UMS Research Reinvestment Fund (RRF)
Annual Report of Activities

UMS Board of Trustees Meeting March 24 & 25, 2019

Executive Summary

The University of Maine System (UMS) is responsible for conducting research and development that supports and expands the Maine economy. These efforts are primarily led by the University of Maine (UMaine), the land grant, sea grant, and space grant university of the State. UMaine partners with the other system campuses to ensure that its efforts are indeed statewide in focus and impact. The purpose of the Research Reinvestment Fund (RRF) is to strengthen research and development activities that are tied to Maine businesses, and to industries that are critical to the future of Maine. The Board of Trustees (BOT) committed an initial $10.5MM for this initiative (2.1MM/year for 5 years, FY15 – FY19), from savings accruing from the UMS Administrative Reviews.

This report highlights FY2019 and cumulative program activities within the three distinctly funded initiatives of the RRF program established by the UMS Board of Trustees:

I. Competitive Grant Funding to UMS Researchers Initiative
II. Infrastructure Support to the Business Development Enterprise Initiative
III. Infrastructure Support to the Research Enterprise Initiative

Notable highlights by initiative include:

I. **Competitive Grant Funding to UMS Researchers Initiative (Page 3)**

- The RRF Advisory Board established the following funding competitions designed to advance UMS research, development, and commercialization projects and attract follow-on funding from external sources: seed grants; planning grants; graduate assistantship grants; undergraduate assistantship grants; Interdisciplinary Undergraduate Research Collaborative (IURC); Interdisciplinary Graduate Research Collaborative (IGRC); and the RRF Maine Innovation, Research and Technology Accelerator (MIRTA)
- The RRF Advisory Board has awarded $5,830,914 in competitive grants since the program's inception. RRF funded grantees have submitted 161 follow-on grant applications to external funding agencies, of which 63 have been funded totaling $18,188,442 in additional external research dollars. Return on Investment = 3.1:1
- RRF funding has provided valuable seed funding to advance research, development, and commercialization within the UMS and has provided dynamic research experiences for participating UMS students.

II. **Infrastructure Support to the Business Development Enterprise Initiative (Page 13)**

- License revenue for FY18 was $552,833. UMaine's technology pipeline has been filling up over the last 10 years, and many new technologies take an average of 10 years from lab invention to marketable technology. UMaine technology transfer manages more than 125 active commercialization projects that range from initial patent applications, ongoing R&D, early prototypes and field trials, initial market trials, company startup and formation to licenses with mature companies. In FY18, 19 notifications of new inventions were received and evaluated for technical readiness, commercialization potential and patentability. Six new U.S. patents were issued; five for UMaine and one for USM. Six new provisional patent applications were filed and ten non-provisional U.S. or PCT applications were filed.
- The Office of Innovation and Economic Development (OIED) has been working on several initiatives to grow innovation, examples of which are the creation of the RRF MIRTA Accelerator, which helps move RRF-funded projects closer to

commercialization; the application for designation of the University of Maine as a National Science Foundation I-Corps site; and the establishment of support for, and partnership with, USM and other UMS campuses.

- The work of the Innovation and Economic Development Council (IEDC) has advanced the previous recommendations of the Commercialization Working Group to actively address policy, practice, culture, and outreach issues that will further commercialization within the UMS.

III. Infrastructure Support to the Research Enterprise Initiative (Page 20)

- RRF represents a significant investment in bolstering the UMS Research Enterprise infrastructure through staff positions in the Office of Research Administration (ORA) and the Office of Research Development (ORD). ORA is a University-wide office authorized to submit proposals and receive awards from external sources on behalf of the Board of Trustees of the University of Maine System. ORA is also the fiduciary for the University of Maine on grant-related matters. It manages and administers extramural grants and contracts for UMaine, UMM, and UMFK, with discussions underway to provide similar services to UMA.
- The Office of Research Development (ORD) provides proposal writing services to faculty with a particular emphasis on interdisciplinary/multi-institutional, large dollar grants and early career faculty outreach and support designed to enhance new researchers' ability to compete for extramural funds, while also protecting the university's investment in new talent. ORD recently organized the proposal development process of the $20M NSF EPSCoR RII – Track 1 submission (in collaboration with Bigelow Laboratory for Ocean Sciences, USM, UMM, and others); supported 12 separate NSF Early Career Development (CAREER) submissions requesting a total of $7.2M; and were key contributors to UMaine's first NSF National Research Traineeship (NRT) award that will train cohorts of graduate students who will become the next generation of environmental conservation leaders.
- The number of awards over $1,000,000 have increased significantly over the last year (# of $1M+ awards July-Dec 2017 (FY18) = 3 vs. Number of $1M+ awards July-Dec 2018 (FY19) = 10). ORA and ORD staff have played a key role in supporting university faculty in pursuit of high dollar value awards. Notable examples include: $5.8M Department of Defense award for biofuels research; $3M National Research Traineeship award from NSF; and a $2.6M DOT University Transportation Center award.
- RRF has been instrumental for UMaine gaining ground in national ranking, where according to the HERD survey, in FY 16 it reported $79.2M in research expenditures and ranked 160, in FY 17 it had reached $99.5M and ranked 155, and in FY 18 we surpassed the $100M research expenditure mark by reaching $106.7M, which has just been reported to NSF and which we expect to result in UMaine gaining several more points in national ranking. Such progress is consistent with the University's goal of reaching R1 Carnegie classification status and continued investment in R&D by the UMS through such programs as RRF will help to achieve this goal.

Appendices

I. Competitive Grant Funding to UMS Researchers Initiative

The competitive grants program supported by RRF provides funding for research, development, and commercialization projects. These funded projects seed larger initiatives that are tied to advancing aspects and sectors of Maine's economy. Measurable outcomes of seed grant investments include: the attraction of additional extramural funding, the provision of meaningful hands-on experiences for undergraduate and graduate students within the UMS, and the translational movement of basic and applied research to commercialization. Several of the funded research and development initiatives within the RRF portfolio have generated significant private sector engagements. By creating collaborations with the private sector, economic and workforce development activities are being accomplished in designated economic sectors of benefit to the State of Maine and beyond. Final funding decisions for the RRF competitive grants programs are made by the RRF Advisory Board whose membership is comprised of faculty and administrators from UMS campuses as well as representatives from the private sector and the Maine Technology Institute (MTI) (See Appendix A for the membership roster of the RRF Advisory Board).

Description of RRF grant programs and composition of the funded portfolio

RRF Planning Grants provide funding for 6-month projects that allow teams from UMS campuses and external partners to form and advance research, development, and commercialization projects.

RRF Seed Grants provide funding for 12-month projects to generate pilot data or proof of concept testing and target specific follow-on grant opportunities for federal, state, and private sources. Leveraging the investment of RRF funds by attracting additional funding to the University is a requirement of RRF grantees. Seed grant teams are comprised of UMS researchers and external partners from business, industry, and non-profits in Maine and beyond. Funding preference is given to projects that are able to demonstrate a likelihood of near-term commercialization and/or workforce development outputs.

RRF Student awards provide funding for 12-month UMS faculty/staff-led research, development, and commercialization projects that involve UMS students as major contributors. There are four separate student award programs supported by RRF: 1. Graduate Student Assistantships; 2. Undergraduate Student Assistantships; 3. Interdisciplinary Undergraduate Research Collaborative (IURC); and 4. Interdisciplinary Graduate Research Collaborative (IGRC). Programs 1 & 2 above support one student per project, whereas programs 3 & 4 fund teams of student researchers. The IURC program was established in FY 2018 as a means to further enhance collaborative science teams for undergraduate students within the UMS. The IGRC program is new in FY 2019 and is designed to help give UMS researchers a competitive edge in follow on graduate training grants such as the National Science Foundation's *National Research Traineeship* (NRT) program or the National Institutes of Health T-32 program.

The RRF Accelerator program, *Maine Innovation and Research Technology Accelerator – MIRTA*, was launched in winter 2017 with the goal of identifying projects within the existing RRF funding portfolio that could achieve measurable commercial outputs after a 16-week time frame with an infusion of technical assistance and funding. Potential outputs from the MIRTA program include starting a company, licensing UMS technology to an existing company, filing a patent, or forming an extended research collaboration with an external partner. Five accelerator projects were selected by the RRF Advisory Board in the Spring 2018 pilot of the program and a second cohort of four projects were selected in Fall 2018. This program is discussed further in the *Infrastructure Support to the Business Development Enterprise Initiative* section of this report.

FY 2019 Applications

In FY 2019, a total of 65 applications were received for the established RRF competitive grant programs which resulted in 29 new awards (5 planning grants; 6 seed grants; 14 student awards, and 4 accelerator grants). Several of these projects are highlighted within this report and a full listing of the project abstracts can be found in Appendix B.

Cumulative RRF Grant Program Data

Since June 2015, the RRF Program has received 454 proposals from UMS researchers spanning all seven campuses. Of these applications, a total 161 projects have been competitively selected by the RRF Advisory Board for awards totaling $5,830,914 in grant funding. UMaine spearheaded 141 of these projects, with other system campuses taking the lead on 20 projects and being actively involved as Co-Investigators on an additional 38 projects. The number of competition rounds and number of projects funded by RRF Advisory Board approved funding programs were as follows:

- Seed Grants (5 rounds, 47 funded projects)
- Planning Grants (rolling basis, 18 funded projects)
- Graduate Assistantship Grants (4 rounds, 39 funded projects)
- Undergraduate Assistantship Grants (4 rounds, 39 funded projects)
- Interdisciplinary Undergraduate Research Collaborative (2 rounds, 8 funded projects)
- Interdisciplinary Graduate Research Collaborative (1 round, 1 funded project)
- RRF Accelerator (2 rounds, 9 funded projects).

Follow-on Grant Submissions and Awards

To date, RRF funded grantees have submitted 161 follow-on grant applications to external funding agencies.

63 were funded totaling $18,188,442 in additional external research dollars (Return on Investment = 3.1:1).

122
Publications

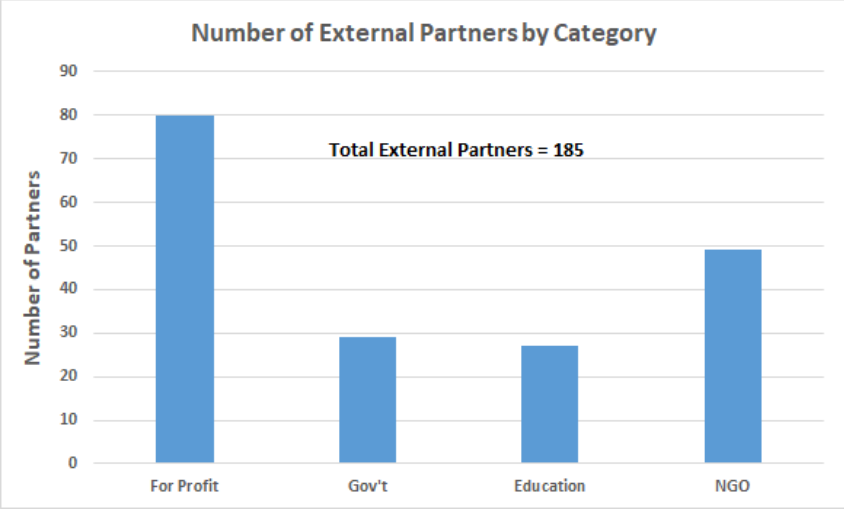
229
Presentations Given

408
Student Participants

Cumulative Total of Publications, Presentations and Student Involvement

Private Sector Investment, Engagement and Advancement in Maine Economic Sectors

In recognition of the fact that successful commercialization of University-based research requires meaningful engagement with external partners, applicants to the RRF are required to collaborate with private sector businesses and/or other key stakeholders. As a result of the programmatic focus on external engagement, ***a total of 185 external entities have served as project partners on RRF projects*** (several on multiple projects), many of which reside within the private sector and are Maine-based businesses**.** Chart 1 below illustrates the type of partners that are collaboratively participating on RRF funded projects.



Economic Sector Representation of RRF Funded Projects

RRF funding has been directed towards a variety of economic sectors. As shown in Chart 2 below, the greatest investments have been made in Aquaculture and Marine Sciences, Education, Biotechnology, Environmental Technologies, and Advanced Technologies for Forestry and Agriculture. The breadth of RRF funding reflects the sectors highlighted on a state level by the legislature, as well as signature strengths within the System. Sector representation includes Maine Economic Improvement Fund designated sectors as well as sectors beyond MEIF that are of significant relevance to Maine's economy, such as Education and Healthcare.

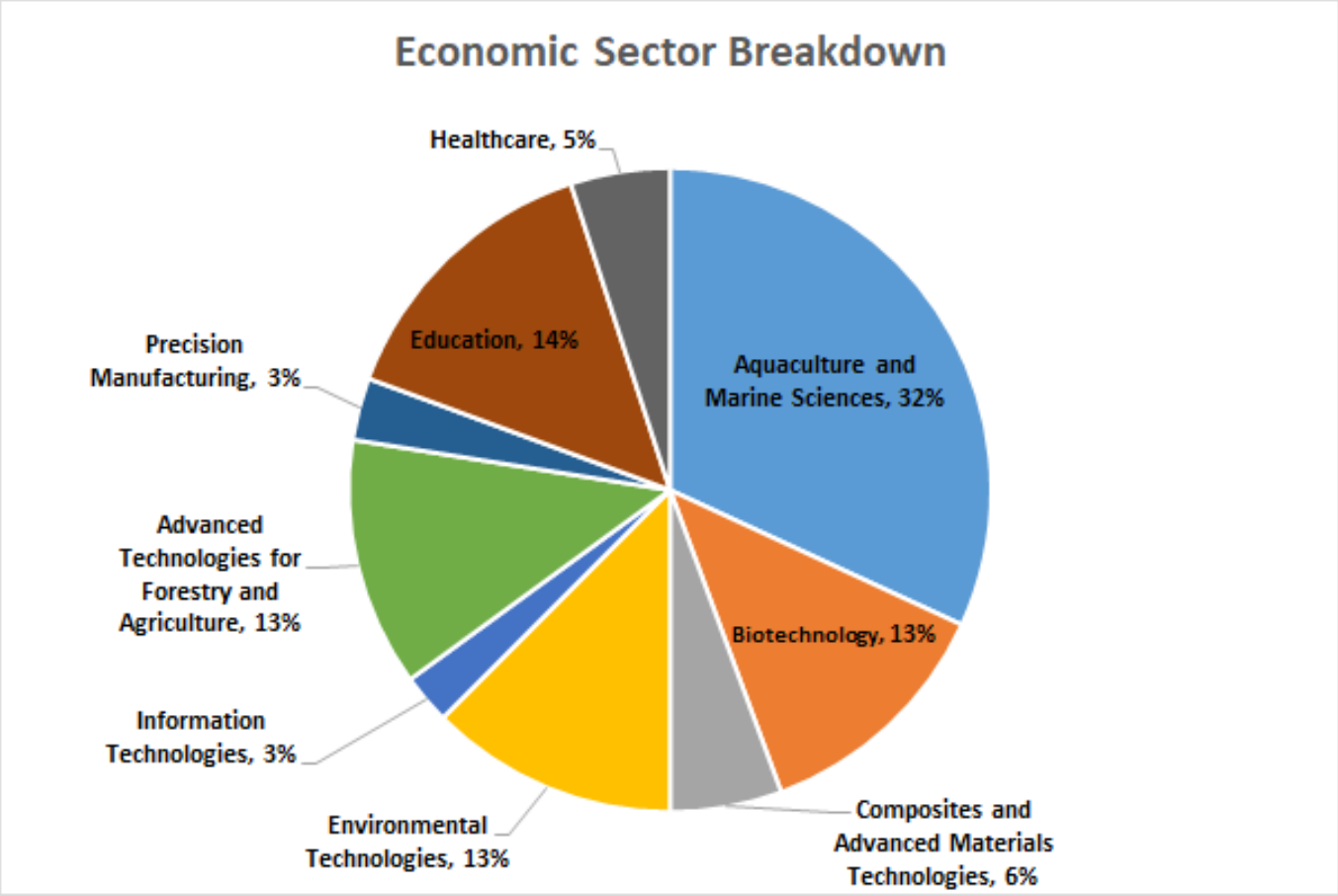


Chart 2: Economic Sector Breakdown for RRF Funded Projects

Updates from select funded RRF projects that exemplify UMS campus collaborations and student research and training

RRF Seed Grants

Unmanned aerial systems: Supporting development and training on UAV applications for Maine businesses and State agencies
Industry sector: Education
PI: Thomas Abbott (UMA)
Co-PI: Colonel Dan Leclair (UMA)

This project was the first step in establishing an Unmanned Aerial Vehicle (UAV) training and education center at the University of Maine at Augusta (UMA). The larger goal was to demonstrate that a Maine-based UAV training and education center is valuable and an investment beacon for businesses, state agencies and external funders. The training and education center will draw investments from, and for, businesses, state and federal agencies, and assist in recruitment for UMA's own BS in Aviation program. With Dr. Abbott's efforts, UMA has supported the establishment of the UMA Flight Center and has trained almost 200 students in their FAA Remote Pilot course. With one of the lowest aviation program costs in the country, UMA expects to be able to recruit nationally.

Improving Maine's Coastal Infrastructure Upgrade Decisions through High Frequency Nutrient Measurements in Casco Bay
Industry sector: Aquaculture and Marine Sciences
PI: Damian Brady (UM School of Marine Sciences)
Co-PIs: Karen Wilson (USM Environmental Science and Policy)

The goal of this project was for UMaine and USM to work with the Maine Department of Environmental Protection, the Portland Water District, and the Friends of Casco Bay to help fill a key data gap in the relative contribution of different sources of nitrogen to Casco Bay. This new technology for high frequency nitrogen sampling is already allowing the best available information to be used in making decisions about future coastal infrastructure management in Maine. Dr. Brady now serves on the Casco Bay Estuary Partnership Management Council and Nutrient Council, and his team has informed the recent wastewater bond initiative that passed in November 2018. They have also become a part of Portland's new Integrated Planning process and have contributed to the East End Wastewater Treatment Plant's work to decrease nutrient loading to the bay by about 75%.


Eco-Sno with Ski Tips

Eco-Sno
Industry sector: Precision Manufacturing
PI: Elizabeth DePoy (UM School of Social Work)
Co-PIs: Scott Hoisington (UMF Business Administration), Vincent Caccese (UM Mechanical Engineering), and Stephen Gilson (UM Social Work)

This collaboration between University of Maine and external commercial partners proposes an innovative co-design method to develop and test the Eco-Sno, an aesthetically designed, modular, adaptive fitness support device for the growing number of elders who need and/or want standing support equipment to participate in outdoor winter recreation, fitness, and safe walking on snow and ice. With support from the seed grant, Drs. DePoy and Gilson, with assistance from the Advanced Manufacturing Center have designed a working prototype. The next step will be to bring together older adults who could benefit from the technology with researchers in order to test the device.

Local Transportation Decisions for a Resilient Future
Industry sector: Education
PI: Martha Sheils (USM Cutler Institute)
Co-PI: Jack Kartez (USM New England Environmental Finance Center)

The Maine Department of Transportation developed a screening tool to meet their federal mandate to establish a process for risk-based transportation asset management planning. The "Transportation Risk Assessment for Project Planning and Delivery" (TRAPPD) initiative considers risk in terms of project delivery (i.e., on schedule, on budget) for infrastructure replacements and upgrades of state owned culverts and bridges. TRAPPD provides a numeric comparison using existing data that asset managers can view online and adjust expectations for asset condition and project delivery in real time, prior to inclusion of a project into a work plan. The New England Environmental Finance Center is conducting a pilot study in the Town of Scarborough, Maine to test the tool's applicability to provide transportation asset replacement information at the municipal level. The pilot study components are: a) processing municipal culvert data to fit the Maine DOT framework, b) analyzing how the results inform and augment municipal capital planning and spending, c) developing a process that will allow the lessons learned to be transferred to other municipalities, and d) developing estimates of the value of the service and the usefulness of the tool to municipalities.

Sensor Development/Adaptation to Improve Healthcare: A Partnership Between the University of Maine and St. Joseph's Hospital (SJH)
Industry sector: Healthcare
PI: John F. Vetelino (UM Electrical and Computer Engineering)
Co-PIs: Nuri Emanetoglu (UM Electrical and Computer Engineering), David Koffman,M.D., FACP(St. Joseph's Hospital)
Collaborators: Ali Abedi (UM Electrical and Computer Engineering), Jason Harkins (Maine Business School), Leonard Kaye (UM Social Work), James Moreira (UMM Arts & Letters), Mauricio Pereira da Cunha (UM Electrical and Computer Engineering), Steven Quackenbush (UMF Psychology), Rosemary Smith (UMaine Electrical and Computer Engineering/FIRST), William Wood (St. Joseph's Hosptial)

The goal of this project is to develop a partnership between UMS researchers and Saint Joseph Hospital (SJH) to develop, adapt and commercialize sensors to detect and monitor diseases and medical conditions to improve public healthcare. The partnership was inaugurated with a pilot project focused on motion sensors for use with elderly populations. This project involved collaborations with SJH physicians and caregivers in concert with UM, UMM and UMF faculty and students. Concurrently with this project collaborations between Dartmouth College and UM are ongoing to develop a biosensor to detect biomarkers associated with pancreatic cancer. Proposals to NSF and/or NIH are anticipated as a result of these partnerships and collaborations.

RRF Graduate Assistantships

An Interdisciplinary Approach to Explore Risks Associated with Winter Ticks
Industry sector: Education
PI: Sandra De Urioste-Stone (School of Forest Resources)
Co-PIs: Pauline Kamath (School of Food and Agriculture), Kristin Peet (Penobscot Indian Nation), Peter Pekins (University of New Hampshire)
Graduate student: James Elliot

This is an interdisciplinary project that analyzes the actual risk of winter tick disease transmission carried by moose vs. the perceived risk by key stakeholder groups. So far, biological data collection and analysis have begun, and a literature review has been completed. Also, by collaborating with the Penobscot Nation, an online questionnaire has been developed and has begun to be distributed to Native American populations in Maine. Graduate student James Elliot (School of Forest Resources) is conducting research and collaborating closely with project partners in preparation for conferences scheduled for 2019.

James Elliot works with DNA samples in the Wildlife Disease Genetics Lab

Visible and infrared imaging spectroscopy for high-resolution mapping and health assessment of Maine's forest and agriculture resources
Industry sector: Forestry and Agriculture
PI: Peter R. Nelson (UMFK Biological Sciences and Environmental Studies)
Co-PIs: Daniel Hayes (UM School of Forest Resources Barbara Wheatland Geospatial Lab)
Graduate student: Catherine Chan

This project funds a graduate student to fly and interpret data from unmanned aerial vehicles for agricultural and forestry purposes. Flights with the Visible and Near-Infrared (VNIR) sensor have already been conducted at experimental agricultural fields in Aroostook County. This research is central to pending project proposals with NASA and has already been implemented in a Maine Economic Improvement Fund supported project conducted by a UMFK student in Alaska. Additionally, this project has partnered with a UMFK business major to provide paid access to this technology for agricultural and forestry users through a fee-for-service model.

RRF Undergraduate Assistantships

Beyond the Tides
Industry sector: Education
PI: Susannah Gordon-Messer (USM)
Undergraduate student: Zach Ouelette

Beyond the Tides is a student-developed, location-based, augmented reality (AR) game that educates Mainers on effects of rising sea levels. Players take on specific roles (ex. business executive, environmental researcher) and are asked to make environmental, economic and social decisions. As the game progresses, the player is shown the effects of their decisions on both the environment and the greater community. The game is being developed using TaleBlazer, an AR coding platform. Several locations along Portland's Back Cove walking loop have been mapped with current and future predicted water levels. These locations with then become decision points for players in the game as they walk along the path. The game will be play tested with USM and local high school students during the spring semester.

Interdisciplinary Research for Decision Making about Dams in Maine
Industry sector: Education
PI: Bridie McGreavy (UM Communication and Journalism)
Co-PI: Darren Ranco (UM Anthropology), Tyler Quiring (George J. Mitchell Center for Sustainability Solutions)
Undergraduate students: Brawley Benson and Nolan Altvater

Nolan Altvater working on media documentation on the Penobscot River

The goal of this project is to advance research that analyzes stakeholder needs for information, perceptions about dams, and news media coverage to support decision making about dams in Maine and New England. So far, Dr. McGreavy and her undergraduate assistants have made substantial progress analyzing newspaper articles about dams in Maine. One of their findings was that the Penobscot Nation is often represented in news media for their spiritual connections to the Penobscot River, but not for how they take a cultural approach to their innovative and extensive scientific monitoring program. Student Brawley Benson won a first place award for his media analysis at the UMaine Student Research Symposium, and Nolan Altvater has been helping to lead a media documentation project to raise awareness about the Penobscot Nation's role in river monitoring and restoration.

RRF Interdisciplinary Undergraduate Research Collaborative

MAgApp: The Maine Agriculture Apps Project
Industry sector: Forestry and Agriculture
PI: Joline Blais (UM New Media)
Undergraduate students: Eliza Bennett (UM New Media & Art), Jack Lampinen (UM New Media & Media Studies), Tate Yoder (UM New Media & Maine Studies), Darius Haskell (UMPI Math)
Collaborators: Bill Giordana (SYRA Education Director), Larry Feinstein (UMPI Biology), Stephanie Burnett (Horticulture), Ali Abedi (UM Assistant VP for Research and Director of CUGR)

Joline Blais and Stephanie Burnett in the Roger Clapp Greenhouse

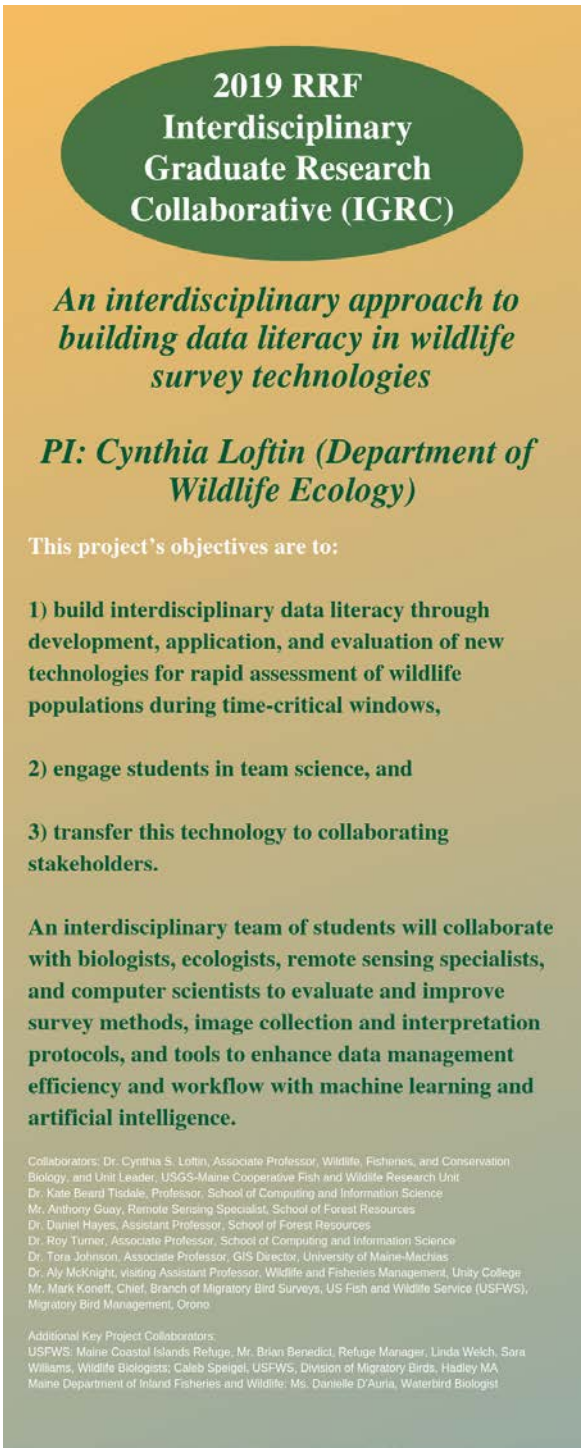
The Maine Agriculture Apps Project (MAg Apps) is developing a mobile app and dashboard that enables farmers to monitor production and environmental data from greenhouses and year-round farm buildings. The MAgApp pilot project will help convey the usefulness and adoption of low cost environmental sensors that are helping to conserve energy and increase production capacity, especially for small Maine food businesses. This is the first step towards field-ready, data-driven decision making tools and a keystone of future rural economic development. Undergraduate research assistants are working directly with farmers in the field and a cross-disciplinary team of faculty advisers. So far, the team has collected data, completed the User Experience Design, tested the mobile app prototype and developed a partnership with Student Life and CITL to host the America East Conference Hackathon at UMaine.

Select FY 2019 RRF funded projects underway

2019 RRF Graduate Assistantship

Detecting changes in zooplankton following the recovery of river herring in the Penobscot
Industry sector: Aquaculture and Marine Sciences
PI: Rachel Lasley-Rasher (USM Biological Sciences)
Collaborators: Karen Wilson, University of Southern Maine, Department of Environmental Science and Policy; Damian Brady, UMaine, School of Marine Sciences

River herring populations have declined dramatically and remained low for over a century after dams were built that blocked access to their spawning habitat. The primary goal of this project is to determine how and if diet selectivity has changed, explore how alewife alter zooplankton communities through selective feeding, and predict community changes as recovery progresses and extend these results to other dam removal projects.



2019 RRF Undergraduate Assistantships

Expansion and Testing of a Habitat Selection Model for a Globally Threatened Bird Species on Industrial Forestland
Industry sector: Environmental Technologies
PI: Neil Thompson (UMFK Forestry)
Collaborators: Amber Roth, UMaine School of Forest Resources; Carol Foss, New Hampshire Audubon; Patricia Wohner, Cuckoo Conservation Initiative; Jason Johnston, UMPI Biology/Environmental Science and Sustainability/Agriculture Science & Agribusiness

The Rusty Blackbird is a threatened species that was recently listed as a Special Concern in Maine. To predict their nesting habitat in northern New Hampshire, a habitat selection model was developed. In this project, that model will be extended throughout western and northern Maine using geographic information system (GIS) technology and field observations. This will allow recommendations to be made for habitat management, hopefully leading to intensive forestry practices that can produce high quality nesting habitats for the Rusty Blackbird.

Coldwater selection for fast growth of American oysters in Downeast Maine
Industry sector: Aquaculture and Marine Sciences
PI: Brian Beal (UMM)
Collaborators: Heather Leslie, UM Darling Marine Center

The goal of this project is to produce a fast-growing, disease-resistant American oyster that will grow to commercial size in 2-3 years in the cold waters of eastern Maine, finally allowing this region to profit from the rapidly growing industry. Building on previous work in rearing juvenile oysters, an undergraduate student will help conduct research to examine the growth rates of those selected juveniles over a one-year period. This will help in understanding which conditions lead to fast growth and survival of juvenile oysters in cold water.

RRF Planning Grants

Arctic Futures Workshop in South Greenland – June 2019
RRF is supporting a unique opportunity for UMaine, USM, and UMaine School of Law researchers and scholars who conduct Arctic research, or hope to in the future, to participate in a one-week workshop in South Greenland called "Arctic Futures." Attendees will actively participate in writing a report addressing the use of South Greenland as a case study for Arctic research, with an emphasis on problem-solving for local South Greenland and synergies with Maine. The workshop provides a venue for participants in a broad range of specialties to collaborate with Greenland citizens and representatives to learn about and work together on topics of mutual interest. The collaborative nature of this endeavor sets up opportunities for collaborative proposals to the National Science Foundation's "Navigating the New Arctic" funding program and other similar mechanisms.
Paricipants include:
Maine Law School: Jeffrey Thaler (Visiting Associate Professor of Law), Charles Norchi (Benjamin Thompson Professor of Law)
USM: Firooza Pavri (Director of the Muskie School of Public Service; Professor of Geography), Vinton Valentine (Director of USM GIS), Jan Piribeck (Professor of Digital Art and Foundations), Matthew Bampton (Professor of Geography)
UMaine: Kristin Schild (Research Assistant Professor School of Earth and Climate Sciences and Climate Change Institute), Kathleen Bell (Professor of Economics), Neal Pettigrew (Professor of Oceanography), Robert Northington (Lecturer/Post-doctoral Research Associate of Ecology), Erin Roche (Crop Insurance Education Program Manager, Cooperative Extension), Yong Chen (Professor of Fisheries Sciences), Alice Kelley (Instructor of Earth and Climate Sciences, Research Associate Professor Climate Change Institute), Paul Mayewski (Distinguished Maine Professor of Earth and Climate Sciences and Director of Climate Change Institute), Jasmine Saros (Professor of Paleolimnology and Lake Ecology), Lee Karp Boss (Associate Professor of Marine Sciences)

Planning for Wraparound Services that Support the Growth of Maine's Craft Beer Industry
Industry sector: Forestry and Agriculture
PI: Terry Shehata (USM, Economic Development Office)
Collaborators: Jake Ward & Renee Kelly, UM Office of Innovation and Economic Development, Sean Sullivan Executive Director of the Maine Brewers' Guild; Luci Benedict USM Director of the Quality Collaboratory; Maggie Vishneau Senior Policy Associate for Research & Organizational Develop, USM Cutler Institute; Ross Hickey USM Asst Prov for Research Integrity; Ryan Wallace Director of the USM Center for Business and Economic Research; Sarah Goan USM Data Innovation Project; Andrew Crawley UMaine School of Economics; Jason Bolton UMaine Cooperative Extension.

The University of Southern Maine (USM) and the University of Maine (UMaine), in partnership with the Maine Brewers' Guild, propose to undertake a 6-month planning effort to develop a comprehensive implementation plan for providing wraparound services to the craft beer industry by leveraging the resources of the University of Maine System and outside service providers. The development of the implementation plan is necessary to help the industry address the challenges it is facing in anticipation of continuing growth in output and employment by 2020. The success of this planning effort will serve as a model for developing industry sector-based tailored services.

2019 RRF Seed Grants

Medical Laboratory Technician (MLT) Practicum Intensive Week Pilot
Industry sector: Education
PI: Judith Clukey (University of Maine at Augusta)
Co-PI: Leigh Belair (University of Maine at Presque Isle)
External collaborators: MaineGeneral Medical Center, Nordx Labs, ALI Labs, Pen Bay Medical Center, Waldo General Hospital, Central Maine Medical Center, Southern Maine Medical Center

RRF funding will support equipment upgrades for the Medical Laboratory Technology (MLT) of Maine program, which was created as a collaborative effort between UMPI and UMA. The program is challenged by limited clinical sites that have the capacity to train students in microbiology and blood banking. This issue combined with staff shortages has led to less participation from hospitals in lab training. Judith Clukey plans to address this by establishing intensive week-long trainings for MLT students that will minimize clinical time and technical instruction commitment from affiliate sites while continuing to develop well-trained lab professionals.

MLT training at UMA and UMPI

A Platform Using a New Cyber Physical System and UAV to Detect Temporal and Spatial Variation for Precision Agriculture
Industry sector: Forestry and Agriculture / Precision Manufacturing
PI: Yongjiang Zhang (UM School of Biology and Ecology)
Co-PIs: Hongzhi Guo (University of Southern Maine), Matthew Wallhead (UM School of Food and Agriculture)
External collaborators: Jasper Wyman & Son, Wild Blueberry Commission of Maine, Cherryfield Foods Inc.

This project proposes the development of a platform that will allow farmers to use their resources more efficiently. A Cyber Physical System (CPS) will be made to monitor temporal variation in the water status of wild blueberries, and Unmanned Aerial Vehicle (UAV) sensors will be used to detect spatial variation across the farm, which produces data for scientists studying plant-environment interactions. The team plans to expand the platform to include fertility and pest management, and also to develop an automated AI system that can analyze and report crop-environment interactions.

II. Infrastructure Support to the Business Development Enterprise Initiative

RRF has provided funding to increase UMS capacity to meet strategic outcomes in the areas of business partnerships, technology transfer and commercialization leading to economic development. This impact has been particularly significant since the completion of the Commercialization Working Group (CWG), which finished its work in late 2017. The findings from the Working Group helped shape commercialization activities that would not have been possible without the Research Reinvestment Fund.

External and internal stakeholder feedback from focus groups conducted by the Commercialization Working Group highlighted the following challenges:

- Maine business and industry partners called for improved ***communication and marketing of services, improved service delivery, and a wider array of services***
- The faculty highlighted the need for ***clear policies, additional resources, and aligned incentives*** supportive of commercialization and innovation. Current challenges include:
    - inconsistent understanding of the importance of public-private partnership to the land-grant mission;
    - inconsistent understanding of the resources the university has in place to support commercialization;
    - inconsistency in the recognition of knowledge transfer activities in the incentive structures (e.g., promotion and tenure criteria);
    - insufficient resources (e.g., release time, monetary rewards, human resources) to support faculty engagement in commercialization activities;
    - insufficient marketing of UMaine R&D resources to potential industry or agency partners.

Innovation and Economic Development Council (IEDC)

One outcome of the CWG was the establishment of the Innovation and Economic Development Council to advise the UMaine and UMM president, to build a campus culture that supports commercialization activities, and to prioritize and implement initiatives that enhance and increase technology commercialization, industry engagement and economic development. The inaugural meeting of IEDC occurred in January 2018. The group is chaired by UMaine Provost Jeff Hecker and IEDC membership includes UMaine, UMS, and Graduate School of Business representation. IEDC has established priority areas with associated short- and long-term goals based on the report completed by CWG.

The IEDC was charged with addressing the following tasks listed below in its first year. The activities are in priority order:

1. Develop a vision for economic development for the university
2. Develop an action plan to implement the recommended IP policy and practice changes
3. Develop a plan for integrating information about commercialization and economic development into new faculty orientation, and chairs and directors training curricula
4. Develop a plan for marketing UMaine's research and economic development resources to potential business, industry and community partners
5. Develop a plan for revamping the university's web presence so that information about innovation, economic development, industry-university partnerships and commercialization are more visible and easily identified via search
6. Develop recommendations for increasing incentives for faculty and staff to engage in commercialization activities and move university intellectual property to "market"
7. Develop recommendations for reviewing promotion and tenure criteria in key disciplinary areas to ensure that commercialization related activity is recognized.

IEDC Working Groups:

To systematically address the activities above, the IEDC has established working groups

1. **Culture**
    a. Develop a vision for economic development for the university
    Status: A summit was held in January 2018 to outline short-term and longer-range goals to enhance commercialization. A subcommittee of IEDC created a draft vision statement for commercialization at the University of Maine and UMS.
2. **Policy**
    a. Develop an action plan to implement the recommended IP policy and practice changes
    Status: A revised IP policy that reflects current law and trends has been presented to UMaine Faculty Senate and additional changes are in progress to incorporate their input.
    b. Develop recommendations for reviewing promotion and tenure criteria in key disciplinary areas to ensure that commercialization related activity is recognized.
    Status: Review will follow implementation of IP policy.
3. **Organizational Structure**
    a. Identify and enable existing staff to efficiently support commercialization (including RRF funded staff); engage contractors and plan for new employees where needed to expand capacity
    Status: Business incubation staff and RRF-funded staff form the key team members supporting faculty/staff/student teams in the commercialization process through the MIRTA accelerator and I-Corps program (see below for more detail). Contractors are being used to perform technology and market analyses to assist in the development of commercialization plans.
    b. Operationalize an independent research foundation to enhance business development and commercialization.
    Status: The IEDC is further evaluating the role of the University of Maine R&D Foundation.
4. **External Engagement**
    a. Revamp and enhance the process and options for companies to engage in sponsored research; provide tools and training to faculty
    Status: Implementation of Wellspring Sophia software to provide a central solution to manage customer data, contacts, project financials and intellectual property is in process (see below for more detail). In addition, the University of Maine hired a Forest Industry Business Development Manager as a primary point of contact for this specific sector. The goal is to test this position as a model for engaging companies in sectors important to the state where UMS has significant research resources.
    b. Create materials and systems for marketing research capacity
    Status: Draft of a new website for the Office of Innovation & Economic Development, which will serve as a portal for businesses to find and access the many R&D resources of the University of Maine System, is complete and in testing. The website will link to the Wellspring Sophia software, making it easier for faculty and staff to create, track and manage industry projects.
5. **Internal Resources**
    a. Provide training and programs (such as the RRF accelerator) to enable faculty to engage in commercialization
    Status: Within the last fifteen months the Office of Innovation and Economic Development launched three new programs: a new workshop series, the RRF MIRTA accelerator, and I-Corps site program to provide varying levels of training for faculty, staff and students (see below for more detail).
    b. Adopt administrative tools and systems to enhance service to stakeholders
    Status: The Wellspring Sophia software makes it easier for faculty and staff to create, track and manage industry projects. Having better data in a customer relationship management (CRM) program is expected to yield better marketing of UMaine technologies and R&D services, and increase the overall capacity for systematic engagement with external partners around Maine and beyond.
    c. Advise the development and administration of institutional funding mechanisms (such as RRF

grants) to accelerate commercialization, build the project pipeline and increase collaboration among campuses and with industry partners.
Status: Extensive interaction is happening between multiple campuses. A new project of USM and UMaine is underway that involves working with the craft brewing industry to identify their needs, inventory UMS assets and develop new resources where there may be gaps. This project can serve as a model for collaboration among campuses to support industry sectors.

Innovation & Commercialization Initiatives

The Office of Innovation and Economic Development (OIED) has been working on several initiatives to grow and accelerate innovation, industry engagement and commercialization activities at UMaine and throughout UMS. These initiatives involve growing the pipeline of faculty, staff and students engaged in industry work and commercialization by providing them with the tools and training they need as well as accelerating and supporting their projects so that they can better engage industry partners and commercialize new innovations. Several of the current and future, planned activities come from priorities identified by the Innovation and Economic Development Council from the results of the Commercialization Working Group (CWG).

Innovation & Commercialization Culture
As a result of RRF and its staffing support, the Office of Innovation and Economic Development, working with the Vice President for Research & Dean of Graduate Studies Office, provided formal professional development and training to faculty and staff. OIED launched an Introduction to Commercialization workshop, with a more extensive series of workshops that began in February 2019. These workshops form the basis of a new certification program for faculty, staff and graduate students to include in their CVs. The longer-term goal is to offer these workshops online in addition to in-person opportunities for faculty and staff across UMS. In addition, OIED worked with the Graduate School to hold a one-day workshop for graduate students interested in private sector or entrepreneurial career paths. A one-day workshop for undergraduate and graduate students is planned for April 2019 on the basics of transforming an invention into an entrepreneurial venture.

MIRTA (Maine Innovation, Research and Technology Accelerator)
In response to the need for more commercialization support, the Office of Innovation and Economic Development created the MIRTA Accelerator to move RRF-funded projects significantly closer to commercialization. The goal of the accelerator is to have each participating team develop a realistic commercialization plan by validating their hypotheses about their innovation's market opportunity. Each team has been eligible for up to $25,000 for commercialization activities and another $10,000 in release time for faculty and staff from RRF funding. MIRTA directly addresses the needs faculty and staff identified in the focus groups by:

- providing commercialization training and professional development for faculty, staff and students;
- building additional internal programmatic resources to support faculty and staff commercialization activities;
- developing relationships with key advisors and private sector partners to accelerate speed to market;
- providing internal and external recognition for engagement in commercialization;
- leveraging additional external financial resources for further research and development; and
- providing financial support for release time to focus on commercialization activities.

The success of this program depends upon the support that the Office of Innovation and Economic Development RRF-funded staff provides. The staff offers learning sessions on a variety of commercialization topics relevant to their projects, meets weekly with each of the four teams to coach, sets milestones, assigns "homework," and reviews progress. In addition, outside of these meetings, the staff provides guidance and feedback on grant proposals, presentations, financial projections and many other faculty and staff needs as they advance their projects. The staff also manages intellectual property, identifies and manages connections with external advisors, and makes connections with potential customers or partners.

While the second MIRTA cohort is participating in the accelerator now, results from the first cohort have been extremely positive: two teams have created start-up companies that are participating in the Office of Innovation and Economic Development's Top Gun program, with plans to apply for Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) grants to further their work; one team has a private sector partner funding prototypes for use in field trials in their facilities; one team has a direct license to a private sector partner imminent, which will also include ongoing research funding; and the final team has received ongoing funding from their private sector partner and is making proof of concept prototypes for targeted applications.

Hari Palani, presenting at MIRTA demo day in Spring 2019

The second cohort is comprised of the following teams:

1. Next-Gen Orthopedic Biomaterial - Dr. Michael Mason's team is developing a nanocellulose composite orthopedic implant that promotes the growth of strong natural bone while safely dissolving over time, eliminating the need for costly and permanent metallic foreign devices.
2. Bio-Based Insulative Protective Packaging - Dr. Mehdi Tajvidi's team is developing a biodegradable wood-based technology that produces a foam-like matrix to protect fragile items and insulate them from extreme temperatures.
3. Half-Shell Oyster Sorter - Dr. Stoll's team is building a cost- and scale-appropriate oyster sorter to support the long-term success of the small-scale aquaculture sector in Maine and around the world.
4. Midlina - Dr. Nicholas Giudice's team has developed a multimodal software solution for providing blind and visually-impaired (BVI) people with access to digital graphical information.

See Appendix C for a description of all nine teams from the first and second cohort, including a list of industry partners, additional funding and status updates.

I-Corps

The Office of Innovation and Economic Development recently used RRF funding and activities to successfully apply for designation of the University of Maine as a National Science Foundation I-Corps site. NSF selects university programs, such as UMaine's Foster Center for Innovation, that have a demonstrated track record of moving entrepreneurial ventures out of labs to act as I-Corps "sites" to further increase the number of scientists and engineers exposed to commercialization opportunities.

NSF sponsors I-Corps to foster innovation and entrepreneurship by providing faculty, staff and students with the tools and guidance needed to identify the market opportunity for their STEM-based research. The NSF I-Corp site designation includes $150,930 of funding over three years to provide modest stipends to each participating team for prototyping and market research.

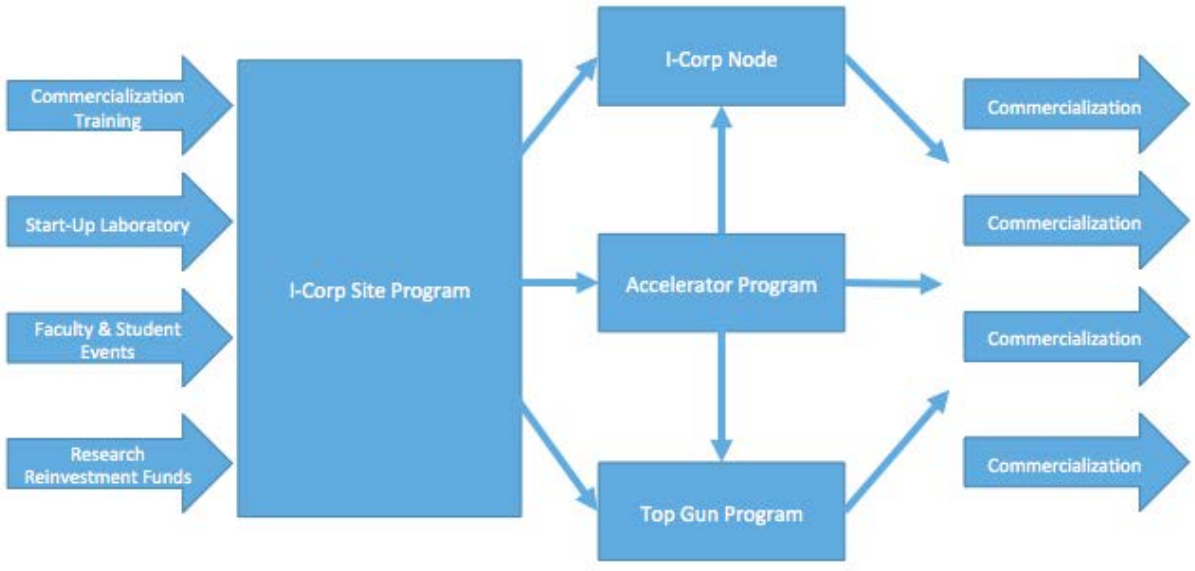
In the program, the teams of faculty, students and entrepreneurial mentors will undergo training to refine and identify high potential market applications for their research. The I-Corps program is envisioned as a pre-accelerator to help teams enter the University's MIRTA Accelerator having already validated a customer need. The success of the I-Corps proposal was directly tied to the pipeline of projects created by RRF and the ongoing RRF-funded staff and financial support that the I-Corps teams receive after completion of the program.

UMaine's first NSF I-Corps workshop was held on February 8th at the Foster Center for Innovation. Six teams working on innovative technologies with potential for commercialization were selected to be part of the first cohort. The teams include faculty and students from business, biomedical engineering, food science, mathematics and human development. The program runs for six weeks, during which teams conduct customer interviews to validate that their solution solves a problem for the intended customer segment. The teams meet on a weekly basis for one-on-one coaching sessions with the Foster Center team. The goal for the first calendar year of this program is to have 10 teams, so we are well on our way to meeting and exceeding this goal. There are two additional cohorts planned for this calendar year – one in the summer and another in the fall.

Development of Accelerated Commercialization Pathways

MIRTA and I-Corps represent two important elements of a pathway for accelerating projects through the commercialization process. The combination of commercialization training, RRF awards, and other ongoing entrepreneurial training creates a stronger pipeline leading to increased industry R&D projects, commercialization and economic development. Because RRF required funded projects to have a direct relationship to the Maine economy, it has facilitated stronger private sector partnerships and led to innovations with the potential to impact the state through research, development and commercialization.

In addition to MIRTA, teams may also move from the local I-Corps site into the national NSF I-Corps program, or startups resulting from MIRTA can participate in our community-based Top Gun business accelerator offered in partnership with Portland-based Maine Center for Entrepreneurs. This pathway builds upon existing OIED business development and start-up supports including licensing, business incubation and entrepreneurship support (see figure below), with the goal of increased licensing, industry collaborations, and jobs created and retained.



Support for USM and other UMS campuses
As part of RRF and the One University initiative, the Office of Innovation and Economic Development has been tasked with expanding technology transfer and commercialization capacity throughout UMS and expanding industry engagement and partnerships. UMaine and the University of Southern Maine entered into a memorandum of understanding for shared business development services and commercialization initiatives between the campuses.

- OIED assumed responsibility for USM intellectual property management, patent licensing, industrial contracting and activities related to increasing and enhancing commercialization at USM. This partnership generated efficiencies by eliminating a ½ FTE and made additional services and resources available to USM.
- OIED conducts outreach with a number of USM faculty to promote commercialization of their work and to facilitate the next stages of product development.
- OIED is assisting with USM's MEIF-funded internship programs by providing its Innovate for Maine model and training for their interns working with industry partners on innovation projects.
- OIED has engaged in innovation and outreach visits to University of Maine at Farmington and University of Maine at Presque Isle.

Business Development & Industry Engagement
As noted above, one of the biggest needs expressed by both the private sector and internal stakeholders is more communication and marketing of the University of Maine and the UMS campuses resources for innovation and commercialization.

- With the recommendations of the Commercialization Working Group, the Office of Innovation and Economic Development has used RRF funding for staffing to focus on marketing and communication of industry partnerships and R&D resources. A new communication plan and draft website has been created.
- Through the MOU with UMS and USM, the Office of Innovation & Economic Development is facilitating industry engagement projects with USM faculty and staff. Recently, USM and OIED staff have created a plan to assess the needs of the craft brewing industry in Maine, identify UMS resources that can address those needs and identify areas where new resources could support the industry. The intention is that this model of UMS entities working together could be applied to multiple industry sectors important to Maine, such as data science and biotech.

Operational Efficiencies
Recommendations and findings from the CWG focus groups indicated a need for more commercialization capacity and operational efficiency. In 2018, the Office of Innovation and Economic Development purchased Wellspring Sophia software. Many universities use this software to manage business engagement, intellectual property and licensing, and company-funded R&D projects. The software interfaces with the university enterprise management software and the general ledger (GL). This new implementation will shorten response time for both external private sector and internal university constituents. Having better data in a customer relationship management (CRM) program is expected to yield better marketing of UMaine technologies and R&D services, and increase the overall capacity for systematic engagement with external partners around Maine and beyond.

Creating Policy & Procedures to Facilitate and Incentivize Commercialization
The Office of Innovation and Economic Development, UMS Human Resources and UMS Counsel examined all University of Maine and University of Maine System policies relating to commercialization activities. The purpose was first ensuring compliance, and then to use policy to facilitate and incentivize commercialization and industry collaboration. Updates to the System policy governing patents and copyrights that will bring the UMS policy up to date with recent case law are underway. OIED also devised a "start-up checklist" for employees considering new company formation. This tool helps UMS faculty and staff who are considering a start-up company to identify and work through potential conflicts of interest and other topics encountered when starting a business as a faculty or staff member.

New Technologies, Licensing and Commercialization Outcomes

UMaine saw continued growth in industry projects in FY18. Licensing revenue for FY18 was a record high of $552,833.

Number of Maine Projects since FY16

The University of Maine System continues to build on existing industry engagement mechanisms including company funded R&D and product development contracts. These projects provide companies with access to UMS faculty, staff and facilities. Projects with formal contracts with companies totaled for each fiscal year:

- FY16: 517 total projects (233 Maine projects)
- FY17: 557 total projects (271 Maine projects)
- FY18: 518 total projects (228 Maine projects)
- FY19 YTD: 344 total projects (131 Maine projects)

License Revenue

License revenue to date in FY19 exceeds $140,000. License revenue for FY18 was $552,833. UMaine's technology pipeline has been filling up over the last 10 years, and many new technologies take an average of 10 years from lab invention to marketable technology. UMaine technology transfer manages more than 125 active commercialization projects that range from initial patent application, ongoing R&D, early prototypes and field trials, initial market trials, company startup and formation to licenses with mature companies.

Invention Disclosures and Patents

- In FY18, 19 notifications of new inventions were received and evaluated for technical readiness, commercialization potential and patentability.
- Six new U.S. patents were issued; five for UMaine inventors and one for a USM inventor
- Six new provisional patent applications were filed
- Ten non-provisional U.S. or PCT applications were filed

Conclusion

The Research Reinvestment Fund, in combination with the work of the Commercialization Working Group and Innovation and Economic Development Council, has led to significant improvements in the University of Maine System's infrastructure to support business development and commercialization. The strides that have been made in the last three years will have long-lasting impacts on the System's capacity to support industry and to accelerate the commercialization process in a way that will foster the growth of the Maine economy.

See appendices for commercialization updates on RRF-funded projects:
Appendix C: Maine Innovation, Research & Technology Accelerator Teams
Appendix D: Commercialization Progress of Select RRF Funded Grants

III. Infrastructure Support to the Research Enterprise Initiative

RRF has been instrumental for UMaine gaining ground in national ranking, where according to the HERD survey, in FY 16 it reported $79.2M in research expenditures and ranked 160, in FY 17 it had reached $99.5M and ranked 155, and in FY 18 we surpassed the $100M research expenditure mark by reaching $106.7M, which has just been reported to NSF and which we expect to result in UMaine gaining several more points in national ranking. Such progress is consistent with the University's goal of reaching R1 Carnegie classification status and continued investment in R&D by the UMS through such programs as RRF will help us to achieve this goal.

RRF represents a significant investment in bolstering the UMS Research Enterprise infrastructure through staff positions in the Office of Research Administration (ORA) and the Office of Research Development (ORD).

The Office of Research Administration (ORA) is a University-wide office authorized to submit proposals and receive awards from external sources on behalf of the Board of Trustees of the University of Maine System. ORA is also the fiduciary for the University of Maine on grant-related matters, manages and administers extramural grants and contracts for UMaine, UMM, and UMFK, with discussions underway to provide similar services to UMA.

The following ORA positions are supported by RRF and help to bolster capacity for the university to process grant proposals and awards:

> Grant & Contract Administrator: Provides guidance on proposal preparation, which includes review of proposal budget and budget justification, full proposal for completeness and compliance with sponsor requirements and University policies, and submission of final proposal to sponsor.
>
> Post Award Staff Associate: Provides post award support by creating project accounts and inputting budgets; coordinates, submits and processes post-award requests to sponsoring agencies on behalf of Principal Investigators (PIs); monitors and coordinates the submission of project reports and deliverables required by the terms of the award and the administrative closeout of the project when the award expires.
>
> Administrative Specialist: Supports the pre and post award services by electronically filing proposal and award documents, monitors office emails for incoming proposals, awards and amendments, communicates and follows up with faculty.

The Office of Research Development (ORD) provides proposal writing services to faculty with a particular emphasis on interdisciplinary/multi-institutional, large dollar grants and early career faculty outreach and support designed to enhance new researchers' ability to compete for extramural funds, while also protecting the university's investment in new talent. Additional services to faculty include funding opportunity searches and alerts, project management of proposal writing teams, delivery of a variety of grant writing workshops, and management of internal funding programs, including RRF.

In FY 2018, ORD staff provided technical assistance to faculty and researchers in the development of 56 proposals to sponsors requesting a total of $52,286,889 and conducted 38 separate training sessions providing professional development opportunities to 330 faculty, staff, and students.

ORD recently organized the proposal development process of the $20M NSF EPSCoR RII – Track 1 submission (in collaboration with Bigelow Laboratory for Ocean Sciences, USM, UMM, and others); supported 12 separate NSF Early Career Development (CAREER) submissions requesting a total of $7.2M; and were key contributors to UMaine's first NSF National Research Traineeship (NRT) award that will train cohorts of graduate students who will become the next generation of environmental conservation leaders (more information on this and other awards are included below).

The following ORD positions are supported by RRF and bolster faculty proposal development support to enable the university to compete for large center grants, increase proposal activity, and diversify funding targets for faculty to pursue.

Large Center Development Associate: Coordinates interdisciplinary and inter-institutional grant writing teams in pursuit of multi-year, multi-million dollar proposals that take 6-12 months to develop. Creates technical and non-technical content and organizes all aspects of the proposal.

Proposal Development Associate: Raises awareness of funding opportunities aligned with university strengths and provides proposal writing services to faculty pursuing external funding opportunities from federal, state, and private foundation sources.

Research Development Specialist: Focuses on early career faculty development including orienting research active faculty to available research support services, creation and delivery of grant writing training offerings, and proposal development/editing services.

It is noteworthy to mention that the number of awards received over $1M have increased significantly over the last year. ORA and ORD staff have played a key role in supporting university faculty in pursuit of high dollar value awards.

- Number of $1M+ awards received July-Dec 2017 (FY18) = 3
- Number of $1M+ awards received July-Dec 2018 (FY19) = 10

Amount	PI	Sponsor	Project Title
$5,800,000	Dr. Hemant Pendse	US Dept of Defense/Defense Logistics Agency	Woody Biomass Conversion to Liquid Hydrocarbon Fuels
$2,570,600	Dr. Habib Dagher	US Dept of Transportation	University Transportation Center
$1,017,006	Dr. Steve Shaler	USDA	Forest Based Products
$1,250,000	Dr. Susan McKay	National Science Foundation	Integrating Computing into Science Teaching and Learning in Grades 6-8: A Diverse Partnership to Develop an Evidence-Guided Model to Serve Rural Communities
$3,000,000	Dr. Habib Dagher	US Dept of Energy	New England Aqua Ventus I
$1,576,688	Dr. Allison Gardner	National Science Foundation	CNH-L: Coupled dynamics of tourism and mosquito-borne disease transmission in the Americas
$2,998,314	Dr. Sandra De Urioste Stone	National Science Foundation	NRT: Enhancing conservation science and practice: An interdisciplinary program

University Transportation Center
RRF funding is helping to support matching fund requirements for part of this award.

The DOT is awarding as much as $14.2 million over five years to establish a Transportation Infrastructure Durability Center (TIDC), which aims to save taxpayer dollars by extending the life of assets such as bridges, roads, and rail. UMaine is leading the coalition that includes the University of Rhode Island, the University of Connecticut, the University of Massachusetts at Lowell, the University of Vermont and Western New England University. The TIDC will work with state DOTs to identify new materials and technologies to maximize the return on investment in infrastructure, while training 280 student researchers.

Integrating Computing into Science Teaching and Learning in Grades 6-8: A Diverse Partnership to Develop an Evidence-Guided Model to Serve Rural Communities
Project began as 2016 Seed Grant "Revolutionizing Computing Across the University of Maine System"

The National Science Foundation awarded $1.25 million to the Maine Center for Research in STEM Education for an exploratory study with a goal of developing test activities that integrate computer science into middle school science instruction. Dr. Susan McKay, Director of the UMaine RiSE Center, leads the collaborative effort of thirty teachers from 10 Maine schools in response to the Maine Computer Science Task Force's recommendation to expand computer science instruction at the middle-school level statewide.

New England Aqua Ventus I
Project was supported by a 2018 RRF Seed Grant "Maine-Based Construction and Assembly of Aqua Ventus Floating Hull"

The Advance Structures and Composites Lab leads this project which will help Maine become a leader in a technology that will change the future of energy. The objective is to put a two-turbine, 12-megawatt project off the coast of Monhegan Island. It is the first project of this type that uses concrete for the floating platforms.

NRT: Enhancing conservation science and practice: An interdisciplinary program
RRF supported staff from ORD provided proposal writing support on the initial submission and subsequent resubmission that attracted UMaine's first National Research Traineeship (NRT) award from NSF.

Dr. Sandra De Urioste Stone leads an interdisciplinary team of faculty to develop a new graduate education model for the next generation of conservation science leaders. The team plans to train over 20 NSF-funded graduate students from forest resources, wildlife conservation, communications, and environmental sciences to develop interdisciplinary communication, collaboration, and professional skills that will help them prepare to solve environmental and conversation issues.

Q2 FY 2019 awards received over $1M

Amount	PI	Sponsor	Project Title
$1,955,519	Dr. Eric Gallandt	US Dept. of Agriculture	Integrating seed- and seedling-focused weed management in organic vegetable systems
$4,000,000	Dr. Kody Varahramyan	National Science Foundation	Maine EPSCoR: The Nexus of Coastal Marine Social-Environmental Systems and Sustainable Ecological Aquaculture Year 5
$6,418,000	Dr. Habib Dagher	Consortium Management Group (CMG) /US Dept. of Defense	Design Development of Prototype Engineered Energy Efficient and Low Logistic Burden Materials and Processes IV

Appendix A: RRF Advisory Board Members

Name	Title	Organization
Brian Beal	Professor of Marine Ecology	University of Maine at Machias
Martha Bentley	Director of Innovation Infrastructure	Maine Technology Institute (MTI)
Seth Berry	Vice President for International Business Development	Kennebec River Biosciences
Jason Charland (Operations Committee)	Director of Research Development	University of Maine
Doug Gardner	Professor of Forest Operations, Bioproducts and Bioenergy	University of Maine
Kody Varahramyan (Operations Committee)	Vice President for Research and Dean of the Graduate School	University of Maine
Mike Kinnison	Professor of Evolutionary Applications, School of Biology and Ecology	University of Maine
Jennifer Baker (Operations Committee)	Senior Officer for Finance and Administration	University of Maine
Kris Sahonchik	Director, Cutler Institute for Health and Social Policy	University of Southern Maine
Terry Shehata	Senior Policy Associate: Research and Economic Development/MEIF Coordinator	University of Southern Maine
Rebecca Van Beneden	Director of the School of Marine Sciences	University of Maine
James Ward (Operations Committee)	Vice President of Innovation and Economic Development	University of Maine

Appendix B: FY 2019 Funded RRF Projects

The University of Maine System (UMS) Research Reinvestment Fund (RRF) Advisory Board is pleased to announce the winners of the FY 2019 funding competitions. The objective of the RRF is to strengthen research and development activities that are tied to Maine businesses and to industries that are critical to the future of Maine, including providing internal grant funding to UMS research teams to stimulate such activity.

In FY 2019, a total of 65 applications were received for the established RRF competitive grant programs which resulted in 29 new awards (5 planning grants; 6 seed grants; 14 student awards, and 4 accelerator grants).

RRF Planning Grants provide funding for 6 month projects that allow research teams comprised of UMS researchers and/or external partners to form and develop plans to advance and develop research, development, and commercialization projects.

RRF Seed Grants provide funding for 12 month projects that generate pilot data, proof of concept testing, and target specific follow-on grant opportunities to leverage the investment of RRF funds by attracting additional funding to the University. Seed grant teams are comprised of UMS researchers and external partners. Funding preference is given to projects that are able to demonstrate the likelihood of near-term commercialization and/or workforce development output.

RRF Student Awards provide funding for UMS faculty/staff led research, development, and commercialization projects that involve UMS students as major contributors to the execution of the project. There are four separate student award programs supported by RRF: 1. Interdisciplinary Graduate Research Collaborative (IGRC); 2. Interdisciplinary Undergraduate Research Collaboratives (IURC); 3. Graduate Student Assistantships; and 4. Undergraduate Student Assistantships.

RRF Accelerator Grants are also known as the Maine Innovation, Research and Technology Accelerator (MIRTA). Teams receive funding and participate in a 16 week intensive program designed to advance research projects along the path from discovery to becoming commercial products with public benefit.

A listing of the new FY 2019 RRF awards follows and questions about the program can be directed to Jason Charland, UMaine Director of Research Development, jason.charland@maine.edu.

FY 2019 RRF Planning Grants (5 awards)

Planning for Wraparound Services that Support the Growth of Maine's Craft Beer Industry

- *PI: Terry Shehata, Economic Development Officer, University of Southern Maine*
- *Collaborators: Jake Ward & Renee Kelly, UM Office of Innovation and Economic Development, Sean Sullivan Executive Director of the Maine Brewers' Guild; Luci Benedict USM Director of the Quality Collaboratory; Maggie Vishneau Senior Policy Associate for Research & Organizational Develop, USM Cutler Institute; Ross Hickey USM Asst Prov for Research Integrity; Ryan Wallace Director of the USM Center for Business and Economic Research; Sarah Goan USM Data Innovation Project; Andrew Crawley UMaine School of Economics; Jason Bolton UMaine Cooperative Extension.*

USM and UMaine, in partnership with the Maine Brewers' Guild, propose to undertake a 6-month effort to develop a comprehensive implementation plan for providing wraparound services that support the growth of the craft beer industry. The development of the implementation plan is necessary to help the industry address challenges in anticipation of continuing growth in output and employment by 2020. The success of this planning effort could serve as a model for developing industry sector-based tailored services.

Pilot project for development of Maine Medical Arts (MEMA) MA degree

- *PI: Owen Smith, UMaine Innovative Media Research & Commercialization Center*
- *Collaborators: Patrick McFarlane, Northern Light Health Care; Lewis Mehl-Madrona, MD, University of New England, Susan Smith, UMaine Intermedia Programs.*

This project proposes the development of a pilot Maine Medical Arts (MEMA) MA degree focused on Arts and Medicine. This unusually innovative graduate degree can address both Maine's shortage of medical professionals and high rates of social and health issues such as addiction, food insecurity, and children in poverty. This project has strong potential to succeed because it draws on multiple disciplines that will ultimately complement, challenge, and inspire the imaginations of practitioners and patients alike.

Planning for the future: UMM's Marine Science Field Station

- *PI: Brian Beal, University of Maine at Machias*
- *Collaborators: Heather Leslie, Darling Marine Center, Rebecca Van Beneden UM School of Marine Sciences, and Down East Institute (DEI)*

The University of Maine at Machias, the University of Maine and the nonprofit Downeast Institute, have developed the Marine Science Field Station (MSFS) in Beals, Maine. This grant funds a two-day planning workshop at MSFS to bring together a dozen senior marine scientists with experience working at both large and small marine field stations and local community members to help our leadership team develop a 5-year strategic plan to manage and operate the field station in a way that maximizes scientific discovery, undergraduate and graduate research, and helps create new economic opportunities in eastern coastal Maine.

MBS Professional Development Center Initiative

- *PI: Niclas Erhardt, Maine Business School*
- *Collaborators: Andy Egan, Head of Campus, University of Maine at Machias and Jason Bolton UM Cooperative Extension.*

In order to meet the business needs of the Maine business community and the educational needs of students, the Maine Business School proposes the establishment of the MBS Professional Development Center. The mission of the Center will be fourfold: 1) to provide business consulting services to Maine-based organizations; 2) to offer workforce development opportunities for companies and employees; 3) to provide student internships and internship

consulting to businesses, and 4) to offer integrated classroom-business learning in form of corporate classrooms. In meeting the needs of both the students and Maine's business community, the Center will be supporting economic growth on campus and throughout the state of Maine.

Arctic Futures Workshop in South Greenland – June 2019
RRF is supporting a unique opportunity for UMaine, USM, and UMaine School of Law researchers and scholars who have been engaged in Arctic research or hope to be in the future to participate in a one-week workshop in South Greenland called "Arctic Futures." Attendees will actively participate in the writing of a report addressing the use of South Greenland as a case study for Arctic research, with an emphasis on problem-solving for local South Greenland and synergies with Maine. The workshop provides a venue for participants in a broad range of specialties to collaborate with Greenland citizens and representatives to learn about and work together on topics of mutual interest. The collaborative nature of this endeavor sets up opportunities for collaborative proposals to the National Science Foundation's "Navigating the New Arctic" funding program and other similar mechanisms.
Maine Law School: Jeffrey Thaler (Visiting Associate Professor of Law), Charles Norchi (Benjamin Thompson Professor of Law)
USM: Firooza Pavri (Director of the Muskie School of Public Service; Professor of Geography), Vinton Valentine (Director of USM GIS), Jan Piribeck (Professor of Digital Art and Foundations), Matthew Bampton (Professor of Geography)
UMaine: Kristin Schild (Research Assistant Professor School of Earth and Climate Sciences and Climate Change Institute), Kathleen Bell (Professor of Economics), Neal Pettigrew (Professor of Oceanography), Robert Northington (Lecturer/Post-doctoral Research Associate of Ecology), Erin Roche (Crop Insurance Education Program Manager, Cooperative Extension), Yong Chen (Professor of Fisheries Sciences), Alice Kelley (Instructor of Earth and Climate Sciences, Research Associate Professor Climate Change Institute), Paul Mayewski (Distinguished Maine Professor of Earth and Climate Sciences and Director of Climate Change Institute), Jasmine Saros (Professor of Paleolimnology and Lake Ecology), Lee Karp Boss (Associate Professor of Marine Sciences)

RRF Seed Grant Projects (6 awards)

Medical Laboratory Technology (MLT) Practicum Intensive Week Pilot

- *PI: Judith Clukey, University of Maine at Augusta*
- *Collaborators: Leigh Belair, University of Maine at Presque Isle; MaineGeneral Medical Center, Nordx Labs, ALI Labs, Pen Bay Medical Center, Waldo General Hospital, Central Maine Medical Center, Southern Maine Medical Center*

This project proposes using RRF funds for the Medical Laboratory Technology (MLT) of Maine program, which was created as a collaborative effort between UMPI and UMA. The program is challenged by limited clinical sites that have the capacity to train students in microbiology and blood banking. This issue combined with staff shortages has led to less participation from hospitals in lab training. Judith Clukey plans to address this by establishing intensive week-long trainings for MLT students that will minimize clinical time and technical instruction commitment from affiliate sites while continuing to develop well-trained lab professionals.

A Platform Using a New Cyber Physical System and UAV to Detect Temporal and Spatial Variation for Precision Agriculture

- *PI: Yongjiang Zhang, UMaine School of Biology and Ecology*
- *Collaborators: Hongzhi Guo, University of Southern Maine, Matthew Wallhead UMaine School of Food and Agriculture; Jasper Wyman & Son, Wild Blueberry Commission of Maine, and Cherryfield Foods Inc.*

This project proposes the development of a platform that will allow farmers to use their resources more efficiently. A Cyber Physical System (CPS) will be made to monitor temporal variation in the water status of wild blueberries,

and Unmanned Aerial Vehicle (UAV) sensors will be used to detect spatial variation across the farm, which produces data also useful to scientists studying plant-environment interactions. Dr. Zhang plans to expand the proposed platform to include fertility and pest management, and also to develop an automated AI system that can analyze and report crop-environment interactions.

Nutrient Removal from Recirculating Aquaculture System Water

- *PI: Jean MacRae, UMaine Civil and Environmental Engineering*
- *Collaborators: Deborah Bouchard UM Aquaculture Research Institute, Hunter Swisher, Phospholutions, LLC, and David Noyes, Nordic Aquafarms.*

This project aims to establish a collaboration with the Aquaculture Research Institute, Phospholutions, and Nordic Aquafarms to build a recirculating aquaculture system (RAS) in Maine. The RAS will improve biosecurity and growth efficiency by reducing water consumption and pollutant discharge from aquaculture systems. The team will conduct laboratory experiments to determine the specifics involved with phosphorus removal and impacts of operational changes on water characteristics.

Transforming diploid potato breeding by enhancing potato haploid induction

- *PI: Ek Han Tan, UMaine School of Biology and Ecology*
- *Collaborators: Gregory Porter, UM School of Food and Agriculture and Kathy Haynes, US Department of Agriculture*

Adopting a new, commercially viable variety of potato requires a complicated process that can take as long as two decades. Considering a rapidly changing climate, Dr. Tan feels that Maine needs a more efficient way of breeding new potato varieties. Diploid breeding is a simpler method that many potato breeders in the U.S. have begun to adopt, and this project proposes using RRF funds to implement diploid breeding at UMaine's potato-breeding program, which currently uses conventional methods. Dr. Kathy Haynes, a collaborator in this project, is providing access to her diploid breeding lines in Maryland, which will allow Dr. Tan to establish preliminary data in an effort to secure external funding.

Development and Application of 3D Printing for the Manufacture of Boat Parts

- *PI: James Anderson, UM Advance Structures and Composites Center*
- *Collaborators: Douglas Gardner UM School of Forest Resources, Hinckley Yachts, and Back Cove Yachts.*

A disproportionate amount of the cost of building a boat goes to the dozens of smaller parts, such as doors, hatches, and ducts. Each piece requires one or two molds and a substantial amount of labor. If these parts were 3D-printed instead, significant resources could be saved for work on larger boat parts. The two main barriers to adopting this method are a lack of knowledge on the durability of printed materials as well as which plastics and printers should be used, and how they should be set up for operation.

Development of a Low Cost Environmental Observing Buoy for Aquaculture Site Prospecting

- *PI: Heather Leslie, UM Darling Marine Center*
- *Collaborators: Neal Pettigrew, UM Physical Oceanography Group, Damian Brady, UM School of Marine Sciences, and Joshua Girgis & Chris Davis, Maine Aquaculture Innovation Center.*

In light of the rapidly growing aquaculture industry in Maine, this project will address aquaculturists' need for better water quality data. The team will develop a sensor package for a buoy that will be more practical and affordable than the expensive buoys that are commercially available today. Consultation with aquaculturists over the last five years have determined which parameters the sensor will need to be able to measure, such as water temperature and salinity. After the development of the sensor package and buoy, commercialization will be pursued.

FY 2019 RRF Student Awards (14 awards, 4 different tracks)

RRF Interdisciplinary Graduate Research Collaborative (1 award)

An interdisciplinary approach to building data literacy in wildlife survey technologies

- *PI: Cynthia Loftin, UM Wildlife Ecology and USGS Maine Cooperative Fish and Wildlife Unit*
- *Collaborators: Kate Beard Tisdale, UM School of Computing and Information Science, Anthony Guay & Dan Hayes, UM School of Forest Resources, Roy Turner, UM School of Computing and Information Science, Tora Johnson, GIS Director, University of Maine-Machias, Aly McKnight Wildlife and Fisheries Management, Unity College; Mark Koneff, Chief, Branch of Migratory Bird Surveys, US Fish and Wildlife Service (USFWS); Brian Benedict, Maine Coastal Islands Refuge, Linda Welch & Sara Williams, USFWS Wildlife Biologists; Caleb Speigel, USFWS, Division of Migratory Birds; and Danielle D'Auria, Waterbird Biologist, Maine Department of Inland Fisheries and Wildlife.*

This project's objectives are to 1) build interdisciplinary data literacy through development, application, and evaluation of new technologies for rapid assessment of wildlife populations during time-critical windows, 2) engage students in team science, and 3) transfer this technology to collaborating stakeholders. An interdisciplinary team of students will collaborate with biologists, ecologists, remote sensing specialists, and computer scientists to evaluate and improve survey methods, image collection and interpretation protocols, and tools to enhance data management efficiency and workflow with machine learning and artificial intelligence.

RRF Interdisciplinary Undergraduate Research Collaboratives (4 awards)

Making Maine's Local Food System Sustainable: Opportunities to Address Hunger and Reduce Waste through a Multi-Site, Interdisciplinary Team

- *PI: Deborah Saber, UM School of Nursing*
- *Collaborators: Jean MacRae, UM Civil and Environmental Engineering; Balu Nayak, UM School of Food and Agriculture; Travis Blackmer, UM School of Economics; Linda Silka, UM Mitchell Center for Sustainability Solutions; Cindy Isenhour, UM Anthropology; UMPI; USM, UMA; UMF, and UMFK.*

This project is a continuation of an IURC-I program that focuses on food loss, food waste, and barriers to establishing a circular food system and environmental sustainability while addressing food insecurity. Through this IURC-II program, college-educated Millennials who are engaged in projects and research have the opportunity to join an interdisciplinary team that aims to discuss problems, conduct research, develop solutions, participate in decision-making processes, and expand a youthful workforce in growing work sectors in Maine.

The Western Passage student research collaborative: Considering physical, biological, and social dynamics of a tidally energetic system in Eastern Maine

- *PI: Kristina Cammen, UM School of Marine Sciences*
- *Collaborators: Gayle Zydlewski, Maine Sea Grant, Jessica Jansujwicz, UM Mitchell Center for Sustainability Solutions; Lauren Ross, UM Civil and Environmental Engineering; Tora Johnson, UMM Marine Biology; and Gabriella Marafino, UM School of Marine Sciences*

The objectives of this project are 1) to evaluate the utility of available water current data for building a three-dimensional turbulence model of the Western Passage region, 2) to describe the frequency of occurrence and interactions among multiple trophic levels of marine species in Western Passage, and 3) to document local ecological knowledge of Western Passage and identify remaining data gaps and regulatory and social implications.

Science and Workforce Development for Sustainable Aquaculture in Maine

- *PI: Heather Leslie, UM, Darling Marine Center*
- *Collaborators: Brian Beal, UMM Marine Sciences Field Station; Rachel Lasley-Rasher, USM Biological Sciences, Theo Willis & Karen Wilson, USM Environmental Science & Policy; Jeremy Rich, Damian Brady & Joshua Stoll, UM School of Marine Sciences*

As part of an effort to ensure Maine's aquaculture potential is met, this project aims to help train the next generation of aquaculture scientists and professionals through research experience. Six complementary projects are involved, examples of which are developing a sustainable system for scallop spat collection, understanding community perspectives and benefits of coastal marine aquaculture, and the development and testing of a freshwater recirculating aquaculture system**.**

Biophysical and social dimensions of tick-borne disease risk in Maine's public parks and natural areas

- *PI: Allison Gardner, UM School of Biology and Ecology*
- *Collaborators**:** Sandra De Urioste-Stone, UM School of Forest Resources, Sean Birkel, UM Climate Change Institute; Danielle Levesque, UM School of Biology and Ecology.*

Climate change is expected to cause an increase in the amount of ticks infected with Lyme disease, which will increase people's chances of exposure to the illness. This is not only a public health concern, but also a potential for losses in Maine's nature-based tourism industry. This project aims to deepen our understanding of the natural and human drivers of tick-borne disease transmission and potential interactions among climate, wildlife, and visitation. Work will be done through field studies, Acadia visitor surveys, and the production of a tick and Lyme disease awareness document for public outreach.

RRF Undergraduate Assistantship Awards (4 awards)

RADAR Stethoscope for Non-Contact Heart Beat Detection

- *PI: Nuri Emanetoglu, UM Electrical and Computer Engineering*
- *Collaborators: Herbert Aumann, UM Electrical and Computer Engineering; and Robert Bowie, M.D., Medical Director Bangor Fire EMS*

This project proposes the development of a prototype for a Doppler radar non-contact stethoscope for use in situations where a medical professional must listen to a heart, but direct skin contact is dangerous or impossible. The undergraduate student selected for this project will the various parts of the stethoscope, and once 10 models are created, they will be provided to health care practitioners for testing.

Expansion and Testing of a Habitat Selection Model for a Globally Threatened Bird Species on Industrial Forestland

- *PI: Neil Thompson, Forestry, University of Maine at Fort Kent*
- *Collaborators: Amber Roth, UM School of Forest Resources; Carol Foss, New Hampshire Audubon; Patricia Wohner, Cuckoo Conservation Initiative; Jason Johnston, UMPI*

The Rusty Blackbird is a threatened species that was recently listed as a Special Concern in Maine. To predict their nesting habitat in northern New Hampshire, a habitat selection model was developed. In this project, that model will be extended throughout western and northern Maine using geographic information system (GIS) technology and field observations. This will allow recommendations to be made for habitat management, hopefully leading to intensive forestry practices that can produce high quality nesting habitats for the Rusty Blackbird.

Coldwater selection for fast growth of American oysters in Downeast Maine

- *PI: Brian Beal, Director of the Marine Science Field Station, University of Maine at Machias*
- *Collaborator: Heather Leslie, UM Darling Marine Center*

The goal of this project is to produce a fast-growing, disease-resistant American oyster that will grow to commercial size in 2-3 years in the cold waters of eastern Maine, finally allowing this region to profit from the rapidly growing industry. Building on Dr. Beal's previous work in rearing juvenile oysters, in this project an undergraduate student will help conduct research to examine the growth rates of those selected juveniles over a one-year period. This will help in understanding which conditions lead to fast growth and survival of juvenile oysters in cold water.

Nutritional quality and the physiological drivers of growth variation in eastern oysters

- *PI: Paul Rawson, UMaine School of Marine Sciences*
- *Collaborators: Eric Moran, co-owner, Bagaduce River Oyster Co.*

The eastern oyster is an important species supporting the current growth of Maine's aquaculture industry, but there is a high degree of variance in growth among individuals within available stocks. This project's goal is to test the hypothesis that individual oyster growth is maximized among the ones with highest growth during non-bloom periods, when more of the nutrition in the river is detritus-based. To accomplish this, Dr. Rawson plans to measure the individual growth of tagged oysters on a bi-weekly basis from March to October and compare those measurements with water quality aspects such as temperature, salinity, and turbidity.

RRF Graduate Assistantship Awards (5 awards)

Detecting changes in zooplankton following the recovery of river herring in the Penobscot

- PI: Rachel Lasley-Rasher, University of Southern Maine Biological Sciences
- *Collaborators*: Karen Wilson, USM Environmental Science and Policy; Damian Brady, UMaine School of Marine Sciences

River herring populations have declined dramatically and remained low for over a century after dams were built that blocked access to their spawning habitat. The primary goal of this project is to determine how and if diet selectivity has changed, explore how alewife alter zooplankton communities through selective feeding, and predict community changes as recovery progresses and extend these results to other dam removal projects.

Graduate Support to Enhance Collaborative Research with Maine's Lobster Industry

- PI: Damian Brady (UMaine School of Marine Sciences)
- *Collaborators:* Richard Wahle UMaine Lobster Institute, Deborah Bouchard UMaine Aquaculture Research Institute, Annie Tselikis & Patrice McCarron Maine Lobstermen's Association., Andrew Goode UMaine SMS Ph.D. student and lobsterman, Phillip Dostie Bates College, Environmental Geochemical Lab, Matthew Jadud Bates College, Digital & Computer Sciences

This project's goal is to increase the profitability of Maine's lobster industry by improving conditions that are causing "shrink," or the mortality of lobster from capture to kitchen. Current shrink rates are at about 3-7%, which if improved by even a few percent could increase profit by millions of dollars. To accomplish this, Dr. Brady plans to monitor water quality at critical points along the lobster supply chain and then work to mitigate stress points that are identified.

Food Waste to Biogas: Optimizing Energy Recovery

- *PI: Jean MacRae (UMaine Civil and Environmental Engineering)*
- *Collaborators: Clayton "Mac" Richardson, Lewiston Auburn Water Pollution Control Authority (LAWPCA)*

To address the need to shift to renewable sources of energy as well as the large amounts of produce grown in the U.S. that is wasted, this project proposes the extraction of energy from food waste through anaerobic digestion. Researchers at UMaine will work with the Lewiston-Auburn Water Pollution Control Authority (LAWPCA) to conduct laboratory tests to determine the specifics on this energy-extraction process. If successful, this effort will allow farmers and communities to recover economic value from food waste throughout the state.

Graduate Assistantship: Predicting the Effects of Climate Change on the Range and Distribution of Small Mammals in Maine

- *PI: Danielle Levesque, UMaine School of Biology and Ecology*
- *Collaborators: Jason Johnston, Wildlife Ecology, and University of Maine at Presque Isle*

Recent changes in environmental conditions have brought to the forefront the importance of understanding the relationship between environmental temperatures, energetics, and performance in animals as species ranges shift in response to warming temperatures. This project will support a graduate student to study some small mammals in a laboratory setting to ultimately model heat and energy balance budgets at the edge of the species' range distributions.

Understanding the role of policy interventions in shaping market entrepreneurship in New England Fisheries

- *PI: Joshua Stoll, UMaine School of Marine Sciences*
- *Collaborators: Patricia Pinto da Silva, Social Scientist, Northeast Fisheries Science Center; Dave Love, Johns Hopkins University*

Catch shares are an increasingly common tool used in fisheries management. Under fisheries managed as catch shares, the total allowable harvest is allocated to individuals (or firms) based on their catch history and these individuals are free to buy, sell, or trade their allotment. There are two primary questions that are driving this research project: (1) What role are catch shares in New England playing in seafood distribution strategies; and (2) What market strategies are fishermen in New England utilizing to distribute their catch?

RRF Accelerator Grants (Cohort 2)
Maine Innovation Research and Technology Accelerator (MIRTA) (4 awards)

Customer Discovery and Market Validation of Midlina - A multimodal software solution that will provide blind and visually-impaired (BVI) people with access to graphical information

- *PI: Nicholas Giudice, UMaine School of Computing and Information Science*

Gaining access to graphical information (such as maps, graphs, and diagrams) is one of the biggest challenges for blind and visually-impaired (BVI) people. To address this major unmet and immediate need in the field of blindness accessibility, we have invented an innovative multimodal software solution that will enable BVI people with independent information access to combined textual and graphical information in digital media via commercial off-the-shelf smartphones and tablets. Through this project we plan to continue our customer discovery process with the goal of understanding product-market fit and to identify our target market for commercialization.

Nanocellulose based Composites for Orthopedic Fixation Devices

- *PI: Mike Mason, UMaine Chemical and Biological Engineering*

The targeted market for the proposed technology is that of orthopedic fixation devices, or devices used to hold bones together after surgery or trauma. Currently, this market is valued at ~$40.2 billion and predicted to grow to $61 billion by 2021. Biomaterials within this field currently possess significant flaws, creating a suboptimal performance in a multitude of scenarios and presenting vast opportunities within the market for a novel biomaterial solution. Over the past few years, we have explored the use of cellulose nanofiber (CNF), a green, renewable, value-added product, as the material to usher in this new age of biomedical structural materials. Research has led to promising results, proving advantages over current technology and developing proof of concepts that have garnered the attention of influential stakeholders within the market. We look to further IP and prototype development, along with increasing market analysis and stakeholder discovery.

Commercialization of Molded Wood Flour-Cellulose Nanomaterial Products

- *PI: Mehdi Tajvidi, UMaine School of Forest Resources*

We propose commercialization of molded products that can be fabricated from wood flour and lignocellulosic nanomaterials, originated from Maine's abundant fiber resource. The main advantage of the proposed product, compared with its plastic counterparts, is biodegradability and environmentally-benign end-of-life disposal. Moreover, both major components are made from Maine's renewable resources. The target market is home and office accessories including desk organizers, pencil cups, etc. as well as children's toys (e.g. toy building blocks). Briefly, various formulations based on wood flour, CNF, LCNF, Fiberlean and other additives are blended and then casted into 3D printed molds that are designed for specific geometries. Typical products include desk organizers and pen cups as well as toy building blocks. Coloring pigments are added into the mixture to achieve colorful products. The wet shaped products will be dried in an oven under light pressure to avoid warpage. The prototypes will be used for commercialization efforts and a start-up company will be formed to produce the developed products.

New Gear for New Growers: Commercializing a Low-cost Oyster Sorter for Small-Scale and Diversified Business Enterprises

- *PI: Josh Stoll, UMaine School of Marine Sciences*

Aquaculture represents a major economic opportunity for coastal communities in the United States and has the potential to be a way for fishermen to diversify their employment. Small-scale aquaculture businesses are the fastest growing subset of farms in Maine. In 2017 the Maine Department of Marine Resources issued more than 400 limited purpose aquaculture permits to over 100 independent businesses. For small-scale aquaculture businesses like these to be profitable in the long-term there is a need for cost- and scale-appropriate tools that facilitates efficient operations. However, this equipment largely does not exist in the marketplace at this point. Acknowledging this issue, we propose to commercialize a small, low-cost oyster sorter that we have been developing (and tested with farmers in the summer of 2018). We will focus on the oyster sorter because: (1) we have an existing prototype; (2) oyster farming is rapidly expanding in Maine and more broadly; and (3) sorting is an essential part of oyster husbandry, but it an extremely time-consuming process if it is not mechanized. In the long-term, this equipment could be packaged as part of a suite of scale-appropriate gear for aquaculture start-up companies and small-scale farmers.

Appendix C: Maine Innovation, Research & Technology Accelerator Teams

Spring 2018 Cohort

Beverage (Wine and Beer) Spoilage Detector
Near real-time instrument for detection of microorganisms to avoid ruined product.
PI: Laurie Connell, School of Marine Sciences, with Connell Lab staff Corey Hirn and Leslie Astbury
RRF: 2015 Seed Grant and 2018 Seed Grant
Other funding: MTI seed grants, industry contracts
IP: Patent application in process
Industry partners: Beacon Analytics, Saco, Maine; Constellation, NY
Current Status: Preparing for customer trials and license is planned with industry partners

Low-Cost Geoinformatics for Forests
Near real-time mapping of forest characteristics for improved forest management.
PI: Erin Simons-Legaard, Kasey Legaard, Aaron Weiskittel, all from School of Forest Resources and staff from UMaine Advanced Computing Group
RRF: 2016 Seed Grant
IP: Provisional patent application in development
Current status: Plan to license directly to the end user with the first research collaboration and license likely to happen early in 2019

Microfluidics Platform Technology for Biomedical Applications
Lower cost and environmentally-friendly point of care diagnostics
PI: Caitlin Howell, biological engineering, with staff Matt Talbot, and students Amber Boutiette and Bailey Corliss
RRF: 2016 Seed Grant
Other funding: Industry contracts
IP: Patent application in process
Industry Partners: Sappi, Westbrook, Maine
Current Status: Ongoing research collaboration with Sappi, high potential applications for first markets identified, license to already identified existing Maine companies

Early Diagnosis and Treatment of Peripheral Neuropathy
Device to detect neuropathy much earlier than current methods.
PI: Kristy Townsend, School of Biology & Ecology; Rosemary Smith, electrical engineering; students Magdalena Blaszkiewicz and Michael Small
RRF: Round 1 & Round 2 Undergraduate Assistantship
IP: Patent application in process
Industry relationships: Mount Desert Island Biological Laboratory, Bar Harbor, Maine
Current Status: Start-up company formed (Neuright) and participating in Top Gun program

Bee Hive Activity Monitoring System
Monitoring system that is an early warning tool against colony collapse disorder.
PI: Nuri Emanetoglu, electrical engineering; Herbert Aumann, electrical engineering; Frank Drummond, School of Biology & Ecology; student Berkay Payal.
RRF: Round 1 Undergraduate Assistantship
Other funding: National Science Foundation
IP: Provisional patent application in process
Industry relationships: State of Maine apiarist
Current status: Start-up company (Healthy Hives) in process and participating in Top Gun program

Fall 2019 Cohort

Customer Discovery and Market Validation of Midlina
A multimodal software solution that will provide blind and visually-impaired (BVI) people with access to graphical information
PI: Nicholas Giudice, UM School of Computing and Information Science
RRF: n/a
Other funding: NSF I-Corps, Maine Technology Institute, NSF SBIR
IP: Know-how identified and license planned to start-up company
Industry relationships: partnerships with a variety of organizations that support visually-impaired people
Current status: Start-up formed (UNAR Labs) and awarded a $225,000 NSF SBIR commercialization grant

Nanocellulose based Composites for Orthopedic Fixation Devices
PI: Mike Mason, UM Chemical and Biological Engineering
RRF: 2016 Graduate Assistant Award, 2017 Seed Grant
Other funding: Industry-sponsored project, MTI grant pending
IP: Patent application pending and another application planned
Industry relationships: Maine-based orthopedic surgeons
Current status: Possible start-up and potential commercialization partner identified

Commercialization of Molded Wood Flour-Cellulose Nanomaterial Products
PI: Mehdi Tajvidi, UM School of Forest Resources
RRF: 2015 & 2017 Seed Grant
Other funding: MTI application pending
IP: Patent application pending and another application planned
Industry relationships: Lignetics, Strong, Maine
Current status: Potential start-up to further develop technology, then license to manufacturing partners

New Gear for New Growers:
Commercializing a Low-cost Oyster Sorter for Small-Scale and Diversified Business Enterprises
PI: Josh Stoll, UM School of Marine Sciences
RRF: n/a
Other funding: EPSCoR funding, MTI application pending
IP: Copyright of sorter designs
Industry relationships: multiple small-scale
Current status: Possible start-up to commercialize sorter and develop additional services

Appendix D: Commercialization Progress of Select RRF Funded Grants

UMaine OIED worked closely with the majority of RRF seed grant applicants and recipients. This work includes implementing intellectual property protection, developing commercial development plans, identification of commercial partners and leveraging additional investment funding from other sources in an effort to accelerate and advance commercial development.

The following are examples that are progressing towards commercialization and leveraging RRF for industry engagement and business development.

Forest Products & Agriculture

2017 Seed Grant: Cross-laminated timber demonstration building design and cost analysis
PI: James Beaupre
Engagement: Led to engagement with multiple land owners and municipalities; facilitated 2018 announcements by two companies to build CLT manufacturing facilities in Maine. Planning is underway for a Maine-based demonstration building to utilize manufactured CLT panels.
Advancement: Seed grant was used as match for a 2017-2020 $455,000 grant from the U.S. Economic Development Administration to create a Mass Timber Commercialization Center. UMaine continues to improve business attraction packages for CLT and other forest products in collaboration with Maine communities and regional economic development leaders.

Biotechnology

2017 Seed Grant: Variable and high porosity nanocellulose solid forms for biomedical applications
PI: Michael Mason (UMaine Department of Chemical and Biological Engineering)
Engagement: UMaine School of Forest Resources and private equity investment.
Advancement: Executive-level discussions began in December 2018 with investment firm specializing in biomedical engineering applications (facilitated by MIRTA participation) on non-CNF material applications, with expectation of evaluation and sponsored research in CNF devices. From MIRTA accelerator work, planning to form a start-up company to further develop the technology.

2015 Seed Grant: (relates to above): Development of additively manufactured highly porous implantable devices that promote post-surgical wound healing and a biological transcutaneous seal: Testing of implant material and internal pore geometry in a porcine model
PI: James Weber (Food and Agriculture, UMaine)
Engagement: Stryker Orthopedic
Additional Investment: Stryker Orthopedic in-kind funding
Advancement: No update

2017 Seed Grant: Cellulose Nanofibers: A novel adjuvant for veterinary and medical applications
PI: Deborah Bouchard (UMaine, Aquaculture Research Institute)
Engagement: Benchmark Animal Health
Advancement: Currently under evaluation by Benchmark for a license option and funded research.

2016 Seed Grant: Liquid-infused paper substrates for new biomedical applications
PI: Caitlin Howell (Biomedical Engineering, UMaine)
Engagement: SLIPS Tech, Sharklet Technologies, SAPPI Fine Paper North America, IDEXX
Advancement: SAPPI sponsorship research; patentability and commercial assessment pending; RRF Accelerator participant. Participated in MIRTA accelerator, received funding from the Maine Technology Institute to develop

first market application of the technology.

Healthcare

2017 Seed Grant: Development of Intrac™: A weight bearing and fitness tracking system for assistive devices
PI: Vincent Caccese (UMaine, Department of Mechanical Engineering)
Engagement: UMaine School of Social Work and Center for Community Inclusion and Disability Studies, USM Lewiston, Occupational Therapy Programs, Mobility Technologies
Advancement: Product line expansion for UMaine licensee and SBIR awardee Mobility Technologies.

2017 Seed Grant (relates to above): Eco-Sno co-design project
PI: Elizabeth DePoy (UMaine School of Social Work and Center for Community Inclusion and Disability Studies)
Engagement: UMF, Outdoor Recreation Business Administration, UMaine School of Social Work and Center for Community Inclusion and Disability Studies, UMaine Center on Aging. Mobility Technologies.
Advancement: Product line expansion for UMaine licensee and SBIR awardee Mobility Technologies.

2018 Seed Grant: Augmented reality respiratory simulators for combined visual and haptic medical training in low-resource settings & 2018 Undergraduate Assistantship: Haptic feedback sensor suite for AR-enhanced simulators
PI: Caitlin Howell (UMaine, Department of Chemical & Biomedical Engineering)
Engagement: Zephyrus Technology, Denham Ward (Maine Medical Center Research Institute)
Advancement: Zephyrus Technology is a tenant in the Foster Center for Innovation at UMaine and is participating in the 2019 cohort of the Top Gun program to accelerate business development.

Composites & Advanced Materials

2017 Seed Grant: Application of low-cost bio filled thermoplastics to 3D printed marine tooling
PI: Douglas Gardner (UMaine, Advanced Structure and Composite Center)
Engagement: UMaine, School of Forest Resources, UMaine, ASCC, Lyman Morse, Hinckley Yachts, Hodgdon Yachts, Sabre, & Thermwood Corporation
Advancement: Used to leverage $300,000 from Oakridge National Laboratory; industry-sponsored projects continuing. In August 2018 the team received a $500,000 Maine Technology Institute award to support the application of the technology to Maine's boat building industry cluster.

2017 Seed Grant: Turning Maine's wood fiber resource into renewable food packaging systems
PI: Mehdi Tajvidi (UMaine School of Forest Resources)
Engagement: UMaine, Department of Chemistry, UMaine ASCC, Synthesis Group Minerals Technologies, UMaine School of Food and Agriculture, USDA Forest Products Lab
Advancement: Leveraged grants from P3Nano, technology of interest to multiple licensees, including opportunities for Maine industry. Discussions underway. Participated in MIRTA accelerator to determine best market applications for packaging. Planning for a start-up to further the development of the technology with the goal of licensing to manufacturers.

2017 Seed Grant: Novel fire resistant low-formaldehyde emitting fiberboard panels made from deadwood or wood residuals and nanocellulose
PI: Mehdi Tajvidi (Forest Resources, UMaine)
Engagement: Early discussions underway with a large global end user, a Maine sawmill and large potential end-user licensees in building products and consumer goods.
Advancement: Patent application filed

2015 Seed Grant: Development of structural wood plastic composite timber for innovative marine applications
PI: Douglas Gardner (Advanced Structures and Composites Center, UMaine)
Engagement: Innovasea
Advancement: Discussions underway to secure material supply agreement between Innovasea and a multi-national

UMaine license & development partner.

2018 Seed Grant: Maine-based construction and assembly of Aqua Ventus floating hull
PI: Habib Dagher (Advanced Structures and Composites Center, UMaine)
Engagement: Maine Aqua Ventus
Advancement: Leveraged additional $3MM Department of Energy of funding toward the development and deployment of full-scale demonstration project.

Aquaculture

2015 Seed Grant: Energy recovery dehumidification (ERDH) for energy efficient increased drying capacity of high-quality sea vegetables
PI: Peter Van Walsum (Chem & Bio Engineering/Forest Bioproducts Research Institute, UMaine)
Engagement: Nyle Corporation, Brewer Maine
Advancement: Discussions with three Maine sea vegetables companies. Nyle Corporation has expressed interest in developing commercial units for sale to Maine seaweed processors. Pilot prototype unit will be built spring of 2019 by the University of Maine Advanced Manufacturing Center.

2015 Seed Grant: Sustainable bio-conservation technology for aqua-feed production and waste management
PI: Andrei Alyokhin (Biology and Ecology, UMaine)
Engagement: Acadia Harvest, Inc.
Advancement: Additional Investment: Federal Small Business Innovation Research (SBIR) grants Phase I & II ($40,000 to UMaine) from USDA and NSF. Start-up/UMaine incubator tenant. Acadia Harvest is in the process of building an aqua-feed rearing facility to implement this technology in Waldoboro, Maine.

Environmental/Food Technologies

2015 Seed Grant: Prototype development for detection of wine and beer spoilage yeasts
PI: Laurie Connell (Marine Sciences, UMaine)
Engagement: Constellation Brands, NY; Beacon Analytical System, Saco, Maine
Advancement: Additional Investment: Maine Technology Institute ($28,360); Constellation Consortium ($77,082). Partnership (license options) with Saco, ME, company Beacon Analytical Systems for future manufacturing of reagent kits. Participated in the MIRTA RRF Accelerator. Field trials planned for 2019 with Constellation Brands.