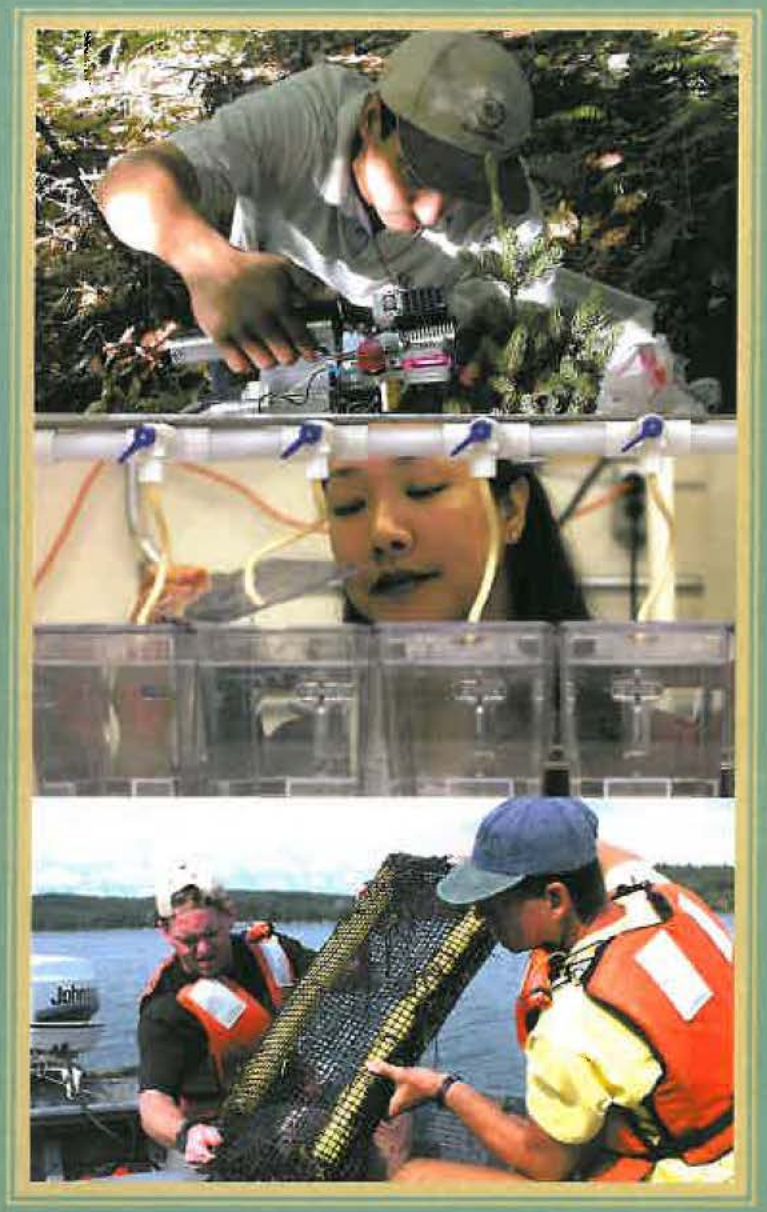

UNIVERSITY OF MAINE SYSTEM

MAINE'S MOST VALUABLE PUBLIC ASSET

The catalyst for Maine's future

Maine's Public Universities

UNIVERSITY OF MAINE SYSTEM

STATE FUNDED RESEARCH ANNUAL REPORT

December 2004

Maine's Public Universities

UNIVERSITY OF MAINE SYSTEM

STATE FUNDED RESEARCH ANNUAL REPORT

DECEMBER 2004

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* The narratives provided demonstrate the breadth and diversity of research conducted at UMaine and USM in FY04. Far from all-inclusive, these stories highlight the significant ways that R&D activity spurs innovation, job creation, and economic development in Maine.

INTRODUCTION

Maine's Public Universities

UNIVERSITY OF MAINE SYSTEM

STATE FUNDED RESEARCH ANNUAL REPORT

December 2004

In 1997, the Maine Legislature established the Maine Economic Improvement Fund (MEIF) to help increase federal and private investment in university-based research. The action responded to the documented cause-and-effect relationship between university research activity and economic growth—specifically, the creation of new products, new technologies, new industries, and new jobs. By creating and funding MEIF, Maine policy makers forged a successful partnership between the State and its University System, one that is helping accelerate and facilitate a stronger, healthier, and more vibrant economy and economic climate.

MEIF was created to focus on seven key areas of great importance and potential to Maine:

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

Under Maine law, the State appropriates MEIF funds directly to the University of Maine System, which in turn allocates the funds to the University of Maine (UMaine) and the University of Southern Maine (USM), the two universities with specific institutional responsibility for basic and applied research in the seven research areas.

At both universities, MEIF funds are used for similar purposes: 1) to provide the required matching funds necessary to leverage grants and contracts; 2) to purchase research equipment and acquire or upgrade the physical space in which research will be conducted; and 3) for targeted support of researchers, support staff, and students. However, the use of those funds differs according to the role, history, and current needs of the two universities.

For UMaine, MEIF funding is intended to help extend and expand the university's well-established, historic role as the State's primary and most diverse research institution. With UMaine's formal responsibility as a research institution dating back to its founding in 1865, it already has a significant amount of infrastructure in place and therefore can use a large portion of its MEIF funds to target specific research and grant opportunities.

For USM, MEIF funding is intended to serve a different, equally important purpose: to help the university build and develop the necessary infrastructure to compete for research funding in fields of scientific and economic relevance to the institution and its region. Though its program of externally funded research is much younger than UMaine's, USM has, in recent years, made significant progress in building both its research potential and its ability to attract research grants. For USM, MEIF funding is essential to develop the infrastructure necessary to expand the university's research capacity and promise. Once that infrastructure is in place, USM will be better positioned to attract external research grants and contracts.

Through utilization of the State research appropriations, the University of Maine System is contributing dramatically to the State's economic development. During the fiscal year ending June 30, 2004 (FY04), UMaine and USM used MEIF funds to attract $42.8 million in external grants and contracts, primarily from the federal government. Those funds support hundreds of jobs, purchase millions of dollars in goods and services, and lead to the creation of new technologies and industries that will fuel Maine's economy.

Consider the following highlights from FY04:

- **SUCCESS:** Using MEIF funds as leverage, UMaine and USM were awarded a record **$42.8 million** in external grants and contracts for research related specifically to the MEIF initiative's seven targeted areas of economic growth and potential.
- **RETURN ON INVESTMENT:** The State of Maine received a **4-for-1** return on investment for its $10.5 million of MEIF appropriation.
- **STRATEGIC IMPACT:** Overall, a total of **$53.3 million** ($42.8 million in external grants and contracts plus $10.5 million of MEIF investment) was invested in university-based research and development in MEIF's seven targeted areas (Table 1).
- **CREATING JOBS:** **857** full-time equivalent (FTE) positions were created and/or supported as a result of MEIF funds and external grants and contracts. Of that total, **150** positions were supported directly through MEIF funds, and **707** positions were partially or totally paid from R&D grants and contracts leveraged through MEIF funds.

TABLE 1

	FY04 Expenditures & Physical Plant Commitments	Used To Match Grants & Contracts	Total Funds Utilized	Funds Carried Forward to FY05
UMaine	$6,914,492	$1,631,644	$8,546,136	$0
USM	$1,860,776	$115,395	$1,976,171	$36,522
Total R&D Funds	$8,775,268	$1,747,039	**$10,522,307**	$36,522
Grants & Contracts Generated			**$42,846,202**	
Total Funds			**$53,368,509**	

UNIVERSITY OF MAINE *HIGHLIGHTS*

GRANTS AND CONTRACTS: **The Return on Investment in University-based Research**

With MEIF support, UMaine made significant progress in its efforts to expand R&D activity and the positive economic influence it creates.

Overall, in FY04 UMaine submitted 609 grant proposals involving 355 researchers from 52 departments. Those grant proposals totaled $150.7 million, a substantial increase over FY03 (535 proposals totaling $124.9 million). The rate of success was extremely impressive: UMaine faculty members, graduate students, and other researchers were awarded $59.7 million in overall grants and contracts. That amount constituted a 13 percent increase over the previous year and produced the highest total in UMaine history.

Of that total, $40.5 million was linked directly to—and thus made possible by—strategic use of MEIF funding to leverage federal and private research grants and contracts for the seven target research areas. When factoring into the equation additional research funding provided through UMaine itself, total university expenditures for R&D—that is, money from federal, private, State, and university sources that was spent on research-related payroll, goods and services, and other expenses—increased by 16 percent over FY03 totals, to a record $70.6 million in FY04. That blend of funds and funding sources—much of which came from out-of-state public- and private-sector investment—represents a significant and direct infusion of money into Maine's economy. Of the $70.6 million, just $8.1 million was funded through MEIF; an additional $9.9 million was provided through voter-approved R&D bond issues.

TABLE 2

The University of Maine had significant grant and contract activity in all seven of Maine's targeted sectors, leveraging nearly $40.5 million in external grants and contracts:

Maine Targeted Research Area	External Grants
Aquaculture/Marine Science	$12,183,772
Biotechnology	$4,507,252
Advanced Materials and Composites	$6,196,543
Environmental Technologies	$3,533,453
Advanced Technologies for Forestry and Agriculture	$5,716,850
Information Technologies	$6,083,536
Precision Manufacturing	$2,232,765
Total All Sectors	**$40,454,171**

UMaine also experienced a 22 percent increase in research and development contracts with businesses and industries, spurred by UMaine's improved R&D infrastructure and research capacity. Those contracts reached $2.7 million in FY04.

POSITIONS LEVERAGED

- In FY04, 739 job positions at UMaine were created and/or supported as a result of MEIF funds and external grants and contracts. This includes a total of 125 positions directly supported by MEIF funds, and an additional 614 people paid through R&D grants and contracts leveraged from the MEIF funds.
- The Institute for Molecular Biology (IMB) is a major new research initiative. Started with a National Science Foundation EPSCoR grant, the IMB-a partnership with the Jackson Laboratory and the Maine Medical Center Research Institute-has supported the hiring of five faculty researchers, six staff, and three post-doctoral researchers. In addition, two graduate and three undergraduate students were supported in the program's first year. In all, 23 other faculty, staff, and graduate students are affiliated with the center. The IMB has the potential to become a major research group, and NSF has just awarded the group more than $1 million for a 4Pi microscope-the first of its kind in the United States and only the second in the world.

FACILITIES AND EQUIPMENT

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

- In FY04, construction was nearly completed on the new 51,000 square-foot Engineering and Science Research Building. Scientists and students from the Laboratory for Surface Science and Technology (LASST) and the Department of Electrical and Computer Engineering began moving into the building in July 2004. The building includes a 3,500 square-foot "class 1000" clean room for research and development in the areas of nanotechnology, microfabrication, sensors, and biotechnology.
- The Advanced Manufacturing Center was nearing completion at the end of FY04, with move-in expected in the late fall. The 30,000 square-foot facility dedicates 20,000 square feet to machining and materials testing.
- The Advanced Engineered Wood Composites Center completed the lab expansion that was funded by the June 2003 Jobs for Economic Growth Bond. The 7,500 square-foot addition increases the world-class lab's size to 48,000 square feet, and will help the center prepare for the $7

million in Army funding due in FY05 for development of an Army Center of Excellence in Composite Structures.

- At the Center for Cooperative Aquaculture in Franklin, construction began on a new 32,000 square-foot hatchery building, which was primarily funded by the Economic Development Administration and Maine incubator funding. In addition, construction began on a large portion of the USDA Agriculture Research Service aquaculture center, which is co-located at Franklin. The center includes nearly $3 million in shared infrastructure, including a new state-of-the-art seawater pumping, filtering, and sterilization building; new seawater and freshwater reservoirs; and complete back-up power generation.
- Design work has begun on the Student Innovation Center, a 5000-plus square-foot building on campus that will support the creation of innovative businesses by students involved in R&D and the creative economy. In addition, credit and non-credit courses are being developed to encourage entrepreneurship and increase opportunities for graduates to use their education in Maine. Several of the companies started at the Target Technology Incubator have been created by graduate students commercializing their research.
- Major equipment (greater than $50,000) purchases included 19 pieces of scientific equipment with a total value of $2 million. This equipment outfits labs throughout the University.
- Super-computing capabilities received a major boost with the installation of the U.S. Army-funded 256 dual node Apple G5 cluster at the Target Technology Center. Added to the existing Blackbear/Kearney Machine, it gives UMaine capacity on par with any educational institution north of Pittsburgh.

INCREASED STUDENT INVOLVEMENT IN RESEARCH

Graduate and undergraduate students continue to play a major role in research at UMaine. Nearly $14 million from grants and contracts was used to support students in all technology sectors. Graduate students receive stipends and tuition, while undergraduates are paid hourly to work in labs and on projects.

Two National Science Foundation GK-12 programs support graduate science and engineering students who go into K-12 classrooms and work with students and teachers to better understand their research and science. Students also worked with blueberry farmers and food science researchers looking at the health benefits of blueberries, while others worked with sensor researchers on the development of new sensors.

TECHNOLOGY TRANSFER AND COMMERCIALIZATION

UMAINE continues its vibrant technology transfer and commercialization program. The University's total patent portfolio now contains more than 50 patents, patent applications, and international patents.

In FY04 UMaine filed four new patent applications, and six new U.S. Patents were issued:

1/ U.S. 6,598,013 "Method for reducing cross-talk within DNA data" *Information Technology: increases the speed and accuracies of DNA sequencing*

2/ U.S. 6,610,125 "Selective filtration and concentration of toxic nerve agents" *Biotechnology: technology to be commercialized by Orono Spectral Solutions*

3/ U.S. 6,699,575 "Wood composite panels for disaster-resistant construction" *Composites: Advanced Engineered Wood Composites Center*

4/ U.S. 6,699,363 "Modified starch and process therefore" *Forestry and Environment: reduces expensive chemicals in papermaking; used in Maine paper making, and soon to be used throughout North America and Europe*

5/ U.S. Patent 6,703,014 "Attractants and repellents for Colorado potato beetle" *Forestry: joint with USDA Agriculture Research Service (ARS)*

6/ U.S. Patent 6,745,132 "Method for determining the molecular weight of a substance contained in a solution" *Environment*

UMaine signed license agreements with three Maine companies to commercialize UMaine patents: Stillwater Scientific of Orono; Biode Inc. of Westbrook; and Saltwater Marketing of Portland.

UMaine helped start or spin-off four new companies: Orono Spectral Solutions of Orono; Maine Marine Manufacturing LLC of East Boothbay; Entwood, LLC of Bangor; and Knife Edge Productions of Orono.

UMaine's Target Technology Incubator, one of seven such incubators among the state-wide Applied Technology Development Centers, provides both physical space and business counseling services to technology companies. Even though the center had only been open for two years at the end of FY04, it had already graduated one company that has located in Ellsworth. Two other spin-off companies from UMaine—Stillwater Scientific and Intelligent Spatial Technologies—were tenants during FY04. The incubator also has an affiliate program that serves companies that want to take advantage of the programs and services of the incubator,

but do not need physical space. There were 11 affiliate companies in FY04. In addition, more than 100 other individuals received referrals or counseling from the incubator.

More than 200 people from all parts of the State have participated in the program's award-winning Lunch and Learn series of seminars since the program began. The seminars cover topics such as patent basics, market research, commercialization, business development, and human resource issues.

The Target Technology Center also hosts a patent attorney from the Maine Patent Program, which is part of the University of Maine School of Law. Students, faculty, and area companies can receive assistance without traveling to Portland. The Patent Program also held eight inventors' forums in FY04, with 38 people attending and 14 attending more than once.

UMaine also partners with the Maine Aquaculture Innovation Center to manage an aquaculture incubator, another of the Applied Technology Development Centers. The incubator has locations in Franklin, at the Center for Cooperative Aquaculture Research (CCAR) and in Walpole, at the Darling Marine Center. The CCAR incubator has two tenants: Seabait of Maine; and Maine Halibut Farms. The Darling Center incubator has one tenant: Microtechnologies. All of these companies are moving toward full-scale commercialization and have received Maine Technology Institute grants to further their development.

The Composites Technology Center is also managed by a partnership that includes the Sanford Industrial Development Corporation, the Town of Greenville, Eastern Maine Development Corporation, and UMaine. The Target Technology Incubator provides management assistance while the Advanced Engineered Wood Composites Center provides sources of new technology and technical assistance. The facility in Sanford is fully occupied and a new building is under construction in Greenville that will open in January 2005.

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 Coastal Acadia Development Corporation, the Piscataquis Economic Development Corporation, the Millinocket Area Growth and Investment Council, the Town of Franklin, the City of Brewer, the Town of Greenville, and the City of Bangor. These projects also support business development, attraction, and recruitment.

THE UNIVERSITY OF MAINE FY04 HIGHLIGHTS

UMaine R&D activity marked record-setting milestones in FY04:

- **Grants and contracts reached $59.7 million.**
- **Total R&D expenditures reached $70.6 million.**
- **609 proposals were submitted, with $150.7 million requested from external sponsors.**
- **More than 1,900 publications were produced by faculty and staff.**
- **UMaine leveraged $40.5 million in external grants and contracts.**
- **739 job positions were created and/or supported through MEIF funds and external grants and contracts.**
- **Nearly $14 million from grants and contracts was used to support students in all technology sectors.**
- **Construction progressed on several state-of-the-art research facilities.**
- **$2 million in major equipment was secured to outfit labs throughout the University.**
- **Four new patent applications were filed, and six new U.S. Patents were issued.**
- **UMaine helped start or spin-off four new companies.**
- **The Target Technology Incubator housed two tenants, supported 11 affiliate companies, and provided referrals or counseling to more than 100 individuals.**
- **UMaine-affiliated aquaculture incubators – located in Franklin and Walpole – supported three tenants moving toward full-scale commercialization.**

GRANTS AND CONTRACTS: **The return on Investment in University-based Research**

MEIF investments have significantly increased both USM's ability and success in attracting federal research dollars and has allowed USM to secure equipment and infrastructure that will put it in position to attract even more outside funding in the future. Overall, externally funded R&D activity increased 36 percent in FY04—on pace to double every five years—with every MEIF dollar spent matched by 1.1 times that amount in federal dollars ($2M to $2.2M).

The number of research proposals submitted for external funding grew significantly as well, with USM faculty members and other researchers applying for a total of $77.6 million in FY04. Of special note, The School of Applied Science, Engineering and Technology reached a new high with proposals totaling $10.7 million. As a result of the record proposal level, awards totaled $48.4 million, a $6.1 million increase over FY03. Over the past two years alone, USM has generated a $14.1 million increase in external funds, a 41 percent gain. Every division has shown increased activity over this period, led by the School of Applied Science, Engineering and Technology; and the College of Nursing and Health Professions, which both received more awards in FY04 than in the two prior years combined.

When factoring into the equation all research funding sources—federal, private, State, and university—the total amount USM spent in FY04 on research-related payroll, goods and services, and other expenses increased to $40.5 million compared to $34.8 million in FY03. (Some of the $48.4 million awarded to USM in FY04 will be expended in FY05 or later, given that the research activity itself is not confined to a single fiscal year.) Without MEIF support and the incentives and opportunities it provides, USM would not have experienced the same level of research success and certainly could not have generated the same level of economic infusion resulting from its R&D activity.

POSITIONS LEVERAGED

- In FY04, 118 job positions at USM were created and/or supported as a result of MEIF funds. This includes a total of 25 FTE positions directly supported by MEIF funds, and an additional 93 positions paid partially or totally through R&D grants and contracts leveraged from the MEIF funds.
- The growth of bioscience research at USM has included new positions for postdoctoral fellows and Ph.D. students. In FY04, the Wise Laboratory of Environmental and Genetic Toxicology recruited two postdoctoral fellows, and USM's R&D effort supported five doctoral candidates in the USM/UM cooperative Ph.D. program in Biochemistry, Microbiology and Molecular Biology.
- As part of its Biosciences initiative, USM recruited and hired a new faculty member, Douglas Currie, to its department of Biological Sciences in September 2003. The appointment of Dr. Currie, a developmental neurobiologist, has created opportunities for collaboration with other researchers and members of USM's toxicology center. This collaborative research is focusing on investigating the effects of exposure to arsenic in utero on neuronal development in the brain. Arsenic contamination of ground water is a significant issue in a number of New England states, including Maine.

FACILITIES AND EQUIPMENT

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

- In FY04, Phase One of the biosciences addition to the Science Building on the Portland campus was completed and made fully operational, with laboratory suites, equipment rooms, an animal facility, and technology infrastructure that includes data back-up and storage systems as well as wireless networking. Administrative offices for Research Initiatives were moved to temporary occupancy on the third level of the building in January 2004, bringing total research space utilized in the new wing of the building to 27,000 square feet. Phase Two construction began in the summer of 2004 to build three additional floors (27,000 square feet) that will eventually house more laboratories and bioscience research facilities.
- Major equipment (greater than $50,000) purchases included five pieces of scientific equipment to outfit the core facilities of the toxicology center: a Genepix Microarray Scanner; a Quantitative PCR System for the analysis lab; a high-speed centrifuge; a high-power light microscope with high resolution optics; and a high throughput Comet Assay system for detection of damaged DNA at the cellular level.
- Throughout FY04, USM worked with the Gulf of Maine Research Institute to prepare for USM's lease of approximately 6,000 square feet of research and laboratory

UNIVERSITY OF SOUTHERN MAINE *HIGHLIGHTS*

space at the newly constructed GMRI facility on Portland's waterfront. This partnership with GMRI, and USM's planned occupancy in January 2005, will open up new opportunities for USM's aquatic systems research and regional collaboration among marine scientists.

- The State bond passed in June 2002 provided approximately $4 million to upgrade and expand the John Mitchell Center at USM's School of Applied Science, Engineering and Technology on the Gorham campus. State monies were matched by $2 million in federal funds and $2 million dollars in contributions from local industry, for a total of $8 million for the project.

The initiative to expand the John Mitchell Center at USM is a response to the State need for increased offerings in engineering and technology programs—both vital to the economic growth of Maine and the region. The project was completed in Fall 2004, and provided:

- Laboratory space for computer engineering, mechanical engineering, environmental safety and health, material testing, and electro-mechanical technology
- Expanded laboratory space for digital arts and technology
- Equipment and instrumentation needed to support engineering and technology laboratories
- Administrative and faculty offices
- Modern and flexible classrooms and seminar rooms

INCREASED STUDENT INVOLVEMENT IN RESEARCH

- The expansion of research activity at USM has benefited students in many ways, from new opportunities for internships and fellowships, to collaborative projects with faculty mentors. The visibility, student involvement, and pride in research activity at USM was evident at USM's first undergraduate research conference, Thinking Matters, held in April of 2004. More than 200 USM students participated in the conference, which included poster displays illustrating student research and oral presentations.

- The National Science Foundation awarded $2.4 million to a USM team to increase the number and diversity of students receiving degrees in science, technology, engineering, and mathematics (STEM) throughout northern New England.

TECHNOLOGY TRANSFER AND COMMERCIALIZATION

- USM's School of Business Center for Entrepreneurship and Small Business hosted a statewide Technology Commercialization and Incubation Summer Institute in the summer of 2004. The event drew policy makers and entrepreneurs, among others, for an opportunity to share best practices on ways to convert new ideas and products into successful businesses that, in turn, boost the State's economy.

- **Technology Law Center/Maine Patent Program**
  The Technology Law Center at USM operates at the intersection of law, science, and innovation. Founded in 1999, the Center offers courses, public seminars and workshops, conferences, and other educational outreach activities to teach Maine's academic and business communities about the role of intellectual property in economic growth.

  The Center also administers the Maine Patent Program, and through this program the Center provides patent counseling services to Maine's entrepreneurs, small businesses, research scientists and independent inventors. Since its founding in 2000, the Program has grown significantly in staff, stature, and output.

  With offices in Portland and Orono, the Center and Program presently employ two full-time attorneys who are experts in intellectual property law, a part-time patent agent, a full-time administrative manager, and two part-time administrative assistants. Professional staff work with up to three law students in the office at any given time and offer internship opportunities for students in other departments within the University System. Another full-time patent attorney will be hired within the next few months to serve as Director of the Program.

  In FY04, the Center hosted and participated in several significant conferences on intellectual property law, science, and innovation. In June 2004, the Bio-Innovations conference drew 90 attendees from the business, legal, economic development, technology transfer, and scientific research communities in Maine. The Program also offered several workshops across the state on the basics of patents, trademarks, and product commercialization; received more than 100 requests for videotaped presentations of basic patent seminars; and hosted the Maine Inventors Forum.

PROGRAMS IN FY04	ATTENDEES
Patent Basics	130
Special Workshops	150
Maine Inventors Forum	270
Conferences & Forums	500
No. of mailed videotapes/requests for services	125
Total number of Maine residents reached in FY04	**1,200 (approx.) at 34 events**

The Program's services component has grown significantly in recent months as Maine inventors, small businesses, and scientists seek patent and licensing counseling. The Program averages 10 new applications for services each month, and recently that average increased to 12.

In FY04, patent, trademark, or licensing counseling was provided to approximately 125 clients. For calendar year 2004, the Program anticipates serving 145 Maine scientists and entrepreneurs, which would mark a 23 percent increase over the previous year. Through FY04, 316 Maine clients have been served since the Maine Patent Program began.

UNIVERSITY OF SOUTHERN MAINE FY04 HIGHLIGHTS

USM R&D activity marked record-setting milestones in FY04:

- **USM generated $48.4 million in external funding.**
- **Total R&D expenditures reached $40.5 million.**
- **$77.6 million was requested through proposals.**
- **118 job positions were created and/or supported through MEIF funds and external grants and contracts.**
- **Growth of bioscience research included new positions for postdoctoral fellows and Ph.D students, the recruitment of developmental neurobiologist Douglas Currie, and the purchase of five pieces of major equipment to outfit the core facilities of the toxicology center.**
- **Facility expansion included completion of Phase One of the biosciences addition to the Science Building on the Portland campus; and expansion of the John Mitchell Center, a response to the State need for increased offerings in engineering and technology programs.**
- **USM hosted a statewide Technology Commercialization and Incubation Summer Institute that explored ways to help convert new ideas and projects into successful businesses.**
- **The Technology Law Center at USM and the Maine Patent Program continued to assist Maine's entrepreneurs in significant ways. The Center hosted and participated in several major conferences; and patent, trademark, or licensing counseling was provided to approximately 125 clients.**

AQUACULTURE AND MARINE SCIENCES

Tropical Fish Aquaculture

Maine is the perfect place to raise tropical fish, according to two University of Maine graduate student entrepreneurs in marine sciences.

Søren Hansen and Chad Callan have founded a company, Sea & Reef Aquaculture, LLC, to raise stock for the home aquarium industry. With help from a Maine Technology Institute seed grant, the Ph.D. students intend to develop new methods and lower costs for raising saltwater aquarium fish.

Both contend that tropical fish aquaculture can help the aquarium industry be more ecologically focused. Callan's interest stems from his work with a tropical fish importer, where he saw a high mortality rate among species captured in the wild. Hansen's interest is in finding alternatives to damaging the reef environments in which wild tropical fish are harvested. Since their quarry often hide inside the coral, divers sometimes use sodium cyanide solutions to stun the fish, which can kill the coral as well.

Initially, Callan and Hansen talked of starting their business in Hawaii following graduation. It was UMaine Professor of Marine Sciences David Townsend who pointed out the potential ecological dangers of exotic species escaping into warm island waters. That's when thoughts turned to Maine, where a tropical saltwater fish won't survive in the cold waters of the Penobscot River or the Gulf of Maine.

In their research, Callan is focusing on the nutritional requirements of broodstock, while Hansen focuses on the kind and concentration of prey needed to raise tropical fish larvae.

Juvenile Oyster Disease

Maine's Damariscotta River estuary is an ideal place to grow oysters. However, an organism that causes juvenile oyster disease (JOD) also finds the estuary to its liking. First recognized as a significant problem in Maine in 1988, JOD can kill more than 90 percent of the cultured young oysters in a farmer's stock.

With funding from Maine Aquaculture Innovation Center (MAIC), the U.S. Department of Agriculture and Maine Sea Grant, UMaine microbiologist Kathy Boettcher and research assistant Aaron Maloy have focused on methods to detect the troublesome bacteria (Roseimarina) and learn how it infects cultured oysters. They already know that the species has the ability to swim freely, attach to tissues and create a colony that, in effect, smothers the animal inside its shell. Yet to be understood is the complex chemistry of that process.

In 1999, UMaine researchers demonstrated that the disease could be treated with antibiotics, and thus had a bacterial origin. They then used new laboratory culture techniques and DNA analysis to discover the presence of a previously unknown species of bacteria on sick oysters.

Boettcher and Maloy are testing an inexpensive probiotic oyster treatment to protect the young from JOD. Their approach uses a species of harmless, naturally occurring bacteria identified in oysters that had survived previous JOD outbreaks. By dipping the oysters in an enriched solution of the bacteria, the scientists hope to confer a protective coating that will keep Roseimarina at bay.

Contemporary Evolution

In the rainforests, biologist Michael Kinnison studies contemporary evolution in Trinidadian guppies with funding from a nearly $400,000, four-year National Science Foundation grant. The little fish are one of the best model systems for studying how natural selection and other evolutionary processes are ongoing and observable in real time.

Such studies stand to rewrite our perceptions of evolution and perhaps even conservation strategies for endangered species like the Maine Atlantic salmon. Kinnison is involved in UMaine-based research into wild salmon conservation and serves as a statewide representative for the Maine Atlantic Salmon Technical Advisory Committee.

The controversy surrounding the endangered species listing of wild salmon involved some of the same scientific questions underlying Kinnison's guppy research, such as how the intermixing of populations of the same species affects adaptation and survival in a changing environment.

The bottom line, Kinnison says, is whether the trait variation—differences in characteristics like egg and body size, and growth rate—in salmon today is healthy and advantageous to their survival.

Genetic trait variation is at the heart of his guppy studies, in particular a process known as "gene flow," or simply the exchange of genes when different populations mix. Little is known from an empirical standpoint about the degree to which gene flow really limits most natural populations.

It's this uncertainty that makes it difficult to judge the impact of historic stocking efforts in salmon or to evaluate the implications of human impacts on gene flow in many species of concern, Kinnison says.

Cod Aquaculture

In the cold waters off Eastport, thousands of 2-year-old cod swim in 50-foot-wide aquaculture pens owned by International Aqua Foods USA. The fish raised in captivity will stay here for almost 15 months, monitored by University of Maine scientists and aquaculture industry experts, until ready for market.

The feasibility of raising cod from egg to market in Maine is the focus of research by UMaine scientists Linda Kling, an animal nutritionist; food scientist Denise Skonberg; and Nick Brown, manager of UMaine's Center for Cooperative Aquaculture Research (CCAR) in Franklin. Their work, in collaboration with Maine's aquaculture industry, is supported by a $358,000 Department of Commerce grant.

In addition to the economics of farm-raised cod, the UMaine research project is looking at disease potential, environmental impacts, feeding behavior, feed utilization, and consumer acceptance. At CCAR, a quarantine system is being developed for fish brought in as potential broodstock to prevent diseases from being carried into the hatchery.

Kling, who in the mid-1990s found a way to increase the survival of larval cod and developed a pellet feed palatable to the fish early in their development, continues to work on an early weaning diet. Skonberg will study the differences between wild and farm-raised cod, including the nutritional qualities of the meat and average weight of processed fish. Once the fish are harvested and production data collected at the end of the project, Brown will work together with the economists at Stolt Sea Farm to develop a business model for cod aquaculture.

In Cobscook Bay near Eastport, UMaine scientists Linda Kling and Bill Palmer use a video monitor to see live underwater images of some of the thousands of 2-year-old cod being grown in captivity. The cod will stay in the aquaculture pens for almost 15 months, and are expected to be ready for market in 2005.

Start-up companies:

- Microtechnologies, Seabait, Maine Halibut, and Sea & Reef are incubating on the UMaine campus.

New facilities:

- Construction has begun on a 24,000-square-foot fish hatchery at UMaine's Center for Cooperative Aquaculture Research (CCAR) in Franklin. Financed with a $1.2 grant from the U.S. Economic Development Administration and matching funds from UMaine and the Maine Aquaculture Innovation Center, the building will be used to rear commercial quantities of marine fish juvenile species including cod and halibut. The fish will be supplied to industry partners who currently have no capacity to produce these species, says Nick Brown, CCAR director.

BIOTECHNOLOGIES

Inner Workings

In Maine, three research institutions—the University of Maine, the Maine Medical Center Research Institute, and Jackson Laboratory—have combined efforts to offer a new Functional Genomics Ph.D. Program. UMaine student researchers work in collaboration with some of the leading scientists in their fields to tackle front-line questions to understand how life's building blocks function.

The National Science Foundation has jump-started the Ph.D. program with a $2.6 million IGERT (Integrative Graduate Education and Research Traineeship) grant.

Students in the program conduct research at each institution. They work closely with two mentors in different scientific disciplines, applying expertise from both disciplines in solving questions related to gene function. More than ever, addressing how genes work requires interactions among the biological, physical and computational sciences.

The program's goal is to give students opportunities to explore the inner workings of the cell's command center—the DNA, proteins and other chemicals that control development. Such knowledge is at the heart of research centers and businesses working in healthcare, the environment and the biotechnology industry.

UMaine Professor of Biochemistry and Molecular Biology Keith Hutchison administers the program with Barbara Knowles, vice president for training and education at The Jackson Laboratory. It is the collaboration among scientists in disciplines across these research organizations, says Hutchison, that gives students an advantage in pursing leading questions in genomics.

Program concentrations include the application of computational techniques to questions in genome architecture, and the interactions among genes and proteins that make the difference between health and disease. Physical processes in this molecular world also are a focus for the new Institute for Molecular Biophysics that links the three Maine institutions in collaborative research.

Securing the Home Front

Drawing from their expertise in information technology, chemistry, environmental monitoring and structural engineering, University of Maine researchers are pushing our ability to detect homeland security threats early, gather information, and give an advantage to those who are charged with maintaining vigilance.

- With support from a $1.25 million U.S. Army grant, chemist Howard Patterson is leading a research project to develop a device to detoxify the VX nerve agent. He is working with two partners—Applied Thermal Sciences Inc., (ATS) in Sanford and the Army's Edgewood Chemical Biological Center in Edgewood, Md.
- Chemist Carl Tripp and colleagues at the Laboratory for Surface Science and Technology are developing a lightweight, portable device that can identify chemicals in the air or water within seconds. His project has attracted $1 million of U.S. Army research funds to develop the device.
- With National Science Foundation support, Paul Millard of the Department of Chemical and Biological Engineering, and Mauricio Pereira da Cunha of the Department of Electrical and Computer Engineering are developing a new class of acoustic wave-based sensors to detect pathogens such as E. coli in aquatic environments.
- Neal Pettigrew, UMaine oceanographer and chief scientist for the Gulf of Maine Ocean Observing System (GoMOOS), is working with colleagues at Rutgers University and CODAR Ocean Sensors to develop an around-the-clock tracking system for ocean vessels.
- Computer scientist George Markowsky is exploring how the Internet can be used to monitor potential threats to safety and security. Moreover, new sensor systems can be combined with developing wireless communications and information technologies to enhance public safety. Markowsky also has created a homeland security laboratory in the Department of Computer Science.
- Advanced Engineered Wood Composites Center researchers are developing standards for tough new composite structures designed to withstand both terrorist-related and natural disasters. They are working with the military and government agencies, as well as private companies, on ways to apply composite technologies to bridges, ships, buildings, and other facilities.
- Understanding how security policies affect businesses that ship goods across the U.S.-Canada border is a goal for Marie-Christine Therrien of the Maine Business School and Georges Tanguay of the Department of Economics.
- With a grant from NSF's Approaches to Combat Terrorism Program, engineer Bill DeSisto is working with a Connecticut company, Yardney/Lithion Technical Products Inc., to increase the amount of energy that can be packed into a battery.

Tiny Technology

Nanotechnology and MEMS (microelectromechanical systems) are the next big design and manufacturing fields in this country. University of Maine bioengineer Rosemary Smith and biochemist Scott Collins have a combined 50 years of experience in MEMS technology, working in government, academic and industrial laboratories. Both came to UMaine from the University of California-Davis, where they directed the Microinstruments and Systems Laboratory. Their research focused on chemical and physical biomedical microsensors, and technology development for analytical microinstruments.

Smith and Collins were attracted to Maine by the possibility of doing research and development to address the needs of scientists at Jackson Laboratory. In addition, Fairchild Semiconductor International is licensed to offer the SUMMiT micromachining process, a multi-level MEMS technology created by Sandia National Laboratories, funded primarily by the U.S. Department of Defense.

Recent funding for research by Smith and Collins includes a two-year, $850,053 grant from the National Human Genome Research Institute of the National Institutes of Health. They will work with David Kotecki of the UMaine Department of Electrical and Computer Engineering to fabricate a nanopore with tiny electrodes and built-in circuits that will be used in DNA sequencing experiments.

The focus by Smith and Collins on silicon-based microelectronic technology complements the material science research of UMaine's Laboratory for Surface Science and Technology. For more than two decades, UMaine researchers have conducted research in high-tech areas related to surfaces, interfaces, and thin film materials. Their work in advanced materials ranges from basic science to applied technology in such areas as microelectronics and chemical sensors.

LASST now has a new home in the $16 million Engineering and Science Research Building opened in fall 2004.

Start-up companies:

- Tethsys is a small company based at UMaine that is developing enzymes for pulp and paper with an MTI seed grant.

For more than two decades, UMaine researchers have conducted research in high-tech areas related to surfaces, interfaces, and thin film materials. Their work in advanced materials ranges from basic science to applied technology in such areas as microelectronics and chemical sensors.

Rosemary Smith and Scott Collins use UMaine's new "clean room" laboratory for nanotechnology research.

ENVIRONMENTAL TECHNOLOGIES

Gone South for the Winter

Geologist Brenda Hall is among a small community of glacial geologists, oceanographers and climatologists who conduct research in Antarctica. By studying the melting history of the West Antarctic Ice Sheet and uncovering evidence for huge lakes in the Dry Valleys that grew and shrank with surprising rapidity, Hall is making key discoveries about the complex, interrelated mechanisms that drive worldwide climate.

Her West Antarctic Ice Sheet investigations are prompted by concerns that the massive structure could collapse and raise worldwide sea levels by up to 18 feet. The ice sheet, unlike others in Antarctica, is inherently unstable. There is evidence that the ice began rapidly shrinking about 8,000 years ago – melting that lagged millennia behind the advent of sea level rise 17,000 years ago as the last ice age ran out of steam, and may be continuing today even though sea level largely stabilized 7,000 years ago.

"It's clear there's more at work here than just sea level rise, maybe some internal mechanism in the ice that is still operating today," says the UMaine scientist. "We're trying to isolate that mechanism."

Her fieldwork is helping to test the so-called "Bipolar SeeSaw" theory that circulation patterns of two great ocean systems—the North Atlantic Deepwater and the Antarctic Bottom Water—affect global climate. According to the theory, when one system strengthens, the other weakens, which means the climate of Antarctica is out-of-phase and may exhibit telltale changes long before the rest of the globe.

Seagrass Health

Marine biologists worldwide are working with electrical and computer engineers to monitor an ecosystem in retreat. Seagrass, which provides critical habitat for commercially important fish species, occupies about 10 percent of the world's coastal seas. A continuing decline could deal another blow to an already struggling global fishing industry.

To address this problem, Australian biologist Suzanne Fyfe is using light reflected from seagrass leaves to develop an early warning system. To turn measurements of reflected light into a predictive tool, Fyfe has worked with UMaine Assistant Professor Habtom Ressom in the Intelligent Systems Laboratory (INTSYS) of the Department of Electrical and Computer Engineering. Ressom specializes in a computer software system known as an artificial neural network.

In INTSYS, the seagrass project is one of several active studies in the lab. Others focus on DNA analysis, gene expression and industrial process control. Ressom's neural network transforms the database of information into a mathematical tool, which can then be applied to remote sensing data.

Ressom and his team also are working with NASA to apply a neural net to ocean data from satellites. Their goal is to estimate chlorophyll concentrations, an indication of algal growth and ocean vitality.

On the Trail of Maine's Ice Age

Geologist Harold Borns looks out across the landscape near Cherryfield and describes a time, almost 14,000 years ago, when ocean waves broke against sheer ice cliffs and rivers poured off the edge of a dying ice sheet. It was the beginning of Maine as we know it today.

Borns has spent much of his life following the clues left by the last great ice sheets in North America, Antarctica and Europe. Now he and a group of private citizens and government agency representatives are working on a plan to share what he and other scientists have learned in Maine. The goal is to create Maine's Downeast Ice Age Trail, an idea that could have economic and educational benefits.

The Downeast Ice Age Trail could bring new visitors to the region, according to Fred Cook of Gouldsboro, executive director of the Downeast Acadia Regional Tourism Council. "We envision the trail as part of a package that will entice people who visit Acadia National Park to go to the Schoodic Peninsula, Campobello, and other places," he says.

In addition, Borns notes, the hope is to eventually extend the trail through Calais to the Bay of Fundy, creating an international attraction.

A Sea Change

Archaeologist Dan Sandweiss studies how ancient Peruvians used the seas and struggled with environmental changes. At the heart of his research are prehistoric seashells of warm-water species discovered on what is today a cold-water coast.

About 5,800 years ago, rising sea level and shifting ocean currents led to environmental change along the northern Peruvian coast in a 500-year period, he says. The climate change that gave birth to El Niño set the stage for a cultural revolution.

Knowing how El Niño got started and how people responded is important if we want to understand how environmental changes affect people today.

Anatomy of an Ice Core

Ice cores drilled from mountaintop glaciers and the world's great ice sheets provide scientists in the Climate Change Institute with unparalleled views of the planet's past. Snow containing dust from volcanic eruptions, and dissolved chemicals from land and sea, accumulates layer upon layer, providing fingerprints of past environments. University of Maine scientists study changes in atmospheric circulation, temperature, sea ice extent, volcanics, environmental change, solar variability, nutrients feeding marine ecosystems, and other areas. Ice cores enable high-resolution reconstructions of climate going back as far as 450,000 years.

Patents:

- Method for determining the molecular weight of a substance contained in a solution: A systematic treatment of chemical equilibria is used to determine the average molecular weight of the Suwannee River fulvic acids directly from aqueous solutions. Additionally, parameters such as equilibrium constant and reaction stoichiometry can be calculated. The measurement of the initial mass of unknown analysis is not needed for the determination.

Scientists from UMaine's Climate Change Institute who retrieve ice cores from Antarctica, Greenland, Asia, and North America endure some of the highest, coldest, and windiest places on Earth. They use drills that bore deep into the ice to extract cores up to 5 inches in diameter. In the field, measurements and visual observations of the cores' layers are recorded. Then the ice cores are packaged in plastic sleeves and shipped in insulated boxes. It's important to avoid chipping or melting on the long trip home. Cores come to UMaine or to the National Ice Core Lab in Colorado. On campus, the ice cores are kept in a freezer at -27 degrees Celsius.

INFORMATION TECHNOLOGIES

Target: Technology Incubation and Research Center Sets Sights on Growing Companies

Larry Thompson is a research engineer with Applied Thermal Sciences Inc., (ATS) of Sanford, but his office is more than 150 miles away at the Target Technology Center near the University of Maine. Here, he and his university colleagues work with Maine's newest supercomputer—high-end technology composed of 208 dual-processor PCs linked by more than three miles of fiber-optic cable. They are applying the latest computer modeling techniques to engineering problems as diverse as missile defense and engine performance.

Meanwhile, in a neighboring office in the technology center, partners in Stillwater Scientific Instruments Inc., are designing circuitry. UMaine scientists recently created the company to take advantage of technology developed by one of their colleagues, UMaine chemist Brian Frederick, to build a device that significantly increases the speed of mass spectrometers

Down the hall, a group of researchers is talking about forming a company to develop a digital travel aid. The invention could be the first of a family of products based on "smart maps" research at the university.

Being located at Target places ATS, Stillwater Scientific, and UMaine engineers at the heart of a much needed statewide effort to develop businesses and create jobs. The Target Center is one of seven state-supported economic development facilities known as business incubators. These facilities are designed to put scientists and engineers face to face with business development specialists, patent attorneys, and owners of existing businesses. Located in communities from Limestone to Sanford, the incubators are focusing on technology sectors such as aquaculture, precision manufacturing, and composite materials.

Target specializes in information technology. Owned by the nonprofit Bangor Target Development Corp., the 20,000-square-foot facility has rental space for existing businesses, new start-up companies and university researchers.

Debbie Neuman, director of Target Technology Incubator, is banking that a new economy can grow out of the initiatives under way in Orono. On a daily basis, she works with scientists and inventors who want to create products and jobs out of technological insight.

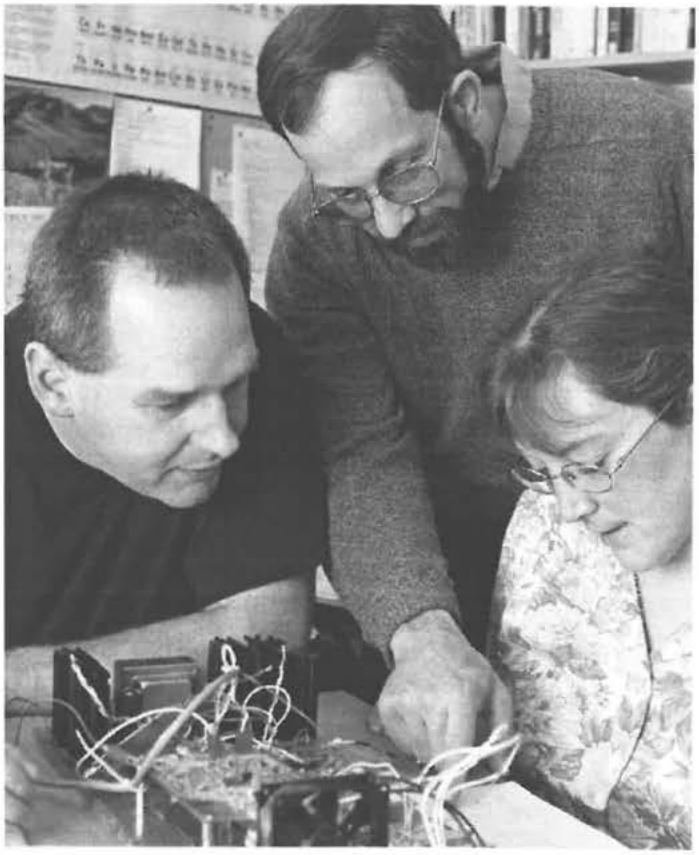
In addition to ATS, three existing firms have offices at the center: Four Directions Development Corp., of Bangor; MapTech Inc., of Amesbury, Mass.; and SGC Engineering of Westbrook. By putting emerging business neophytes like Chris Frank together with veterans, Target creates networking opportunities.

Rounding out the mix of technical and business expertise at Target are UMaine students and faculty in business, electrical and computer engineering, new media, spatial information sciences, and computer science. Moreover, businesses not ready to commit to renting space in the facility can participate in a Target Affiliate Program.

Jack Smith, vice president of ATS, sees Target as a huge benefit for his company, UMaine, and the state. To date, Smith and ATS have been instrumental in helping UMaine secure nearly $4 million in funding from the Department of Defense to build the supercomputer housed at Target. The supercomputer has been ranked as one of the 500 fastest in the world.

Using the supercomputer, ATS is simulating missile flights for the U.S. Army. In addition, Aerohydro Inc., of Southwest Harbor, has trialed software that would dramatically reduce the time it takes to create a high-performance hull. That company may be the pioneer in a supercomputing collaborative, an effort by the university to make the supercomputer accessible to all businesses in the state.

Stillwater Scientific partners review plans for state-of-the-art circuitry in a new generation of laboratory instruments.



The strong support of local companies, the in-kind contributions, and the money-making aspects were pluses in the eyes of the Maine Technology Institute, which provided a $201,000 grant for the digital filmaking initiative.

Nathan Hankla is building a "render farm" with Macintosh computers that will make parallel processing possible. The supercomputer will do in an hour what now takes eight hours to accomplish.

3-D

A new digital filmmaking laboratory at the University of Maine is expected to be a drawing card for students, businesses, and the movie industry. New media assistant professor Raphael Di Luzio has established a digital filmmaking program, including a lab equipped with cutting-edge hardware and software that could be used by both students and, for a fee, filmmakers in the state.

The lab will allow students to learn the latest ways to use digital equipment for filming, audio, animation, three-dimensional computer effects, and compositing. But Di Luzio is not just looking to build an educational program; he hopes to directly link students and the lab with filmmakers who come to Maine. This connection—plus the potential for helping nourish the state's creative economy, creating jobs, and generating revenues by teaching industry-approved software certification programs—led the Maine Technology Institute to provide a $201,000 grant.

The idea is to produce a healthy base of digital content developers who make Maine their home. The hope is to put the state on the leading edge of a changing film industry.

The program is an excellent example of adapting new technology to an existing industry that will increase Maine's competitiveness, says MTI Director Janet Yancey-Wrona. A bonus is that it will be the only lab of its kind in New England. Filmmakers will be able to use the lab, along with students, thus helping to train the local workforce and strengthen state efforts to boost its cultural economy.

Starting with versionZero

Nathan Hankla owns a small business that helps start-up companies reach potential customers. Hankla owns versionZero, a multimedia design company dedicated to "information design"—from Web pages and branding to graphic design for DVDs and brochures. He and five other UMaine undergraduates started talking about such a company two years ago, but only Hankla pursued the idea. Last year, he launched his company with the help of Target Technology Center. Hankla has since designed marketing campaigns for Target and MaineTech 2003.

Hankla, from Georgetown, Maine, was among the first UMaine students to graduate with a degree in new media. Now as a graduate student in liberal studies, he also teaches an introductory new media course.

Primary Source

Raymond H. Fogler Library, Maine's largest research library, operates in the digital age, providing 24-hour access to resources whenever and wherever they are needed. In the past decade, Fogler has taken the leadership role in the electronic networking of public and private libraries throughout Maine. As a result, the size of the library available to every citizen in the state has multiplied exponentially as patrons gain access to unlimited information resources in Maine and beyond. Fogler librarians are information specialists rather than generalists, guiding library users through the ever-changing world of digital information.

The University of Maine's digital library is poised to enter a new phase when $52.9 million in funding is secured to construct an addition, to renovate the existing facility, and to expand the library annex. The improvements are indicative of the new role large libraries play today. As libraries provide access to more information services and resources, they enhance the lifelong learning, economic growth, cultural, and entertainment aspects people want in their daily lives.

Historically, Fogler Library has always played a significant role in Maine because of its location at "the public's university," says Gary Nichols, Maine's state librarian, headquartered in Augusta. For years, Fogler Library and the Maine State Library have shared the responsibility to ensure that citizens in public libraries have access to collections statewide.

Fogler Library took the first steps into the digital age with the help of a bond issue. In the late 1980s, the referendum funded the creation of URSUS (University Resources Serving Users Statewide), an online catalog of holdings that included all University of Maine System libraries, then all libraries in the state, including legislative. And the cooperation didn't stop there.

Fogler's interlibrary loan service filled over 15,000 requests for materials held by other libraries that were requested by patrons, and loaned to other libraries more than 25,000 items from its 1 million holdings last year.

Fogler has helped Maine libraries address one of the greatest challenges in the digital age—the price tag levied on information. Often the costs for access to information databases are prohibitive for individual libraries. Fogler has helped negotiate annual subscriptions to a number of commercial databases. Purchasing these databases allows them to be accessible via the Internet to people in Maine.

"Fogler is part of the backbone of the state's library community," says Barbara McDade, director of the Bangor Public Library, noting that, per capita, Maine has more small community libraries run by volunteers than most states do. "Its leadership has meant that even the smallest communities have access to resources."

Fogler Library's collections include more than 2 million government documents and 1.4 million microform pieces. As a federal document depository, Fogler Library provides government information to Maine, Vermont, and New Hampshire. The library is a Patent and Trademark Depository, and home to a nationally recognized Canadian Studies collection. Also found in the library are such valuable collections as the William S. Cohen Papers, the manuscript collection of Stephen King, and Maine-related archives.

URSUS (University Resources Serving Users Statewide) provides an online catalog of holdings that includes all University of Maine System libraries, and all libraries in the state including legislative libraries. As libraries provide access to more information services and resources, they enhance the lifelong learning, economic growth, cultural, and entertainment aspects people want in their daily lives.

Shipshape Composites

Engineers in the University of Maine's Advanced Engineered Wood Composites Center are working with the U.S. Navy and Maine businesses to improve shipbuilding technologies. With two new federal grants totaling $2.36 million from the Office of Naval Research, the researchers will focus on redesign of the high-speed Mark V Patrol Craft and the reliability of fiber-reinforced composite ship components.

Improving the Mark Vs seaworthiness is a goal, says Robert Lindyberg, manager of technical services for AEWC. The Mark V has developed a reputation for a very rough ride, affecting the performance of SEAL teams and boat crews. Working with Hodgdon Yachts of East Boothbay, Lindyberg and other UMaine engineers will design and build a prototype that meets the Navy's needs for improved handling. In the second project, engineers will study composite material manufacturing processes. Navy tests have revealed significant differences among similar composites produced by different manufacturers. The research goal is to determine why such differences occur and how manufacturers can consistently produce reliable materials for ship construction. Collaborating on the composites research is Applied Thermal Sciences of Sanford.

UMaine's Advanced Engineered Wood Composites Center uses technology to create new, value-added products. Fiber-reinforced polymer technology has been applied to pilings for marine piers. The goal is to protect wood from attack by shipworms and other marine borers.

Patents:

- Wood composite panels for disaster-resistant construction. Analysis of structures damaged by storms, earthquakes and other disasters has found that weaknesses can exist where panels are attached to structural members. At the Advanced Engineered Wood Composites Center, fiber-reinforced polymer materials are being designed, built, and tested for use in disaster-resistant construction. These wood sheathing panels incorporate reinforcement strips of fiber-reinforced polymer in the perimeter or corners.

Start-up companies:

- AEWC research has sparked the start of four spin-off businesses, including Entwood LLC, which provides consulting services to private-sector companies interested in incorporating composites-based materials; and Advanced Engineering Solutions LLC, which is developing prefabricated composite structures. AEWC scientists and engineers consult with nearly 50 companies throughout the state.
- Maine Marine Manufacturing LLC, a spin-off of Hodgdon Yachts is working with UMaine and other Maine companies to develop next generations of the Navy's Mark V and a high-speed composite passenger ferry.

New facilities:

- The expansion of the Advanced Engineered Wood Composites Center was begun, funded by the Jobs Bond.

ADVANCED TECHNOLOGIES FOR FORESTRY AND AGRICULTURE

Alternative Energy Fueling Debate

Despite rising oil prices and federal initiatives to make the U.S. more energy self-sufficient, the nation hasn't got many advanced-technology vehicles on the road. Obstacles still exist to manufacturing them, bringing them to market, and getting people to buy them.

The stalemate is the subject of intensive study nationwide, and one of the leading researchers in the field is Jonathan Rubin of the Margaret Chase Smith Center for Public Policy. Rubin and colleagues at the Oak Ridge National Laboratory in Tennessee have created a model for analyzing the barriers to transitioning to alternative-fuel vehicles or hybrid vehicles. Alternative fuels include ethanol, methanol, propane, compressed natural gas, and electricity. Hybrid cars might run on a combination of gasoline and electricity.

The model that Rubin co-developed for analyzing barriers to getting advanced-technology vehicles on the road—the Transitional Alternative Fuels and Vehicles Model—simulates the use and cost of non-petroleum fuels under various conditions. Cost barriers are built into the model, then the effectiveness of various government policies is tested, says Rubin. To date, his analysis shows that an oil price shock lasting five years or less would not be effective, by itself, in making alternative-fuel vehicles feasible.

Maintaining Biological Diversity

As the dominant ecosystem in the northeastern United States, forests harbor much of the region's biodiversity. That's why ecologists and foresters seek timber management practices that do not degrade ecosystems. The forest industry has identified riparian areas in Maine as key sites of concern.

Riparian areas provide habitat for a broad array of species and are critical to maintaining stream water quality. To protect these sites, many forestry companies leave buffer strips, but it is unclear whether current regulations are adequate for water quality and biodiversity.

Maine Agricultural and Forest Experiment Station researchers are using amphibians to study the effects of different buffer widths on riparian biota along first-order streams in western Maine using experimental and retrospective approaches. This study is being conducted in the mountainous west-central region of Maine.

This study will help enhance the health of managed forest ecosystems by determining whether existing regulations are sufficient to maintain the biological integrity of small streams in managed forests.

Rockefeller's Views

In 1913, six years before much of Maine's Mt. Desert Island was designated as the first national park east of the Mississippi, industrialist John D. Rockefeller Jr., began constructing 57 miles of carriage roads through its heavily wooded coastal wilderness. Now those same forests along the carriage roads are getting a makeover with help from some of the best aspiring foresters in the state. Students and faculty members participating in the University of Maine's annual forestry camp are working to restore the carriage road landscape to maintain the historical integrity of Rockefeller's vision.

Fifteen years ago, the National Park Service surveyed Acadia's carriage roads and made recommendations for their rehabilitation and maintenance. That year, UMaine set up its forestry camp near Acadia to be part of the rehabilitation effort.

Since the 1920s, UMaine's annual forestry camp has provided students with hands-on training in forest management. The first forestry camps were held near the town of Princeton and at Nicatous Lake, in cooperation with loggers and local landowners. With changes in land use, UMaine's program was looking for a new location 15 years ago. That's when the mutually beneficial agreement was struck between Acadia and UMaine's Department of Forest Management.

UMaine students have conducted natural resource inventories, prepared management plans, and updated trail maps using GPS.

Future Forests

To the public, the North Woods has many faces: a source of livelihood and forest products, a recreation and sports destination, a wilderness to preserve, and an undeveloped area waiting to be tapped. Forestlands in Maine and beyond are cultural as well as natural resources with economic, aesthetic, and environmental benefits.

Underpinning all those expectations is the ability to manage forested landscapes.

As they have for centuries, our forests must continue to contribute to this country's economic foundation while increasingly being part of the global marketplace. The economic benefits, whether realized in the form of forest products, tourism, or quality-of-life issues, are crucial to our future. Such contributions to economic well-being help to stabilize the human population and ultimately to protect the environment.

Clues to what the North Woods might look like 100 years from now are rooted in the issues facing today's forests and the research being done to secure their future. This year, the University of Maine celebrates 100 years of teaching and research in one of the country's longest-running forestry programs. In recognition of the milestone, faculty provided perspectives on what it will take to balance competing demands and sustained productivity in future forests (www.umainetoday.umaine.edu/Issues/v3i5/forest.html).

The University of Maine's College of Natural Sciences, Forestry, and Agriculture conducts research on forestlands in Maine.

Waiter! There's a Blueberry in My Burger!

UMaine's food scientists are working with the state's natural resource-based industries—seafood, blueberry, potato, apple, and others—to develop new products to boost revenues and create jobs. Economic growth in Maine's modern agriculture industry cannot occur without food product development research, says Rod Bushway, chair of the UMaine Department of Food Science and Human Nutrition.

"The days are over when production agriculture is the lone factor in growth," says Bushway. "Unless you are changing the raw commodity into value-added products, you're missing the biggest potential for economic development and growth that agriculture can contribute to a state's economy."

The University of Maine is the only institution in New England and the Maritimes—and one of only 15 nationwide—that offers a formal sensory evaluation program. The state-of-the-art sensory evaluation lab has a new home in a food research pilot plant. The Department of Food Science and Human Nutrition recently relocated to Hitchner Hall, with its new $12 million science wing and pilot plant, financed largely by a research and development bond referendum in 1998.

New value-added foods are important economic development initiatives. For instance, in her seafood-based pasta research, Denise Skonberg uses both rock and Jonah crabs, the by-catch of lobster harvesting. In addition, crab is an underutilized natural resource when it is processed.

Seafood-based pasta is just one of the new products in development in UMaine's Department of Food Science and Human Nutrition. Skonberg and her colleagues worked with Cal Hancock of Hancock Gourmet Lobster Co., in Cundy's Harbor to develop stuffed ravioli. In 2001, Hancock received a $10,000 seed grant from the Maine Technology Institute to develop new lobster and crab pasta products.

In fisheries or any other natural resource-based industry, it's critical to go beyond sales of fresh products and look at frozen, value-added, and processed alternatives. With the support of the Lobster Institute, UMaine food scientists did just that in 1999 by patenting a new process to preserve the flavor and texture of frozen seafood, particularly lobster.

Other milestones in UMaine product development: the "invention" of the blueberry raisin; studies of new apple varieties; research on potatoes to improve frying, baking, boiling, and processing quality; seafood-based snack foods using calcium- and protein-rich crab; blueberry and cranberry burgers to take advantage of the natural antioxidant properties of the fruit to help preserve fresh flavor in frozen patties; high-fiber flour made from potato peels that can be added to muffins, cookies, breakfast cereals, and other foods;

ADVANCED TECHNOLOGIES FOR FORESTRY AND AGRICULTURE

antioxidant-rich blueberry puree as an oil substitute in baked goods; and salmon pepperoni and sausage.

The latter, using trim from fresh or smoked salmon, was based on research by Al Bushway and aquaculture major Doug Ewart in the early 1990s. The researchers worked with Maine's salmon industry to find naturally occurring preservatives such as spice extracts to prevent oxidation and increase shelf life. When Ewart graduated, he and his wife, also a UMaine alum, launched Out of the Blue, a company in Waldoboro, that still makes salmon sausage.

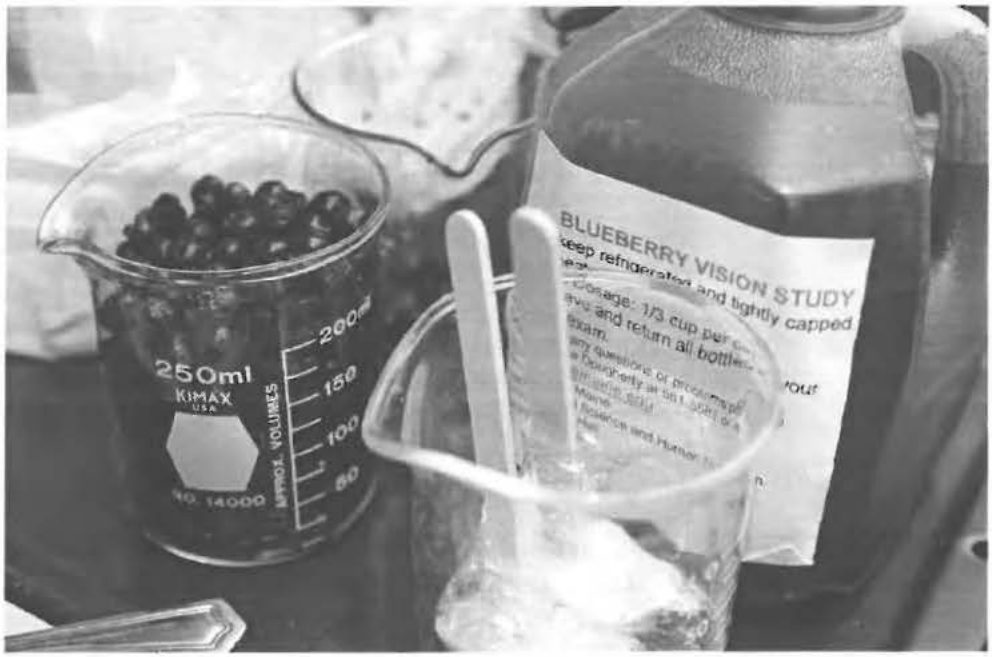
Patents:

- A method has been discovered for attracting Colorado potato beetles to an object or area using natural plant chemicals. Beetles could then be trapped or killed to reduce damage to crops.

Strengthening Rural Food Retailers

The number of independent supermarkets and small grocery stores decreased by 17.2 percent and 35.9 percent, respectively, between 1990 and 2000. While consumers have seen little change in food prices, rural communities may feel the results in accessibility to products, declining sales in other retail sectors, and a shrinking market access for small agricultural growers and producers.

To better understand the attitudes and grocery-shopping behavior of consumers, Maine Agricultural and Forest Experiment Station researchers surveyed households in eight target retail areas in rural Maine. Results from the consumer surveys have identified the major differences in how consumers view small and independent grocers compared to the larger regional and national retailers. These results will be used to develop training programs to assist small and independent grocery retailers to devise business plans that will help them increase or stabilize their businesses. Linkages between local producers and retailers will be established to evaluate models of mutual benefit for both parties as well as local consumers.



UMaine research revealed that the addition of natural antioxidants like those found in blueberries can protect the flavor of frozen meat. Seafood products are being developed at UMaine in cooperation with the university's Lobster Institute, whose research and educational outreach focus on protecting, conserving, and enhancing lobsters and lobstering as an industry.

Advancing Manufacturing

The Advanced Manufacturing Center (AMC), an innovation resource for Maine manufacturers and research laboratories, is the result of more than 90 meetings between UMaine and manufacturing companies. In 2000-2001, UMaine faculty traveled the state asking companies how the university could help them. Their answer was a one-stop shop, from concept to something that can be manufactured.

"We are not here to compete with the private sector," says Scott Dunning, AMC executive director. "We are a unique niche resource for the state, a rapid-response center for new product development."

Financial support for AMC included the Maine Economic Improvement Fund and a June 2003 public bond referendum. The advisory board includes representatives of wood, metal, and plastics products manufacturers statewide.

Dunning serves on the board of the Maine Metal Products Association and during the 1990s, managed UMaine's Industrial Assessment Center, a federally funded program to increase energy efficiency in small and medium-sized manufacturing companies. He and Tom Christensen, associate professor of bioresource engineering and AMC operations manager, knew that manufacturers could benefit from research support, but when AMC opened its doors in January 2003, they were in for a surprise. The new venture was overwhelmed with demand for its services.

AMC undertook design challenges from companies such as Fisher Engineering in Rockland, Shape Global Technology in Sanford, and Hilltop Log Homes in Bowdoinham. In addition, inventors and entrepreneurs bring new product ideas to AMC.

AMC will soon have a new, 30,000-square-foot home, enabling it to triple its student workforce and add machinery.

Students at the Center of Innovation

Graduate student Jacob Pelletier appears to be on the entrepreneurial fast track as president of Pell Innovations Inc., his newly created company in the Target Technology Center. Pell Innovations is dedicated to the commercialization of new ideas and innovations in transportation, health, structural information, agriculture, and energy technology.

But when Pelletier was an undergraduate, he says that he could have benefited from more hands-on interaction among the business, engineering, and manufacturing disciplines at UMaine. With such coordination, a student engineer like Pelletier could design a product, work with business experts to locate project resources, and then find the manufacturing know-how to fabricate a prototype.

It's the very kind of coordinated expertise that other young entrepreneurs will find in UMaine's Technology Innovation Center starting next year.

The state bond referendum in June 2003 provided $1.5 million for the creation of the center, which will help student entrepreneurs develop ideas and access the expertise of engineering, business and marketing, and manufacturing on campus.

Providing expertise and academic support for the center will be the College of Engineering and the College of Business, Public Policy and Health.

The Innovation Center will fulfill one of the key links in the state's R&D strategy for economic development—namely equipping UMaine's graduates with the skills to translate the research knowledge that they gained into businesses and jobs that will help grow the state's economy.

At the Advanced Manufacturing Center, students get practical experience with project management, teamwork and business, in addition to technical skills.

AQUACULTURE AND MARINE SCIENCES

Partnering on the Gulf

Through a partnership with the Gulf of Maine Research Institute, the University of Southern Maine is leasing research facilities on Portland's waterfront to expand its aquatic systems research and regional collaboration with marine scientists. One of the leaders in USM's emerging focus on aquatic systems is Bioscience Research Institute Senior Research Scientist Lewis Incze, whose recent activities include new collaborations and large-scale scientific projects.

The Gulf of Maine Area Census of Marine Life (CoML) program is one such project. The objective is to more fully understand regional biodiversity, the processes that determine patterns of diversity, and the functional roles of that diversity in ecosystem processes.

The Gulf of Maine Area CoML is a member of the Gulf of Maine Ocean Data Partnership, a multi-agency consortium that provides on-demand access to oceanographic data from U.S. and Canadian institutions. The partnership is hosted by the Gulf of Maine Ocean Observing System (GoMOOS).

In his research, Incze focuses on two of Maine's best-known crustaceans—lobsters and shrimp. He is part of a three-year data synthesis and modeling effort to look at the coupling of circulation in the Gulf of Maine with the egg-to-catch life history of lobsters. The project, involving 12 principal investigators from the U.S. and Canada, is driven by both basic scientific questions about population and coupled biophysical models, as well as the societal, industry, and management applications. This will be the first time that all of the life history data will be aggregated for modeling at the Gulf of Maine scale.

Incze also studies the onshore movement of shrimp, including the oceanographic conditions that influence the extent and timing of these movements, and the consequences for larval distributions and recruitment. Now entering the last third of this three-year study, Incze is in collaboration with the University of Maine, the Department of Marine Resources, the Gulf of Maine Research Institute, and the University of New Hampshire.

In the Georges Banks GLOBEC (Global Ocean Ecosystems Dynamics) program, Incze is part of a modeling team looking at the influence of physical processes at the tidal mixing front on the transport and production of plankton supporting the early life stages of larval cod. USM's portion of the work addresses the zooplankton and zooplankton-larval fish coupling component.

Natural Filters

In the Northeast, where salmon is the dominant aquaculture species, the ability of hatcheries and finfish farms to meet the Environmental Protection Agency's wastewater discharge standards is a matter of major economic concern. To address environmental pollution through discharge, one of the major problems of finfish aquaculture, University of Maine System scientists are exploring seaweed-fish integrated polyculture systems

Seaweed polyculture removes or bioremediates dissolved nitrogen and phosphorous from effluents prior to discharge producing one or more valuable byproducts. The commercially valuable seaweed called Porphyra or nori is an especially attractive biofilter in such an integrated bioremediation system because of its accelerated growth rates over a wide range of temperatures, high rate of nutrient uptake, well-developed aquaculture technology, harvesting ease, and ability to grow in reduced salinities.

One of the researchers studying the viability of seaweed polyculture is Lewiston-Auburn College professor Ira "Ike" Levine, who is developing a freshwater hatchery effluent bioremediation system to reduce effluent discharge. With a two-year, $150,000 USDA Northeastern Regional Aquaculture Center grant, Levine is studying how to increase Porphyra cultivar growth rates and development of freshwater-tolerant strains.

The successful assemblage of a land-based system and the development of ultra-low salinity tolerant seaweed cultivars reduce environmental pollution in marine (salmon, halibut, cod, and shrimp) and freshwater (juvenile salmon, catfish, trout, and tilapia) aquaculture operations, enabling the technology to be independent of coastal operations resulting in nation-wide applications. Pilot farm development has been discussed with fish farm operators from West Virginia to Maine.

Future pilot scale testing of the system is scheduled at the Gulf of Maine Research Institute in Portland and the University of Maine's Center for Cooperative Aquaculture Research Facility in Franklin.

Investigating Invasives in Casco Bay Estuary

A team of 25 scientists from around the world gathered last fall to hunt for aliens in the waters stretching from Casco Bay to New York Harbor—non-native invasive species with the potential to impair sport and commercial fishing, degrade recreational experiences, and spark public health problems. The focus of their eight-day rapid assessment were marine invasive species on floating docks and piers in coastal waters.

The team was assembled by the University of Southern Maine's Casco Bay Estuary Project, in cooperation with other Northeast National Estuary Program partners and MIT Sea Grant. It was accompanied by a National Geographic Society film crew that was preparing a segment for an "Explorer" television program.

Goals of the study are to develop a baseline inventory of species, to identify creatures recently introduced into the ecosystem, and to assist managers in preventing and controlling future invasions.

The Casco Bay Estuary Project supports cooperative efforts to protect and restore the health of the Casco Bay ecosystem, while ensuring compatible human uses through effective management and stewardship. Early last year, the project received more than $500,000 to protect and restore the Bay's ecosystem—one of 28 National Estuary Programs to be funded under the federal Omnibus Appropriations Bill.

The funding will provide storm water technical assistance to local municipalities, funds for locally driven habitat restoration and conservation projects, and the publication of a State of the Bay 2005 report. In addition, funding will support water quality monitoring by local environmental groups, Friends of Casco Bay, Presumpscot River Watch and Lakes Environmental Association; and local watershed planning by the New Meadows River Watershed Committee and the Friends of the Royal River.

Lewiston-Auburn College Professor Ira "Ike" Levine is studying the viability of growing the commercially valuable seaweed called Porphyra. Levine is using a two-year, $150,000 USDA grant to research ways of increasing Porphyra growth rates and to develop freshwater-tolerant strains.

BIOTECHNOLOGIES

Targeting Toxins

University of Southern Maine scientist and Portland native John Wise, until recently an environmental toxicologist at Yale, doesn't think Maine is the way life should be. Maine ranks first and fifth in the nation for bladder cancer deaths among females and males, respectively. It also is above the national average for lung and colorectal cancers, and has one of the highest rates of asthma-related deaths in New England. Arsenic, mercury, lead, and other metals are prevalent in Maine, and scientific findings have established direct links between these contaminants and many fatal diseases.

Despite all this, Maine has been the only state in New England without a toxicology center for studying the effects of environmental contaminants on human health. Wise has changed that with the establishment of Maine's first toxicology center, USM's Center for Toxicology and Environmental Health. The plan is to develop an internationally recognized research program that develops new knowledge about the causes and prevention of environmentally related diseases.

Four new investigations into the toxic effects of metals are being launched, including studies of the toxic effects of arsenic by USM professors Stephen Pelsue and Doug Currie, and Professor Ed Bilsky at the University of New England, and a study of the toxic effects of lead by USM Professor Vince Markowski. These new studies complement exposure assessment studies of arsenic and lead in Maine already underway by Center member Andy Smith at the Maine Bureau of Health.

In his research, Wise uses cell culture models and state-of-the-art molecular and toxicological techniques to investigate the effects of metals and particulates on humans and marine animals. With NIH funding, Wise's team has developed human lung cells that have been altered genetically to extend their lifespan, but that otherwise retain a normal cellular state, thereby providing cell lines better suited for researching cancer.

They also are studying the role of heavy metals in causing cancers in marine mammals, and comparing the effects to metal-induced carcinogenesis in humans.

The Center's associate director is USM epidemiologist Douglas Thompson, who specializes in cancer studies, especially in breast and lung. Thompson conducted the first study to show the impact of secondhand smoke: his research showed that nonsmoking adults who grew up in households with smokers have an increased risk of lung cancer. He has also studied genetic markers and risk factors for breast cancer.

Inside the Maine Center for Toxicology and Environmental Health

The new Maine Center for Toxicology and Environmental Health has three core facilities that provide state-of-the-art technology to center members to support major research initiatives. An emerging fourth core facility is Gene Expression. The Center's core facilities include:

- Biostatistics, Bioinformatics and Computational Analysis: The work in the center involves large epidemiology studies, developmental toxicology, animal studies and gene expression studies involving microarrays. These efforts generate large databases that require the extensive use of complicated statistics.
- Cellular and Molecular Imaging: The ability to image and understand the events that occur at a cellular or subcellular level is an important aspect of toxicological investigations. A principal objective is to provide instrumentation and expertise for imaging of toxicant effects in vivo and in vitro.
- Chemical Exposure and Assessment: Measuring and interpreting levels of environmental contaminants is key to the center's research. This core facility provides exposure of study animals to contaminants and assessment of contaminant levels in tissues and cell cultures. The inclusion of medaka, a small Japanese fish, provides an important parallel to the mouse model, fostering comparative, collaborative research projects within the center.

Early Detection

In recent years, antibiotic resistant strains of infectious bacteria have proliferated. In response, medical professionals attempt to treat the problematic bacteria by prescribing progressively harsher antibiotic medications, but adverse side effects can result. In the worst case, bacterial strains are emerging that cannot be thwarted by any antibiotics currently available.

The majority of antibiotics prescribed to treat bacterial infections belong to a class of compounds known as the ß-lactams or cillins, such as penicillin, ampicillin and amoxicillin. These compounds contain a consistent chemical structure, known as a ß-lactam ring, the structural feature responsible for antibiotic efficacy. It also is the site in the compound susceptible to attack by rogue strains of bacteria. Over time, bacteria develop resistance to antibiotics because they are capable of producing an enzyme, called ß-lactamase, which chemically reacts with and cleaves the cyclic ß-lactam portion of the antibiotic, rendering the drug inactive.

USM Assistant Professor of Chemistry Caryn Prudenté is exploring the development of early, easy and fast methods capable of detecting ß-lactamases, a primary indicator of antibiotic resistance. The primary goal of this Prudenté's research is to help design a small, easy-to-operate ß-lactamase screening device, providing an alternative format to current costly and labor-intensive detection methods.

A Cell Library for Marine Mammals

Researchers at the University of Southern Maine have established the nation's most extensive Marine Cell Line Library, a vital tool for understanding and protecting endangered whales and other marine mammals. The living cell repository will allow scientists worldwide to conduct research on endangered marine mammals without harming or interfering with living animals. It will provide critical information for researchers hoping to discover the cause of major die-offs and strandings among some whale species, and also may lead to comparative studies between marine mammals and humans.

The National Marine Cell Line Library is supported, in part, by grants from the National Oceanic and Atmospheric Administration and the National Institutes of Health.

People around the world do human cell culture and rodent cell culture, but very few people do marine animal culture, says USM toxicologist John Wise, who is leading the initiative. These animals are too big to bring into the lab, they are federally protected, and many are endangered. Consequently, we have very limited knowledge of how viruses, toxicants, and pollution are affecting them.

USM scientists receive their tissue samples from a network of collaborators, including Mystic Aquarium and the Marine Mammal Center in Sausalito, Calif.

USM scientist John Wise established USM's Center for Toxicology and Environmental Health, the state's first toxicology center. The Center focuses on important issues such as childhood asthma, Maine's arsenic problems, and environmental causes of cancer.

Spinach Strength

Residents of Portland's Parkside neighborhood may soon have an unusual tool to help combat lead contamination in their soil—spinach.

The Environmental Protection Agency recently awarded $30,000 to a University of Southern Maine soil scientist and Portland city officials to develop phytoremediation gardens in Parkside yards that test positive for unsafe levels of lead. Phytoremediation is the use of plants—in this case, spinach—to help clean up environmental toxins. Plant roots absorb contaminants from the soil and concentrate them in their own cells. Those plants can then be removed and destroyed as toxic waste, leaving a cleaner soil behind.

Professor of Environmental Science and Policy Samantha Langley-Turnbaugh, aided by a team of student researchers, has been testing soils at 39 Parkside properties for lead contamination. Once test results are tabulated, properties will be identified as potential sites for phytoremediation gardens to be planted in the spring.

Langley-Turnbaugh pioneered her work in urban phytoremediation in Portland's Bayside neighborhood under an EPA grant. Three spinach gardens were planted there, with toxic spinach harvested and analyzed at USM laboratories. Preliminary data indicate soil lead contamination at one garden was reduced by 50 percent following phytoremediation.

While lead contamination is a concern in any neighborhood, Langley-Turnbaugh says it is of special concern in neighborhoods such as Bayside and Parkside with their large populations of immigrants and refugees. Many people grow crops in small backyard gardens for cultural reasons and to supplement limited income, she says, so lead can pose health problems.

USM Professor Samantha Langley-Turnbaugh (l.) and a student researcher harvest spinach from a Portland neighborhood to remove toxins from the soil. Langley-Turnbaugh has pioneered her work through an EPA grant.

The IRIS Interface

USM's Institute for Research in Information Science (IRIS) is dedicated to building capacity and technology infrastructure to serve the growing number of research projects and complex instrumentation requirements in the biosciences. Among the FY04 activities highlights:

- IRIS students and staff designed, developed and deployed the Web site for the Gulf of Maine Biogeographic Information System (GMBIS). The GMBIS Web site (http://gmbis.iris.usm.maine.edu) makes spatially referenced data available and easily accessible to a wide variety of users including researchers, policy makers and educators.
- IRIS Web designers worked collaboratively with members of the Maine State Planning Office Maine Coastal Program on a contract to develop the State of Maine Think Blue Web site (www.thinkbluemaine.org). The Web site serves as a clearinghouse of information, acts as a catalyst for networking and partnering amongst local stream and river groups, and provides reference materials and training opportunities to advance stream protection efforts throughout the state.
- RI-NET, a local area network customized to the needs of USM researchers, was created to support the increase in research activity and needs for high-quality data management, delivery, and storage.
- The final production version of the Earth System Science Idea Book Web site was established, hosted on the IRIS production server (http://research.usm.maine.edu/earth/). The purpose of the Earth System Science Ideabook, an NSF-funded project, is to provide support for educators in making earth science courses and careers accessible to all students. The site has been demonstrated internationally and is linked to the NSF Earth Science educational site library.

When North America and Africa Collided

Two University of Southern Maine professors are using space-age technologies and sea kayaks to map the collision between North America and Africa that happened 500 million years ago.

Geographer Matthew Bampton and geologist Mark Swanson are analyzing previously undocumented evidence of the complex geologic history of the Maine coast. The two professors and students use sea kayaks to navigate the Muscongus Bay region, where they set up their recording equipment on rocky outcrops.

The researchers' tools include a Global Positioning System (GPS) integrated with infrared equipment to pinpoint tiny geologic details along Maine's coastline. The information gathered is then displayed using Geographic Information Systems (GIS) technology, which combines a powerful database and a three-dimensional graphic capacity. Using this digital mapping capability, they can map much more precisely and zoom out via computer from tiny details to the large scale.

This collaborative professor-student research project is part of a National Science Foundation-funded Research Experience for Undergraduates (REU) program. The program is designed to attract talented undergraduate students and to encourage them to continue their careers in scientific and technology-based research.

The USM-based project, which has attracted nine students throughout the country, is one of only three or four such programs in the country using the emerging spatial technologies.

USM Associate Professor of Geography Matthew Bampton, USM Professor of Geology Mark Swanson, and a team of students used a Global Positioning System (GPS) and Geographic Information Systems (GIS) technology to map the collision between North America and Africa that happened 500 million years ago. This collaborative professor-student research project is part of a National Science Foundation (NSF) funded Research Experience for Undergraduates (REU) program. The USM-based project attracted nine students throughout the country and is one of a handful of programs in the country using the emerging spatial technologies of GPS and GIS.

APPENDIX A

LEGISLATIVE HISTORY OF STATE RESEARCH APPROPRIATION FOR OPERATIONS

The following is a summary of the actions of the 118th, 119th, 120th, and 121st Maine Legislatures with regard to appropriating research funds for operations to the University of Maine System:

118th LEGISLATURE

March 26, 1997: Governor signed into law the Economic Improvement Strategy (Chapter 24) that appropriated $0.5 million 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 1999/00 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 $0.3 million 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 2002/2003 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 & 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 on July 1, 2002.

121st LEGISLATURE

January 30, 2004: Governnor signed into law a Supplemental Appropriation budget (Chapter 513) that includes a provision to transfer to MEIF up to $2.0 million of any unbudgeted State revenue remaining at the close of FY04. The full amount was subsequently transferred and added to MEIF's FY05 base budget.

NEW APPROPRIATION

118th LEGISLATURE

	FY98	FY99	Total 2-Year
UM	$400,000	$2,300,000	$3,600,000
USM	100,000	800,000	900,000
Total	$500,000	$4,000,000	$4,500,000

119th LEGISLATURE

	FY00	FY01	Total 2-Year
UM	$4,440,000	$40,000	$4,480,000
USM	1,110,000	10,000	1,120,000
Total	$5,550,000	$50,000	$5,600,000

120th LEGISLATURE

	FY02	FY03	Total 2-Year
UM	$0	$0	$0
USM	0	0	0
Total	$0	$0	$0

121st LEGISLATURE

	FY04	FY05	Total 2-Year
UM	$0	$1,600,000	$0
USM	0	$400,000	0
Total	$0	$2,000,000	$0

TOTAL YEARLY RESEARCH APPROPRIATION

	FY01-FY04
UM	$ 8,080,000
USM	2,020,000
Total	$10,100,000

STATE FUNDING FOR CAPITAL RESEARCH PROJECTS

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 issue to be used 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 on August 15, 2000 that provides $20 million for the UMaine Engineering & Science Research Facility 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 being 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 in part to stimulate job creation and economic growth. UMaine and USM received a combined total of $15 million to support their research efforts, $13.6 million of which was matching funds for MEIF R&D projects.

FY 2004 SUMMARY OF STATE FUNDING FOR RESEARCH CAPITAL PROJECTS

UMAINE/USM COMBINED

Project Name	Referendum Bond Portion	Other Funds	Total Project Budget	Expenditures to Date
FY1999 State Bond Issue (approved by voters 11/3/1998)				
UM	$10,800,000	$1,363,622	$12,163,622	$11,811,191
USM	2,700,000	155,000	2,855,000	2,855,000
Total	$13,500,000	$1,518,622	$15,018,622	$14,666,191
FY2001 University R&D Revenue Bonds (Debt Service Paid by $2,500,000 State Appropriation – Issued 8/15/2000)				
UM	$20,000,000	$837,896	$20,837,896	$19,073,874
USM	5,000,000	4,211,334	9,211,334	9,072,154
TOTAL	$25,000,000	$5,049,230	$30,049,230	$28,146,028
FY2001 One-Time State Appropriation (signed by Governor 4/25/2000)				
UM	$9,000,000	$3,226,986	$12,226,986	$10,482,170
FY2002 State Bond Issue (approved by voters 6/11/2002)				
UM	$5,000,000	$0	$5,000,000	$2,530,626
USM	4,000,000	73,500	4,073,500	2,915,434
Total	$9,000,000	$73,500	$9,073,500	$5,446,060
FY2003 State Bond Issue (approved by voters 6/10/2003)				
UM	$7,000,000	$132,905	$7,132,905	$1,934,526
USM	4,400,000	0	4,400,000	531,509
Total	$11,400,000	$132,905	$11,532,905	$2,466,035

UMAINE

Project Name	Referendum Bond Portion	Other Funds	Total Project Budget	Expenditures to Date	Funds Carried Forward To FY2005	Estimated Completion Date
FY1999 State Bond Issue (approved by voters 11/3/1998)						
Hitchner Expansion & Renovation and Food Science Building	$9,400,000	$739,220	$10,139,220	$9,899,302	$239,918	6/30/05
Hitchner FY2001 Revenue Bond Interest	0	438,860	438,860	326,347	112,513	6/30/05
Aquaculture Renovation & Expansion	200,000	0	200,000	200,000	0	10/31/01
CRW Lab Related Work	250,000	64	250,064	250,064	0	6/15/99
Boardman Hall Basement Renovation	0	159,398	159,398	159,398	0	2/01/02
Barrows Lab Renovation	74,015	1,080	75,095	75,095	0	5/10/01
Software Eng & Adv Material Labs	875,985	25,000	900,985	900,985	0	10/25/00
	$10,800,000	1,363,622	$12,163,622	$11,811,191	$352,431	
FY2001 University R&D Revenue Bonds (Debt Service Paid by $2,500,000 State Appropriation – Issued 8/15/2000)						
Engineering & Science Research Facility	$14,600,000	$500,000	$15,100,000	$13,556,682	$1,543,318	3/31/05
Machine Tool Lab Addition	200,000	0	200,000	194,823	5,177	6/30/05
Advanced Manufacturing Center	2,460,000	0	2,460,000	2,244,473	215,527	12/01/04
Hitchner Addition	2,000,000	0	2,000,000	2,000,000	0	12/31/02
Boardman Hall Renovation	500,000	0	500,000	500,000	0	2/01/02
Underground Steam Distribution Upgrade	240,000	337,896	577,896	577,896	0	10/31/03
	$20,000,000	$837,896	$20,837,896	$19,073,874	$1,764,022	
FY2001 One-Time State Appropriation (signed by Governor 4/25/2000)						
Aubert Hall–Phase 1	$9,000,000	$1,226,986	$10,226,986	$10,213,059	$13,927	4/30/04
Aubert Hall–Phase 2	0	2,000,000	2,000,000	269,111	1,730,889	12/31/05
	$9,000,000	$3,226,986	$12,226,986	$10,482,170	$1,744,816	
FY2002 State Bond Issue (approved by voters 6/11/2002)						
Advanced Manufacturing Center	$3,600,000	$0	$3,600,000	$1,494,219	$2,105,781	9/30/05
CAM Tools Advanced Materials Center	$1,200,000	0	1,200,000	1,036,345	163,655	3/31/05
Cloke Plaza	200,000	0	200,000	62	199,938	9/30/05
	$5,000,000	$0	$5,000,000	$2,530,626	$2,469,374	
FY2003 State Bond Issue (approved by voters 6/10/2003)						
Blueberry Hill Building	$150,000	$0	$150,000	$54,539	$95,461	12/31/04
Blueberry Hill Office/Lab	450,000	0	450,000	27,854	422,146	6/30/05
Aroostook Farm Greenhouse	120,519	77,905	198,424	146,926	51,498	12/31/04
Rogers Farm Storage Barn	49,481	0	49,481	48,481	0	12/31/04
Littlefield Garden Electric Service	25,000	0	25,000	15,951	9,049	12/31/04
Highmoor Farm Irrigation	60,000	25,000	85,000	26,277	58,723	3/31/05
Rogers Farm Bathroom Renovation	20,000	0	20,000	15,907	4,093	12/31/04
Witter Center Facility Improvements	58,625	0	58,625	57,463	1,162	12/31/04
Witter Farm Bathroom Improvements	10,000	0	10,000	7,824	2,176	12/31/04
Demeritt Forest Facilities	56,375	30,000	86,375	78,279	8,096	12/31/04
Innovation Center	1,500,000	0	1,500,000	987	1,499,013	6/30/06
AEWC Expansion	3,000,000	0	3,000,000	1,219,632	1,780,368	10/31/05
Capital Equipment for AEWC Expansion	1,500,000	0	1,500,000	233,406	1,266,594	6/30/05
	$7,000,000	$132,905	$7,132,905	$1,934,526	$5,198,379	

USM

Project Name	Referendum Bond Portion	Other Funds	Total Project Budget	Expenditures to Date	Funds Carried Forward To FY2005	Estimated Completion Date
FY1999 State Bond Issue (approved by voters 11/3/1998)						
Portland Science Building Lab Renovation	$2,254,890	$30,000	$2,284,890	$2,284,890	$0	7/01/05
Portland R&D Parking	57,966	0	57,966	57,966	0	7/01/03
Mitchell Center R&D Renovations	387,144	125,000	512,144	512,144	0	11/30/00
	$2,700,000	$155,000	$2,855,000	$2,855,000	$0	
FY2001 University R&D Revenue Bonds (Debt Service Paid by $2,500,000 State Appropriation – Issued 8/15/2000)						
Portland Science Building Lab Renovation	$5,000,000	$4,211,334	$9,211,334	$9,072,154	$139,180	7/01/05
FY2002 State Bond Issue (approved by voters 6/11/2002)						
Mitchell Center Expansion	$4,000,000	73,500	$4,073,500	$2,915,434	$1,158,066	12/15/04
FY2003 State Bond Issue (approved by voters 6/10/2003)						
Portland Science Building Expansion	$4,400,000	$0	$4,400,000	$531,509	$3,868,491	7/01/05

APPENDIX C

SUMMARY OF UTILIZATION OF R&D APPROPRIATION FOR OPERATIONS

UMAINE/USM COMBINED

	Source of R&D Funds			Utilization of R&D Funds						
University	FY2004 R&D Base Budget	Total Unused R&D Funds from Prior Years	Total R&D Funds Available	FY2004 R&D Actual Expenditures	Used To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2005[1]	New Grants & Contracts Generated[2]	Total FTE Positions Supported By All R&D Funds[3]
	(a)	(b)	(a)+(b)	(c)	(d)	(f)	(c)+(d)+(f)			
UM	8,080,000	466,136	8,546,136	6,927,780	1,631,644	(13,288)	8,546,136	0	40,454,171	739
USM	2,020,000	(7,308)	2,012,692	1,860,776	115,395	0	1,976,171	36,522	2,392,031	118
TOTAL	10,100,000	458,828	10,588,828	8,788,556	1,747,039	(13,288)	10,522,307	36,522	42,846,202	857

UMAINE

	Source of R&D Funds			Utilization of R&D Funds						
Targeted Research Area	FY2004 R&D Base Budget	Total Unused R&D Funds from Prior Years	Total R&D Funds Available	FY2004 R&D Actual Expenditures	Used To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2005[1]	New Grants & Contracts Generated[2]	Total FTE Positions Supported By All R&D Funds[3]
	(a)	(b)	(a)+(b)	(c)	(d)	(f)	(c)+(d))+(f)			
Adv. Technology Forestry & Agriculture	$1,950,000	$0	$1,950,000	$724,725	$794,681	$430,594	$1959,000	$0	$5,716,850	221.7
Aquaculture & Marine Science	1,250,000	0	1,250,000	719,444	270,118	260,438	1,250,000	0	12,183,772	128.0
Biotechnology	400,000	0	400,000	1,015,650	(34,175)	(581,475)	400,000	0	4,507,252	37.2
Composites	2,000,000	0	2,000,000	1,088,484	39,835	871,681	2,000,000	0	6,196,543	67.7
Environmental	500,000	0	500,000	763,432	114,903	(378,335)	500,000	0	3,533,453	98.2
Information Technology	580,000	1,467	581,467	1,658,230	236,391	(1,313,154)	581,467	0	6,083,536	149.2
Precision Manufacturing	1,400,000	0	1,400,000	493,146	209,891	696,963	1,400,000	0	2,232,765	36.9
Funds from Prior Years	0	464,669	464,669	464,669	0	0	464,669	0	0	0.0
Total	$8,080,000	$466,136	$8,546,136	$6,927,780	$1,631,644	($13,288)	$8,546,136	$0	$40,454,171	738.9
2003 Jobs for Economic Growth Bond –MEIF Matching Funds	$2,880,000	$0	$2,880,000	$0	$820,000	$0	$820,000	$2,060,000	$0	0.0

[1]Include year-end equipment carry-over funds (equipment ordered, not received, and not paid).

[2]Dollar value of new grants & contracts that resulted from FY2004 State R&D funds.

[3]One FTE position is equivalent to one full-time employee working for an entire year on R&D projects.

UTILIZATION OF OPERATING RESEARCH APPROPRIATION

USM

Project	Source of R&D Funds: FY2004 R&D Base Budget (a)	Source of R&D Funds: Total Unused R&D Funds from Prior Years (b)	Source of R&D Funds: Total R&D Funds Available (a)+(b)	Utilization of R&D Funds: FY2004 R&D Actual Expenditures (c)	Utilization of R&D Funds: Used To Match Grants & Contracts (d)	Utilization of R&D Funds: Transferred Between R&D Accounts (f)	Utilization of R&D Funds: Total R&D Funds Utilized (c)+(d)+(f)	Unused Funds Carried Forward To FY2005[1]	New Grants & Contracts Generated[2]	Total FTE Positions Supported By All R&D Funds[3]
College of Arts and Sciences R&D	$30,000	$9,783	$39,783	$38,733	$0	$0	$38,733	$1,050	$0	0.0
Information Science Institute A	200,750	0	200,750	192,589	20,680	0	213,269	(12,519)	269,689	13.7
Research Development	351,000	(3,913)	347,087	317,605	0	0	317,605	29,482	0	5.0
Bioscience Institute	604,000	0	604,000	526,886	94,715	0	621,601	(17,601)	2,110,358	84.0
Operations (plant, facilities, lease)	230,000	0	230,000	230,000	0	0	230,000	0	0	0.3
Opportunity Programs	44,728	701	45,429	31,990	0	0	31,990	13,439	11,984	4.0
Library	95,000	0	95,000	81,545	0	0	81,545	13,455	0	0.0
Animal Facility	62,000	0	62,000	70,897	0	0	70,897	(8,897)	0	2.0
Wise Lab Personnel	205,500	0	205,500	199,485	0	0	199,485	6,015	0	5.0
Information Science Institute B	197,022	(13,879)	183,143	171,046	0	0	171,046	12,097	0	4.5
Total	$2,020,000	($7,308)	$2,012,692	$1,860,776	$115,395	$0	$1,976,171	$36,522	$2,392,031	118.5
2003 Jobs for Economic Growth Bond –MEIF Matching Funds	$720,000	$0	$720,000	$0	$32,293	$0	$32,293	$687,707	$100,000	0.0

UTILIZATION OF FY2003 MAINE PATENT PROGRAM APPROPRIATION

USM

Major Research Area	Source of Patent Program: FY2004 Patent Program Base Budget (a)	Source of Patent Program: Total Unused Funds from Prior Years (b)	Source of Patent Program: Total Patent Program Funds Available (a)+(b)	Utilization of Patent Program Funds: FY2004 Patent Program Actual Expenditures (c)	Utilization of Patent Program Funds: Used To Match Grants & Contracts (d)	Utilization of Patent Program Funds: Transferred Between Patent Program Accounts (f)	Utilization of Patent Program Funds: Total Patent Program Funds Utilized (c)+(d)+(f)	Unused Funds Carried Forward To FY2005[1]	New Grants & Contracts Generated[2]	Total FTE Positions Supported By All Patent Funds[3]
Maine Patent Program	$306,000	$0	$306,000	$301,414	$0	$0	$301,414	$4,586	$0	3.8

[1]Include year-end equipment carry-over funds (equipment ordered, not received, and not paid).

[2]Dollar value of new grants & contracts that resulted from FY2004 Maine Patent Program.

[3]One FTE position is equivalent to one full-time employee working for an entire year on Maine Patent Program projects.

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