice of sustainable development.

The initiative will create a collaborative Center for Sustainability Solutions and implement related K–20 educational activities for more than 15,000 participants.

By creating partnerships with many of Maine's colleges and universities for research and education efforts, the center is designed to advance economic and community development while protecting the environment. It also will provide support for 200 to 300 people, mainly in the research sector, with the ultimate goal of building capacity for generating solutions to a range of challenging problems and resulting in healthy economies and ecosystems for Maine.

### Preparing for the Future



University of Maine faculty members presented the report “Maine’s Climate Future: An Initial Assessment,” to Gov. John Baldacci. UMaine professors described their findings to the governor and his cabinet at that group’s weekly meeting.

The report is the university’s response to the governor’s 2007 request for a preliminary analysis of the effects of climate change in Maine during the 21st century. The report considers past climate change, recent evidence of accelerated rates of change, and the implications of continued climate change in Maine as a result of greenhouse gas emissions and their associated pollutants.

Teams of participating scientists volunteered their time and expertise to initiate a process that can both inform and facilitate systematic planning and thoughtful decisions related to Maine’s climate change challenges.

The study documents an increasing rate of warming in Maine over the last century, as well as increased regional sea surface temperatures, increased precipitation, rising sea levels, and hydrologic changes in snow melt, lake ice-out, and spring runoff. Modeling of Maine’s future climate performed for the assessment shows a strong trend toward warmer conditions with more precipitation in all four seasons. Subsequent sections of the report detail how these climate changes will affect Maine people, ecosystems, and various economic sectors such as agriculture, forest products, and tourism.

The authors acknowledge Maine’s leadership in addressing climate change and reducing greenhouse gas emissions, but stress that Maine also needs a plan for adaptation during what they describe as “a period of transition.” The report highlights opportunities for Maine to benefit from a changing climate, and identifies gaps in knowledge and the information needed for a positive transition in the 21st century.

The report was prepared under the leadership of UMaine’s Climate Change Institute and Maine Sea Grant with support from the Vice President for Research; Office of the Dean, College of Natural Sciences, Forestry and Agriculture; Center for Research on Sustainable Forests; Senator George J. Mitchell Center for Environmental and Watershed Research; Forest Bioproducts Research Initiative; and the Department of Plant, Soil and Environmental Sciences.



### Building a Creative Future

A renovation project designed to create a new culture of innovation and creativity for the state soon will be under way at the UMaine.

The Maine Technology Institute has awarded the campus \$3.69 million to turn Stewart Commons into the New Media Innovation, Research, and Development Center at UMaine, which will support expanded innovation and development in new media for the entire state.

Construction will include the addition of necessary technical facilities for continued and new training, research, development, and commercialization; pursuing collaborative research and development initiatives with potential for beneficial economic and social impact; and working directly with individuals and businesses to take ideas and prototypes through the stages of development to commercialization.

To accomplish this, director and new media professor Owen Smith will be working with UMaine's ASAP Media Services, and at least eight independent Maine-based new media companies.

### Operation Robot

Researchers, faculty, and students at UMaine are exploring the robotic building blocks of technology that have the potential to help revolutionize human surgical procedures.

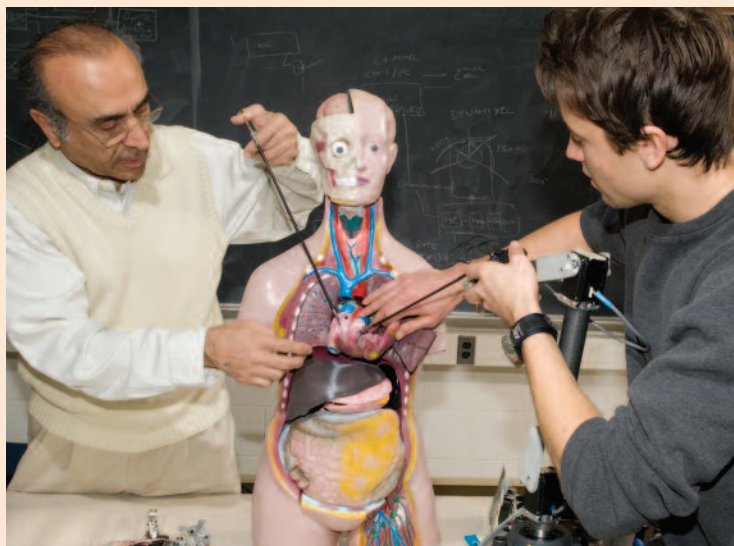
Mechanical engineering researcher Mohsen Shahinpoor, who directs the state's only biomedical engineering technology lab, is focusing on the development of advanced robots for endoscopy and laparoscopy procedures that are less invasive and traumatic than traditional surgeries.

Robotics offers surgeons precision movement, eliminating the inherent unsteadiness of the human hand. That same automated precision will one day soon make it possible for surgeries to be performed by doctors at a distance.

However, what the robotic hand or instrument lacks is tactile sensing capabilities, which Shahinpoor hopes to address with the help of his pioneering research in artificial muscles.

He and his students also are exploring how to build robotic devices with disposable parts, thereby reducing the incidence of infection. The key to such disposable robotic surgery tools is to make them cost-effective and as environmentally friendly as possible, while still maintaining accuracy.

At UMaine, Shahinpoor hopes to make his biomedical engineering lab into a center of innovation and learning, where faculty and students can work with the state's medical institutions to solve problems using robotics and artificial muscles.



Mohsen Shahinpoor, left, is pictured with a student in the biomedical engineering technology lab at UMaine.



### Finding Fuel

The U.S. Department of Energy awarded more than \$712,000 to UMaine chemical and biological engineering professors Peter van Walsum and Clay Wheeler for a three-year project to create a high-quality transportation fuel from renewable biomass resources.

In addition, the nearby Old Town pulp mill, in partnership with UMaine's Forest Bioproducts Research Institute (FBRI), received a \$30 million award in 2008 to design, build, and operate a small-scale commercial integrated biorefinery. The foundation for this project involves the transfer of technology from FBRI labs to private industry, and would create a forest-based cellulosic biofuel value stream for the mill in addition to its normal pulping process. FBRI was also selected to receive \$4.8M from the Maine Technology Asset Fund to create a supporting technology center on the mill site.

Hardwood extract from the kraft pulping process and seaweed by-products from extracting carrageenan—primarily used as a natural food additive—will be fermented into organic acids. The acids will be chemically upgraded into high-quality liquid fuels, such as ethanol and butanol.

The result will be superior, more energy-dense fuels with more miles per gallon; less volatility, which equals less air pollution; and easy blending with gasoline, requiring fewer changes to current infrastructure.

### What's Next: Making Plastic From Potatoes

Researchers at UMaine continue the collaboration with the Bangor-based Environmental Health Strategy Center/Tides Center, which recently received a \$500,000 Maine Technology Institute Cluster Initiative Award to support a *Sustainable Bioplastics Initiative*.

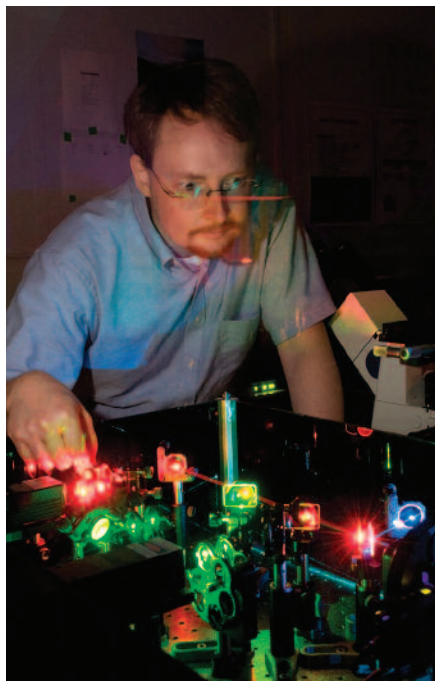
This is the third part of a project that started with an MTI seed grant to research the feasibility of making polylactic acid (PLA) plastics—found in yogurt containers and disposable utensils—using the starch from cull potatoes.

UMaine researchers also have discovered that wood by-products from Maine's forest product facilities, such as pulp mills, are viable sources of fermentable sugars.

The only U.S. plant currently making PLA plastic is in Nebraska, using corn to produce the necessary starch. Companies wanting non-GMO materials (most corn based PLA is from GMO corn) don't have any options, but Maine is poised to fill that void while creating jobs and developing a new industry for the state.



## 2009 PRECISION MANUFACTURING



Sam Hess

### Protein Perspective

U Maine scientists have developed a new way of looking at the molecular organization of cells by creating a microscope system they call FPALM (Fluorescence Photoactivation Localization Microscopy).

The microscopy system was invented to enable scientists to look at the molecular organization of cells by imaging samples labeled with a special kind of fluorescent marker. The FPALM microscopy system breaks a fundamental limit on the resolution of lens-based microscopes, known as the diffraction barrier, which has existed for more than 100 years.

While a normal microscope looks at all of the molecules at once, which can make the individual molecules difficult to see, FPALM uses photoactivatable dyes to identify individual molecules and separate them.

The recent extension of FPALM to include 3-D imaging and provide information about the orientation of single molecules will help address important biological questions.

Already, the ability to image living cells has helped UMaine scientists disprove several existing models of membrane organization.

The UMaine researchers, including Samuel Hess, a FPALM co-inventor, along with colleagues at the Albert Einstein College of Medicine in New York and the National Institute of Child Health and Human Development in Maryland, published their findings in the journal *Nature Methods*.

### Revolutionizing Climate Change Research

U niversity of Maine researchers at the Laborator for Surface Science and the Climate Change Institute are teaming up to create a sensor that will provide groundbreaking information in ice core research.

The William M. Keck Foundation has provided a \$1.6 million grant to fund the continued research of the project, "Major Advances in the Field of Climate Change Reconstruction Using Ice Cores," which will revolutionize climate science.

The project will build on UMaine's ongoing research aimed at developing a global array of ice cores for use in studying historical climate change, in better understanding the Earth's environment and in creating sound hypotheses related to the planet's climate future. Professor Paul Mayewski, director of the Climate Change Institute, is the project leader.

UMaine scientists have been involved in ice core research for decades. Their work, funded by the National Science Foundation, NASA and the National Oceanic and Atmospheric Administration, involves the extraction of ice from polar regions around the world.

By examining the chemical composition at intervals along the ice core, scientists can reconstruct climate history over centuries and they can monitor current climate conditions in critical regions.

The project will allow researchers to accelerate their research and move toward establishing the complete and robust record necessary to gain a thorough understanding of the Earth's climate history. Ice cores are the only means by which scientists can study climate history on a meaningful scale, looking at thousands of years of verifiable records, according to Mayewski.

UMaine scientists are expanding their research capabilities in two specific ways:

- Through the purchase and adaptation of a laser ablation inductively coupled plasma spectrometer (LA-ICP-MS), technology that allows for "rapid, continuous, high resolution sampling of ice core chemistry," increasing the scientists' capabilities with regard to chemical sampling and core assessment.
- Through the development of new ice core measuring capability by developing prototype chemical sensors to be embedded in an ice core drill, along with a "disposable" GPS system that will allow for on-site sampling in hazardous environments and for monitoring changes in glaciers. Scientists in UMaine's LASST laboratory will lead the development of the sensor technology. Some 13 UMaine academic personnel, representing CCI, LASST and several academic departments, will participate in the project.





USM graduate student Heather Anne Wright (left) and Kate Callnan aboard the Revelle, off the coast of Uruguay.

### Studying Algae Blooms in Patagonia

Thanks to a grant from the National Science Foundation, two USM graduate students, Heather Anne Wright and Kate Callnan, spent a month off the Uruguay coast conducting research on algae blooms with Dr. William Balch, a chief scientist at Bigelow Laboratory for Ocean Sciences in West Boothbay Harbor, Maine.

USM biology professor Lisa Moore, whose own marine research originally attracted Wright and Callnan to USM, initiated the 30-day cruise off the Patagonian shelf, which gave the students a rare opportunity to study one of the world's largest recurring algae blooms.

The students collected samples to examine the distribution of picophytoplankton (microscopic plankton cells) as well as their response to ocean acidification in incubation studies aboard the ship. Phytoplankton are any drifting organisms in the ocean that photosynthesize, thus providing a source of food to other aquatic organisms like krill, fish, and whales.

The students' work was part of a larger project investigating the effects of ocean acidification—one of the symptoms of global climate change—on larger phytoplankton.

### Connecting Educators to Habitat Restoration

This summer, USM participated in a National Science Foundation program that provides K-12 teachers nationwide an opportunity to participate in ocean, polar, and environmental science research and peer mentoring.

Teresa Gable, a science teacher, was matched with USM professor Dr. Karen Wilson to conduct field research for two weeks on habitat restoration projects in Maine. Gable assisted Wilson at Sherman Marsh in Newcastle, a salt marsh that was a shallow freshwater lake from the 1930s to 2005. Wilson is monitoring the change in vegetation and other organisms as the marsh transitions from freshwater to a saltwater environment.

The ARMADA Project administered through the University of Rhode Island accepts applications from teachers across the country seeking to become "Master Teachers," who develop ways to bring the results of their research experiences back to the classroom. Upon their return, they mentor new teachers in their school district and share experiences with others.

According to Wilson, the project is a great way for area school groups to get involved with local science projects, and a great way to encourage mentoring between undergraduates in the lab and someone in the real world.



Theresa Gable shows off a juvenile alewife she captured while seining at Damariscotta Lake.



### Unlocking the Secrets of Rocks

USM professors Mark Swanson and Matthew Bampton mentor undergraduates each summer on an adventure-based field program to conduct leading geological research on the rocky coast of Maine. This highly competitive, paid internship program is funded through a Research Experiences for Undergraduates Program grant from the National Science Foundation.

With access to one of the nation's best-equipped precision digital mapping labs, and USM's first-rate Geographic Information System (GIS), the team has focused its research on the regional deformational effects of the Norumbega Fault System, a sideways moving zone of shear running through Maine and one of the main features of the Northern Appalachians.

The group has kayaked to and camped on numerous Maine islands while conducting their research. Work on Seguin Island, for example, has sought to record the patterns of granite intrusions (light-colored rock formed by magma injections) and the detailed folded patterns in the layered rocks that make up the island. Over the years, the students have created an interactive computer display on the island that allows viewers to see the geologic details in the surrounding area.



### Uncovering Bones on Maine Islands

USM research assistant Ingrid Brack and USM archeologist and associate professor Nathan Hamilton are using archaeological bones to help Dr. Lew Incze of the Gulf of Maine Area Program Census of Marine Life develop an extensive database of marine fauna in the Gulf of Maine, which extends from Cape Cod to Nova Scotia. The database will be used to understand the trends in the abundance of different species over time and space.

Over the course of a few years, Professor Hamilton and his USM students have collected over 75,000 pieces of bone from islands off the Maine coast—some as much as 4,500 years old. Current emphasis is on the Isles of Shoals with a field school run through the Shoals Marine Laboratory.

They are also exploring aspects of prehistoric marine ecology with stable isotope analysis of fish and sea bird bones under the technical supervision of Dr. Beverly Johnson, Associate Professor of Geology at Bates College. Johnson, who is exploring the role of fish in the food chain, lacks data from the first 300 years of European colonization of North America. Significant ecological changes took place during this time, and data from the Isle of Shoals and Malaga Island may hold the key.



### Providing High-Tech Images for Industries

With one of the few transmission electron microscopy (TEM) laboratories in Maine, USM's bioscience research staff are providing the region's burgeoning biotech industry with a valuable resource for commercial ventures.

IDEXX Laboratories, the global leader in diagnostics and information technology solutions for animal health and water and milk quality, recently turned to USM when it needed to obtain images of microbes that can be detected using the company's water microbiology test kits. USM's electron microscopy laboratory was able to execute the necessary ultra-thin sectioning of specimens and to provide the high resolution images required by IDEXX using the TEM laboratory's microscope capable of magnification up to 300,000 times.

USM regularly incorporates its high-end electron microscopy core resources into internal and external projects, educational, and commercial. For instance, the TEM facility is enhancing K-12 teacher professional development through USM's signature Science Education Partnership Award from the National Center for Research Resources, a component of the National Institutes of Health, and is also, through National Science Foundation funding, contributing to project-based learning in molecular biology and virology in bioscience education in rural Maine high schools.

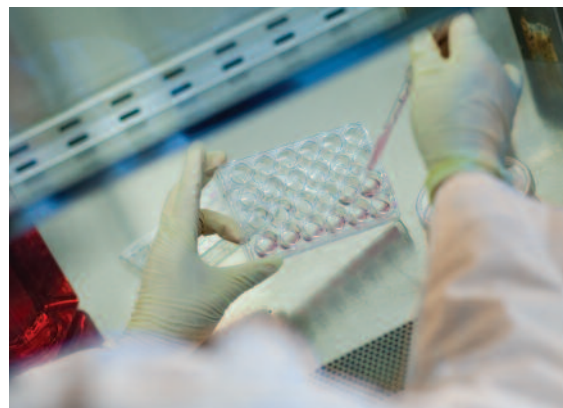
### Learning More about Lupus

With funding from the Lupus Research Institute, USM's Stephen Pelsue has identified a gene (Ttc7) that has caused flaky skin in mice, a condition that shares similar features with human autoimmunity and lupus—one of the most serious autoimmune diseases.

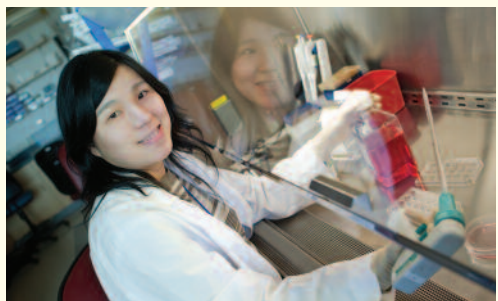
Autoimmunity occurs when the immune response attacks its own cells and tissues, rather than fighting off infections. Besides lupus, prominent examples among humans are celiac disease, multiple sclerosis, and rheumatoid arthritis.

Very difficult to diagnose, lupus arises more often in women than men and can affect many different body systems, including joints, skin, kidneys, blood cells, heart, and lungs. Estimates indicate that as many as 1.5 million Americans have lupus, and there has been no FDA-approved therapeutic in 50 years.

The Pelsue Laboratory at USM, including undergraduates, master- and doctoral-level students, is participating in efforts to uncover the function of the gene and to find a specific pathway between it and the other genes with which it interacts. These studies could help gain significant insights into how lupus develops in its early stages. If so, the team ultimately hopes to contribute to earlier identification of the disease and possible ways to help modify it.



Biological samples being prepared for analysis, one step on the road to a cure for lupus.



Hong Xie

### Testing Space Dust and Paper Particles

From particles on Earth to the moon, assistant research professor Hong Xie is evaluating the impact of human exposure to certain materials with a special emphasis on the links between cancer and heavy metals. Hong, who works in USM's Wise Laboratory of Environmental and Genetic Toxicology, is one of USM's first Ph.D. recipients through collaboration with the University of Maine.

In one project, Hong studied the toxicity of cellulose on human skin cells. About 33 percent of all plant matter is cellulose. For industrial use, cellulose is mainly obtained from wood pulp and cotton and is used to produce cardboard and paper. Because exposure is common, the research has wide-ranging application for a number of industries, including paper, agricultural, food, and pharmaceutical. Understanding the factors that can make cellulose less toxic and safer has the potential of increasing its commercial value.

In other projects, Hong is assisting in the design of a lunar station by characterizing the hazards of lunar dust so that exposure limits can be determined and controls integrated.

Hong plans to continue her research on the impact of environmental toxins on human health and hopes that someday her work will prove widely beneficial.

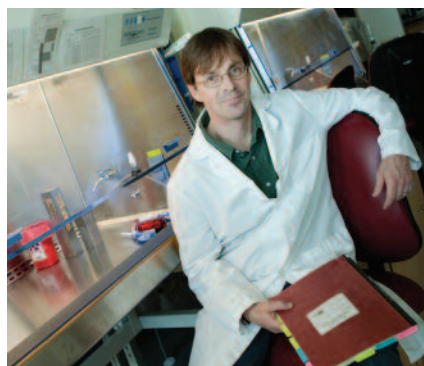
### Researching Connection between Chromium and Cancer

John Wise, director of USM's Maine Center for Toxicology and Environmental Health, has received a \$1.6 million award given by the National Institutes of Health (NIH) to fund research on how chromium causes normal cells to develop into tumors.

The five-year grant, known as a Research Project Grant, or R01, is one of the oldest NIH grant programs and one of the more competitive, with an average success rate of 5 percent. This R01 award is one of only six in the University of Maine System, and the second R01 received by Wise.

The grant makes it possible for Wise to continue his research into how chromium alters cell division, thereby causing normal cells to become tumor cells. Chromium is widely recognized as a carcinogen, but it remains a popular additive in industrial products such as road paint and anti-corrosives. Chromium is also used in boat paints, metal plating and fuel combustion. Wise's research has shown even short-term exposure to chromium produces an abnormal number of chromosomes, yet it is still unknown how this results in cancer.

### Focusing on Arsenic and the Developing Brain



Dr. Doug Currie in the lab

Working with colleagues at the Maine Center for Toxicology and Environmental Health, Doug Currie, an assistant professor of biology at USM, has been awarded a 3-year grant from the National Institutes of Health to further his research into the effects of arsenic on humans.

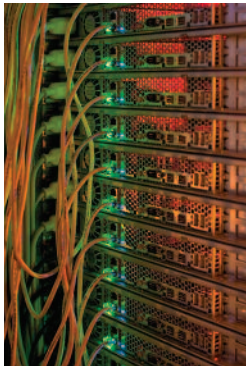
Arsenic contamination of ground water is a significant issue in a number of New England states. In southern Maine, approximately 40% of the

population gets water from private wells and an estimated 13% of these wells contain more than 10 micrograms of arsenic per liter, which is the limit set by the U.S. Environmental Protection Agency.

In previous studies, Currie and his team of USM students showed that arsenic disrupts neuron growth, complexity, and survival. This grant focuses specifically on neuron growth by looking at the low-dose exposure levels that affect growth, but have a minimal effect on survival. Currie hopes to determine the effects that low-level concentrations of arsenic have on the developing nervous system.

As a first step in understanding the potential consequences for the developing brain, Currie has initiated an analysis of the effects of arsenic on growth and the cytoskeleton in neurons developing in culture.

## 2009 INFORMATION TECHNOLOGY



USM's server cluster used in the development of the MoTech software.

### Improving Health with Mobile Phones

USM graduate student Brent Atkinson is part of an international team of faculty, programmers, and health officials who have been funded by the Bill and Melinda Gates Foundation to determine if mobile phones can improve health services in developing countries.

Over the past year, Atkinson, who is pursuing his master's in computer science, has been working with USM Professor Bruce MacLeod and USM programmer Matt Blanchette, a USM graduate, on software that will allow nurses and families to receive timely health information via mobile phones.

The Mobile Technology for Community Health (MoTeCH) initiative will determine how mobile technology could be used to improve natal care in rural Ghana. The project focuses on developing a suite of services delivered over low-end mobile phones that provides relevant health information to pregnant women and encourages them to seek antenatal care from local facilities.

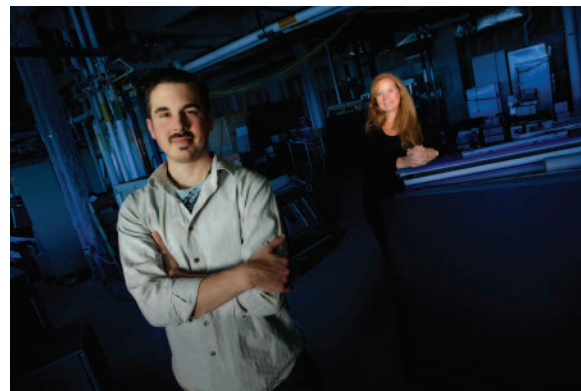
Specific tools will also be created for health workers to track patients and the services they receive. Atkinson and Blanchette are designing the program that will determine when and what information to send to health workers and families. In 2010, Professor MacLeod and Atkinson will travel to Ghana to pilot the project in consultation with a Ghanaian tech company.

### Going Global with GIS

USM undergraduates Alex Peppe and Nevins Bartolomeo—both computer science majors—are key members of a team of faculty and research staff in USM's Research Computing Group (RCG), who are working with the Maine GeoLibrary Board to enhance the GeoPortal, an ever-growing online catalogue of free spatial data that provides information in a wide range of fields, from community planning to public health to the environment.

Peppe, who plans to pursue his Ph.D. next fall, is researching options for the GeoPortal's map viewer to make it more attractive and user-friendly, and will write the actual code to develop it.

Bartolomeo, who administers the servers necessary for the programs to run, started taking classes in industrial technology at USM, but is now planning to pursue a career in data security. For both students the project is an invaluable part of their education and an enhancement to what they learn in the classroom.



USM award-winning student Ryan Small and Assistant Professor Clare Congdon Bates.

### Winning International Awards for Computer Science

USM computer science student Ryan Small of Auburn won an artificial intelligence competition at the 2009 Congress on Evolutionary Computation (CEC) held in Trondheim, Norway.

Small, an undergraduate and program analyst at IDEXX Laboratories, entered the "Unreal Tournament" competition, designed to evaluate how well an artificial intelligence program can play a challenging interactive game. Such games are popular subjects for artificial intelligence research because the games are fast-paced and different each time they are played.

The annual CEC is one of the leading events in evolutionary computation. It is an international conference that covers topics, ranging from computer vision to biological applications to evolutionary games. In addition to presentations from researchers throughout the world, the event features competitions that illustrate advances in computing and pose cutting-edge challenges.

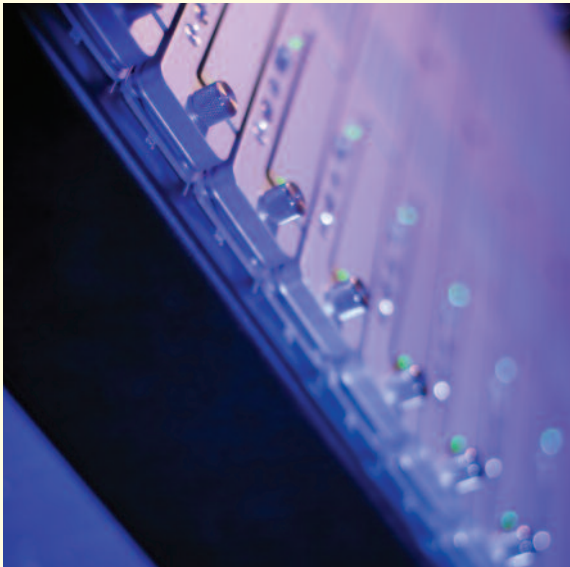
In what USM Assistant Professor Clare Bates Congdon described as an almost unprecedented move, undergraduate Small delivered a research paper at the CEC on designing artificial intelligence systems. It was well received and, according to Congdon, generated "nonstop questions" from the audience.

### Assisting Displaced Workers at BNAS

A team of faculty and students from USM's Research Computing Group and professional staff from USM's Continuing Education program have developed a training program to assist workers at the Brunswick Naval Air Station (BNAS) and the surrounding region who are losing their jobs as a result of the base closure.

In collaboration with the Maine Department of Labor and the Coastal Counties Workforce Institute, the USM team (including USM faculty and a graduate student as instructors) is delivering the program to 25 former BNAS employees as a test case at the Mid Coast Center for Higher Education.

In a departure from more traditional IT training for displaced employees, this program emphasizes both computer skills and an introduction to business fundamentals. In addition to one of two skill concentrations—Web site design or computer networking—the students are provided with workplace skills since some may be unfamiliar with common practices and the culture of private industry.



Micro technology is used to solve macro employment problems.



Dr. Congdon is developing computerized models to reconstruct hypothesized evolutionary histories through the creation of "trees of life."

### Cracking the H1N1 Code

Clare Bates Congdon, an assistant professor of computer science at USM, with help from a of undergraduates, is working on a new project with collaborators at Washington University and the Universidad Nacional Autonoma de Mexico to study the 2009 Swine Flu (H1N1) outbreak.

The project will compare genetic sequences from hundreds of related human, swine, and avian viruses in an effort to model the evolutionary path of the disease and to better understand the potential threats to human health.

The goal of this work is to reconstruct hypothesized evolutionary histories through the creation of "trees of life." Using a high-capacity computer, the USM team will initially interpret the large amount of data collected by biologist Gerardo M. Nava, who curated the extensive flu data.

Sketching out influenza's "tree of life" will show how this common virus has evolved, how the deadly 1918 flu compares to the 2009 outbreak, and how the virus adapts over time. The team is looking at more than 1,500 sequences from samples dating as far back as 1918.

### New in 2009: MEIF Small Campus Initiative

The MEIF Small Campus Initiative is designed to support research performed at the five University of Maine System institutions that previously haven't received MEIF funds: University of Maine at Augusta, University of Maine at Farmington, University of Maine at Fort Kent, University of Maine at Machias, and University of Maine at Presque Isle.

The fund is distributed annually on a competitive basis and helps ensure that each campus in the System has an opportunity to compete for MEIF funds to help build and improve research infrastructure and capacity. The fund is administered by the University of Maine System Office.

Fund guidelines:

- Funds must be used to perform university-based research in one of the seven designated MEIF strategic research areas: aquaculture and marine sciences, biotechnology, composites and advanced materials technologies, environmental technologies, information technologies, advanced technologies for forest and agriculture, or precision manufacturing.
- Funding decisions will also take the following criteria into account: extent to which external funding sources can be leveraged, extent to which research will result in long-term, direct application to enhance Maine's economic or commercial capacity, and extent to which the research builds on a program of successful partnerships, funding and economic impact.
- No single item or request will exhaust the supplemental funds available to the five eligible universities.
- Projects that feature collaborative work between the university applying for the funds and the University of Maine or the University of Southern Maine will receive preferential consideration.



Chunzeng Wang, left, and Michael Sonntag, right, discuss UMPI's GIS project with students Brittany Hickey, second from left, and Letian Zheng.

### FY09 Small Campus Initiative grant recipients:

#### UNIVERSITY OF MAINE AT AUGUSTA

**Project: The Genetic Stock Structure of Spiny Dogfish from the Gulf of Maine: a Collaborative Project between UMA and the Mount Desert Island Biological Laboratory**

Christopher Lage, assistant professor of biology  
Award: \$10,000

#### UNIVERSITY OF MAINE AT FORT KENT

**Project: An Undergraduate Research Study to Investigate the Source of Fecal Contamination in a Fort Kent River Using a DNA-Based Technique**

Kim Borges, associate professor of environmental studies  
Award: \$25,000



UMFK environmental studies student Heather DeCotes collects water samples.

#### UNIVERSITY OF MAINE AT MACHIAS

**Project: Developing Marine Science Programs with Fishermen and Communities to Create New Economic Opportunities in Downeast Maine and Washington County**

Brian Beal, professor of marine ecology and Douglas McNaught, assistant professor of marine biology  
Award: \$50,000

#### UNIVERSITY OF MAINE AT PRESQUE ISLE

**Project: Developing a Cemetery Geographic Information System (GIS) Database for Historic, Cultural, and Social Research in Aroostook County**

Chunzeng Wang, assistant professor in geology; Lynn Eldershaw, assistant professor in the School of Professional Programs and Business; Kimberly Sebold, associate professor of history; Michael Sonntag, vice president of Academic Affairs  
Award: \$15,000

## 2009 APPENDIX A

## LEGISLATIVE HISTORY OF STATE RESEARCH APPROPRIATION FOR OPERATIONS

The following is a summary of the actions of the 118th–123rd Maine Legislatures with regard to appropriating research funds to the University of Maine System for operations:

### 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, Section S-3) that appropriated \$4 million to UMS for research. These funds were allocated from the FY98 year-end state surplus for use in FY99.

### 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 FY99 \$4 million research appropriation that was funded from the FY98 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 1999–00 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 FY03 \$2 million Supplemental Appropriation by \$1 million.

**July 1, 2002:** Governor signed a Financial Order that curtailed the FY03 \$2 million Supplemental Appropriation by an additional \$1 million. This eliminated the FY03 increase of \$2 million for research, bringing the FY03 research and development appropriation back to the FY02 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 FY04. 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 FY05 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 FY07 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 FY08 and an additional \$1 million in FY09 on a “base budget” basis for research.

**2009 APPENDIX A**

**LEGISLATIVE HISTORY OF STATE RESEARCH APPROPRIATION FOR OPERATIONS  
NEW APPROPRIATION**

**118th LEGISLATURE**

	<b>FY98</b>	<b>FY99</b>	<b>Total 2-Year</b>
UMaine	\$400,000	\$3,200,000	\$3,600,000
USM	100,000	800,000	900,000
<b>Total</b>	<b>\$500,000</b>	<b>\$4,000,000</b>	<b>\$4,500,000</b>

**119th LEGISLATURE**

	<b>FY00</b>	<b>FY01</b>	<b>Total 2-Year</b>
UMaine	\$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>

**120th LEGISLATURE**

	<b>FY02</b>	<b>FY03</b>	<b>Total 2-Year</b>
UMaine	\$0	\$0	\$0
USM	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

**121st LEGISLATURE**

	<b>FY04</b>	<b>FY05</b>	<b>Total 2-Year</b>
UMaine	\$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>

**122nd LEGISLATURE**

	<b>FY06</b>	<b>FY07</b>	<b>Total 2-Year</b>
UMaine	\$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

**123rd LEGISLATURE**

	<b>FY08</b>	<b>FY09</b>	<b>Total 2-Year</b>
UMaine	\$1,200,000	\$720,000	\$1,920,000
USM	300,000	180,000	480,000
UMM	0	50,000	50,000
UMFK	0	25,000	25,000
UMPI	0	15,000	15,000
UMA	0	10,000	10,000
<b>Total</b>	<b>\$1,500,000</b>	<b>\$1,000,000</b>	<b>\$2,500,000</b>

**Total Yearly Research Appropriation for FY09**

	<b>FY09 Appropriation</b>
UMaine	\$11,680,000
USM	2,920,000
UMM	50,000
UMFK	25,000
UMPI	15,000
UMA	10,000
<b>Total</b>	<b>\$14,700,000</b>



## UMS STATE-FUNDED RESEARCH

**November 3, 1998:** Maine voters approved a \$20 million bond issue to improve the Maine economy by supporting innovative research and development. UMS received \$13.5 million from this bond for capital improvements and equipment purchases to support research and development. The bond proceeds were distributed between UMaine (\$10.8 million) and USM (\$2.7 million).

**June 4, 1999:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 401) that appropriated \$2.5 million in 2000–01 to UMS on a “base budget” basis to pay the debt service on a \$25 million university R&D revenue bond. The university issued the revenue bond August 15, 2000. It provides \$20 million for the UMaine Engineering Science Research Building and \$5 million for the USM Portland Science Building Lab Renovation.

**April 25, 2000:** Governor signed into law a one-time supplemental appropriation (Chapter 731) that appropriated \$9 million for the renovation of teaching laboratories and classrooms in Aubert Hall at UMaine.

**June 11, 2002:** Maine voters approved a \$35 million bond issue to be used in part to stimulate job growth. UMS received \$9 million, with the bond proceeds distributed to UMaine (\$5 million) for the Advanced Manufacturing Center and to USM (\$4 million) for the Mitchell Center.

**June 10, 2003:** Maine voters approved a \$60 million bond issue to be used to stimulate job creation and economic growth. UMaine and USM received a combined \$15 million to support their research efforts, \$3.6 million of which was matching funds for MEIF R&D projects.

**November 8, 2005:** Maine voters approved a \$20 million bond issue to be used to stimulate economic growth and job creation. UMaine received \$3 million for the development of the Laboratory for Surface Science and Technology, and renovations associated with the Graduate School of Biomedical Sciences. Maine voters also approved an \$8.9 million bond related to agriculture and the environment. UMaine received \$800,000 for improvements to the Witter Teaching and Research Farm.

**November 6, 2007:** Maine voters approved \$50 million in research, development, and commercialization funds for targeted technology sectors, to be awarded after a competitive process administered by the Maine Technology Institute. UMaine received eight awards totaling \$17,378,345 to further support their research and development efforts. The University of Maine at Presque Isle received \$96,800 to implement an information mapping and analysis facility.

**FY09 SUMMARY OF STATE FUNDING FOR RESEARCH CAPITAL PROJECTS  
UMAINE/USM COMBINED**

	Referendum Bond Portion	Total Other Funds	Project Budget	Expenditures to Date
<b>FY99 State Bond Issue (Approved by voters 11/03/1998)</b>				
UMaine	\$10,800,000	\$1,168,622	\$11,968,622	\$11,968,622
USM	2,700,000	155,100	2,855,100	2,855,100
<b>TOTAL</b>	<u>\$13,500,000</u>	<u>\$1,323,722</u>	<u>\$14,823,722</u>	<u>\$14,823,722</u>
<b>FY01 University R&amp;D Revenue Bonds (Debt Service Paid by \$2,500,000 State Appropriation – Issued 8/15/2000)</b>				
UMaine	\$20,000,000	\$1,203,296	\$21,203,296	\$21,087,255
USM	5,000,219	4,730,426	9,730,645	9,730,645
<b>TOTAL</b>	<u>\$25,000,219</u>	<u>\$5,933,722</u>	<u>\$30,933,941</u>	<u>\$30,817,900</u>
<b>FY01 One-Time State Appropriation (signed by Governor 4/25/2000)</b>				
UMaine	\$9,000,000	\$3,446,439	\$12,446,439	\$12,446,439
<b>FY02 State Bond Issue (approved by voters 6/11/2002)</b>				
UMaine	\$5,000,000	\$0	\$5,000,000	\$4,683,909
USM	4,000,000	45,029	4,045,029	4,045,029
<b>TOTAL</b>	<u>\$9,000,000</u>	<u>\$45,029</u>	<u>\$9,045,029</u>	<u>\$8,728,938</u>
<b>FY03 State Bond Issue (approved by voters 6/10/2003)</b>				
UMaine	\$7,000,000	\$799,189	\$7,799,189	\$7,726,149
USM	4,400,000	0	4,400,000	4,400,000
<b>TOTAL</b>	<u>\$11,400,000</u>	<u>\$799,189</u>	<u>\$12,199,189</u>	<u>\$12,126,149</u>
<b>FY05 State Bond Issue (approved by voters 11/08/2005)</b>				
UMaine	\$3,800,000	\$302,105	\$4,102,105	\$3,946,498
<b>FY07 MTI Grants (approved by voters 11/06/2007)</b>				
UMaine	\$6,868,726	\$0	\$6,868,726	\$444,279

APPENDIX C

UNIVERSITY OF MAINE SYSTEM  
UTILIZATION OF FY09 OPERATING RESEARCH APPROPRIATION

UMAINE

Targeted Research Area	Source of R&D Funds			Utilization of R&D Funds			Balance	
	FY09 R&D Base Budget	Unused R&D Funds from Prior Years	FY09 Total R&D Funds Available	FY09 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY10 <sup>1</sup>
Adv. Technology Forestry & Agriculture	\$2,098,000	\$19,078	\$2,117,078	\$2,486,024	\$41,986	(\$784,971)	\$1,743,039	\$374,039
Aquaculture & Marine Science	1,620,000	(905,216)	714,784	2,124,386	749,850	(1,683,783)	1,190,453	(475,669)
Biotechnology	1,300,000	180,516	1,480,516	1,265,326	14,292	(243,248)	1,036,370	444,146
Composites	1,100,000	1,336,079	2,436,079	1,349,359	796,310	(101,959)	2,043,710	392,369
Environmental	1,500,000	145,397	1,645,397	1,460,598	377,772	(582,881)	1,255,489	389,908
Information Technology	2,300,000	511,155	2,811,155	2,396,167	366,966	(125,791)	2,637,342	173,813
Precision Manufacturing	1,420,000	258,457	1,678,457	1,897,805	43,310	(265,569)	1,675,546	2,911
Cross Sector	342,000	285,662	627,662	248,082	36,799	146,954	431,835	195,827
GoMOOS & Commercialization (one-time)	0	0	0	0	0	0	0	0
Unassigned - reallocated by System	0	0	0	0	0	0	0	0
<b>Total State Funding</b>	<b>\$11,680,000</b>	<b>\$1,831,128</b>	<b>\$13,511,128</b>	<b>\$13,227,747</b>	<b>\$2,427,285</b>	<b>(\$3,641,248)</b>	<b>\$12,013,784</b>	<b>\$1,497,344</b>
UM Cost Sharing Funding <sup>2</sup>	\$3,641,248	\$31,926	\$3,673,174	\$0	\$0	\$3,641,248	3,641,248	\$31,926
<b>TOTAL FUNDING</b>	<b>\$15,321,248</b>	<b>\$1,863,054</b>	<b>\$17,184,302</b>	<b>\$13,227,747</b>	<b>\$2,427,285</b>	<b>(\$0)</b>	<b>\$15,655,032</b>	<b>\$1,529,270</b>

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

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

UNIVERSITY OF MAINE SYSTEM  
USM UTILIZATION OF FY09 OPERATING RESEARCH APPROPRIATION

USM

Targeted Research Area	Source of R&D Funds			Utilization of R&D Funds			Balance	
	FY09 R&D Base Budget	Unused R&D funds from Prior Years	FY09 Total R&D Funds Available	FY09 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY10 <sup>1</sup>
Aquatic Systems	\$361,991	\$0	\$361,911	\$341,166	\$0	\$24,985	\$366,151	\$(4,160)
Biotechnology	2,285,321	69,389 <sup>2</sup>	2,354,710	1,693,815	520,847	(39,250)	2,175,411	179,299
Information Technology	272,688	(150)	\$272,538	249,583	8,558	14,265	272,406	132
<b>Total State Funding</b>	<b>\$2,920,000</b>	<b>\$69,239</b>	<b>\$2,989,239</b>	<b>\$2,284,564</b>	<b>\$529,405</b>	<b>\$0</b>	<b>\$2,813,968</b>	<b>\$175,271</b>

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

<sup>2</sup>Includes \$3,472 audit adjustment.

APPENDIX C

UNIVERSITY OF MAINE SYSTEM  
 FY09 SUMMARY UTILIZATION OF OPERATING RESEARCH APPROPRIATION

	Source of R&D Funds			Utilization of R&D Funds				Balance	
	FY09 R&D Base Budget	Unused R&D Funds from Prior Years	University Cost Sharing	FY09 Total R&D Funds Available	FY09 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized <sup>1</sup>	Unused Funds Carried Forward To FY10
UMAINE	\$11,680,000	\$1,831,128	\$3,673,174	\$17,184,302	\$13,227,747	\$2,427,285	-	\$15,655,032	\$1,529,270
USM	2,920,000	69,239		2,989,239	2,284,564	529,405	-	2,813,968	175,271
UMM	50,000			50,000	40,386			40,386	9,614
UMFK	25,000			25,000	24,272			24,272	728
UMPI	15,000			15,000	13,416			13,416	1,584
UMA	10,000			10,000	4,616			4,616	5,384
<b>Total State Funding</b>	<b>\$14,700,000</b>	<b>\$1,900,367</b>	<b>\$3,673,174</b>	<b>\$20,273,541</b>	<b>\$15,595,001</b>	<b>\$2,956,690</b>	<b>\$ -</b>	<b>\$18,551,690</b>	<b>\$1,721,851</b>

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



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