UMS Research Reinvestment Fund
Annual Report of Activities

UMS Board of Trustees Meeting
March 26 & 27, 2017

Table of Contents

I. Executive Summary

This Research Reinvestment Fund (RRF) Annual Report describes RRF funded activities and production data for the 2016-2017 report period. The objective of the RRF is to strengthen research and development activities that are tied to Maine businesses and industries that are critical to the future of Maine. As documented throughout this report, many of the funded research initiatives have generated new and impactful private sector *engagements*, *investments* and *advancements* between commercial businesses and the UMS research community. As a guide, we provide here our working definitions for these activities that fulfill the objective of the RRF program:

> *Engagement*: The creation of research collaborations between UMS campuses and external entities with the intent of meaningful economic and workforce development for the State of Maine.
>
> *Investment*: The commitment of public and private resources to support research endeavors leading to economic and workforce development for the State of Maine.
>
> *Advancement*: Furthering the economy and workforce of the State of Maine through the implementation of research outcomes resulting from Research Reinvestment Initiatives

By creating collaborations and partnerships with the private sector, meaningful economic and workforce development activities are being accomplished in high value economic sectors that benefit the State of Maine.

Since June 2015, the RRF Program has received 234 proposals from UMS researchers spanning all seven campuses. Of these, 76 projects have been competitively selected for awards totaling $2,609,674 in grant funding. Detailed updates on all of the awarded projects are provided in the Appendices. Below is an overview of RRF Outcomes data that has resulted from these funded efforts, along with a list of projects that embody the mission of the RRF Program with respect to Private Sector Engagement, Investment, and Advancement. Planned activities for the coming year follow.

Year 1 RRF Outcomes

- 3 Grants Submitted $7,175,212
- 1 Grant Awarded $9,948
- 3 Workshop/Conference

Year 2 RRF Outcomes

- 63 Grants Submitted $23,599,816
- 17 Grants Awarded $8,402,299
- Match/In-Kind $8,050,000
- Planned Submissions $1,500,000
- 2 IP Disclosures Filed
- 32 Publications
- 36 Workshops/Conferences

Private Sector Engagement

Project Title: *Energy Recovery Dehumidification (ERDH) for Energy Efficient Increased Drying Capacity of High Quality Sea Vegetables (Seed Grant Round 1; page 35)*

- UMS Partners: Peter van Walsum (UMaine), Balunkeswar Nayak (UMaine), John Belding (UMaine), Daniel Martinez (USM)
- External Partner: Nyle Systems, LLC; Brewer, ME
- Outcomes: $269,111 submitted to the Saltonstall-Kennedy Grant Program; and $63,811 submitted to NOAA Sea Grant

Project Title: *Unmanned Aerial Systems: Supporting Development and Training on UAV Applications for Maine Businesses and State Agencies (Seed Grant Round 2; page 58)*

- UMS Partners: Thomas Abbott (UMA), J. Gregory Jolda (UMA)
- External Partner: Maine Civil Air Patrol, Augusta, ME
- Outcomes: Establishing a new UAV aviation program to train commercial pilots

Project Title: *Modeling Estuarine Circulation on Maine Mudflats to Improve Shellfish Harvesting (Graduate Assistantship Round 1; page 97)*

- UMS Partners: Damian Brady (UMaine), Brian Beal (UMM), Bridie McGreavy (UMaine), Gabrielle Hillyer (UMaine Student)
- External Partners: Maine DHHS - Division of Public Health Systems; Maine DEP; Maine DMR - Shellfish Advisory Council
- Outcomes: $74,000 Maine DMR award; $50,000 Davis Spencer Foundation award; $700,000 planned to NOAA Regional Vulnerability Assessments for Ocean Acidification; $585,855 planned to EPA; $3M planned to Maine DMR

Private Sector Investment

Project Title: *Novel Fire Resistant Low Formaldehyde Emitting Fiberboard Panels Made from Deadwood or Wood Residuals and Nanocellulose (Seed Grant Round 1; page 31)*

- UMS Partners: Mehdi Tajvidi (UMaine), Douglas Bousfield (UMaine)
- External Partners: FiberLean Technologies, Cornwall, UK; Composite Panel Association, Leesburg, VA; and the USDA
- Outcomes: $322,528 submitted to the US Endowment for Forestry and Communities

Project Title: *Sustainable Bio-conservation Technology for Aqua-feed Production and Waste Management (Seed Grant Round 1; page 37)*

- UMS Partners: Andrei Alyokhin (UMaine), Michael Peterson (UMaine), Edward Bernard (UMaine)
- External Partner: Acadia Harvest Inc., Franklin, ME
- Outcomes: $44,024 NSF SBIR small business subaward from commercial partner – Acadia Harvest Inc; $64,110 submitted to NOAA Sea Grant; $500,00 planned to USDA-NIFA

Project Title: *Building Campus and Community Connections to Advance Research Development and Communication for Maine's Marine Economy (Planning Grant; pg 74)*

- UMS Partners: Heather Leslie (UMaine), Paul Anderson (UMaine), Jake Ward (UMaine)
- External Partners: Over 20 private and public entities
- Outcomes: $7M Maine ECD award with additional $7.7M in matching funds from partners ($1.8 from UMS)

Private Sector Advancement

Project Title: *Prototype Development for Detection of Wine and Beer Spoilage Yeasts (Seed Grant Round 1; page 29)*

- UMS Partners: Laurie Connell (UMaine), Rosemary Smith (UMaine)
- Commercial Partners: Allagash Brewing Company, Portland, ME; Beacon Analytical Systems, Inc., Saco, ME; Constellation Brands, Inc., Victor, NY
- Oucomes: Five prototype instruments built and currently undergoing customer testing

Project Title: *Development of Structural Wood Plastic Composite Timber for Innovative Marine Applications (Seed Grant Round 1; page 40)*

- UMS Partners: Douglas Gardner (UMaine), Yousoo Han (UMaine)
- External Partners: InnovaSea Systems, Inc, Boston, MA
- Outcomes: $59,972 USDA SBIR small business subaward from commercial partner – InnovaSea Systems, Inc; $154,869 USDA ARS award; joint patent application filed with commercial partner (currently subject to confidentiality)

Project Title: *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 (Seed Grant Round 1; page 43)*

- UMS Partners: James Weber (UMaine), David Neivandt (UMaine), Anne Lichtenwalner (UMaine)
- External Partners: Stryker Corporation, Kalamzoo, MI; Colorado Limb Consultants, Denver, CO
- Outcomes: $750,000 planned to the Department of Defense Health Program; signed IP Agreement with the commercial partner – Stryker Corporation

Anticipated Activities for Coming Year

- Funding decisions for Seed Grants Round 3 – May 2017
- *Undergraduate Assistantships:* Round 2, Due May 31, 2017
- *Seed Grants:* Round 4 – Due September 26, 2017
- *Graduate Assistantships:* Round 3 – Due November 21, 2017
- *Planning Grants:* will continue to be accepted on a rolling basis
- *Innovation and Commercialization:* campus visits – Spring & Summer 2017
- UMPI Graduate School outreach – Spring 2017
- Presentations of RRF students at Cross Insurance Center in Bangor - April 27, 2017
- Grants 101 workshops

II. RRF Advisory Board and Funding Programs Developed To Date

RRF Advisory Board

The primary mission of the RRF Advisory Board is to oversee the competitive distribution of the RRF funds for UMS researchers. The Advisory Board develops and implements the specific policies, processes, and criteria for RRF allocation for this fund. In addition the Advisory Board makes final funding decisions on competitive funding applications to ensure the greatest impact on research and economic development for the state.

The table below lists current RRF Advisory Board membership:

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
Sheena Bunnell	Director/Researcher Maine Health Research Institute	University of Maine at Farmington
Jason Charland	Director of Grant Development (ex-officio)	University of Maine
Doug Gardner	Professor of Forest Operations, Bioproducts and Bioenergy	University of Maine
Carol Kim	Vice President for Research and Dean of the Graduate School (Operations Committee)	University of Maine
Mike Kinnison	Professor of Evolutionary Applications, School of Biology and Ecology	University of Maine
David Neivandt	Associate Vice President for Research and Graduate Studies (Operations Committee)	University of Maine
Tony Paine	Chief Executive Officer	Kepware
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	Interim Director of the School of Marine Sciences	University of Maine
Jake Ward	Vice President of Innovation and Economic Development (Operations Committee)	University of Maine

The RRF Advisory Board meets on a regular basis and convened on the following dates to develop, implement and refine the multiple RRF initiatives across the UMS:

2015: June 19, July 27, August 24, September 29, October 27, November 18 and December 21
2016: February 16, March 16, April 13, May 18, September 20, October 18, November 17, and December 14
2017: January 11, February 1, March 1

Funding Programs Developed To Date

The RRF Advisory Board developed and implemented three competitive funding programs for faculty and researchers across the UMS:

1. Seed Grants: The purpose of the Seed Grants is to provide funding for pilot research and development that will enable UMS faculty and professional staff from all disciplines and ranks to strengthen research, commercialization and economic development activities in the State of Maine.
2. Planning Grants: The purpose of the Planning Grants is to encourage the formation of new collaborative research and development teams spanning UMS campuses and industry in an effort to prepare these teams to submit competitive applications to future UMS RRF Seed Grant or external funding competitions (federal, state, and/or private).
3. Student Assistantships: The purpose of the Student Assistantship grants is to support UMS student activities related to research, commercialization and economic development activities impactful to the state of Maine. Separate requests for proposals exist for Graduate Student Assistantships and for Undergraduate Student Assistantships.

Since the inception of the RRF program in Summer 2015, the following funding rounds have been competed:

1. Seed Grants: Round 1 - Fall 2015 (Applications due 10/1/2015)
2. Seed Grants: Round 2 - Spring 2016 (Applications due 3/21/2016)
3. Planning Grants: Ongoing, submissions accepted on a rolling basis
4. Graduate Assistantships: Round 1 (Applications due 1/19/2016)
5. Graduate Assistantships: Round 2 (Applications due 1/10/2017)
6. Undergraduate Assistantships: Round 1 (Applications due 1/10/2017)
7. Seed Grants: Round 3 - Spring 2017 (Applications due 1/31/2017)

Funding rounds will continue to be competed through FY 2019. For the remainder of calendar year 2017 the following grant due dates are planned:

- *Undergraduate Assistantships:* Round 2, May 31, 2017
- *Seed Grants:* Round 4 – September 26, 2017
- *Graduate Assistantships:* Round 3 – November 21, 2017
- *Planning Grants:* will continue to be accepted on a rolling basis

III. RRF Funding Program Updates

A. Seed Grants Round 1 (Fall 2015)

- Seed Grant Applicants | Round 1: The first round of competition for the UMS Research Reinvestment Fund Seed Grant Program garnered 48 proposals that included collaborations and partnerships among 128 principal and co-principal investigators representing all seven campuses. Of these applicant proposals, 28 of the investigators were from outside of the flagship campus (22% of all participating UMS investigators). Funds requested ranged from under $50K to up to $100K, and the total funding requested from all applicants was $4.2M. The proposals represented all of Maine's major industries and economic sectors with the most representation residing within the sectors of aquaculture/fishing, agriculture/natural resources, biotechnology and aging. The submitted proposals also included 35 external partners comprising Maine-based businesses and other organizations.
    - Details of first round applicant data (Appendix I.A.)

- Seed Grant Awardees | Round 1: For the first round of competition, Hanover Research was engaged to conduct an external review and to rank the proposals based on a rubric developed by the RRF Advisory Board. The Advisory Board employed the external review results in its funding decision deliberations. For this first round of the competition, the RRF Advisory Board awarded 10 proposals that included collaborations and partnerships among 27 principal and co-principal investigators representing five UMS campuses. Of the awarded proposals, 5 of the investigators were from outside of the flagship campus (19% of all participating UMS investigators). The total amount awarded for the 10 funded projects was $807,935. The Round 1 Seed Grant awards represent 6 of Maine's major industries and economic sectors, with the most representation residing within the aquaculture/fishing sector. The awarded projects also include 11 external partners comprising Maine-based businesses and other organizations. Projects were initially funded for 12 months (November 2015 – December 2016) and several no-cost extensions have been granted to allow time for all project objectives to be executed. Research teams are required to submit an external follow-on funding application by December, 2017 to ensure sustainability of the initial UMS RRF investment in their projects.
    - A complete list of awardees from the first round is provided in Appendix I.B. and a detailed breakdown of awardee proposal data is provided in Appendix I.C. Summaries of project progress for each of the 10 seed grant awards is provided in Appendix I.D.

B. Seed Grants Round 2 (Spring 2016)

- Seed Grants Applicants | Round 2: The second round competition of the UMS RRF Seed Grant Program drew 48 proposals that included collaborations and partnerships among 169 principal and co-principal investigators representing all seven UMS campuses. Of the applicant proposals, 36 of the investigators (21% of all participating UMS investigators) were from outside of the flagship campus compared to 28 in the first round. Fourteen of the applications were resubmissions from the first round that incorporated feedback from reviewers and grantsmanship advice from staff from the Grant Development Office. Funds requested ranged from under $50K to up to $100K. The amount of total funds requested by the 48 applicants was $4.0M. The proposals represent all of Maine's major industries and economic sectors with the greatest representation from forestry, agriculture and marine resources. By design, proposals include collaboration with Maine-based businesses and organizations with a total of 36 external partners named in the applications.
    - A detailed breakdown of the second round applicant data is provided in Appendix II.A.

- Seed Grant Awardees | Round 2: For the second round of competition, Hanover Research was again engaged to conduct an external review, scoring and ranking the proposals based on a rubric developed by the RRF Advisory Board. The Advisory Board utilized the external review results in its deliberations and final funding decisions. The RRF Advisory Board awarded 11 proposals that included collaborations and partnerships among 47 principal and co-principal investigators representing all seven UMS campuses. This was a marked increase in collaborations and partnerships among the UMS campuses as compared to Round 1 awardees which include 27 principal and co-principal investigators representing five UMS campuses. Of the awarded proposals, 18 of the investigators were from outside of the flagship campus (or 38% of all participating UMS investigators). The total amount awarded for the 11 funded projects was $957,848. The Round 2 Seed Grant awards represent 6 of Maine's major industries and economic sectors, with the most representation residing within the forest industry sector. The awarded projects also include 11 external partners comprising business, educational, non-profit and government organizations. Projects are funded for 12 months (July 2016 – June 2017) and no-cost extensions have been requested for some of the projects. The research teams are required to submit an external follow-on funding application by July 2018.
    - A complete list of awardees from the second round is provided in Appendix II.B. A detailed breakdown of the second round awardee proposal data is provided in Appendix II.C. Summaries of progress for each of the 11 awarded proposals is provided in Appendix II.D

C. Seed Grants Round 3 (Spring 2017)

- Seed Grants Applicants | Round 3: The third round competition of the UMS Research Reinvestment Fund Seed Grant Program received 50 proposals that included collaborations and partnerships among 146 principal and co-principal investigators representing all seven UMS campuses. Of the applicant proposals, 34 of the investigators (or 23%) of all participating UMS investigators) were from outside of the flagship campus compared to 36 (21%) in the second round, and 28 (22%) in the first round. 13 of the applications were resubmissions from the second round that incorporated feedback from reviewers and grantsmanship advice from staff from the Grant Development Office. Funds requested ranged from $29K to $100K. The amount of total funds requested by the 50 applicants was approximately $4.25M. The proposals represent all of Maine's major industries and economic sectors with the greatest representation from marine/aquaculture, information technology and education sectors. The submitted proposals also included collaboration with many Maine-based businesses and other organizations with a total of 26 external partners named in the applications. Funding decisions will be made by the RRF Advisory Board in May 2017.
    - A detailed breakdown of the third round applicant data is provided in Appendix III.A.

D. Planning Grants (Rolling applications, Summer 2015 - present):

- To date a total of 18 Planning Grant proposals have been received for funding consideration. All proposals were evaluated by participating RRF Advisory Board members according to a rubric developed by the Advisory Board and supplied in the grant application materials. To date, a total of 12 Planning Grant proposals have been selected for funding, with a total award amount of $57.5K for all funded projects.
    - A complete list of awardees to date is provided Appendix IV.A. Summaries of progress for each awarded planning grant project are provided in Appendix IV.B.

E. Graduate Assistantship Grants Round 1 (AY 2017-2018)

- A total of 12 RRF Graduate Assistantship (GA) proposals were received for Round 1, representing faculty from 4 different UMS campuses, in addition to 9 external partners. All proposals were evaluated by participating RRF Advisory Board members according to a rubric developed by the RRF Advisory Board and supplied in the application materials. Eleven proposals were deemed meritorious and were selected for funding (one application requested 2 students and therefore the total number of assistantships awarded in Round 1 was 12. The assistantships provide a stipend of $20,000 for a one year period (September 2016 – August 2017). The Principal Investigator is responsible for payment of tuition and 50% of the health insurance of the Fellow. As a condition of the

award, recipients must inform the Advisory Board if an external Project Grant application related to the graduate assistantship is submitted.
    - A list of awardees from the first round is provided in Appendix V.A. Interim progress reports of the funded Graduate Assistantships awards can be found in V.B.

F. Graduate Assistantship Grants Round 2 (AY 2018-2019)

- A total of 36 RRF Graduate Assistantship (GA) proposals were received for Round 2, representing faculty from 5 different UMS campuses, in addition to 15 external partners. All proposals were evaluated by participating RRF Advisory Board members according to a rubric developed by the RRF Advisory Board and supplied in the application materials. 14 proposals were deemed meritorious and were selected for funding. The assistantships provide a stipend of $20,000 for a one year period (September 2017 – August 2018). As a condition of the award, recipients must inform the Advisory Board if an external Project Grant application related to the graduate assistantship is submitted.
    - A list of awardees from the second round is provided in Appendix VI.A.

G. Undergraduate Assistantship Grants Round 1 (AY 2018-2019)

- A total of 22 RRF Undergraduate Assistantship (UGA) proposals were received for Round 1, representing faculty from 6 different UMS campuses, in addition to 7 external partners. All proposals were evaluated by participating RRF Advisory Board members according to a rubric developed by the RRF Advisory Board and supplied in the application materials. 17 proposals were deemed meritorious and were selected for funding. The assistantships provide a stipend of $5,000, and up to an additional $2,000 in research materials, supplies and travel, for a one year period (September 2017 – August 2018). As a condition of the award, recipients must inform the Advisory Board if an external Project Grant application related to the undergraduate assistantship is submitted.
    - A list of awardees from the second round is provided in Appendix VII.A.

IV. Infrastructure Support to the Business Development Enterprise

In order to expand UMS capacity to serve economic development in Maine, the University of Maine Office of Innovation and Economic Development (UMaine OIED) has focused on two strategies as part of the RRF initiative: 1) expanding technology transfer and commercialization capacity throughout UMS and 2) expanding industry engagement and partnerships. OIED has made significant progress in partnership with USM to grow opportunities for technology transfer and industry partnerships and has undertaken several initiatives to develop best practices that can be used throughout UMS for commercialization. In addition, OIED has strategically increased industry engagement, particularly in the two Maine sectors that have strong potential growth within Maine's economy - the forest sector and the marine sector.

A. Expanding UMS Economic Development, Technology Transfer and Commercialization Capacity

Technology Transfer and Economic Development Partnership between University of Southern Maine and the University of Maine

As part of the initiation of the Research Reinvestment Fund the University of Maine System, the University of Maine and the University of Southern Maine entered into a memorandum of understanding to for shared services for business development services and commercialization initiatives between the campuses. Over the last year the collaboration lead by USM Cutler Institute for Health and Social Policy at the Muskie School of Public Service and UMaine Office of Innovation and Economic Development have established a foundation for regular, systematic intercampus collaboration on economic development initiatives pursuant to the December 2015 MOU. USM provided dedicated office space to OIED in March 2017, with the expectation that the collaboration will continue and expand.

Under USM direction, UMaine-OIED assumed responsibility for USM intellectual property management, patent licensing, industrial contracting and activities related to increasing and enhancing commercialization at USM. This generated efficiencies and made additional services and resources available to USM. It also increased the awareness of both teams concerning the capabilities and resources available at each campus, and introduced opportunities to promote collaboration among faculty.

Activities this year include the migration of the USM intellectual property portfolio and related agreements into the UMaine-OIED IP management system, and assistance with USM contract negotiation and execution as requested. Additionally, UMaine-OIED conducted outreach to a number of USM faculty to promote commercialization of their work and to facilitate the next stages of product development. For example, UMaine-OIED is currently working with USM researcher Joe Staples to manufacture and deliver to customers an initial run of his patented microscope lamp. UMaine-OIED is also assisting USM researcher Erin Oldham in promoting collaborations with UMaine faculty

and Bangor region organizations concerning her rapidly emerging MEIF-funded Data Innovation Project.

UMaine-OIED presence at USM also facilitates outreach to businesses and economic development organizations in southern Maine. OIED met regularly with organizations such as Maine International Trade Center, Bio-based Maine, Maine Technology Institute and others, which resulted in opportunities to promote UMaine technology, research and service capabilities to companies. UMaine-OIED targeted and contacted southern Maine companies, as well as Boston area university collaborators and funding organizations. UMaine-OIED contact with companies in the southern Maine and Boston corridor will be formalized and increased over the next year. In addition to the UMaine-OIED presence at USM, the team schedules tours and meetings for USM at Orono to promote a better understanding of UMS assets, allowing comprehensive promotion of services among the campuses.

In May 2016, USM and UMaine submitted a joint proposal to the Department of Commerce, Economic Development Administration (EDA), University Centers Program, which was awarded and began in September 2016. The USM EDA Center, now in 20+ years, now includes UMaine as a formal partner with seamless integration. Under the direction of USM's Ryan Wallace, Director of the Center for Business and Economic Research and partnered with UMaine School of Forest Resources, the Margret Chase Smith Policy Center and the Office of Innovation and Economic Development this five year/$600,000 grant is focused on providing market analysis and tech development support for the forest products industry, analysis of the knowledge worker capacity in Maine and support of the state's economic development districts.

The Data Innovation Project (DIP), directed by Erin Oldham, Ph.D, helps non-profits and companies use data to inform their work and make decisions. In its first year of existence, DIP generated $1.12 million in funded projects, working with 17 organizations around the state. This is four times the MEIF investment by USM of $266,666 per year. DIP now employs eight highly skilled staff, and expectations for growth are high. UMaine-OIED began working with DIP this year under the RRF funded plan for increased collaboration in technology commercialization and economic development. DIP is hosting the First Annual Data Summit in Portland in April 2017 and in Orono in May 2017 to officially launch their services. A statewide workshop series on data-informed decision making will also be implemented in 2017. UMaine-OIED and USM consider DIP not only to provide an important service to Maine businesses and non-profits, but also as a significant opportunity for revenue growth and inter-campus collaboration. Business development for DIP is a high priority for joint technology commercialization activities.

Innovate for Maine UM/USM Collaboration

The Innovate for Maine Fellowship program connects the best and brightest Maine college students with the state's most innovative, growing companies. Students and companies come together through the UMaine to collaborate on innovative projects that will accelerate company growth and give students a paid, meaningful, hands-on internship experience. The Innovate for Maine program is a public/private partnership operated by UMaine-OIED, with external funding for paid internships from grants,

foundations and private companies. Historic activity has funded 25-50 internships per year.

USM plans to engage approximately 75 MEIF-funded interns on an annual basis through a variety of different programs. UMaine is actively working with USM to explore how the Innovate for Maine internship structure and coordination can enhance the internship experience for the students, faculty, and companies/organizations participating, and meet MEIF outcomes.

Elements of the Innovate for Maine structure for the USM/UM partnership in discussion include the following:

> *Bootcamp experience:* All interns participate in a boot camp to prepare them for the internship experience. In this boot camp, they learn the fundamentals of Innovation Engineering (specific skills to advance innovation projects), the current and projected economic climate in the state, and the soft skills needed for working with companies and being a positive representative of the University of Maine System. Through this boot camp model, interns become part of a cohort and build a strong network of peers and professionals, who work together throughout the duration of their experience and beyond.
>
> *Fellowship mentors:* All selected interns receive an innovation mentor to guide them through their work experience to ensure a meaningful experience for all involved parties and to assist with innovation project outcomes.

UMaine/USM plan to pilot this collaboration in spring and summer of 2017.

<u>Innovation Outreach to Students and Faculty System-wide</u>

UMaine OIED operates the Innovate for Maine program, and is engaging students from the other system campuses and companies in those communities. Last year, we contacted to all the UMaine system campuses to recruit students from across the system. We provided marketing and attended career fairs throughout Fall 2015. Interns from UMaine, UMaine Augusta, and the University of Southern Maine were offered fellowships for the 2016-2017 experience. Over the last year we were able to match selected fellows with 39 companies across the state of Maine.

Over the last year OIED has piloted various events and programs through the Foster Center for Student Innovation that engage students, faculty, staff and community members with the idea that each can be delivered and replicated at the other campuses across the state to build interest in innovation and entrepreneurship at each campus. Our goal has been to make these as "plug and play" as possible and to provide support where needed, whether it be acquiring funding to host events, providing marketing materials, or making connections with industry experts and professionals to participate in these events.

UMaine OIED received an RRF Graduate Student award funding two student assistanships to build an ambassadors program to increase the pipeline of students,

faculty and staff interested in research commercialization and industry research partnerships. These students are testing strategies at UMaine that can then be adapted to do outreach at each of the UMS campuses.

The first graduate assistant work has focused on three primary activities: a) focused outreach with faculty and students who have limited industry relationships to encourage more activity, b) direct commercialization support of student/faculty researchers, and c) general awareness building and event planning. The graduate student has worked on building relationships and educating faculty, administrators and students about commercialization and cooperative research. In particular, given this graduate student's academic and research areas, he has done significant outreach with food and animal science departments and organizations.

In addition, we have been working on doing outreach around our Innovation Engineering program to the other system campuses. We have explored the possibility of offering the Innovation Engineering at the system campuses by offering it as a UMaine course taught by UMS faculty at each campus.

In addition to offering Innovation Engineering at the post-secondary level, we have developed a number of kits in partnership with Cooperative Extension. These kits are focused on K-12 students and are provided through their 4-H program to parents and educators as an easy way to teach innovation concepts to the next generation of innovators. These kits were developed over the spring 2015 and fall 2016, and are set to launch in spring 2017.

We have our first high school pilot program currently being offered at Yarmouth Academy. A faculty member attended our summer training in August 2016, and began teaching it to her students January 2017 with support and coaching from our staff. We hope to work together with Yarmouth Academy to create a model that can be made widely available to high schools across Maine.

B. Increased Industry Engagement and Advancement

OIED has undertaken several initiatives to develop best practices that can be used throughout UMS for industry engagement, advancement and commercialization. In addition, OIED has proactively focused on increasing business and industry engagement in two very important Maine Economic Sectors – the Forest Economy and the Marine Economy Maine's economy - to further expand opportunities for collaboration and growth.

<u>Number of Maine Projects since FY15</u>

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. Project count for each fiscal year:

- FY15: 264
- FY16: 233
- FY17 (through February 2017 only): 151

UMaine OIED has completed an analysis of Maine companies for an expanded engagement outreach effort. This analysis included companies pursing R&D, innovation and growth strategies, which includes companies engaged in the targeted forestry and marine sectors and their affiliated trade associations; companies seeking funding through the Maine Technology Institute and the federal Small Business Innovative Research Program. This targeted list was further analyzed and characterized for three types of potential interactions: supporting company needs, marketing UMS technology transfer and developing workforce through internships and fellowships. The following activities are pursued to further the goals of increasing economic development engagement.

Commercialization Working Group

In 2016, UMaine initiated the commercialization working group (CWG) tasked to assess activities related to technology commercialization and industry engagement, and to propose improvements in these program areas consistent with the UMS BOT priorities and the Research Reinvestment Initiative. The CWG is comprised of the Executive Vice President for Academic Affairs & Provost, the Vice President of Research, the Vice President of Innovation and Economic Development, the Director Human Resources, the UMS General Counsel, the Director Technology Commercialization and the Special Assistant to the Executive Vice President for Academic Affairs & Provost. Activities completed or underway by the CWG include the following:

2017 Survey of Faculty: This survey collected data about awareness and participation in activities related to commercialization, technology transfer and engagement with industry. This process entailed a campus-wide electronic survey of faculty and select staff, as well as several focus groups facilitated by a private consultant. Topics included an assessment of the support services provided by UMaine, identification of any barriers

Dr. Laurie Connell first approached OIED in late 2013 with the idea to apply technology she developed to track harmful marine algal blooms to solve a very different problem detecting microorganism contamination in the beer and wine industry. Using the UMaine Innovation Engineering process, the team prepared a commercial development plan to address technical, market and funding challenges on the pathway to introducing this new product. With support from a Maine Technology Institute technology transfer grant, the team spoke with more than fifty companies to understand their need for a better solution to current methods. Early feedback and product testing by Allagash Brewing Company under a Round 1 RRF seed grant provided invaluable feedback; the RRF grant also was leveraged as match for additional MTI technology transfer funding for technical development. OIED contacted Constellation Consortium, one of the largest producers and distributors of wine in the world, concerning this technology. They have now become a funding and development partner. Additionally, Maine company Beacon Analytical Systems is prepared to manufacture antibody test kits at scale. The integrated commercial system may be distributed by a startup company involving Dr. Connell's student technician, or may be licensed to an established company, depending on the outcome of current work under way.

preventing commercialization, and a garnering of ideas to incentivize and promote faculty efforts. De-identified and compiled results are complete; interpretation will be complete in April 2017.

2017 Survey of Maine Companies: Mirroring the faculty survey, and also facilitated by a private consultant, an electronic survey was sent to more than fifty Maine companies to assess their awareness of opportunities to work with UMS in the development of new products and services, and an assessment of experiences they have had working with UMaine. Focus groups representing a diverse population of Maine companies were held in Brunswick and Orono. De-identified and results and interpretation will be complete in April, 2017.

Triage and Targeted Assessment of the UMS Patent Portfolio: OIED obtained funding from the Alfond Foundation to hire external subject matter experts to assess and recommend commercialization strategies and actions concerning a portion of the UMS intellectual property portfolio. The assessment will be complete in May, 2017.

Evaluation of Commercialization Best Practices. Literature reviews and in-person interviews are ongoing to identify programs and practices successfully implemented at other universities that may also be appropriate for UMaine. Projects are underway in human resources, policy, contracting, marketing and other areas to improve UMaine services offered throughout UMS to faculty and companies. A goal of CWG and OIED is to improve service and increase revenue while maintaining efficient staffing.

The work of the CWG is expected to be ongoing, with learning from the initial year becoming applicable system-wide.

C. Targeted Sector Focus

Target Sector Focus I: Strategic Engagement with Maine's Forest Sector

With the recent closure of five pulp and paper mills in the last two years the Maine delegation urged the U.S. Government through the Department of Commerce to engage all federal economic support and recovery programs that could assist this challenged industry and the impacted communities. Partnering with private companies, the University of Maine, non-profit organizations and impacted communities, the Department of Commerce initiated the Economic Development Assessment Team (EDAT) to evaluate the Maine situation and bring federal programs into a coordinated effort to grow this sector. The Maine Forest Products Council, the Maine Pulp and Paper Association, the Maine Professional Loggers Association, the Small Woodland Owners Association of Maine, the Maine Development Foundation and the University of Maine partnered on this process resulting in a unique collaboration between the private companies, trade associations and the public sector to develop a *Vision and Roadmap for Maine's Forest Economy.*

As a result the Maine Forest Economy Growth Initiative was formed with the following stated goals:

Goal 1. Sustain Maine's existing forest products businesses

Goal 2. Attract capital investments and develop greater economic prosperity in the forest products sector across the State for both existing and new businesses

Goal 3. Support the revitalization of Maine's rural communities as places where people want to live, work and visit

The team has quickly developed actions to support this economic sector. Examples of strategic initiatives include:

Investment: Funding for Strategic Initiatives

A Vision and Roadmap for Maine's Forest Economy (EDA) January 2017.

Grant from the Department of Commerce Economic Development Administration (EDA) $1M* to UMaine/ Maine Forest Products Council. Focus on Global Competitive Analysis, Wood supply analysis and forecast, Subsector Analysis, Transportation and Logistics Analysis and review of Emerging Technologies.

(* there is a pending ask for $1M for phase 2 implementation*)*

A Vision and Roadmap for Maine's Forest Economy (MTI) February 2017.

Grant from the Maine Technology Institute (MTI), $500,000 to UMaine/Maine Forest Products Council. Focus on Global Competitive Analysis, Wood supply analysis and forecast, Subsector Analysis, Transportation and Logistics Analysis and review of Emerging Technologies.

Roadmap to Advance Biobased Manufacturing (EDA) July 2016.

Grant from the Department of Commerce Economic Development Administration, $519,930 to Biobased Maine/University of Maine. Focus is to develop a road map to advance biobased manufacturing, marketing Maine's biobased assets to investors in new technologies and processes, and providing technical assistance to Maine forest products manufacturers and users in the implementation of new biobased technologies. It is anticipated that the cost analysis, technology assessment and market research component of the project could place one or more mills into the production of cellulosic sugars. UMS partners include UMaine Forest Bioproducts Research Institute and the Process Development Center, Office of Innovation and Economic Development and the USM-Center for Business Economic Research.

Engagement: Business Attraction and Site Re-utilization

Biofuel Company Attraction - Ongoing: OIED staff, along with Forest Bioproducts Research Institute researchers, have met with multiple biofuels companies who are seeking to expand in Maine to take advantage of biomass residuals. UMS facilitates connection with forest management companies and land owners, existing Maine production companies while our researchers support technology validation and economic analysis.

Cross-Laminated / Mass Timber Attraction and Development (CLT/MLT): OIED and researchers from the Advanced Structures and Composites Center (ASCC) formed a working group with a variety of stakeholders including Maine engineers, architects, contractors, and several Maine forest products industry representatives to develop the opportunity for a CLT/MLT manufacturer to locate in Maine. In addition, the group is looking at site and market analysis, supporting a CLT demonstration building, as well as possible business incentives/legislation that might facilitate CLT use. ASCC, in partnership with industry, is pursuing the introduction of new grades of CLT using Maine lumber species that would help the state better compete in the market and take advantage of an under-utilized supply.

Hosted Regional Bioeconomy Forum, October 2016: UMaine was selected to host one of five regional bioeconomy forums (other events were in Georgia, Ohio, Texas and Washington) at the behest of the U.S. Department of Agriculture, U.S. Department of Energy and the U.S. Forest Service to help shape federal policy and investment in the national bioeconomy. UMaine OIED/FBRI convened a strong Maine industry representation from manufacturers, sawmills, loggers and forest landowners to focus the Maine session on forest bioproducts.

Advancement: Technology Development, Demonstration and Commercialization

Cellulose Nanofibrils: UMaine is a world leader in the production of cellulose nanofibrils, having the only licensable and scalable manufacturing technology currently available. Three licenses are complete, with several more under development. While outreach and collaborations are underway with companies world-wide, UMaine-OIED continues to exert a special effort to educate Maine companies on applications of these materials. UMaine-OIED staff practices regular cold calls and invitations to campus, and presents at trade organization and similar meetings across the state. Early discussions are underway to establish cellulose nanofibril manufacturing in Maine, as well as the manufacturing of products reliant upon this material.

The *Maine Forest Economy Growth Initiative* will assist with the engagement, advancement and investment in many UMS R&D efforts and RRF funded seed grants including:

- *Development of structural wood plastic composite timber for innovative marine applications*
- *Novel Fire Resistant Low Formaldehyde Emitting Fiberboard Panels Made from Deadwood or Wood Residuals and Nanocellulose*
- *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*
- *Liquid-Infused Paper Substrates for New Biomedical Applications*
- *The Maine forest ecosystem status and trends (forEST) app: Informing management and dynamic landscapes*
- *A Novel Framework for Detecting and Assessing Spruce Budworm (SBW) Forest Defoliation over Maine*

Target Sector Focus 2: Maine's Marine Economy

With the directive to support a whole sector, UMaine OIED helped lead a Planning Grant awarded to the UMaine Darling Marine Center/Maine Sea Grant for the development of a proposal for submission to the Maine Marine Economy Bond solicitation from the Maine Department of Economic and Community Development (DECD). This resulted in a $7 million proposal and the formation of the *"Alliance for Maine's Marine Economy."*

The effort builds on the extensive public and private resources and assets available to support Maine's Marine sector including aquaculture, commercial fisheries and value-added seafood processing. The Alliance is charged with marketing and coordinating the capacity and capabilities while pursuing additional investment to grow this sector.

This statewide/sector-wide Alliance includes the following partners:

- *Private Companies*: Cape Seafood, Cooke Aquaculture, and Maine Fair Trade Lobster
- *Trade Associations*: Maine Aquaculture Innovation Center, Maine Aquaculture Association, Maine Lobster Dealers' Association, Maine Lobstermen's Association, and the Downeast Lobstermen's Association
- *Non-profit organizations*: Downeast Institute for Applied Marine Research & Education, the Gulf of Maine Research Institute, Bigelow Laboratory for Ocean Sciences, Coastal Enterprises, Inc., the Island Institute, and the Penobscot East Resource Center
- *Universities*: University of Maine System including UMaine entities: Darling Marine Center, Maine Sea Grant, the School of Marine Sciences, the Aquaculture Research Institute, the Center for Cooperative Aquaculture Research, Cooperative Extension, the School of Food and Agriculture, the Lobster Institute

& the Office of Innovation and Economic Development and the University of Maine, Machias

The Alliance is actively engaging with other companies, universities/colleges and non-profits to continue to build strategic alliance to grow Maine's marine economy.

Investment: Funding for Strategic Initiatives and Business Development Opportunities

Bond Funding: The Alliance was successful in the competitive process to award voter-approved bond funding for the marine economy. In summer 2016, the total $7 million was awarded to the Alliance and matched by over $7 million in public/private . The new funding will add to the State's facility and equipment capacity to support Maine's aquaculture, commercial fisheries and value added seafood sector, state-wide.

New Grants and Private Capital: The Alliance is seeking additional investment to support the Marine economy, with Alliance members forming collaborations to pursue federal funding, seek business development equity investment and loans and business development funds through Coastal Enterprises Inc., the Maine Technology Institute, the Maine Venture Fund and private angel/equity investors such as Maine Angels and the Bangor Angels.

Engagement: Workforce Development

Internships and Workforce Training: In partnership with Maine EPSCoR, UMaine used the Innovate for Maine program to place 10 student interns in each of the last two years in aquaculture companies throughout the state. The students also participated in a variety of activities to expose them to career opportunities in the industry. In addition, OIED has partnered on an NSF NRT (Research Traineeship) proposal (submitted in February 2017) to create a graduate certificate in aquaculture innovation that would be available to UMaine students and industry.

Advancement: Technology Development, Demonstration and Commercialization

The Alliance will assist with the engagement, advancement and investment in many UMS R&D efforts and RRF funded seed grants:

- *Effects of Ocean Acidification on Reproduction in American Lobsters*
- *Energy Recovery Dehumidification (ERDH) for energy efficient increased drying capacity of high quality sea vegetables*
- *Sustainable Bio-conservation Technology for Aqua-feed Production and Waste Management*
- *Development of Tools for Measuring the Costs of Feeding and Food Utilization in Eastern Oysters*
- *Advancing Algal and Invertebrate Aquaculture*

- *Enhancing the forecasting value of the American Lobster Settlement Index to Maine's Coastal Economy*

D. Engagement, Investment and Advancement of RRF funded Seed Grants
UMaine OIED worked closely with several 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.

Examples from RRF Seed Grant Awardee List

Development of structural wood plastic composite timber for innovative marine applications
Industry Sector: Forestry/Composites
PI: Douglas Gardner (Advanced Structures and Composites Center, UMaine)
Engagement: Innovasea, multi-national composite company
Advancement: Joint patent application filed; field testing planned for 2017; potential Maine manufacturer identified (Duralife Decking, Biddeford). Prototype will be deployed in second quarter 2017.

Prototype Development for Detection of Wine and Beer Spoilage Yeasts
Industry Sector: Food and Beverage, Environmental Science
PI: Laurie Connell (Marine Sciences, UMaine)
Engagement: Allagash Brewing, Portland , Maine, Constellation Brands, Beacon Analytical System, Saco, Maine
Additional Investment: Maine Technology Institute ($28,360); Constellation Consortium ($77,082).
Advancement: Partnership with Saco, ME, company Beacon Analytical Systems for future manufacturing of reagent kits. Estimated initial entry to market second half of 2018.

Novel Fire Resistant Low Formaldehyde Emitting Fiberboard Panels Made from Deadwood or Wood Residuals and Nanocellulose
Industry Sector: Forestry/Composites
PI: Mehdi Tajvidi (Forest Resources, UMaine)
Engagement: Early discussions underway with a large global end-user and a Maine sawmill.
Advancement: Patent application filed

Energy Recovery Dehumidification (ERDH) for energy efficient increased drying capacity of high quality sea vegetables
Industry Sector: Marine/Aquaculture
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.

Sustainable Bio-conservation Technology for Aqua-feed Production and Waste Management
Industry Sector: Marine/Aquaculture
PI: Andrei Alyokhin (Biology and Ecology, UMaine)
Engagement: Acadia Harvest
Additional Investment: Federal Small Business Innovation Research (SBIR) grants phase I & II ($40,000 to UMaine) from USDA and NSF.
Advancement: 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.

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
Industry Sector: Biomedical/Composites
PI: James Weber (Food and Agriculture, UMaine)
Engagement: Stryker Orthopedic
Additional Investment: Maine Technology Institute ($5,000)
Advancement: Patent application filed; early discussions with potential licensees, presentations planned with corporate venture funding organizations.

Liquid-Infused Paper Substrates for New Biomedical Applications
Industry Sector: Forestry/Biomedical
PI: Caitlin Howell (Chem Engineering, UMaine)
Engagement: SLIPS Tech, Inc., Sharklet Technologies, Inc, SAPPI Fine Paper North America, Westbrook, Maine.
Advancement: Patentability and commercial assessment pending

V. Infrastructure Support to the Research Enterprise

Grant Development Office

The UMaine Grant Development Office (GDO) provides proposal development support for large grant applications; high profile programs with system wide and statewide impact; emerging and signature areas of excellence; proposal resubmissions; and early career faculty grant submissions. The types of services provided include grant writing support, review and critique of proposal narratives, budget development, funding opportunity searches and alerts, meeting support for interdisciplinary proposal writing teams, and grantwriting workshops.

GDO Staff

- The GDO employed RRF funds to hire two grant development specialists to work with UMS faculty and professional staff on grant proposal submissions:

    - *Luke Doucette* was hired as a Grant Development Specialist in September of 2015, and was promoted to Senior Grant Development Associate in December of 2016. During this time, Luke has been directly involved with over 70 proposal efforts, and has provided a broad range of proposal development assistance for UMaine and UMS researchers. In addition, Luke has facilitated the formation of interdisciplinary research teams which have produced submissions to DoD and RRF seed grant funding opportunities. With over 12 years of experience working in an R&D capacity within the private sector, Luke has been able to leverage knowledge of DoD and DHS funding agencies to spearhead efforts on 7 grant submissions to Defense related agencies totaling over $4M in requested funds. In all cases Luke provided significant contributions which included identifying relevant programs and small business teaming partners, as well as crafting proposal content to meet DoD/DHS needs.

    - *Dawn Hoelz* was hired as a Grant Development Specialist in September of 2015. Her responsibilities included providing researchers with various grant development needs such as finding funding opportunities, facilitating proposal development meetings, connecting projects with collaborators, establishing of internal deadlines, providing grantwriting advice along with copy editing, budget assistance, administrative coordination of proposal forms and documents, and development and implementation of various training workshops. Dawn played a key leadership role in UMS's $14M application to the Maine Department of Economic and Community Development (DECD) Maine's Marine Economy and Jobs Bond that was recently approved for funding by the State of Maine. Dawn left UMaine in December 2016 to assume the role of Grant Administrator for the *Lieber*

Institute for Brain Development in Baltimore, MD.

- On March 1, 2017, *Kate Walters* was hired to fill the position vacated by Dawn Hoelz. Kate served as a Grant and Contract Administrator in UMaine's Office of Research and Sponsored Programs (ORSP) for 2 years prior to joining the GDO. Before joining UMaine, Kate was a Grant Administrator for the Alaska Department of Commerce. She is currently coordinating a $3M Phase II proposal to the Economic Development Association to support infrastructure enhancements on the working waterfront at Darling Marine Center in Walpole. The enhancements will include the replacement of a commercial pier, upgrades to flowing seawater laboratory space, and expansion of business incubation space to support Maine's ever growing aquaculture industry.

- The GDO is directed by *Jason Charland*, who serves as an ex-officio member of the RRF Advisory Board, providing staffing support to execute RRF initiatives. Jason is responsible for coordinating and facilitating the development, preparation and submission of research grants identified as high priority by the Vice President for Research.

- In collaboration with Fogler Library, the GDO delivers quarterly grant writing workshops to the research community and has trained over 175 faculty, staff, and students since the commencement of RRF activities. Additional workshops included NSF CAREER Awards, NSF Broader Impacts, as well individualized workshops for various schools and departments.

What the research community has to say about the impact of the GDO

"They really went above and beyond, we could not have done this proposal without them and I am so thankful for their help" – Michelle Smith, Associate Professor, STEM Education

"It was close, we had a good 50 minutes to spare, but we submitted the proposal. Let me note that the GDO was very helpful in getting this proposal completed. It was a pleasure working with them." – Jonathan Rubin, Professor of Economics

"You brought a level of expertise and counsel that left me impressed and confident in our collective ability to meet the stringent requirements demanded by the NSF. From an organization that would not have been able to pull this off without your help, thank you." – Frederick Brittain, Associate Chief Information Officer (UMF)

"I wanted to take a moment and thank you for setting us up to work with the GDO staff. They made the process go smoothly, and I don't think we'd have been as successful in pulling everything together for this submission without their assistance. Their recommendations are clear and questions are right on target." – Laura Wilson, Extension 4-H Science Professional; Alex Friess, Assistant Professor of Engineering

"Thank you for the wonderful and timely support we received. It has been a true pleasure to work with you on this proposal, and greatly appreciate all the helpful comments and input" – Sandra De Urioste Stone, Assistant Professor, UMaine School of Forest Resources

Office of Research and Sponsored Programs Staff

The UMaine Office of Research and Sponsored Programs (ORSP) is currently supporting three FTE staff with RRF funding. These positions enhance ORSP organizational capacity to process awards and the ability of investigators to implement sponsored activities. UMaine ORSP also provides grant administration support to the UMM campus.

Grant Accountants (2)
Jennifer Rapp, an accountant with private sector experience, was hired as a Grant Accountant in UM's Office of Research and Sponsored Programs in the spring of 2016. She provides Post-Award financial management services to investigators, and to the departments and cross-disciplinary research units in which they conduct their research.

Megan Dill, a veteran UM employee, was hired in September, 2016 as a Grant Accountant in ORSP's Pre-Award Services Group. Megan is responsible for entering into the MaineStreet Financial System award budgets mutually agreed upon by UM and sponsors, thereby allowing investigators to monitor and reconcile spending accounts on a monthly basis.

Administrative Specialist (1)
Leisa Preble is an Administrative Specialist in ORSP supporting the office's Pre-Award, Information Management and Compliance groups. She joined the ORSP staff on April 4, 2016, replacing Wendy Powers, who after one year in the RRF-supported Administrative Specialist position became a Grants and Contracts Specialist.

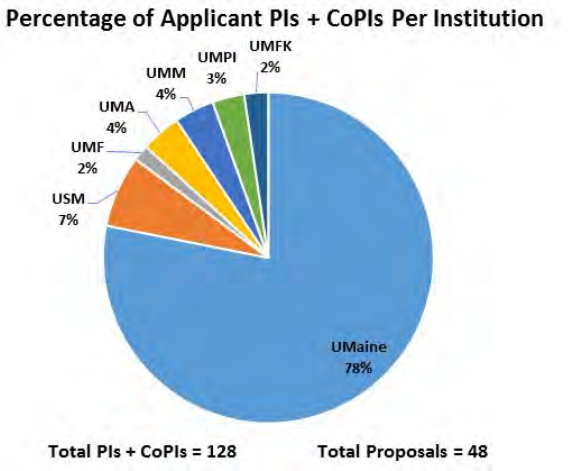
Associate Vice President for Research

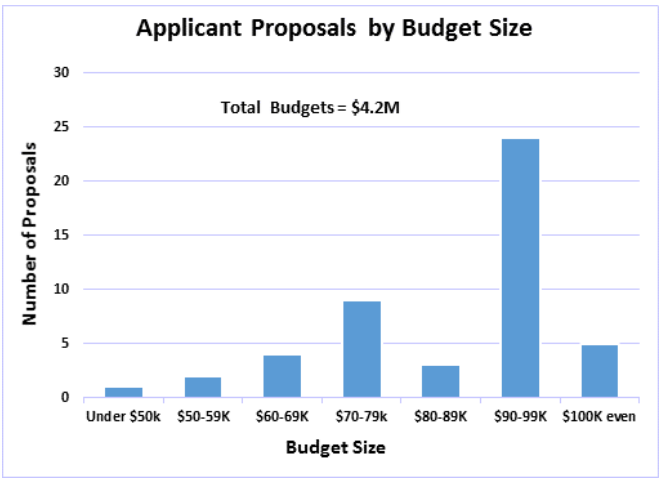
- David Neivandt, UMaine Associate Vice President for Research and Graduate Studies is supported 0.25 FTE by RRF funds to develop interdisciplinary and/or multidisciplinary research collaborations, serve as the faculty liaison for the EPSCoR office, administer faculty-related issues regarding graduate education, assist in moving key research and development areas forward, and make research connections between UMS campuses. Activities to date:
  - Serves on the Operations Committee of the RRF Advisory Committee and co-led the development and implementation of the Seed Grant, Planning Grant, Graduate and Undergraduate Assistant Grant competitions
  - Hired a new Director for the Maine State EPSCoR Office
  - Serves as Executive Director of the $20M EPSCOR RII Track 1 SEANET award
  - Assisted UMaine VPR Kim with development and implementation of the system-wide Aging Initiative
  - Visited all UMS campuses to facilitate the formation of new research and development collaborations, in addition to promoting the RRF.
  - Outreach to UMPI related to Graduate Studies
  - EPSCoR Track 1 pre-applications are in development for the next anticipated 5 year $20M NSF EPSCoR project (FY2019-2024) that will inherently be strongly aligned with Science and Technology aspirations for the State of Maine.

APPENDIX I: RRF Seed Grants | Round 1

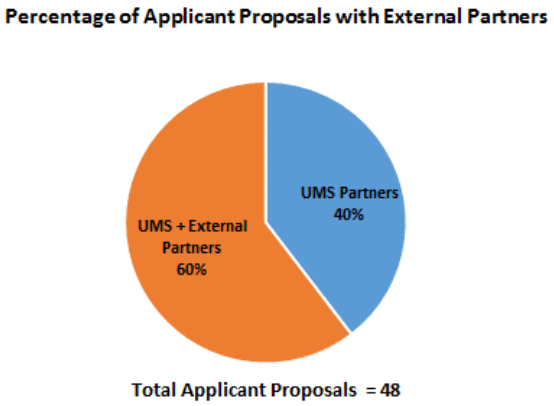
APPENDIX I.A: Round 1 | Seed Grant Applicant Data

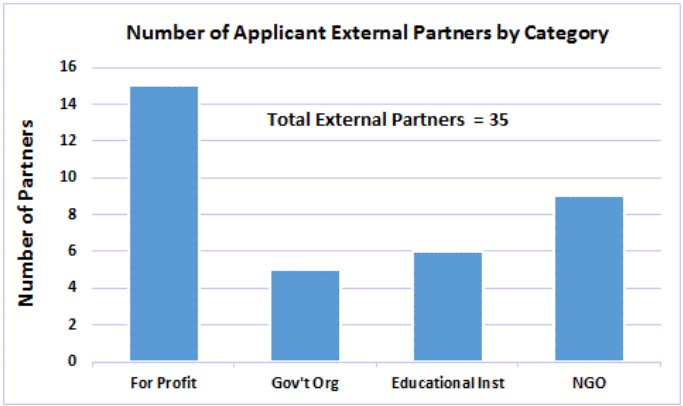
Proposal Data



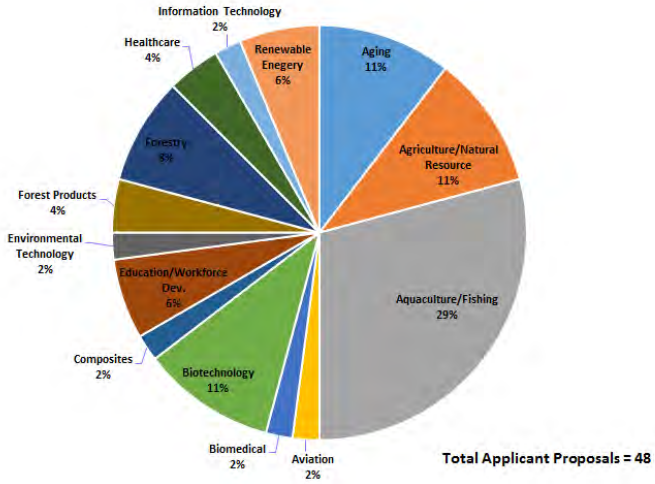


External Partner Data





Economic Sector Data

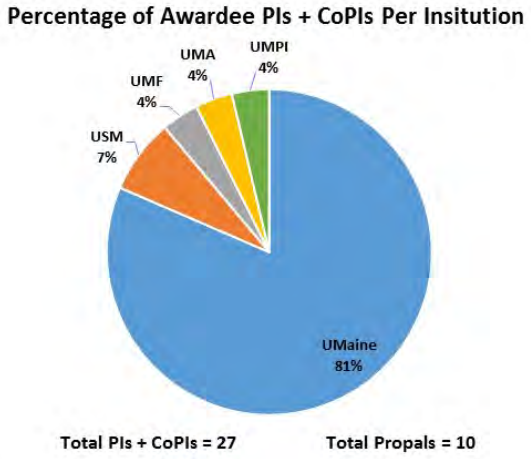


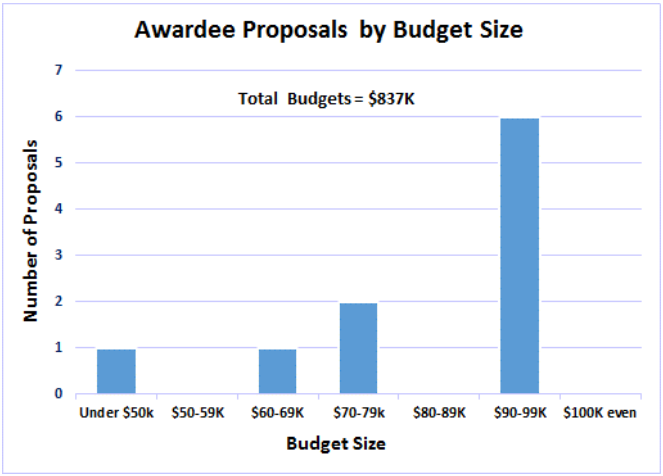
APPENDIX I.B: Round 1 | Seed Grant Awardee List

Principal Investigator	Partners	Project Title
Frank Drummond (Biology and Ecology, UMaine)	Scott Dobrin (Biology, UMPI); Ron Butler (Biology, UMF); Joseph Staples (Environmental Sciences, USM); Christopher Lage (Biology, UMA)	*The Health of Maine's Bumble Bee Community*
Douglas Gardner (ASCC, UMaine)	Yousoo Han (Advanced Structures and Composites Center, UMaine); Steve Ruell (Innovasea)	*Development of structural wood plastic composite timber for innovative marine applications*
Laurie Connell (Marine Sciences, UMaine)	Rosemary Smith (Electrical Engineering, UMaine); Jason Perkins (Allagash Brewing)	*Prototype Development for Detection of Wine and Beer Spoilage Yeasts*
Mehdi Tajvidi (Forest Resources, UMaine)	Douglas Bousfield (Chemical and Biological Engineering, UMaine); John Hunt (Forest Products Laboratory, USDA)	*Novel Fire Resistant Low Formaldehyde Emitting Fiberboard Panels Made from Deadwood or Wood Residuals and Nanocellulose*
Heather Hamlin (SMS/ARI, UMaine)	Deborah Bouchard (Cooperative Extension/ARI, UMaine); Jean McRae (Civil & Environmental Engineering, UMaine); Benjamin King (Regenerative Biology, MDI Biological Laboratory)	*Effects of Ocean Acidification on Reproduction in American Lobsters*
Peter Van Walsum (Chem & Bio Engineering/FBRI, UMaine)	Balunkeswar Nayak (Food Science and Nutrition, UMaine); John Belding (Advanced Manufacturing Center, UMaine); Daniel Martinez (Environmental Science, USM)	*Energy Recovery Dehumidification (ERDH) for energy efficient increased drying capacity of high quality sea vegetables*
Andrei Alyokhin (Biology and Ecology, UMaine)	Tap Pryor (Acadia Harvest, Inc.); Michael Peterson (Mechanical Engineering, UMaine); Edward Bernard (Molecular & Biomedical Sciences, UMaine)	*Sustainable Bio-conservation Technology for Aqua-feed Production and Waste Management*
Ian Bricknell (Marine Sciences/ARI, UMaine)	Deborah Bouchard (Cooperative Extension/ARI, UMaine); William Wolters (USDA National Cold Water Marine Aquaculture Center/NCWMA); Leighanne Hawkins (Cooke Aquaculture)	*A Novel Approach to Prevent Super-chill in Atlantic Salmon*
James Weber (Food and Agriculture, UMaine)	Ian Dickey (Colorado Limb Consultants); David Neivandt (Chemistry & Biological Engineering, UMaine); Anne Lichtenwalner (Food and Agriculture, UMaine)	*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*
Paul Rawson (Marine Sciences, UMaine)	Carrie Byron (Marine Science, University of New England); Chris Davis (Maine Aquaculture Innovation Center)	*Development of Tools for Measuring the Costs of Feeding and Food Utilization in Eastern Oysters*

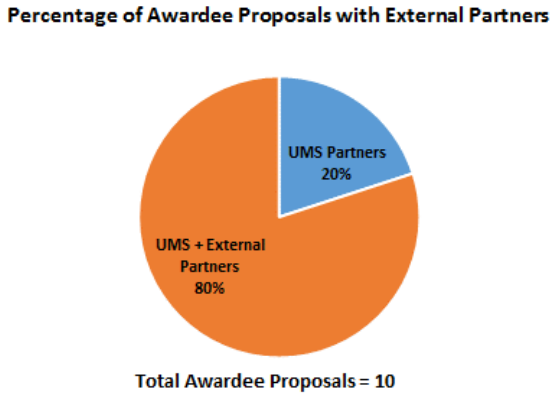
APPENDIX I.C: Round 1 | Seed Grant Awardee Data

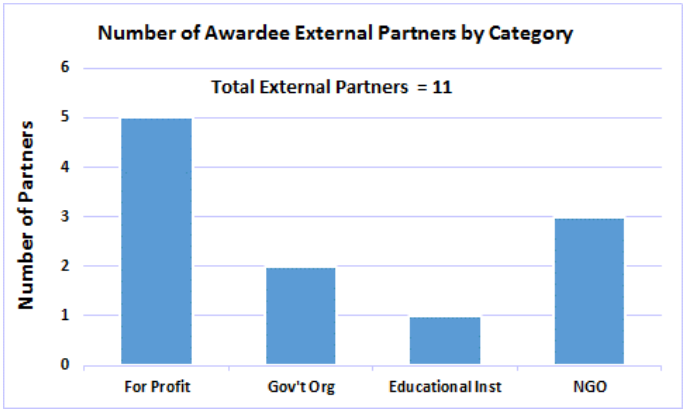
Proposal Data



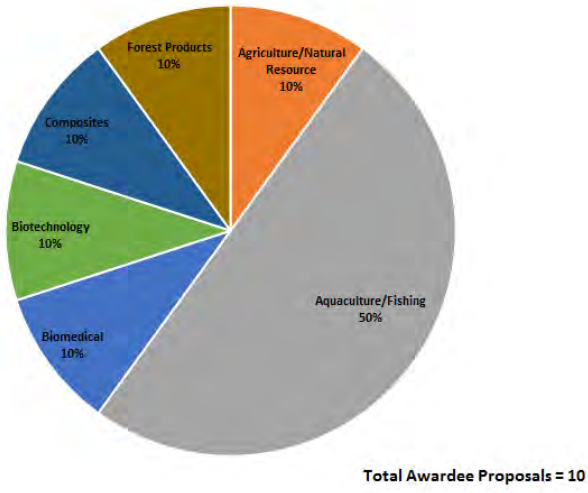


External Partner Data





Economic Sector Data



APPENDIX I.D: Round 1 | Seed Grant Awardee Abstracts & Updates

"Prototype Development for Detection of Wine and Beer Spoilage Yeasts"
Principal Investigator: Laurie Connell (Marine Sciences, UMaine)
Co-PIs: Rosemary Smith (Electrical Engineering, UMaine); Jason Perkins (Allagash Brewing)
External Collaborators: Allagash Brewing Company, Constellation Consortium, and BAS, Inc.
Budget: $ 68,361 Performance Period: 11/01/2015 – 12/31/2016
Economic Sector(s): Biotechnology, environmental technology, and precision manufacturing

Abstract: The goal of this project is to develop a new handheld instrument, called the *InstaProbe*, which will provide the only near-instantaneous solution to detect certain environmental microbes from a complex matrix with minimal sample preparation. The proposed instrument is based on prior art developed at UMaine as part of Federally funded research focused on detecting harmful marine algal blooms, known as red tide. For this project, the target application is the rapid detection of spoilage organisms during wine or beer production, and involves collaborations with the Allagash Brewing Company for product testing.

Notable Highlights to date:

Market Research and market identification: We have accomplished market research to determine where our resources would be a "best-fit". Results from the market research demonstrate that our original proposed market of Micro-Breweries may not be sufficiently mature to be concerned with quality control. This market has been described as "wild west" at this point in time. We then made a strategic pivot to target the larger and more consistent market of worldwide wine, beer, and spirits distributers. We have now entered into collaboration with the world's largest premium wine distributor, Constellation Consortium.

Identification of Maine small business partner: In order to have consistent product provided to our consumer a facility that has sufficient equipment to produce diagnostic kits while maintaining high quality control. We have identified Beacon Analytical Systems, Inc. (BAS) in Saco, Maine, as an appropriate partner. The added advantage of BAS is that they already have a supply chain and market for other diagnostics in a rapidly growing market for wine and beer production, China. Further they have all of the facilities needed for the kit manufacture and shipping already in place. Although BAS now deals with kits based on antibodies, we can easily produce PNA based kits in their facility.

Submission of an external proposal for further product development: In late 2016 we had advanced our transition for the color-dye based chemistry to the G2 (fluorescent-based) chemistry to submit a proposal for further development of specific probes. The chemistry itself can be used as a "plug-and-play", however, for a product to be marketable specific probes must be developed for each specific application. The Maine brewers industry is not sufficiently mature so we applied for funds to develop both Brett and *Zygosaccharomyces* probes from (1) Constellation Consortium and (2) the New York State Wine Industry Association. We have been approved for internal funding for $74,210 to develop probes detecting Brett and

Zygosaccharomyces from red wines from the west coast of the US (*Zygosaccharomyces*) and white wines of the east coast (Brett).

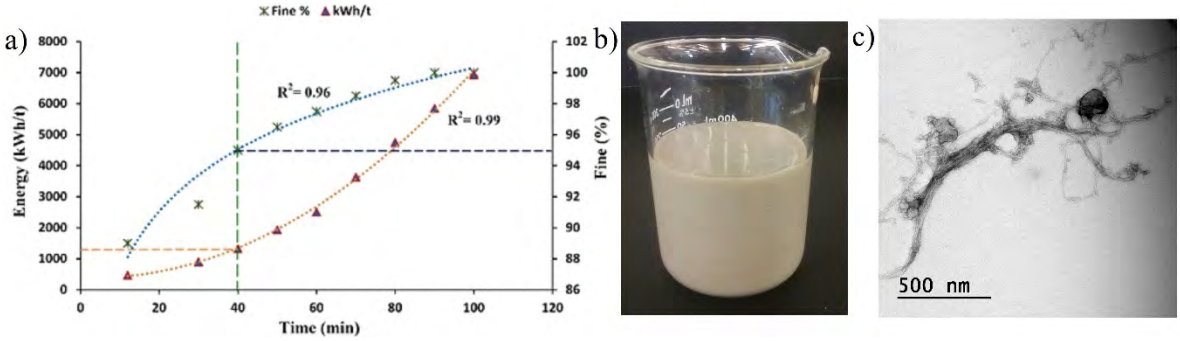
Determination of a business plan for international markets with respect to IP: After examining our market research and entering into collaboration with BAS for kit production we re-examined the plan for protecting our IP worldwide. Because China is an active and expanding a market potential for us a product IP must be protected there. Filing a US patent would be detrimental, as would publication of papers with the methods. We have therefore determined that our best protection will be to use "know-how" and we will not pursue a US patent filing.

A prototype instrument for use with Instaprobe-F chemistry: Concurrent with development of the Instaprobe-F chemistry we redesigned our older Instaprobe handheld instrument for detection of the florescent signal produced by PNA-FIT probe hybridization with target. Five prototype instruments were built and used by potential end users for feedback in design. Several changes to the design were requested from potential end users including software improvements, circuit board updates, increased power, terminal instructions, and water tight ports for power and connectivity. We have a second version that works via blue tooth, and the prototype is shown below.

"Novel Fire Resistant Low Formaldehyde Emitting Fiberboard Panels Made from Deadwood or Wood Residuals and Nanocellulose"
Principal Investigator: Mehdi Tajvidi (Forest Resources, UMaine)
Co-PIs: Douglas Bousfield (Chemical and Biological Engineering, UMaine); John Hunt (Forest Products Laboratory, USDA)
External Collaborators: USDA, FiberLean Technologies, and Composite Panel Association
Budget: $ 100,231 Performance Period: 11/01/2015 – 5/31/2017
Economic Sector(s): Forest products, pulp and paper, composite panels

Abstract: This project involves a collaboration between several UMaine units and the USDA Forest Products Laboratory on the production of a novel fire-resistant fiberboard building material that can be sourced solely from deadwood and other wood residues without the use of a formaldehyde-based resin in a fully environmentally friendly production system. This product will provide a unique incentive for the forest products industry to maximize the utilization of low-value wood and reduce hazardous fuels and other wood residues from forests.

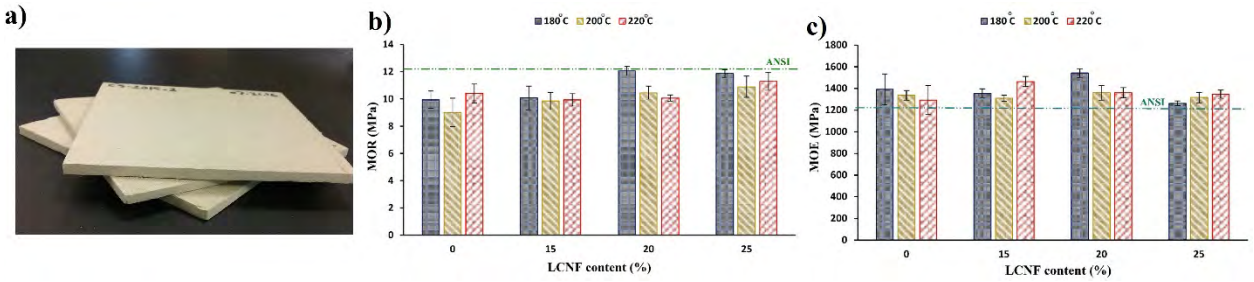
Notable Highlights to date:
In the current project, thermomechanical pulp (TMP) was produced using atmospheric refining of mixed softwood that was ground to isolate lignocellulose nanofibrils (LCNF). Forty minutes and a specific energy of about 1300 kWh/t were necessary to reach the end-point of the process defined by the presence of 95% fines in the LCNF slurry. 100% fines were reached after 90 minutes and 5800 kWh/t. The similarity in structure between pilot-scale produced CNF and LCNF with an average fibril diameter of 12 ± 3 nm confirmed the negligible effect of residual lignin on the grinding process. The thermal stability of LCNF was 30°C lower compared to CNF due to the lignin influence, but was in the range of processing temperature used for engineered wood composite materials. The project also assessed the effect of using LCNF as an adhesive replacement in fiberboard.



a) Energy consumption and fine% in function of the LCNF grinding time. **b**) LCNF slurry (3 wt.% consistency). **c**) TEM of LCNF

The physico-mechanical properties of the panels were affected by the LCNF content and the press temperature. At any given temperature, modulus of rupture (MOR) and internal bonding (IB) showed a linear relationship with increasing LCNF. A temperature of 180°C and 20% LCNF content were the optimum processing conditions giving MOR value of 12.1 MPa, close to the minimal recommended for commercial fiberboards. The IB, the thickness swelling, and modulus

of elasticity met the standard values. The board's densities varied between 550 and 610 Kg/m^3 but the differential density between the core and surface was reduced as LCNF content increased. The three-dimensional LCNF network promoted fibers bonding and allowed inter-fiber voids filling, during the MDF production.



a) Image of adhesive-free MDF panels, **b**) MOR and **c**) MOE of fiberboards in function of the LCNF content.

Follow on grant activity:
The data collected through the implementation of this seed grant project was used as proof-of-concept to apply for the 2016 round of funding from U.S. Endowment for Forestry and Communities (P3Nano). The project is titled “Enclosed please find my proposal entitled “Pilot-scale production of composite panels made from low-cost cellulose nanomaterials and wood residues”. Total funds requested is $322,528 (pending). This project aims at pilot scale production of lignin containing CNF (LCNF) as a low-cost formaldehyde-free binder as well as large scale (4 feet by 8 feet) panel production over two years. FiberLean™ Technologies and the Composite Panel Association (CPA) as well as the Forest Products Laboratory (FPL) have provided support for this project. One important aim is to work with CPA to increase awareness of this promising technology within the panel manufacturing community. FiberLean™ Technologies is also very interested in this work as a potential route for the commercialization of their nanofibril product and has pledged over $10,000 in kind support.

Industry contact/workforce development:
A postdoctoral associate was fully funded through the Seed Grant project and became trained on the production of LCNF and MDF panels. Lead by the USDA, the PI had a visit with IKEA and Blue Ridge Fiberboard to discuss potential collaborations. Locally, we are in contact with a large saw mill in Maine who is interested in investing in the area of MDF production.

"*Effects of Ocean Acidification on Reproduction in American Lobsters*"
Principal Investigator: Heather Hamlin (SMS/ARI, UMaine)
Co-PIs: Deborah Bouchard (Cooperative Extension/ARI, UMaine); Jean McRae (Civil & Environmental Engineering, UMaine); Benjamin King (Regenerative Biology, MDI Biological Laboratory)
External Collaborators: MDI Biological Laboratory
Budget: $ 69,264 Performance Period: 11/01/2015 – 4/30/2017
Economic Sector: Maine's lobster fishery

Abstract: Marine invertebrates, such as lobster, support valuable commercial fisheries in Maine valued at nearly $457 million in landings, and have a 3x to 5x multiplier on the total dollar value of the extended industry. Recent findings indicate that increasing levels of ocean acidification (OA) and water temperatures generate physiological stresses to all life-stages of lobster, and present a significant threat to Maine's marine economy. The focus of this project is develop a cutting edge hormone assay technique that will monitor specific genetic markers within lobsters to determine the effects of OA an water temperature, and ultimately provide the critical data needed to pursue larger research funding opportunities to fully fund this project.

Notable Highlights to date:
With assistance from Maine EPSCoR and the Aquaculture Research Institute, construction of the acidification system was completed in November, 2016. Following a period of system refinement and lobster acclimation, a two month study exposing sub-adult lobsters to a control versus an acidified environment was completed in January, 2017. One of the goals of this project was the implementation of a system that was of comparatively low-cost, yet robust enough to allow for the production of data acceptable for publication in high-impact journals. The system was also designed to allow for the investigation of a wide range of aquatic models, including other invertebrates (e.g. bivalves) or vertebrates (e.g. fish), greatly increasing system utility. System operation and performance was excellent, and results of system performance were presented at the Northeast Aquaculture Conference and Exposition in January, 2017.

Following the conference, our group was contacted by Dan Martino at Cottage City Oysters (Oak Bluffs, Martha's Vineyard MA), who expressed interest in our system and how it could be used to research potential effects of ocean acidification (OA) on their oysters. They indicated there was a bill on the MA Senate floor that if passes, would establish a committee to research the effects of OA on commercial species, and they were interested in establishing a collaboration with us.

We are currently in the process of refining techniques for the extraction of RNA for lobster hepatopancreas. Although we believe we have optimized RNA extraction techniques, we are in the process of determining the best strategy to determine RNA quality. Similar to some insects, the American lobster is unique in that it contains an e10ndogenous hidden break in the 28s portion of the rRNA, which when denatured, breaks into two smaller fragments that migrate very closely (and can overlap with) the 18S rRNA. Once we establish the best method to determine quality, samples will be sent for RNASeq analysis. We aim to begin working on the hemolymph ecdysteroid assay by early March, 2017.

Lobsters in the study that were not lethally sampled underwent a temperature ramping study, in which very small electrodes were placed on either side of the heart, and heart rate was

monitored over a period of slow temperature increases. The point at which the heart becomes erratic is termed the Arrhenius break temperature. If an animal is stressed or otherwise compromised, it may "break" sooner or at a lower temperature than a healthy animal. In this regard, this can determine if an animal has a lower scope of tolerance or scope for activity. Animals exposed to acidified environments have a variety of compensatory mechanisms, which could mask outward signs of stress or physiological impairment. However, this test could determine whether they have a decreased tolerance for additional stress, which in the environment could include pathologic insult, or increasing ocean temperature. Interestingly, our study showed a strong trend toward significance, and we intend to repeat this portion of the study with a greater number of animals to see if this trend will become significant.

Products:
Poster presentation: Harrington A, Harrington R, Greenberg N, Hamlin HJ. Designing a recirculating seawater system to explore impacts of ocean acidification on commercially important species. Northeast Aquaculture Conference and Exposition, January 11-13, 2017.

Private sector engagement, investment, and advancement:
As discussed, we've presented the system performance portion of our project at NACE, a conference with strong stakeholder attendance. We received positive feedback at the conference from both stakeholders and academics alike, and were contacted after the conference regarding a potential collaboration with a commercial farm. As our data unfolds into a more comprehensive story, we hope to generate a greater understanding of the effects of OA, which we can convey to stakeholders, and these data can be used to devise policy decisions, and predictive scenarios. In addition, the OA system we developed serves to increase the research capacity at the Aquaculture Research Center, extending the benefits to other commercially relevant and important species to the State of Maine.

"*Energy Recovery Dehumidification (ERDH) for energy efficient increased drying capacity of high quality sea vegetables*"
Principal Investigator: Peter van Walsum (Chemical & Biological Engineering/FBRI, UMaine)
Co-PIs: Balunkeswar Nayak (Food Science and Nutrition, UMaine); John Belding (Advanced Manufacturing Center, UMaine); Daniel Martinez (Environmental Science, USM)
Budget: $ 73,701 Performance Period: 11/01/2015 – 8/31/2017
Economic Sector: Aquaculture

Abstract: Seaweed aquaculture is a global activity with an annual worth of $5.65 billion. We propose to investigate Energy Recovery DeHumidification (ERDH) as a highly energy efficient means for the drying of seaweed and other sea vegetables at moderate temperature, which is necessary to preserve the valuable antioxidant properties of the product. Development of inexpensive and effective methods for drying sea vegetables will help to develop this nascent industry in Maine and increase the supply of healthful and sustainable food.

Notable Highlights to date:

Modeling: ASPEN-Plus modeling software was used by Justin Tracy, a CHE undergraduate summer student researcher to model the energy consumption of a kelp dryer. The project will be continued by Praveen Sappati, a Ph.D. student in Food Science co-advised by van Walsum and Nayak. The model flow sheet includes a drying chamber with input air of variable flow, temperature and humidity. Humid exhaust air is sent to the heat pump where a condenser removes the moisture and dries the air. The dry air is then heated by the heat rejection unit of the heat pump and recirculated back to the dryer. A second comparison model was also created deploying a propane heater instead of a heat pump. As expected, the ERHD system shows lower energy consumption but higher complexity and capital cost, which would necessitate near year-round operation to generate attractive economics. This suggests designing a dryer that has flexible capabilities, allowing it to be used for various different crops, either aquacultured or from traditional farming.

Experimental drying and optimization: Several iterations for designing and assembling a drying unit were done, including assembly of a system on campus, combining power assisted drying with a solar-assisted drying unit, purchasing an established commercial unit designed for food applications, and finally we decided to modify an existing heat pump driven environmental chamber available in the AMC to do our detailed drying experiments. The modifications include constructing a drying cabinet to be installed within the existing environmental chamber. This drying cabinet allows for air passage in up, down and side draft orientations and should provide uniform plug flow air movement through the drying area. It is designed to handle both long fronds of seaweed and smaller pieces. The cabinet is currently nearing completion at the AMC.

Food qualities of the dried sea vegetables. Research methods and results on seaweed drying have been carried out under EPSCoR SEANET funding. These well-developed methods will be

applied when evaluating the results from drying seaweeds in the drying cabinet under different air flow regimes. Analyses carried out so far include: Proximate analyses (pH, moisture content, total crude protein, and ash content), water activity (A_w), rehydration ratio (RR), dehydration kinetics, glass transition temperatures, total phenolic content (TPC), antioxidant activity, vitamin C, shrinkage.

Collaboration: University of Southern Maine researchers have been reviewing the literature for similar studies on drying foods and developing suitable parameters to apply to our drying system. Results from the modeling work from part a will be incorporated into the LCA models.

Commercial Adoption: We have met several times with industry representatives to discuss their needs and interests in seaweed drying. Input from these representatives has been incorporated into our design of the drying cabinet. We have submitted several grant proposals and pre-proposals to fund the scale up our drying work, and these were positively reviewed, but unfortunately, to date, none of these applications have been funded. It is our hope that high quality drying data derived from the system currently being assembled will provide compelling support for acquiring funding to scale up the process with a commercial partner.

Private sector engagement, investment, and advancement. This project has been linked to Maine sea vegetable producers from the start. On at least three occasions we have met formally with representatives of Maine sea vegetable companies to discuss needs and priorities for drying, in addition to chance encounters at conferences or site visits. Important issues identified in these meetings include the need to develop higher throughput and lower labor demands to support expansion of operations when expanding to farmed sea vegetables; means of handling seaweed that becomes sticky as it dries; optimal conditions to achieve desired appearance of sea vegetables, especially with respect to precipitation of dissolved sugars and salts on the surface; retention of bioactive and other healthful components in seaweeds through the drying process. We have also met with representatives of the Nyle Corporation, which manufactures food drying systems in Maine. Lessons learned through our research will be made available to Nyle to assist in developing commercial units for sale to Maine seaweed processors.

Products: Grant proposals that have been submitted since the start of this work include applications to Seagrant ($63,811), Saltonstall-Kennedy ($269,111), and a preproposal to NOAA.

"*Sustainable Bio-conservation Technology for Aqua-feed Production and Waste Management*"
Principal Investigator: Andrei Alyokhin (Biology and Ecology, UMaine)
Co-PIs: Tap Pryor (Acadia Harvest, Inc.); Michael Peterson (Mechanical Engineering, UMaine); Edward Bernard (Molecular & Biomedical Sciences, UMaine)
External Collaborators: Acadia Harvest, Inc.
Budget: $ 92,487 Performance Period: 11/01/2015 – 5/31/2017
Economic Sector(s): Aquaculture and marine technology, environmental technology, advanced technologies for forestry and agriculture

Abstract: Maine's aquaculture industry is the largest in the U.S. and is growing rapidly. However, it currently relies on aquafeeds made with fish meal and fish oil from wild-caught small fishes, which is not an economically and environmentally sustainable approach. We propose adopting an alternative aquafeed production technology that relies on biological conversion of organic wastes using black soldier fly, Hermetia illucens (L.). Our project will result in technology that allows producing large volumes of fly larvae at low cost to meet the needs of Maine aquaculture industry in sustainable aquafeed.

Acadia Harvest Inc.™

Notable Highlights to date:

Optimizing food substrates for best bioconversion rates and chemical composition of resulting feed: We screened a variety of locally available organic wastes for their suitability for BSF development. We also evaluated their market price and potential availability for the large-scale production of BSF larvae. Fin fish trimming proved to be an excellent food source for BSF larvae. Unfortunately, these are widely utilized by pet food industry; therefore, their supply is limited and prices are relatively high. Another excellent source was cafeteria food waste. However, its composition varies widely, complicating its use in a large-scale production. Yet another promising substrate for BSF development was wet sea cucumber waste. The down side is that harvested volumes of this organism are not very high, and there could be an emerging competition for this material with the alternative medicine and food supplement industry. Cull potatoes and crab meal were significantly poorer substrates for BSF development. Nevertheless, larvae grew to the sizes comparable to that grown on better-quality diets (see above), although time of their development (in case of potatoes) and mortality (in case of crab meal) were significantly higher. However, given economic considerations, these may be the most promising materials. Our next step (funded by the NSF as described below) is to test whether mixing these substrates with other materials will improve the BSF performance. We are particularly interested in looking at cull potatoes. In Maine, potato farmers have a perennial problem with disposal of cull potatoes that are unmarketable because of their size, internal or external defects, and infection with a variety of diseases.

Designing a working prototype of a bioreactor for large-scale production of BSF larvae under typical Maine conditions: We designed a prototype BSF bioreactor comprised of a system of vertically arranged ventilated larval holding trays. Unlike other bioreactors that rely on a fairly cumbersome drainage system, moisture contents of larval feeding substrates are controlled by changing air flow through the system. A system of ramps and doors allows harvesting both by

taking advantage of natural dispersal behavior of the larvae before their pupation, as well as by manually harvesting larvae at the time of peak biomass production. The designed system represents a significant improvement compared to several commercially available and custom-made systems that we tested. We also believe that it is scalable to industrial sizes.

Establishing breeding stock colonies of the BSF: Breeding BSF colonies were successfully established in Clapp Greenhouse (Fig. 3) and maintained for several generations. An automated fouling-proof sprinkler system was designed to provide water for reproductive adults. Eggs for colony maintenance were successfully collected on strips of corrugated recycled cardboard.

Evaluating properties of vermicompost byproducts: Carbon: nitrogen ratio of vermicompost generated by black soldier fly larvae was slightly lower compared to the reference compost, but still within the range suitable for application to field soil (Fig. 4). However, the tested vermicompost was still immature and characterized by high microbial activity. As a result, its field application proved to be damaging to potato plants and resulted in significant reduction in tuber yields (Fig. 5). This situation could be ameliorated by maturing vermicompost before field applications, but further investigations are needed to determine an optimal composting regime.

Grant Submissions/Awards

NSF SBIR Phase II: Developing Alternate Aquafeeds by Using Sustainable Methods of Bio-remediation of Seafood Residuals. $44,024 awarded to Andrei Alyokhin via Acadia Harvest, Inc.

UMaine Sea Grant: Animal Feed Production through Bioconversion of Organic Wastes. Pre-proposal submitted on Feb. 24, 2017. $62,110.

In addition, collected preliminary data should be sufficient for competing for the USDA-NIFA Agricultural Engineering grant in the amount of up to $500,000. RFA for this year has not been released yet, but the usual due date for this program is July 1.

Private Sector Investment

Industry partner on the grant, Acadia Harvest Inc., is in the process of building a BSF rearing facility in Waldoboro, Maine. Once completed, it will contain larval bioreactors and adult breeding colonies.

"*A Novel Approach to Prevent Super-chill in Atlantic Salmon"*
Principal Investigator: Ian Bricknell (Marine Sciences/ARI, UMaine)
Co-PIs: Deborah Bouchard (Cooperative Extension/ARI, UMaine); William Wolters (USDA National Cold Water Marine Aquaculture Center/NCWMA); Leighanne Hawkins (Cooke Aquaculture)
External Collaborators: USDA NCWMA, Cooke Aquaculture
Budget: $ 78,463 Performance Period: 11/01/2015 – 4/30/2017
Economic Sector: Atlantic salmon aquaculture industry

Abstract: This project will investigate a novel approach to mitigating superchill in cultured Atlantic salmon. Superchill is a physiological collapse in salmon occurring during periods of extremely cold weather in Maine's waters. The Maine salmon aquaculture industry has stated that superchill risk is the major limiting factor for growth of the industry. The remaining sites suitable for salmon aquaculture are vulnerable to superchill events. If superchill risk was mitigated, production could reach three times the current levels increasing from $76 million to $228 million annually.

Notable Highlights to date:

1) Successful NRAC Funding of a Proposal Based on the RRF work: A full proposal was submitted to the Northeastern Regional Aquaculture Center in 2015/16: The funding request was for $165,624 for 2 years. This grant was successful and the NRAC funded project began in November 2016. The project is also titled "*A Novel Approach to Prevent Super-chill in Atlantic Salmon"* and greatly expands the scope the initial RRF proposal. Research collaboration will continue with the USDA ARS for the diet formulation and feed trials. Cooke Aquaculture strongly supports this proposal and the newly funded project involves direct participation by Cooke. Cooke Aquaculture's lead veterinarian, Leighanne Hawkins and US marine production manager, David Morang will be informed of all research progress.

Chris Bartlett, Maine Sea Grant's extension professional, is stationed in Eastport Maine where Cooke has its primary salmon culture operations. Bartlett has taken the lead role in extension activities and communication with Cooke Aquaculture required by both the RRF and NRAC. Project management will be carried out monthly with regular assessments of progress communicated to UMaine, NCWMAC, URI and Bartlett. It is anticipated that Bartlett will organize a workshop at the end of years 1 and 2 with the PIs and collaborators presenting their finding to the industry.

2) Progress of research: Standard curves of the sugar alcohols (SA) in fish serum have been developed and analyzed. Standard curves were produced to determine the freezing point depression of the SA modified plasma and, indeed, the addition of SA's did change the freezing point depression point (FPDP) of the salmon plasma. All the SA's that were tested were successful in depressing the FPDP. From this work Trehalose (a large MW SA) and sorbitol (a small MW SA) were selected for assessment in the diet uptake study. The diets were formulated as described, although manufacture of the diets took longer than originally anticipated. The uptake study at the USDA NCWMAC is nearing completion and the first super chill trial is about to begin.

3) Presentations: One presentation was made in 2016 based on the RRF's research and a second update presentation is planned for March 2017. Both will have been presented at the Annual Maine Aquaculture R&D & Education Summit. This forum presents the latest aquaculture research from the University and is attended by major industry stakeholders as well as other groups who represent the working waterfront in Maine. The meeting is reported in the local media, Maine's digital commons and UMaine's web site.

"*Development of structural wood plastic composite timber for innovative marine applications*"
Principal Investigator: Douglas Gardner (Advanced Structures and Composites Center, UMaine)
Co-PIs: Yousoo Han (Advanced Structures and Composites Center, UMaine); Steve Ruell (Innovasea)
External Collaborators: Innovasea
Budget and Performance Period: $94,274 11/01/2015 – 6/30/2017
Economic Sector(s): Composite materials technology and aquaculture

Abstract: The overall goal of this project is to evaluate the potential of a structural wood plastic composite material (WPC) technology for use in marine applications; more specifically, its application in fish cage pens. Aquaculture structures operate in one of the most demanding of environments in which most materials do not survive for long. Traditional materials that have longevity do not have sufficient strength or affordability. To resolve this problem, UMaine researchers will team with Maine aquaculture businesses to construct an improved cage that utilizes a UMaine patented WPC technology that is stronger, stiffer and less prone to degradation as compared to current WPC materials.

Notable Highlights to date:

- Industry partner in collaboration with UMaine received $99,771 USDA SBIR grant supporting Phase 1 commercialization of technologies funded by this project. UMaine will receive a subcontract in the amount of $59,972 from this award.
- Joint patent application between UMaine and a commercial partner (currently under confidentiality agreement) on new composite material and composite product comprising a cellulosic material, high impact polystyrene and styrene maleic anhydride.
- Received $154,869 in funding from USDA ARS for 3 year field study in Mexico and Maine of the WPC materials in real world application.
- Several formulations of the WPC technology have been developed and are currently being tested.
- PhD student is developing dissertation project based on the research program.

"Development of Tools for Measuring the Costs of Feeding and Food Utilization in Eastern Oysters"
Principal Investigator: Paul Rawson (Marine Sciences, UMaine)
Co-PIs: Carrie Byron (Marine Science, University of New England); Chris Davis (Maine Aquaculture Innovation Center)
External Collaborators: University of New England, Maine Aquaculture Innovation Center (MAIC)
Budget: $40,896 Performance Period: 11/01/2015 – 6/30/2017
Economic Sector: Aquaculture

Abstract: Maine's oyster culture industry has grown substantially since its inception four decades ago. Continued growth of the industry will rely on increasing the efficiency of production through improved and more uniform growth of oysters on Maine's farms. To accomplish this, the goal of this project is to provide detailed knowledge of the genetic and ontogenetic variation in food utilization and costs of food acquisition in oysters supporting improved site selection and selective breeding for oysters with improved food conversion efficiency.

Maine Aquaculture Innovation Center

UNE

Notable Highlights to date:

Our RRF seed grant addresses three interconnected objectives: 1) determine temporal variation in the efficiency of food utilization and metabolic costs for eastern oysters provided with natural food sources, in-situ, 2) determine the degree to which food conversion efficiency in oysters varies both as a function of oyster size and environmental temperature, and 3) estimate the level of variation in feeding efficiency within and between existing lines of selectively bred eastern oysters.

The primary goal of our project has been to design and test feeding chambers that will allow us to employ a bio- deposition method for the quantification of feeding and absorption rate with different size classes of oysters and other shellfish. Larger chambers (~500 ml volume) have been used routinely with shellfish above 50-60 mm in length. Graduate student Cheyenne Adams, working closely with undergraduate intern Toni Barela, demonstrated during the summer of 2016 that the existing larger chambers can be used to measure feeding in smaller size classes of oysters.

We also proposed, however, to measure the metabolic costs of feeding by measuring the amount of oxygen consumed as shellfish feed on different types of organic material that may support shellfish growth. To achieve this we have been working to incorporate fiber optic oxygen sensors into the chamber design our new chambers. Measuring oxygen consumption also requires that the chamber can be sealed and that we

reduce the total volume of water in which the animal is held. As can be seen in the figure, we have built a set of such chambers (~150 ml total volume), although fitting of the oxygen sensors took much longer than initially anticipated. At this time, we have "deployed" the chambers in a wet lab setting in Murray Hall on the UMaine Orono campus and believe we have a working system.

The retrofits, however, set our schedule back significantly and we were not able to deploy the chambers under field conditions, which we feel is essential to show "proof-of-concept" for our planned follow-on grant submissions. By the time the chambers were field ready, water temperatures had already dropped below 7°C a temperature at which oysters stop feeding (even if there is food available in the water). In related work we completed last season, we saw strong seasonal effects on individual growth at our industry partner's farm (Pemaquid Oyster Co.) on the Damariscotta River. We are comparing the variation in growth rate with water quality and food availability data from the Maine EPSCOR/SEANET program.

One of the most interesting features of the data we have gathered, so far, is that individual growth over the season is not correlated with the maximum growth rate for the oysters in our experiment – which occurred during June 2016 (figure 3). We look forward to deploying our feeding chambers together with Pemaquid Oyster Co as soon as they begin field operations in April/May of 2017.

Private sector engagement, investment, and advancement

This deployment will provide key data for linking the variation in food supply to the variation in individual growth rates and provide us with the "proof-of-concept" necessary to move forward with our planned grant submissions to agencies such as Northeast Regional Aquaculture Center (USDA, NRAC; fall 2017), the National Institute of Food and Agriculture (Spring 2018) and the NOAA National Marine Aquaculture Initiative. Although these submissions are still in progress, we have worked closely and with the direct support of our industry partners at Pemaquid Oyster Co. throughout this project and will continue to work with the on grants and future projects stemming from this RRF support.

"*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*"
Principal Investigator: James Weber (School of Food and Agriculture, UMaine)
Co-PIs: Ian Dickey (Colorado Limb Consultants); David Neivandt (Chemistry & Biological Engineering, UMaine); Anne Lichtenwalner (School of Food and Agriculture, UMaine)
External Collaborators: Colorado Limb Consultants, Stryker Orthopedic, Inc.
Budget: $99,632 Performance Period: 11/01/2015 – 9/01/2017
Economic Sector(s): Biomedical industry

Abstract: This project will complete a controlled *in vivo* study of University of Maine-designed medical implants in a porcine model of skin healing. If successful, the proposed study would revolutionize the medical implant industry because currently available transcutaneous implants suffer high rates of post-surgical infections from superficial bacteria that migrate into deeper tissues. The proposed work supports economic development in the Maine biomedical industries by establishing UMaine and our collaborators as "Centers of Excellence" in clinical testing of porous materials in human surgical implants.

Notable Highlights to date:

Our research group has been collaborating since 2006 to develop novel materials and designs that would increase the stability and longevity of medical devices that are chronically or permanently implanted in human patients. The goal of our RRF-funded seed grant project, was to test the ingrowth of porcine soft tissues into novel 3-D printed porous medical implants. Specifically, we are measuring the ingrowth of skin, subcutaneous tissues and muscle into porous titanium implants that were designed as a collaborative effort between the University of Maine and Stryker Orthopedic, Inc. We reached out to Stryker because they are the world leaders in the design and manufacture of human medical implants.

After the announcement of our RRF award, we met with a group of executives and engineers from Stryker in March 2016 to co-design six porous implant designs for use in the study. We then worked with lawyers from the University of Maine and Stryker to draft an agreement on any intellectual property that might come from our collaborative efforts during this project. Soon after the signing of an IP agreement early this fall, we surgically implanted twelve Stryker-manufactured implants into two pigs. Eleven of the twelve implants remained in place through the post-surgical period, while one implant was removed after it was dislodged soon after surgery. The remaining eleven implants were harvested at ten days or two weeks post-surgery, and are currently awaiting histological processing and evaluation.

Based on our initial examination at tissue harvest, the surrounding soft tissues appeared to have formed a "biological seal" by growing into the porous portions of the implants, with no gross evidence of inflammation or infection in the surrounding skin, subcutaneous tissues or muscle. *Note that these results represent a breakthrough in soft tissue medical implants*, since solid titanium implants that span the skin surface currently suffer a high failure rate due to non-union with soft tissues followed by deep tissue infections.

Private Sector Engagement, Investment, and Advancement:

Based on these initial positive experimental results, we plan to complete the remainder of the grant-related surgical implantations during the Spring and Summer of 2017, with post-surgical healing periods of 2, 4 or 6 weeks. We are scheduled to meet with Gene Kulesha, Senior Director of Platform Technology Engineering at Stryker Orthopedic, on March 3 to discuss modifications in implant design and the timing of future surgeries.

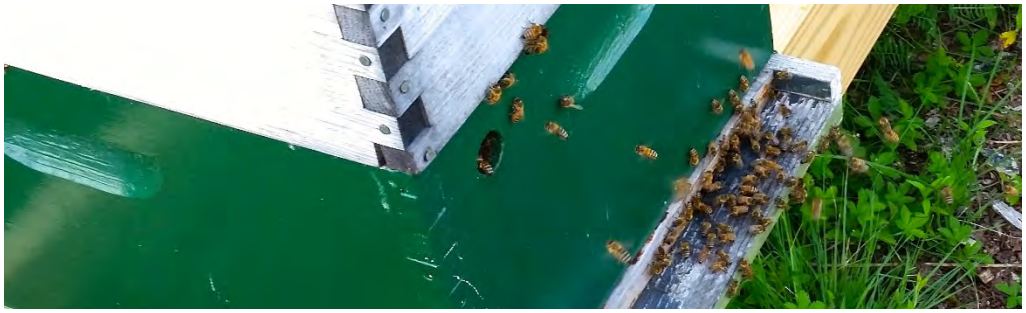
The ongoing involvement of Stryker Orthopedic as an industrial partner in this study has been a very positive outcome of our RRF grant award. Stryker is the world's leader in the development of "custom-made" medical implants that are rapidly manufactured to the specifications of each individual patient using additive manufacturing. Our ability to test medical implants in an *in vivo* swine model fills a need in their research and development efforts, while still allowing us to design and test our own porous implant designs.

We foresee additional funded research based on collaborations with the team at Stryker. For example, we are poised to submit a Request for Pre-Proposals during 2017 to the Department of Defense Peer-Reviewed Orthopedic Research Program. The objective of our submission would be to study the use of porous metal foams for the stabilization of long bone fractures sustained by soldiers in battle. If we are invited for a full proposal, we plan to submit under the DOD focus area "*Surgical Care: Extremity Fractures: Strategies to optimize patient outcomes after extremity fracture*". We feel that our submission would be competitive for this large (up to $750,000 per grant) competitive grant program due to our ongoing Industrial collaboration, our developing reputation as whole animal medical implant researchers, and the preliminary data that is being generated by our RRF-funded grant.

Implant design by Alex French (Advanced Manicuring Center, UMaine)

"*The Health of Maine's Bumble Bee Community*"
Principal Investigator: Frank Drummond (School of Biology and Ecology, UMaine)
Co-PIs: Scott Dobrin (Biology, UMPI); Ron Butler (Biology, UMF); Joseph Staples (Environmental Sciences, USM); Christopher Lage (Biology, UMA)
Budget: $90,627 Performance Period: 11/01/2015 – 4/30/2017
Economic Sector(s): Maine's natural resources: agriculture, especially fruit production

Abstract: The goal of this project is to investigate the 'health' of Maine bumble bees in light of their critical importance to Maine commercial businesses. Since 2006, global concern has emerged about decline of bumble bees. This is due to the collapse of the honey bee, a pollinator that is a major component of both global and Maine agricultural production. Bee decline is a serious matter and requires a large team to investigate its multiple dimensions.



Notable Highlights to date:

As of February 2017, we have finished all of our field based data collection of bumble bee species richness and diversity. We have processed all of the plant identifications records of bumble bee floral species utilization. Bumble bee samples that were sent to North Carolina State University and the USDA Pesticide Analysis Laboratory in Gastonia, North Carolina have been analyzed and the data received. The analyses being conducted to determine genetic diversity of both common and rare bumble bee species has been initiated at UMA.

In the one year of this study, we have developed important baseline data of bumble bee diversity, abundance, and health. First, we have shown that bumble bee communities are regional within Maine and not homogeneous throughout the state. This is significant, because it suggests that: 1) factors that negatively affect bumble bee communities will probably vary across the state, and 2) that rare and endangered bumble bee species may still have small residual populations in some regions, but not others. This is important as far as the federal listing of the rusty-patch bumble bee in Maine because the state will be given the responsibility of sampling the landscape to determine if extinction has occurred. Our data suggests that a stratified statewide survey will be necessary.

We also have documented that pesticides are probably NOT the cause of our bumble bee declines, but instead diseases. We found almost no evidence of pesticide exposure in bumble bees across the state. However, we did find much higher titers of disease in the rare and threatened yellow banded bumble bee compared to the more common orange belted bumble bee.

1. Media Coverage - four articles
   a. Article in Portland Press Herald, M.Pols interviews of both F. Drummond and E. Venturini (February 5th, http://www.pressherald.com/2017/02/05/the-plight-of-the-bumblebee/)
   b. F. Drummond interviewed for forthcoming article on bumble bee decline by Mr. Dallon Adams of Digital Trends (http://www.digitaltrends.com/users/dadams/)

c. Pols, M. 2017. UMaine scientist Eric Venturini encourages growth of life-sustaining bees. The Portland Press Herald, published in Source on February 5th, 2017.

d. Robison, A. J. 2017. UMaine scientist researches bee sustainability. The Maine Campus Newspaper, published February 12, 2017.

2. Grant Proposals - four submitted on bees, fifth in planning stage

a. 2016. Development of a model of mummy berry disease transmission in Maine Wild Blueberry, PI: S. Annis, Co-PI: F.A. Drummond. submitted to and FUNDED by Maine/SCRI for $29,510. (focus on comparing bumble bees to honey bees in disease vectoring)

b. 2016. Climate Change, Consequences and Mitigation: A Blueberry Industry Priority. PI: S. Annis, Co-PI: F. Drummond (climate change bumble bee objective) and others. Submitted to USDA/SCRI for $1,980,000. REJECTED.

c. 2016. Modeling bumble bee vectoring of mummy berry disease. PI: S. Annis, Co-PI: F. Drummond. submitted to USDA/NIFA for $500,000. REJECTED.

d. 2017. Priority Pollinator Project – Roadside Bumblebee and Butterfly Survey, PI: E. Venturini, Co-PI: F. Drummond. submitted to the Maine Department of Transportation for $14,000. PENDING.

e. Mr. Venturini is currently discussing a joint project with Apex Clean Energy to plant pollinator reservoirs to enhance bumble bee and other wild bee populations in the Maine blueberry barrens about their planned 50 windmills for electrical power generation (contact: Mr. Paul Williamson).

3. Publications

Rivernider, R. E. M. Venturini, and F. A. Drummond. In Review. Phleum pratense (Poales: Poaceae), a pollen forage for native bumble bees Bombus Latrielle (Hymenoptera: Apidae). Short Communication. The Journal of the Kansas Entomological Society, In Review.

4. Outreach

a. Dr. Butler, Dr. Drummond, and Ms. Bickerman (a PhD candidate working with Drummond) participated and presented at two workshops in the spring 2016 on biology, collecting and recording bumble bee specimens for the Maine Atlas in Orono and Portland.

b. Dr. Butler and Ms. Bickerman also conducted a summer bumble bee identification workshop in Augusta.

c. F. Drummond made presentations to the Maine blueberry growers about bumble bee health on July 20, 2016 at the Maine Blueberry Summer Field Day in Jonesboro. He also made presentations to the Maine Wild Blueberry Commission on November 16 and February 17 in regards to bumble bee health and the federal listing of the rusty patch bumble bee.

d. Venturini, E. M, F. A. Drummond, R. G. Butler, C. Lage, J. K. Staples, and S. E. Dobrin. 2017. The health of Maine's bumble bee community: A collaborative University of Maine research effort. Talk scheduled for April, 27, 2017 at UMaine Presque Isle.

e. Venturini, E. M, F. A. Drummond, R. G. Butler, C. Lage, J. K. Staples, and S. E. Dobrin. 2017. What's up with Maine's bumble bees? Date TBD, Lakes Environmental Association, Bridgton, Maine.

f. Rivernider, R., E. M. Venturini, and F. A. Drummond. 2017. Timothy grass, a pollen forage for native bumble bees? UMaine Student Symposium, scheduled for April 24th, 2017.

g. Maine Department of Inland Fisheries and Wildlife: The participants of this project have donated our bee collections to the Maine Bumble Bee Atlas. This is a citizen science project finishing its second of five years to develop a baseline for current bumble bee diversity in Maine. Submitted 2,327 bumble bee specimens and associated data to the Maine Bumble Bee Atlas Project, nearly doubling their total collection for the season. This project may be the basis for future decisions regarding mitigation and funding for the federally endangered rusty patch Bumble bee.

h. U.S. Fish and Wildlife: F. Drummond has been in discussions with Mr. Marc McCullough of the U.S. Fish and Wildlife Service about potential projects in Maine to address the federal

listing of the rusty patch bumble bee. Currently, Dr. Drummond has been asked to serve on a statewide planning committee in anticipation of the federal listing.

APPENDIX I.E: Round 1 | Seed Grant Rubric

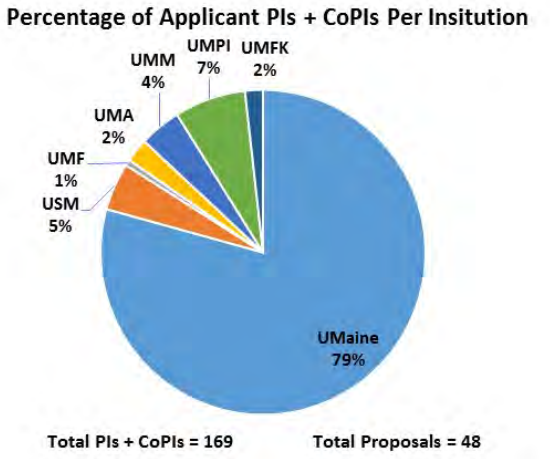
2015 Research Reinvestment Funds (RRF) Planning Grant Program

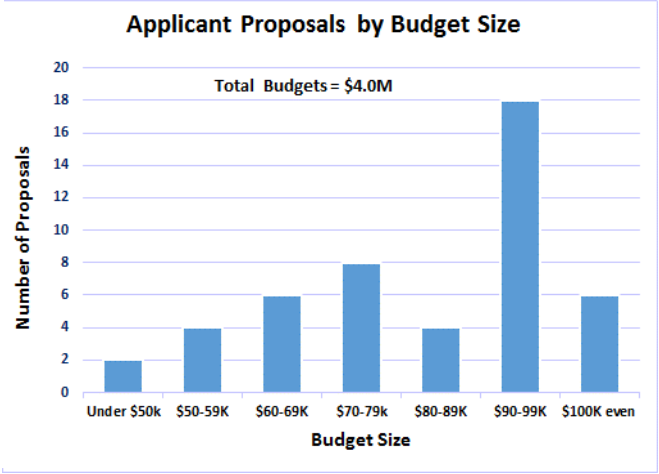
Intellectual merit 35 POINTS	**Poor (0 POINTS)**	**Good (15 POINT)**	**Very Good (25 POINTS)**	**Excellent (35 POINTS)**	**Score**
Evaluation Criteria for Intellectual Merit	Proposed research unlikely to lead to completion of objectives; methodologies not well suited; poorly articulated hypotheses/researc h h questions	Proposed research likely to lead to partial completion of objectives; methodologies suitable; some unresolved questions regarding the hypotheses/research questions	Proposed research likely to lead to completion of objectives; methodologies are suitable and well-reasoned; hypotheses/ research questions largely clear	High probability that the research will lead to completion of objectives; methodologies very well suited and reasoned; hypotheses/ research question clear and appropriate	
Relevance to Maine's economy 30 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (30 POINTS)**	**Score**
Evaluation Criteria for Relevance to Maine's Economy	No clear link of the proposed activities to Maine's economy. Likelihood of job creation, workforce and economic development low	Proposed activities somewhat linked to Maine's economy. Likelihood of job creation, workforce and economic development moderate	Proposed activities well linked to Maine's economy. High likelihood of job creation, workforce and economic development	Proposed activities intimately linked to Maine's economy. Likelihood of job creation, workforce and economic development very high	
Likelihood of additional funding 20 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (15 POINTS)**	**Excellent (20 POINTS)**	**Score**
Evaluation Criteria for Likelihood of additional funding	Proposed research unlikely to lead to external funding	Proposed research somewhat likely to lead to external funding; Targets lacking	Proposed research likely to lead to external funding; Targets given	Proposed research highly likely to lead to external funding; specific targets given	
Extent of Collaboration 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Extent of Collaboration	Proposal has no evidence of collaboration across the UMS and/or external partners, collaborations are not clearly linked to the proposed activities, roles and responsibilities are not clearly defined	Proposal has some evidence of collaboration across multiple campuses and/or external partners, collaborations are linked to the proposed activities, roles and responsibilities are somewhat defined	Proposal has good collaboration across multiple campuses and/or external partners, collaborations are well linked to the proposed activities, roles and responsibilities are defined	Proposal has strong evidence of collaboration across multiple campuses and/or external partners, collaborations are clearly linked to the proposed activities, roles and responsibilities are clearly defined	
TOTAL POINTS					

APPENDIX II: RRF Seed Grants | Round 2

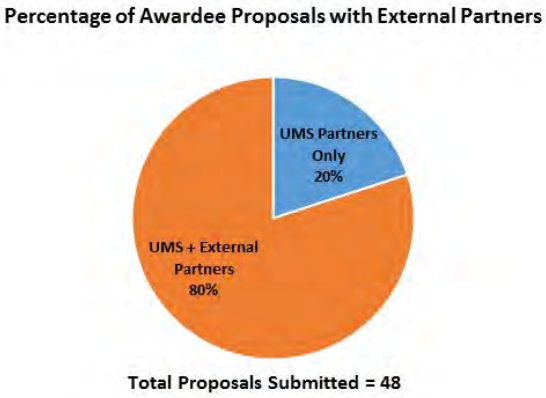
APPENDIX II.A: Round 2 | Seed Grant Applicant Data

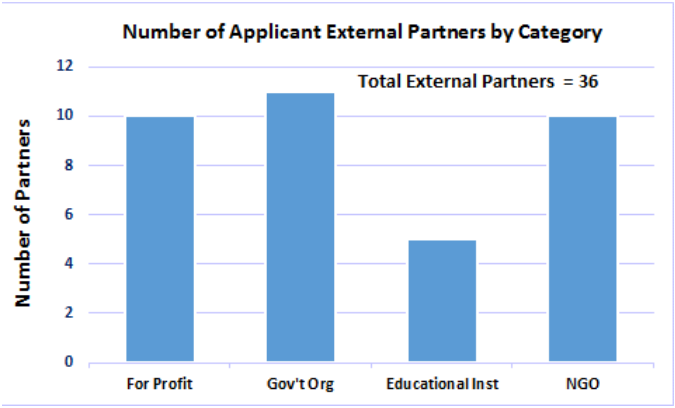
Proposal Data



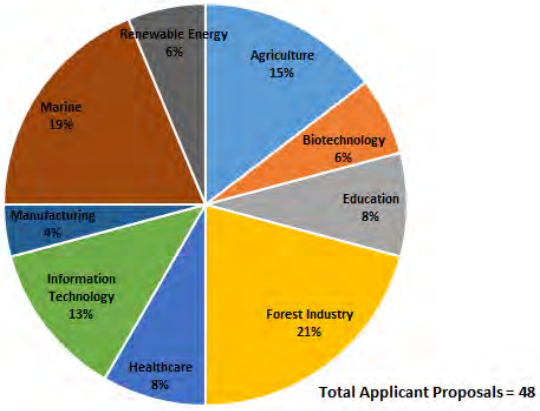


External Partner Data





Economic Sector Data

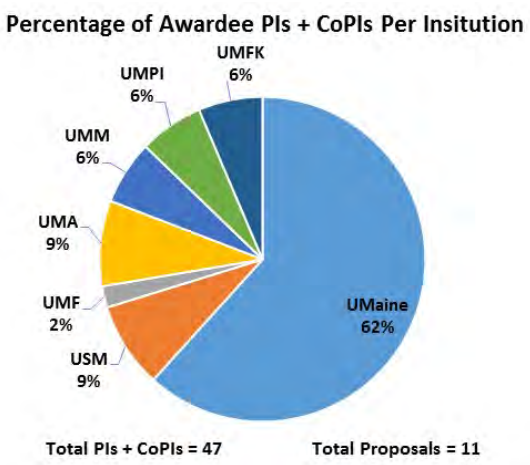


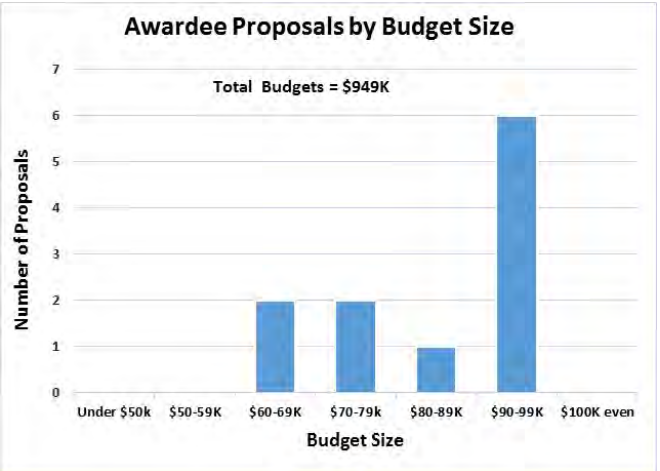
APPENDIX II.B: Round 2 | Seed Grant Awardee List

Principal Investigator	Partners	Project Title
Willhelm Friess (Mechanical Engineering, UMaine)	Michael Davis (USM), Shari Templeton (UMA), Luke Shorty (Maine School for Science & Mathematics), Mohamad Musavi (UMaine), Craig Mason (UMaine), Betsy Webb (Bangor School Dept.), Shari Templeton (ME Dept. of Ed), Tony Paine (Kepware Technologies)	*Finding the E in STEM: Survey of Engineering Instruction in Maine's K-12 Schools*
Michelle Smith (Biology & Ecology, UMaine)	Mindi Summers (UMaine), Eric Jones (UMM), Jason Johnston (UMPI), Joseph Staples (USM), Judith Ladd Roe (UMPI), Karen Pelletreau (UMaine), Kim Borges (UMFK), Larry Feinstein (UMPI), Lisa Moore (USM), Nancy Prentiss (UMF), Peter Nelson (UMFK), Sandra Haggard (UMA), Sherrie Sprangers (UMM), Theresa Theodose (USM), Charles Wray (The Jackson Laboratory), David Edson (James W. Sewall Company), Campbell Scott III (OceansWide)	*Workforce Development: Helping UMaine Faculty develop classroom activities that prepare students for skills needed in Mane's science careers*
Harlan Onsrud (Computing & Info Science, UMaine)	Susan McKay (UMaine), Constance Holden (UMA), Richard Corey (UMaine), Torsten Hahmann (UMaine), Reinhard Moratz (UMaine), Silvia Nittel (UMaine), Michael Scott (UMaine), Roy Turner (UMaine)	*Revolutionizing Computing Across the University of Maine System*
Caitlin Howell (Chem Engineering, UMaine)	Philseok Kim (SLIPS Tech, Inc.)	*Liquid-Infused Paper Substrates for New Biomedical Applications*
Thomas Abbott (UMA)	Col. Daniel M. Leclair (Civil Air Patrol, Northeast Region), J. Gregory Jolda (UMA)	*Unmanned aerial systems: Supporting development and training on UAV applications for Maine businesses and state agencies*
Susan Brawley (Marine Science, UMaine)	Luz Kogson (UMaine), Sarah Redmond (UMaine Marine Extension Team/Maine Sea Grant), Shep Erhart (Maine Coast Sea Vegetables), Seth Barker (Maine Fresh Sea Farms), Phil Harrington Bait (Wholesale Marine Worms), J. West (Commercial Fisherman)	*Advancing Algal and Invertebrate Aquaculture*
Rick Wahle (Marine Science, UMaine)	Brian Beal (UMM), Damian Brady (UMaine), Burton Shank (NOAA/NMFS)	*Enhancing the forecasting value of the American Lobster Settlement Index to Maine's Coastal Economy*
Rosemary Smith (Electrical Engineering, UMaine)	Scott D. Collins (UMaine), Douglas Sawyer (MMC/MMCRI)	*Engineering cardiac tissues regeneration and repair*
Erin Simons-Legaard (Forest Resource, UMaine)	Kasey Legaard (UMaine), Aaron Weiskittel (UMaine), Dave Struble (Maine Forest Service), Ryan Hanavan (US Forest Service)	*The Maine forest ecosystem status and trends (forEST) app: Informing management and dynamic landscapes*
Carl Tripp (Chemistry, UMaine)	Joshua Henry (Maine Maritime Academy), Robert Lad (UMaine)	*Layer-by-layer Fabrication of Thermoelectric Films Using Nanoparticles to Yield High Efficiency Thermoelectric Generators for Marine Applications*
Parinaz Rahimzadeh (Forest Resource, UMaine)	Aaron Weiskittel (UMaine), Peter Nelson (UMFK), David Maclean (University of New Brunswick), Daniel Kneeshaw (University of Quebec)	*A Novel Framework for Detecting and Assessing Spruce Budworm (SBW) Forest Defoliation over Maine*

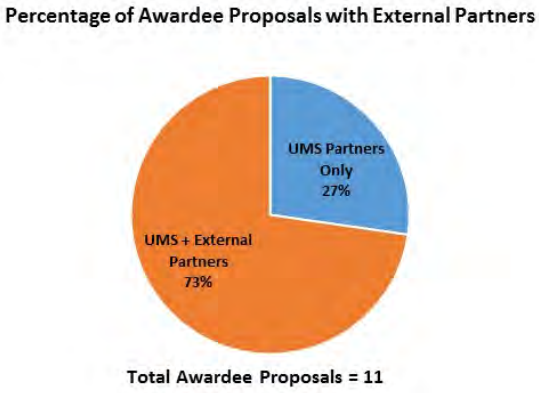
APPENDIX II.C: Round 2 | Seed Grant Awardee Data

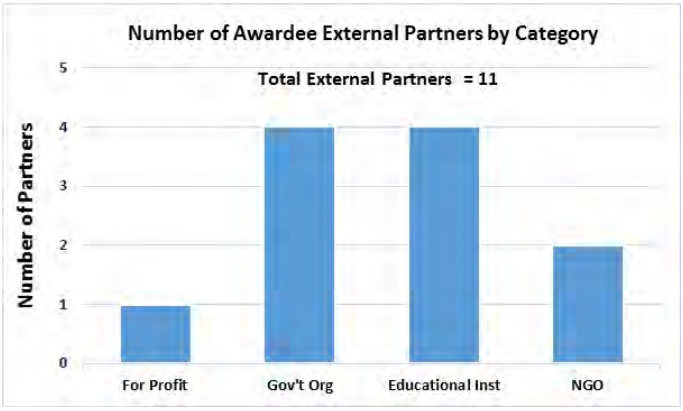
Proposal Data



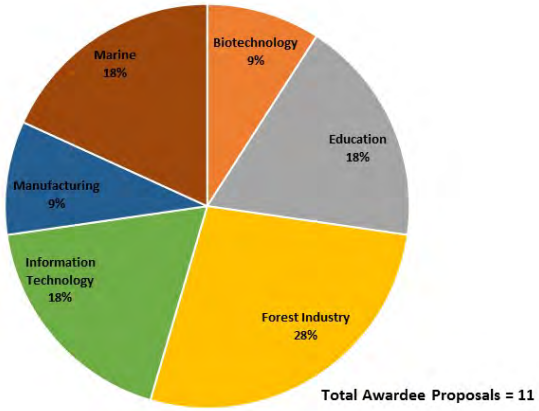


External Partner Data





Economic Sector Data



APPENDIX II.D: Round 2 | Seed Grant Awardee Abstracts & Updates

"Finding the E in STEM: Survey of Engineering Instruction in Maine's K-12 Schools"
Principal Investigator: Willhelm Friess (Mechanical Engineering, UMaine)
Co-PIs: Michael Davis (Mechanical Engineering, USM), Mohamad Musavi (College of Engineering, UMaine), Craig Mason (College of Education, UMaine),
External Collaborators: Luke Shorty (Maine School for Science & Mathematics), Betsy Webb (Bangor School Dept.), Shari Templeton (ME Dept. of Ed), Tony Paine (Kepware Technologies)
Budget: $ 99,849 Performance Period: 6/15/2016 – 9/29/2017
Economic Sector(s): Education

Abstract: The vast majority of all jobs are created by the STEM-trained, and most high-salary jobs of the increasingly tech-based economy are in the STEM fields; these jobs are either in or related to engineering. Maine K-12 students receive very little engineering instruction and there has never been a broad assessment of engineering literacy in K-12 schools. The goal of this project is to build the foundation for the development of an effective engineering pathway for Maine students.

Notable Highlights to date:

Private Sector Engagement: The research team has approached the public and private sectors during the definition of engineering interventions and surveying of existing engineering interventions. Educators and engineers with different backgrounds were invited to participate in our advisory board. Additionally, 595 principals and 80 teachers of Maine's K-12 public and private schools have been contacted to participate in two web-based surveys.

Advancement: Twenty-five educators and engineers in Maine participated in our advisory board to define an engineering intervention, and provide valuable information to formulate questions for the surveys. This participation was provided in two steps. In the first step, the advisory board provided us with information about the engineer profession and what motivates a person to study engineering. This information together with available literature helped us identify the main skills, attitudes, and behaviors of the engineering profession in Maine. In the second step, the advisory board helped us rank these skills, attitudes, and behaviors in the engineering profession, and provided information of the main barriers that schools face to implement engineering interventions.

Two surveys were conducted to study the available engineering and technology instructional materials in Maine's K-12 schools. After securing IRB approval, the web-based surveys were deployed. The first web-based survey was sent to 595 school principals on December 20th, 2016. The current response rate for this survey has been 19%, after sending three reminders. Principals were asked about the engineering interventions in their schools, and which are the challenges of implementing engineering-related interventions. Additionally, the principals were asked to refer us to the teachers that are performing engineering interventions in their schools. The second web-based survey was first sent to teachers that are involved in engineering-related interventions in K-12 schools on January 6th, 2017. In total 80 teachers have been invited to participate in the survey. The response rate for this survey has been 42.5%, after sending two reminders to twenty nine teachers, and one reminder to twenty teachers. Teachers are being asked about their backgrounds, the engineering interventions that they teach, and the challenges of implementing engineering interventions. The responses of both principals and teachers are currently being analyzed using geographical and demographics indicators such as county, and economically disadvantage index. To protect the privacy and identity of the teachers and principals of K-12 schools who have participated in the survey, a server has also been customized to process, storage, and encrypt the survey data. The survey for principals and

teachers will be closed in March 2017. An analysis of the acquired data will follow. The analyzed data will form the basis for the report on current state of engineering instruction in Maine K-12 schools.

IRB approval has been secured to conduct visits to better understand the currently available engineering and technology instructional materials in K-12 schools. The project team has identified 25 schools that are of particular interest. These schools were chosen to give a fair representation of the different geographical, demographic and social indicators and engineering interventions being used in K-12 schools in Maine. As part of these visits, the principals and teachers of these schools will be interviewed, and if possible, the facilities and equipment used for engineering related interventions will be surveyed. The data of both principals and teachers will complement data that had been obtained in previous surveys (Objective 2) and analyzed using geographical and demographics indicators such as county, limited English proficiency, and economically disadvantaged.

The visits to 25 schools will take place in March, April and May 2017. An analysis of the acquired data will follow. The analyzed data of the visits with the acquired data of Objective 2 will form the basis for the report on the current quality of engineering instruction, implementation capacity and administrative supports in K-12 Maine schools. Preparations for the Maine Teachers Conference to take place at the Wells Conference Center at UMaine on June 10th, 2017 are currently on-going. This conference has been checked with the educators on our advisory board for teachers' availability.

Grant Applications: The Seed grant has formed the basis for two grant applications (NSF AISL "Increasing youth engineering literacy through a windpower design competition", PI Friess, submitted November 2016 and awaiting funding decision, and Maine DOE "Engineering for k-12 teachers: Literacy and Problem-based learning" PI Musavi, Co-pi Friess, submitted December 2017, not funded). It currently also constitutes a basis for a Maine EPSCoR track 1 concept paper that proposes the formation of an Engineering Education Excellence Center.

Publications: An abstract has been submitted to the Frontiers in Education 2017 Conference (paper #1570339434, "Assessing the state of Engineering Instruction in Maine's K-12 Schools"). A journal paper will be submitted at the conclusion with the summative results of the project.

"Workforce Development: Helping UMaine Faculty develop classroom activities that prepare students for skills needed in Maine's science careers"
Principal Investigator: Michelle Smith (School of Biology & Ecology, UMaine)
Co-PIs: Mindi Summers (Biology & Ecology, UMaine), Eric Jones (Plant Biology, UMM), Jason Johnston (Biology, UMPI), Joseph Staples (Environmental Science & Policy, USM), Judith Ladd Roe (Biology, UMPI), Karen Pelletreau (Biology & Ecology, UMaine), Kim Borges (Biology, UMFK), Larry Feinstein (Biology, UMPI), Lisa Moore (Biological Sciences, USM), Nancy Prentiss (Biology, UMF), Peter Nelson (Biological Sciences & Environmental Studies, UMFK), Sandra Haggard (Biological Sciences, UMA), Sherrie Sprangers (Biology, UMM), Theresa Theodose (Biological Sciences, USM)
External Collaborators: Charles Wray (The Jackson Laboratory), David Edson (James W. Sewall Company), Campbell Scott III (OceansWide)
Budget: $ 67,727 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Education

Abstract: UMaine biology students require preparation for a range of careers including healthcare, forestry, agricultural, natural resources management, and laboratory research. At the same time, employers are seeking applicants who have biology degrees and scientific skills to solve problems and foster economic development in the state of Maine. We propose to bring together faculty from all campuses in the UMaine System with Maine employers familiar with the workforce needs to develop, iteratively revise, and study the impacts of shared instructional activities used in introductory biology courses at all of the system campuses.

Notable Highlights to date: A recent assessment of 715 undergraduate biology students from six campuses in the University of Maine System revealed that they struggle to understand the roles of nutrients, carbon dioxide, and light energy in plant growth and how rising levels of global atmospheric carbon dioxide are predicted to impact aspects of Maine's economy that are based on these biological processes (e.g., timber, agriculture, and aquaculture). To help students overcome common conceptual difficulties in these areas, life science faculty from six University of Maine System campuses joined with an industry partner, Hurricane Island Center for Science and Leadership, to develop a student-centered in-class activity and common assessment questions. The activity helps students learn about matter and energy, and explore how and why increased carbon dioxide would impact certain industries. This spring semester the activity will be taught in 13 classrooms throughout the University of Maine System. We are using student learning and faculty observation data to iteratively revise the instructional materials.

Planned Economic Outcomes
University of Maine Presque Isle and University of Maine Orono faculty associated with the grant are included in an EPSCoR Research Infrastructure Improvement Program Track-2 Grant focused on genomes to phenomes that was submitted in February 2017. If funded, the University of Maine Presque Isle and University of Maine Orono faculty will use a similar collaborative faculty learning community structure to develop lessons for genetics and ecology classes at the University of New Hampshire, University of Maine, University of New England, and Plymouth State University.

- The PIs of this proposal are applying for an NSF Improving Undergraduate STEM Education (IUSE) grant, the anticipated due date is October 2017.

The PIs of this proposal are developing a survey for industries throughout the state to share what skills and competencies they expect life science students to learn during their undergraduate education. The data will be shared with life science programs throughout the University of Maine System.

Additional Highlights:
715 students from across the University of Maine System have taken a common assessment Ecology and Evolution Measuring Achievement and Progress in Science or EcoEvo-MAPS (Summers et al., submitted). The results from this assessment were used to identify student conceptual difficulties and design the content for this lesson. The data can also be incorporated in the design of future lessons proposed in the NSF IUSE grant.

1) Nine faculty from six different campuses throughout the University of Maine System and the Director of Education from the Hurricane Island Center for Science and Leadership met in November 2016 at the University of Maine-Orono campus to examine student assessment results, discuss how important aspects of Maine's economy could be used in the lesson, and develop initial ideas for the student-centered classroom activity. After this in-person meeting, the group has met online every month to discuss changes to the lesson, determine how to integrate information about how rising levels of global atmospheric carbon dioxide are predicted to impact the Maine economy, and develop additional assessment questions.

2) This spring nine faculty members are teaching this lesson in 13 classrooms across six campuses in the University of Maine System. All of the class periods in which the lesson is being taught will be video recorded to document instructional practices, and observe how students think about the connections between biological processes and the Maine economy. In addition, student answers to both pre- and post-assessment questions are being shared with the group. We will collaboratively write a journal article about this activity this summer and submit the manuscript to the journal CourseSource by Fall 2017.
3) Master of Science in Teaching student Elizabeth Trenckmann analyzed EcoEvo-MAPS assessment data and helped to develop the activity. She has submitted an abstract about this work to the UMaine Student Symposium which takes place in April 2017.
4) The work of this grant was including in the following UMaine news article: https://umaine.edu/news/blog/2017/01/23/facultys-active-learning-lesson-improves-student-understanding-biology-concept/

6). Summers MM, Brownell SE, Couch BA, Crowe A, Knight J, Semsar K, Wright CD, and Smith MK. EcoEvo-MAPS: An ecology and evolution assessment for introductory and advanced undergraduates. Submitted to Life Science Education, Feb 2017.

"Revolutionizing Computing Across the University of Maine System"
Principal Investigator: Harlan Onsrud (Computing & Info Science, UMaine)
Co-PIs: Susan McKay (Physics and the RiSE Center, UMaine), Constance Holden (Mathematics, UMA), Richard Corey (VEMI Lab, UMaine), Torsten Hahmann (Computing & Information Science, UMaine), Reinhard Moratz (Computing & Information Science, UMaine), Silvia Nittel (Computing & Information Science, UMaine), Michael Scott (New Media and ASAP, UMaine), Roy Turner (Computing & Information Science, UMaine)
Budget: $ 99,319 Performance Period: 6/15/2016 – 8/31/2017
Economic Sector(s): Information Technology and Education

Abstract: The bulk of STEM jobs in the U.S. are in computing and this proposal takes an initial step in potentially revolutionizing the approach that UMS and the nation's universities use to teach computing to far better meet the nation's workforce needs. We hypothesize that project-based, hands-on, team-focused problem-solving courses addressing authentic societal and science challenges incorporated throughout the computer science curriculum would attract and retain many more and a greater diversity of students including women to careers in computing. Our objective with this project is to demonstrate that such an approach verifiably attracts young people and excites them about computing.

Notable Highlights to date: The project developed appropriate course content for a semester course in Introduction to Programming and two summer Institutes that incorporate evidence-based best-practices for the teaching of computer science. The semester course was developed by seven faculty members and seven computing learning assistants during the Fall 2016 semester and is now being offered during the Spring 2017 semester. The content for the semester course is open access licensed and available at http://umaine.edu/computingcoursesonline/cos120. The 2017 summer institute for high school students is scheduled for the week of June 26-30 and the summer institute for high school teachers where faculty from UMS campuses serve as learning assistants is in July.

Private Sector Involvement: The project is focused on attracting and educating human resources for the IT community. Similar to the engagement of faculty from other UMS campuses, computing professionals from selected Maine companies are being invited as well to participate in any or all of the following at their own expense:

(a) critique the content, methods and processes used in the newly developed semester course,
(b) attend a half day briefing in Orono about the course and project (March 24), and
(c) attend a five-day short version of the course (July 10-14) and serve as mentors/coaches for middle and high school STEM teachers as they work through some of the course modules OR take time to work through some modules by the computing professionals. The last day of the Institute will be to write revisions for the course materials.

Among the companies invited to send a representative to engage in these activities include those on our Computer Science Advisory Board (Emera Maine, Esri, IDEXX, Tyler Technologies, UNUM) and selected invitations will be made to other companies affiliated with Project>Login which is part of Educate Maine.

Grants: A proposal based on this RRF Seed Grant was submitted to NSF on 1/18/17 to NSF under the title IUSE/PFE:RED Founding the Frontiers of Sustainability Computing ($1,934,845).

"Liquid-Infused Paper Substrates for New Biomedical Applications"
Principal Investigator: Caitlin Howell (Chemical Engineering, UMaine)
External Collaborators: Philseok Kim (SLIPS Tech, Inc.)
Budget: $ 83,233 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Forest Industry

Abstract: Durable fouling-resistant materials are highly sought after as solutions to a wide range of problems in both medicine and industry. We propose to apply a new bio-inspired approach utilizing immobilized liquid layers. We will develop and validate rapid, low-cost, and easily adaptable methods of immobilizing these liquid layers on paper for biotechnological applications such as fluid handling, anti-bacterial surfaces, and improved paper-based diagnostics, which have direct reliance to Maine's paper-based economy.

Private sector engagement, investment, and advancement:

As a direct result of this funding, we have recently deepened private sector engagement by signing an NDA with Sappi-Warren release papers and have received a number of proprietary samples for testing in conjunction with the new technology being developed. We are now in the process of performing these tests.

Also as a direct result of this funding, one student (Alexander Collins, UMaine Bioengineering '15) developed skills in engineering and lab-based research sufficient enough to be hired directly into a full-time position at IDEXX in Westbrook, ME. Alex presented his independent research on liquid-infused paper substrates in a talk to IDEXX hiring managers as part of the interview process.

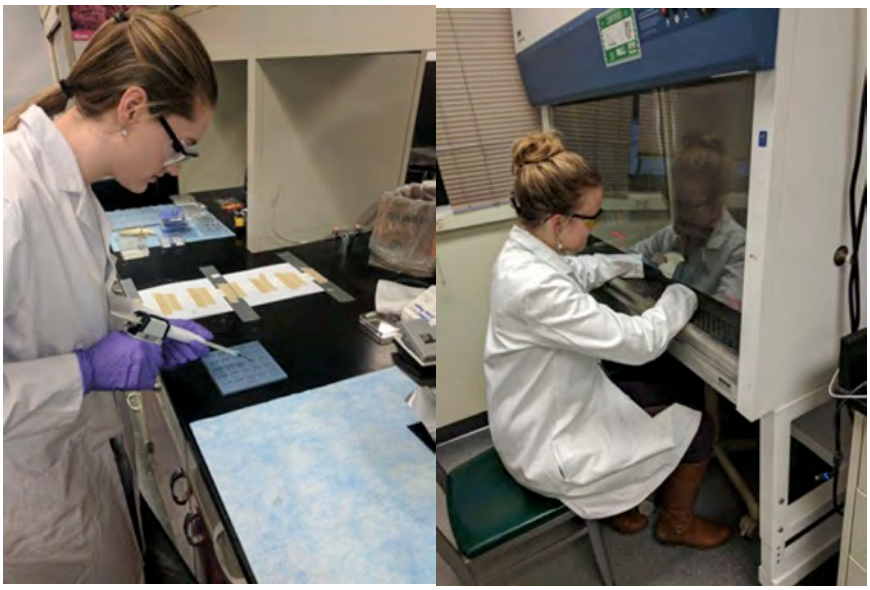
We have furthermore achieved our goal of developing and validating rapid-low cost easily adaptable methods of immobilizing liquid layers on paper on a lab scale. We presented the results at two international conferences at the end of 2016, leading to the development of new industry contacts who have expressed interest in the potential of the technology (e.g. LioChem, Inc.). We are now performing the proof-of-principle studies on efficacy, focusing on bacteria as a promising target of interest to our external industry contacts.

The final results are currently being prepared as preliminary data to support an NSF GOALI submission to the Biomaterials division (due September 2017) and a DoD Pre-proposal for the United States Special Operations Command - Extramural Biomedical Research and Development (due April 2017). We have recruited paper-coating expert Doug Bousfield for this submission and are working to recruit Sappi to this effort as well. Both calls are interested in low-cost, lightweight materials for use as diagnostics in remote and rural locations.

Contact with Industry:
The PI and partner have begun talks with a third company, Sharklet Technologies, Inc., which currently works with Sappi-Warren release papers and has an interest in the combination of their technology with ours.

Student Involvement:

This project is currently supporting two full-time undergraduate research co-ops in the place of the originally planned master's student, as well as 4 part-time undergraduate students. The co-ops spend full days in the lab conducting independent investigations and optimization trials associated with the development of these paper-based surfaces (see Figure below). They will be presenting their work as part of the University of Maine's Student Research Symposium Event in late April, 2017 where they will be able to connect with the public to share their findings.



Bioengineering sophomores Abby Weigang (left) and Chloe Lilly (right), both UMaine Bioengineering Class of 2019, conducting experiments as full time co-op students supported by this project.

"Unmanned aerial systems: Supporting development and training on UAV applications for Maine businesses and state agencies"
Principal Investigator: Thomas Abbott (Office of the Provost/VPAA, UMA)
Co-PIs: J. Gregory Jolda (Aviation Program Coordinator, UMA)
External Collaborators: Col. Daniel M. Leclair (Civil Air Patrol, Northeast Region)
Budget: $ 99,363 Performance Period: 8/29/2016 – 8/31/2017
Economic Sector(s): Information Technology and Education

Abstract: This project will be 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 of this project is to demonstrate that a Maine-based UAV training and education center is valuable and an investment beacon for businesses, state agencies and external funders, and will draw investments from and for businesses, state and federal agencies, and assist in recruitment for UMA's own BS in Aviation Program.

Build a UAS training center at UMA

- The new UAS Operations Center has been established in room 41 of Katz Library Building with three staff members including Col. Greg Jolda, Coordinator of the Aviation Program, Dr. Tom Abbott as Project Mgr., and Col. Dan Leclair as Research Associate and Instructor.
- Our proposal for a 60' x 50' hanger building and a 900' x 20' runway on campus to support the UAS Pilot Training Program is being actively considered by UMA.

Project will draw investments from state, Federal and private sources

- While still early in the process, the UAS Center is in the process of accepting a gift of two medium sized unmanned aircraft (8' hull and wingspan of 15') which can be used for training and search and rescue; and surveying flights - staying aloft as long as 4 hours. The cost of construction of these handmade units is approximately $170,000 each. The donor has asked UMA to work with them to build 100 additional units and 400 ground stations at a lower production cost – all here in Maine. The Teaming Agreement once finalized will allow the two aircraft design companies (from Nevada and New Hampshire) and UMA to share the financial benefits, our portion in support of the UAS program at UMA. UMA is collaborating with the Advanced Manufacturing Center at Orono on the planning for startup investment manufacturing on this project
- Col. Dan Leclair visited Washington in February 2017 to speak with the Maine congressional delegation on behalf of the Civil Air Patrol of which he is the Northeast Regional Commander. He also provided an update on what UMA is doing in the UAS environment to explore future potential funding and support.

Project will assist UMA in recruitment for its BS in Aviation.

- To move the program forward as quickly as possible, we offered a 40-hour non-credit UAV Pilot Training course three weeks after the new FAA regulations (Part 107) were released on 8/29/16. This course prepares students to take the FAA Remote Pilot exam to become commercial UAV pilots. That first course filled with 38 students and the second section beginning shortly on March 14 is already at 45 students. Each of these students has an interest creating a new business or applying these piloting skills to the organization they currently work for. Survey results will be forthcoming
- UMA has received indications of interest in delivering this noncredit course as a combined offering to the Presque Isle and Fort Kent Campuses, to UM in Orono and to Central Maine Community College.

- A new UAS option in the BS program has been approved by the UMA Curriculum Committee, and we will begin recruiting for it this spring. Six new courses related to Unmanned Aircraft Systems plus 6 credits of Cooperative Education experience with industry will replace the current BS Aviation senior year instructional pilot training. Given the number of very lucrative position in the UAS world today, our BS graduates with private, instrument and commercial ratings plus the new UAS certificate will be in very high demand

Offer a summer 2017 conference at UMA focused on enhancing economic development in Maine through the use of UAS Business Applications.

- Conference is scheduled for August 2 – 4 and will include national speakers from the FAA, a major airline, the Airline Owners and Pilots Association who have added a new UAS section, one or more UAV design companies, at least 100 Maine business leaders, Maine Emergency Management as well as national and international vendors.
- We are collaborating with Cianbro's leadership in the planning of the conference, especially as it relates to growth of Maine businesses. We have invited CEO Peter Vigue to be a keynote speaker.
- We expect 150 to 200 participants and significant public and media interest

Collaborate with Maine's Law Enforcement community to provide training, expert assistance and begin process of establishing UMA's Unmanned Aircraft Systems operation as a statewide asset

- We are in the process of completing a Memorandum of Understanding with Maine Emergency Management's Operations and Response section to establish UMA's UAS Ops Center as an asset that can be called on in time of disaster, search and rescue and for training and planning for the state.
- In March 2017 we will hold a planning meeting with a small group of Maine's law enforcement leadership to prepare ½ day seminar to be held prior to the August conference to attempt to bring as many Maine Law Enforcement agencies on board for a shared asset management protocol as described above.
- Among other training equipment now available in our Operations Center at UMA, we will shortly have one of the few high power mobile infrared cameras available to the non-military UAV market and maybe the only one in Maine. Coupled with our new service UAVs and with more training, our staff and students will be able to provide search and rescue support to these agencies.

Collaboration K-12 STEM initiatives

We are working with the Harpswell Coastal Academy and Edward Little High School to offer a drone training course that will prepare students 16 or more years old to take the FAA Remote Pilot exam. These will be a test run to determine if the concept is of interest to high school students, especially young women. We will also offer a two-week summer institute for high school students.

"Advancing Algal and Invertebrate Aquaculture"
Principal Investigator: Susan Brawley (Marine Science, UMaine)
Co-PIs: Luz Kogson and Steve Eddy (Center for Cooperative Aquaculture Research, UMaine), Sara Lindsay (School of Marine Sciences, UMaine),
External Collaborators: Shep Erhart (Maine Coast Sea Vegetables), Seth Barker (Maine Fresh Sea Farms), Phil Harrington (Bait Wholesale Marine Worms), J. West (Commercial Fisherman)
Budget: $ 96,020 Performance Period: 6/15/2016 – 10/31/2017
Economic Sector(s): Marine

Abstract: Interest in sea vegetables as a healthy superfood was one of the top food trends of 2016, and demand for high quality seafood from Maine is increasing. This proposal will promote a seasonally diversified sea vegetable (Marine macroalgae) aquaculture industry based on multiple kelps, lavers, and dulse through further cultivar isolations and comparative growth tests at the University's CCAR-based Sea Vegetable Research Nursery. This work will include grow-outs demonstrating commercially applicable methodologies on two sea farms located in Maine that hold experimental sea vegetable leases, Maine Coast Sea Vegetables and Maine Fresh Sea Farms.

Notable Highlights to date:

- Peer-reviewed publications in scientific journals and presentations to stakeholders
- Apply for an MTI, NOAA and/or Maine Sea Grant for follow on research
- Assist with commercial partners to qualify for SBIR grant support to commercialize this work
- Industry partners and CCAR to submit proposals to e.g., MTI, NOAA
- PI Brawley has applied for a Round 1 RRF Undergraduate Assistantship grant to fund an undergraduate to work in the project beginning in May-November, 2017. Brawley is also a Co-PI on a larger, pending RRF Round 3 Seed grant (PI Mark Wells) to culture algae in our CCAR organic nursery for a project to study methane reduction in ruminant farm animals by including algae in their feed. She is about to send Maine SeaGrant Director Paul Anderson project ideas that might be incorporated into the $1 million NOAA Aquaculture proposal in a few weeks.

Private Sector Engagement:
<u>Sea Vegetables:</u>

- In association with support by Maine Coast Sea Vegetables, we have submitted a renewal to MOFGA for our organic seeding nursery at CCAR. During November 2016-January 2017, we seeded *Alaria* onto 2000 feet of kuralon string on spools. We provided Maine Sea Farms (Seth Barker, Peter Fischer) with the 150 feet of organic *Alari*a they requested in late January. Shep Erhart (CEO, Maine Coast Sea Vegetables); Dylan Cottrell, our RRF-hired sea vegetable technician at CCAR; and a CCAR captain planted 1050 feet of organic *Alaria* on the Frenchman's Bay lease site in early February, and another 400 feet of non-organic seeded *Alaria*. We still have some spools, which may be provided to a grower in southern Maine. We will monitor health and grow-out over the

coming three months before harvest. We also have some dulse spools nearly ready to plant. Both industrial partners plan to harvest the seeded lines for sale of crop at the end of the season.

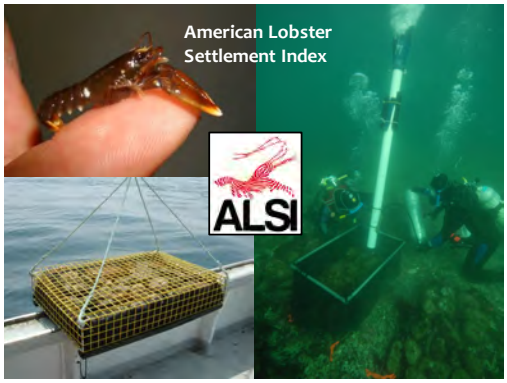
- We are calculating costs this spring for producing spools of dulse and alaria, so that we can begin the transition to being a seller of spools to growers at reasonable cost from our Organic Sea Vegetable Seeding Nursery at CCAR in fall 2017/fall 2018.
- Our research activities continue as detailed in the proposal, with emphasis in the coming months on laver and other *Porphyra/Pyropia* development.

Bloodworms:

- A system based on 12 tanks (15 gal) with flow of 2 LPM/tank was established. Biofiltration is in place to control ammonia, and a tank in which amphipods are being cultured as food for the blood worms is operational. Frozen fish/squid pieces were tried as food after Phil Harrington Bait (Margaret Harrington, CEO) provided 580 bloodworms for the proposed trials in January. Bloodworms are predators, and this (dead) food choice did not support worms well. Kogson and Cottrell then collected wild amphipods for the IMTA set-up of food grow-out next to the bloodworm system. Bloodworms are being fed 3x week, and have been observed feeding on the amphipods. A blended mixture of fish and squid are also being offered to the bloodworms once a week. The proposed media tests are underway, and Kogson, Cottrell, Lindsay and Eddy will investigate additional food sources. The CCAR website (https://umaine.edu/cooperativeaquaculture/2016/12/29/bloodworms-find-new-home-ccar/) has news of the project posted as "*Bloodworms find a new home at CCAR*".

"Enhancing the forecasting value of the American Lobster Settlement Index to Maine's Coastal Economy"
Principal Investigator: Rick Wahle (Marine Science, UMaine)
Co-PIs: Brian Beal (Biology, UMM), Damian Brady (Marine Science, UMaine)
External Collaborators: Burton Shank (NOAA/NMFS)
Budget: $ 93,812 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Marine

Abstract: The goal of this proposal is to enhance and broaden the impact of the *American Lobster Settlement Index* (ALSI) as a stock assessment and forecasting tool for the US Northeast lobster fishery, the largest economic, and most geographically disbursed, sector of Maine's marine natural resource-based economy. Specific objectives of this work are (1) to integrate ALSI-based forecasting tools into the stock-wide assessment of the lobster fishery for the US Northeast, and (2) to optimize the design of a sampling tool that will widen the geographic coverage of ALSI monitoring to a broader habitat range, especially deep offshore lobster nurseries, which have not been systematically monitored to date.



Progress to Date - Engagement, Investment, Enhancement:

Objective 1 – Integrate ALSI-based forecasting tools into the ASMFC stock assessment: During spring/summer of 2016, co-investigator, Shank (NOAA/NMFS), initiated the process of incorporating the ALSI data base into the Atlantic States Marine Fisheries Commission (ASMFC) lobster stock assessment. Co-investigators Wahle and Brady have also been examining alternative versions of the ALSI-based forecasting tool that incorporate industry observations of growing numbers of sublegal lobsters in deep water, and build off current funding from Maine Sea Grant to further explore the question of expanded thermal habitat and deep water larval settlement.

Objective 2 - Optimizing the design of deep water lobster larval collectors: Co-investigator Beal is getting this objective under way during the spring of 2017 because of the need to time it with the summer larval hatching period. We will be engaging members of the fishing industry to deploy our experimental collectors. Two UMaine Machias undergraduates will be involved as interns during the summer of 2017 to assist with objective 2. The project is also supporting partial salary for a Research Associate in the Wahle lab to assist with the two objectives.

Media coverage, Outreach and Engagement:

- With Wahle as co-chair, UMaine is hosting the *International Conference and Workshop on Lobster Biology and Management*, Portland, June 4-9, 2017. Going since 1977, this is the largest and longest-standing meeting on lobsters in the world. See

www.11thicwl.com . US Senator Angus King will give the welcome address. Some 150-200 attendees are expected. Our lobster forecasting research will be presented in several talks by current and former UMaine graduate students (N. Oppenheim, A. Goode). The fourth day of the meeting is a dedicated *Industry Day* organized by lobster fishing industry members to focus on issues of interest to lobster harvesters, dealers and processors around the world. They include adapting to climate change, profitability, international trade.

- Our lobster forecasting research was featured on WCSH Channel 6 Portland on March 3, 2017 http://www.wcsh6.com/news/local/record-lobster-catch-announced-for-2016/419674458.
- Also, linked to our forecasting work is research on lobster age determination. This was recently picked up by the Associated Press on Feb 22, 2017: https://umaine.edu/news/blog/2017/02/22/mainebiz-reports-dmc-testing-technique-determine-lobsters-age/
- The forecasting work will also be a feature on the *Weather Channel* in the near future.

Proposals Funded and Pending since our RRF Seed Grant submission (Spring 2016):

Funded:

- Funding Agency: NOAA - Northeast Regional Sea Grant Consortium ($200,000)
- Funding Agency: NOAA-SK ($268,386)
- Funding Agency: NOAA-SK ($227,804)

Pending:

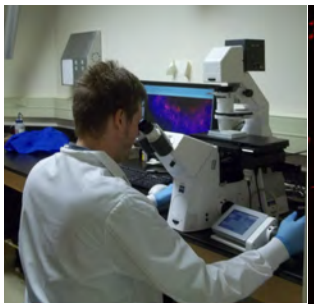
- Funding Agency: NOAA-SK ($244,000)
- Funding Agency: NOAA-COCA ($1,147,508)
- Funding Agency: NOAA-SK ($232,099)

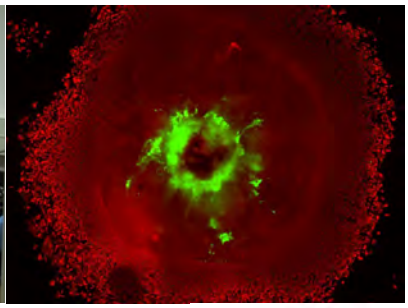
"Engineering cardiac tissues regeneration and repair"
Principal Investigator: Rosemary Smith (Electrical Engineering/ Laboratory for Surface Science & Technology, UMaine)
Co-PIs: Scott D. Collins (Chemistry/Laboratory for Surface Science & Technology, UMaine)
External Collaborators: Douglas Sawyer (Maine Medical Center Research Institute)
Budget: $ 99,980 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Biotechnology

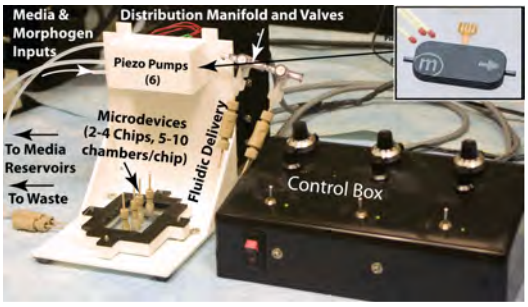
Abstract: Each year, nearly one million Americans have a heart attack (myocardial infarction, MI). Patient outcomes are highly variable, but all suffer some loss of cardiac function due to permanent tissue damage. This project is an interdisciplinary collaboration between the UMaine and Maine Medical Center Research Institute (MMCRI) that aims to develop cardiac tissue regeneration and repair strategies at the molecular and cellular level. This research initiative will apply recent advancements at UMaine in microsystems engineering to direct the differentiation of embryonic stem cells into complex spatially-organized tissue *in vitro*.

Notable Highlights to Date

- A collaborative research grant proposal with MMCRI was submitted to NIH AREA R15 program in October 2016 requesting $426,000, which will be reviewed in March 2017.
- Two PhD graduate students and one undergraduate engineering student are working on this project. One student is receiving trained at MMCRI in the handling and differentiating human embryonic stem cells.
- A jointly authored journal manuscript with MMCRI collaborator, Dr. Doug Sawyer, is in preparation, in which recent results obtained on differentiation of mouse stem cells into carodiomyocytes, using a novel method that employs a 3D cell culture matrix, will be published.
- A test apparatus has been designed and 3D printed, which supports multiple piezoelectric pumps to deliver controlled volume flow of reagents to microfluidic channels on a cell culturing microdevice. It contains six piezoelectric pumps, individually controlled via an electronic interface. The platform will be used in conjunction with microfluidic cell culturing devices to test the effectiveness of differentiation of stem and progenitor cells into cardiomyocytes, after exposure to a specific combination of bioreagents.







"The Maine forest ecosystem status and trends (forEST) app: Informing management and dynamic landscapes"
Principal Investigator: Erin Simons-Legaard (School of Forest Resources, UMaine)
Co-PIs: Kasey Legaard (School of Forest Resources, UMaine), Aaron Weiskittel (School of Forest Resources, UMaine)
External Collaborators: Dave Struble (Maine Forest Service), Ryan Hanavan (US Forest Service)
Budget: $ 75,748 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Forest Industry

Abstract: An intense outbreak of eastern spruce budworm expanding south from Quebec is without question a leading threat to Maine's forest economy. We propose to develop a web-based resource mapping system to support management and conservation decisions as outbreak conditions evolve. This system will enable the visualization and interpretation of high-resolution maps of forest and habitat conditions that will be updated annually from freely available satellite imagery using an innovative and nearly automated process. Initial implementation will include an interface providing visualization, navigation, and download of spatial data layers identified as critical to near-term budworm mitigation planning by forest managers.

Planned Economic Outcomes:

- Design and development of an interactive web mapping application called the Forest Ecosystem Status and Trends (ForEST) App and associated technologies
- Apply for the USFS Forest Health Monitoring Program and/or NASA's Applied Sciences Program
- Publication of map updating methods and analysis of current resource conditions and vulnerabilities

"Layer-by-layer Fabrication of Thermoelectric Films Using Nanoparticles to Yield High Efficiency Thermoelectric Generators for Marine Applications"
Principal Investigator: Carl Tripp (Chemistry/Laboratory for Surface Science & Technology, UMaine)
Co-PIs: Robert Lad (Physics/Laboratory for Surface Science & Technology, UMaine)
External Collaborators: Joshua Henry (Maine Maritime Academy) and METEL
Budget: $ 98,827 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Manufacturing

Abstract: Thermoelectric generators (TEGs) have attracted much interest because of their potential for converting waste heat from power sources to useful electricity. This technology is especially important for Maine's future marine industries, where energy recovery from on-board ship engine heat will improve drive efficiency and provide power for onboard electronics. A pilot study is proposed to develop the methodology for fabricating low-cost, highly efficient TE films using a simple layer-by-layer (LbL) deposition method that aims to yield nanoporous TE films consisting of bismuth telluride (BiTe) nanoparticles with high electrical / low thermal conductivity. Low-cost, commercially available BiTe powder raw material will be refined and processed to attain well-controlled nanostructure, and prototype TEGs will be produced/tested.

Notable Highlights to date:

- Methods to generate cationic and anionic Bismuth telluride nanoparticles (50 nm diameter) have been established.
- Experimental conditions leading to high electrical conductivity for pressed disks of the nanoparticles have been identified.
- Fabrication of prototype thermoelectric modules are in progress.
- One manuscript in preparation and 1 external grant submitted

Private Sector Engagement: Weekly meetings have been held with Marine Engine Testing & Emissions Laboratory (METEL) personnel. METEL is currently constructing a medium-speed, 1 MW diesel engine test facility at Maine Maritime Academy. Only one other public research facility in the United States has comparable facilities. Once online the engine will be capable of running the heavy fuels standard in the marine shipping industry and quantifying their performance both in terms of fuel efficiency and emissions. Researchers at LASST and METEL are incorporating heat exchangers into the exhaust stream of this engine to quantify the potential of thermoelectrics for harvesting 'waste heat' in real world applications.

Grants submitted: National Academy of Sciences: "Functionally Graded Thermoelectric Nanocomposites: Fabrication, Testing and Modeling. C. P Tripp, Y. Shabana R.J. Lad, J. Henry, Z.Jin 07/01/2017 - 06/30/2020 $396,312 Status: Pending

"A Novel Framework for Detecting and Assessing Spruce Budworm (SBW) Forest Defoliation over Maine"
Principal Investigator: Parinaz Rahimzadeh (Forest Resource, UMaine)
Co-PIs: Aaron Weiskittel (Forest Resource, UMaine), Peter Nelson (Biological Science & Environmental Studies, UMFK)
External Collaborators: David Maclean (University of New Brunswick), Daniel Kneeshaw (University of Quebec)
Budget: $ 62,993 Performance Period: 6/15/2016 – 7/31/2017
Economic Sector(s): Forest Industry

Abstract: This research is on developing a practical, rapid, and cost effective method to detect annual spruce budworm (SBW) defoliation in Maine at a broad spatial scale using advanced technologies in forestry. This will provide Maine forest industry with a lower cost, accurate and near real-time decision making tool for the expected SBW outbreak to mitigate economic loss. The results of this one year project will be used as the basis for a larger research proposal to be submitted to U.S. Forest Service Forest Health Monitoring funding program.

Notable Highlight to date:

Using this seed grant we were able to form a comprehensive research framework to study SBW infestation impact for Maine using advanced technologies in the field of satellite and aerial remote sensing. This designed framework will be our research focus for the next five years. The progress on "goals" and "required grant activities" are described below:

The overall goals of this project are to acquire, compile, and analyze the necessary remote sensing, geospatial layers, and other information needed. To address this, four main sets of data have been identified to be able to detect SBW defoliation accurately:

I. Remote seeing data divided into three categories as described in Section 2.1.
II. Information on forest phenology and pest phenology for Maine forests: (Fig. 2)
III. Recent map of Maine forest cover type: provided
Forest disturbance history update: We are working on this to produce the data for years 1990 to current using Landsat satellite data. We are working on other potential ancillary data that can be useful for our analysis.

Develop a sound framework based on multispectral satellite imagery that can be used for SBW defoliation detection in Maine: A framework was designed to develop methods to detect annual SBW defoliation extent and severity using multispectral sensors on three different scales:

I. SBW defoliation detection methods on Landscape scale using MODIS satellite imagery having 500 meter spatial resolution for SBW defoliation identification for landscape studies (Fig. 1). Four RS vegetation indices have been identified as the most efficient indices to detect defoliation (Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Normalized Difference Infrared Index (NDII5) and (NDII7) (examples are shown in Fig. 2). Pre-processing and calculation of time series of these indices have been automated in IDL.
II. SBW defoliation detection methods on regional scale to be used for forest planning and management on regional scale and also to be used in forest carbon stock, yield and damage modeling. Two moderate resolution satellite imagery (Landsat and Sentinel-2) will be applied on this scale.
III. Local scale methods of SBW damage detection using aerial imagery acquired by unmanned aerial vehicles system that will be designed and will used for SBW monitoring in Maine (see Section 2.2)

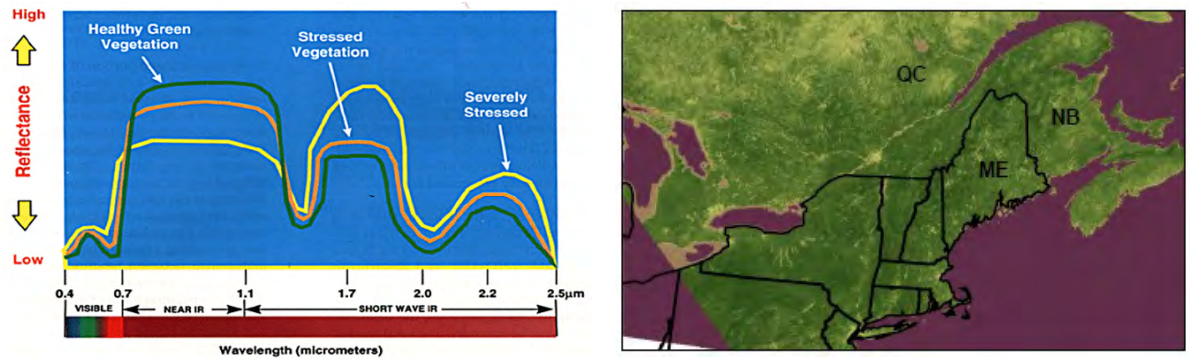


Fig.1 Left: Spectral signature of healthy and unhealthy vegetation (www.csc.noaa.gov/product/sccoasts/html/rsdetail.htm), Right: Map of MODIS 500m EVI (vegetation cover) for Maine and eastern Canada

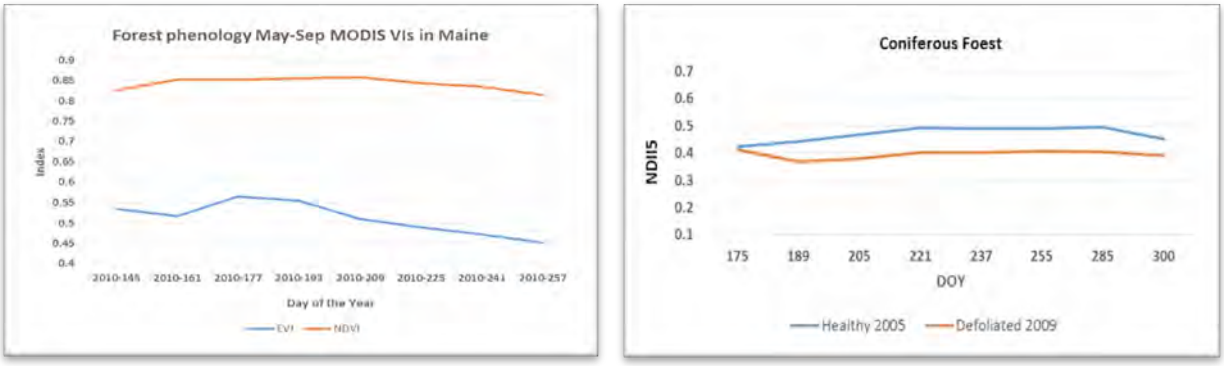


Fig. 2. Left: Vegetation phenology in a mixed forest in Maine, Right: Detecting spruce budworm defoliation in a coniferous forest using vegetation indices

Grant submissions: The results of this one year research project will be used as the basis for a larger research proposal to be submitted to U.S. Forest Service Forest Health Monitoring funding program. Two grants have been submitted to two larger research programs so far. We are anticipating to submit one more proposal by Nov. 2017 based on the results obtained from this Seed Grant activity. A proposal was submitted on Nov. 1st 2016 to the above mentioned program (Forest Service Forest Health Monitoring funding program) on addressing regional scale SBW defoliation estimation and mapping. RRF Seed Grant funds were used as the matching fund (4.5 months of the PI salary). Project title: An alternative/complementary cost-effective tool for Insect Disease Surveys of spruce budworm defoliation using satellite imagery". $78,623 requested+$78,626 cost share. A research collaboration formed between three UMaine Departments (Mechanical Engineering, Forestry and Electrical Engineering) to work on SBW research on local scale. A proposal was submitted to NASA-EPSCoR program On Dec. 18th 2016. The proposal title: "Health monitoring of Maine's forest resource using an autonomous lighter-than-air vehicle". $743,291requested +$743,291cost share.

APPENDIX II.E: Round 2 | Seed Grant Rubric

2016 Research Reinvestment Funds (RRF) Seed Grant Program

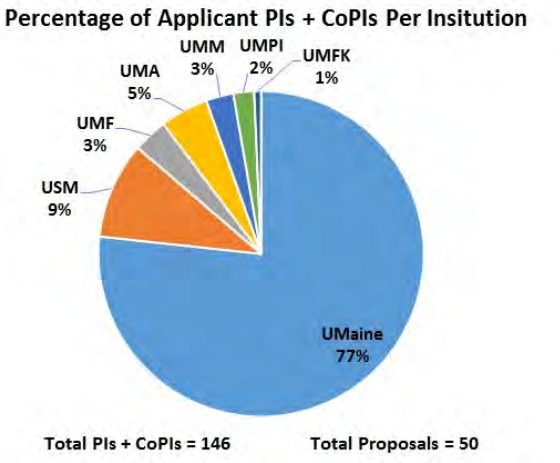
Evaluation Criteria

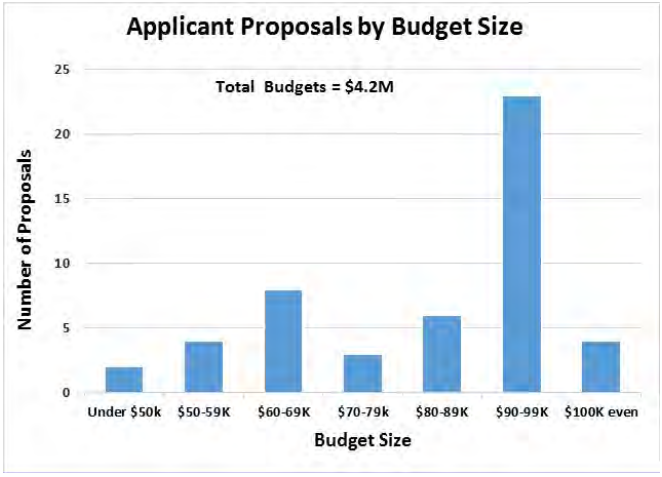
Intellectual merit: 25 POINTS	Poor: (0 POINTS)	Good: (15 POINTS)	Very Good:(25 POINTS)	Excellent(25 POINTS)	Score
Evaluation Criteria for Intellectual Merit	Proposed research unlikely to lead to completion of objectives; methodologies not well suited; poorly articulated hypotheses/research questions	Proposed research likely to lead to partial completion of objectives; methodologies suitable; some unresolved questions regarding the hypotheses/research questions	Proposed research likely to lead to completion of objectives; methodologies are suitable and well-reasoned; hypotheses/ research questions largely clear	High probability that the research will lead to completion of objectives; methodologies very well suited and reasoned; hypotheses/ research question clear and appropriate	
Relevance to Maine's economy 40 POINTS **Note: Proposals may address aspects of workforce development, economic development, or both. A maximum of 40 points will be awarded, irrespective of the workforce development/economic development approach taken**	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (40 POINTS)**	**Score**
Evaluation Criteria for Relevance to Maine's Economy-Workforce Development	No clear link of the proposed activities to Maine's economy. Likelihood of job creation, workforce training, internships, workforce development low	Proposed activities somewhat linked to Maine's economy. Likelihood of job creation, workforce training, internships, workforce development moderate	Proposed activities well linked to Maine's economy. High likelihood of job creation, workforce training, internships, workforce development	Proposed activities intimately linked to Maine's economy. Likelihood of job creation, workforce training, internships, workforce development very high	
AND/OR					
Evaluation Criteria for Relevance to Maine's Economy-Economic Development	No clear link of the proposed activities to Maine's economy. Likelihood of job creation, commercialization, licensing, technology, economic development low	Proposed activities somewhat linked to Maine's economy. Likelihood of job creation, commercialization, licensing, technology, economic development moderate	Proposed activities well linked to Maine's economy. High likelihood of job creation, commercialization, licensing, technology, economic development	Proposed activities intimately linked to Maine's economy. Likelihood of job creation, commercialization, licensing, technology, economic development very high	
Likelihood of additional funding 20 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (15 POINTS)**	**Excellent (20 POINTS)**	**Score**
Evaluation Criteria for Likelihood of additional funding	Proposed research unlikely to lead to external funding	Proposed research somewhat likely to lead to external funding; Targets lacking	Proposed research likely to lead to external funding; Targets given	Proposed research highly likely to lead to external funding; specific targets given	
Extent of Collaboration 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Extent of Collaboration	Proposal has no evidence of collaboration across the UMS and/or external partners, collaborations are not clearly linked to the proposed activities, roles and responsibilities are not clearly defined	Proposal has some evidence of collaboration across multiple campuses and/or external partners, collaborations are linked to the proposed activities, roles and responsibilities are somewhat defined	Proposal has good collaboration across multiple campuses and/or external partners, collaborations are well linked to the proposed activities, roles and responsibilities are defined	Proposal has strong evidence of collaboration across multiple campuses and/or external partners, collaborations are clearly linked to the proposed activities, roles and responsibilities are clearly defined	
TOTAL POINTS					

APPENDIX III: RRF Seed Grants | Round 3

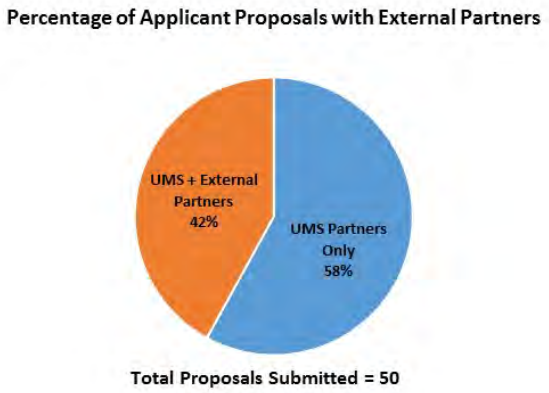
APPENDIX III.A: Round 3 | Seed Grant Applicant Data

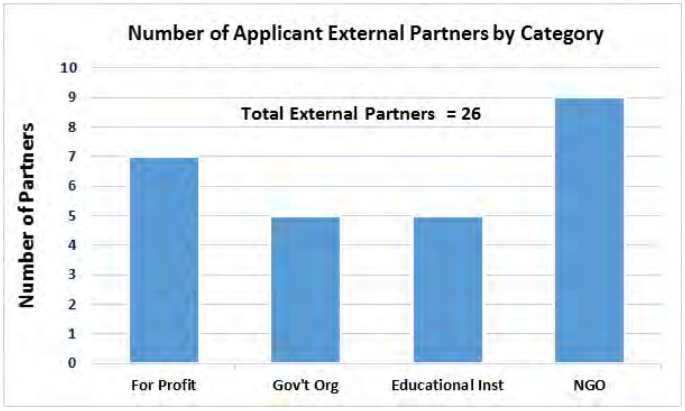
Proposal Data



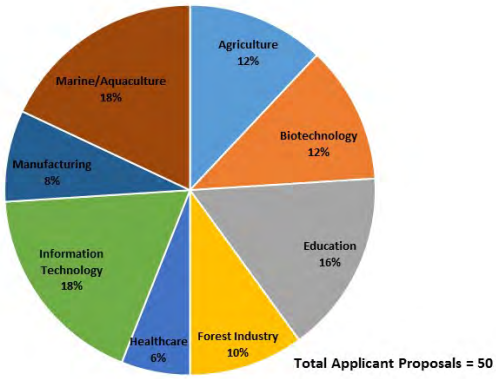


External Partner Data





Economic Sector Data



APPENDIX IV: RRF Planning Grants 2015-2017 | Rolling

APPENDIX IV.A: Planning Grants | Awardee List

Principal Investigator	Partners	Project Title
Lenard Kaye (Center on Aging, UMaine)	Carol Kim (Office of the Vice President for Research, UMaine)	University of Maine System-Wide Cross Campus Workshop in Aging Research
Heather Leslie (Marine Sciences, UMaine)	Paul Anderson (Maine Sea Grant, UMaine); Jake Ward (Economic Development, UMaine)	Building Campus and Community Connections to Advance Research Development and Communication for Maine's Marine Economy
Fei Chai (Marine Sciences, UMaine)	Joshua Stoll (Marine Sciences, UMaine); Ziwen Ye (Marine Sciences, UMaine)	Changing Seafood Economy: Understanding China's Increasing Appetite for Gulf of Maine Seafood
Yong Chen (Marine Science, UMaine)	Robert Boenish (Marine Science, UMaine); Jocelyn Runnebaum (Marine Science, UMaine)	Working Group on Incidental Catch and Discard Mortality of Groundfish in Gulf of Maine Fisheries
Janet Fairman (Education, UMaine)	James Artesani (Education, UMaine); Catherine Fallona (Education, USM); Pat Red (Education, USM); Brian Cavanaugh (Education, UMF)	Building a Collaborative Partnership to Support K-12 Educator Professional Development in Maine
Heather Leslie (Marine Sciences, UMaine)	Jake Ward (Economic Development, UMaine)	Planning for the Future of Shoreline Infrastructure of the Darling Marine Center to Enhance Capacity in Applied Marine Science Education
Aaron Strong (Marine Sciences, UMaine)	Damian Brady (Marine Sciences, Sea Grant, UMaine); Esperanza Stancioff (UMaine Extension, Maine Sea Grant, UMaine)	Dynamics of Ocean and Coastal Acidification in Coastal Maine: Assessing the Potential Risks to Livelihoods and the Economic Opportunities for Adapting to and Mitigating Acidification
Esperanza Stancioff (UMaine Extension, Sea Grant, UMaine)	Samuel Belknap (Climate Change Institute, Anthropology, UMaine); Aaron Strong (Marine Science, UMaine)	Addressing Emergent Threats to the Maine Lobster Fishery Through an Expanded and Improved Community-Based Systems Dynamic Model Co-Developed by Lobster Harvesters
Sandy Butler (Social Work, UMaine)	Marialla Passarelli (UMF); Tanya Sleeper (UMFK); and Venessa Patenaude (UMPI)	Strengthening Maine's Eldercare Workforce
Paul Anderson (Sea Grant)	Heather Leslie (Darling Marine Center); Brian Beal (UMM)	A Facilitated Process to Establish the Alliance for Maine's Marine Economy (AMME)
Ken Elliot (Social Sciences, UMA)	Amber Howard (UMA); Christopher Howard (Husson)	Strengthening Higher Education Pathways for Eldercare Providers: Undergraduates
Richard Wahle (Marine Sciences, UMaine)	Cathy Billings (Lobster Institute, UMaine)	11th International Conference and Workshop on Lobster Biology and Management

APPENDIX IV.B: Planning Grants | Awardee Abstracts & Updates

"University of Maine System-wide Cross Campus Workshop in Aging Research"
Principal Investigator: Lenard Kaye (Center on Aging, UMaine)
Co-PIs: N/A
External Collaborators: N/A
Budget: $ 5,000 Performance Period: 7/01/2015 – 8/31/2016
Economic Sector(s): Aging, Health Care, Recreation/Leisure, Technology and Information Systems

Abstract: The UMaine Center on Aging (CoA), in conjunction with the Office of the Vice President for Research (OVPR), proposed to convene a one-day System-wide workshop for 50-75 faculty on August 25, 2015 for the purpose of growing an inter-campus collaborative network in aging and technology research . A System-wide initiative will be advanced that engages cross disciplinary and inter-professional faculty for the purpose of building expertise across the UMS. A major aim of this initiative is to expand team-based research inquiry into technologies, products, and programs that respond to the economic and workforce expansion opportunities created by Maine's distinction of having the oldest populace in the nation.

Notable Highlights:
UMaine spearheaded the *August 2015 Aging Symposium* in Orono to leverage expertise from UMS campuses as well as external partners from across the state. All seven UMS campuses were represented and faculty from multiple academic areas met to discuss emerging opportunities in addressing Maine's rural-aging phenomenon. This symposium was the inaugural event of the *UMS Aging Initiative.* Under the direction of Vice President for Research Dr. Carol H. Kim, nearly 100 UMS researchers have committed to collaborate to promote aging research collaborations between and among UMS campuses. Since the symposium, the UMS Aging Initiative accomplished the following:

- 7 different private sector assisted living and continuing care retirement communities have committed to serving as community beta testing sites for UMaine aging initiative R&D devices and products under development (smart mattress pad, three-wheeled standing support device, edge protection device, protective head gear, hip protection system, indoor navigation wireless networking technologies, driving simulator). In particular, a formal business partnership is being actively developed with the Good Shepard Rehabilitation and Nursing Center (Jaffrey, NH) to explore commercial opportunities.

- *The ElderTech Collaborative*, a business partnership between the UMaine Center on Aging, Phillips-Strickland House Corporation, and Elder Technology Labs, a private sector, Maine-based start-up is being developed.
- *The Aging-in-Place Services Suite Partnership*, a collaborative service enterprise including private sector engagement leading to the offering of a suite of aging-in-place services designed to assist older adults discharged from both inpatient and outpatient settings in making successful transitions back to their homes is under development

- Three NIH R-21 applications have been prepared and submitted that include private sector engagement (the total requested funding for all 3 grants is approximately $1.2M).
- Two NIH/AHRQ applications (R-18 and R-15) are under development scheduled for May/June 2017 submission that include broad engagement of academic and community sector engagement (the total requested funding for the 2 grants is approximately $1.9M)
- The *Eco-Sno Co-Design Project* brings together aging initiative faculty from the Center for Community Inclusion and Disability Studies, the Center on Aging, the University of Maine at Farmington, and Machias and the R.M. Beaumont Corporation and other external commercial partners to advance R&D of 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. An RRF application in the amount of $87,533 is currently pending.

  A proposal for advanced hip protection as a Phase 1 SBIR proposal is under development. This project brings together aging initiative faculty at UMaine (mechanical engineering, social work and the Center on Aging) and commercial partner Alba-Technic. An NIH SBIR application is currently under development.
- A proposal titled: Sensor Development/Adaptation to Improve Healthcare, A Collaboration Between The University of Maine System and Saint Joseph's Hospital has the goal of developing a working relationship between University of Maine System (UMS) researchers in engineering, social work, and business and Saint Joseph's Hospital (SJH) physicians and their associates to develop/adapt sensors to detect/monitor diseases and/or medical conditions to improve the healthcare of the public. An RRF application is currently pending.
- *An REU Site application entitled Smarter Homes for Aging Research Programs* would have brought together UMaine aging initiative faculty in engineering, psychology, social work, computing and information sciences, in partnership with California State University at Long Beach. This application was not funded but will be revised and resubmitted.
- A Maine EPSCoR FY19-24 NSF RII Track Concept Paper titled *Successful Aging for*
- *Independent Living* that brings together aging initiative faculty from UMaine, USM, Farmington, Machias, Fort Kent, Presque Isle, UMA, and UNE to pursue develop technologies to assist elders to age and thrive in the workforce, and in their homes, and thus to retain independence into their later years. This concept paper is currently pending.

"Building Campus and Community Connections to Advance Research Development and Communication for Maine's Marine Economy"
Principal Investigator: Heather Leslie (Marine Science, UMaine)
Co-PIs: Paul Anderson (Maine Sea Grant, UMaine), Jake Ward (Economic Development, UMaine)
External Collaborators: N/A
Budget: $5,000 Performance Period 10/01/2015 – 9/30/2016
Economic Sector(s):

UMaine marine sciences student Antonia (Toni) Barela working out of a Darling Marine Center research skiff. Toni conducted research in partnership with shellfish growers in summer 2016.

Abstract: We will convene UMS researchers, marine industry professionals, and stakeholders statewide to assess industry needs and identify a cohesive set of capital investments. Based on this collaborative deliberation, we will write and submit a unified funding proposal to the State of Maine Department of Economic & Community Development that addresses the Maine's Marine Economy and Jobs Bond priority: "…to facilitate the growth of marine businesses and commercial enterprises that create jobs and improve the sustainability for the State's marine economy." Only one $7,000,000 grant will be awarded statewide to the winning proposal that presents a well-conceived, 10-year strategic initiative.

Planned Project Outcomes:

- Identify and conduct meetings with a team of collaboratively minded individuals who are knowledgeable about commercial fishing, aquaculture, and value-added seafood processing
- Submitting a competitive proposal in response to the RFP "Maine's Marine Economy and Jobs Bond" that outlines capital investments, distributes benefits across multiple sectors, and has a transformative impact on the sustainability of Maine's marine economy.
- At least two other grant submissions to NSF, NOAA, USDA/NIFA, MTAF, SBIR/STTR and/or private philanthropy.

Notable Highlights:

In October 2015, University of Maine gathered leaders from the Maine's fishing and aquaculture industries, together with researchers from across the University of Maine System, at the University of Maine Darling Marine Center. The goal of the workshop was to envision a new way of working together, one that leveraged the talents of the institutions represented at the table. Timing was critical. In 2014, voters approved $7 million in state bonds to support of infrastructure investments in Maine's marine economy. In August 2015, state officials requested proposals on how to best use these funds to "facilitate the growth of marine businesses and commercial enterprises that create jobs and improve the sustainability of the State's marine economy and related industries through capital investments." The fall 2015 gathering, which was funded by a planning grant from the UMS Research Reinvestment Fund, resulted in a proposal that included more than 20 public and private sector partners. Led by the University of Maine, the proposal outlined how this new collaboration would catalyze targeted infrastructure investments that facilitate business development, accelerate product innovation, assess and prevent risks to resource health, and forecast changes in marine product supply.

And so, the Alliance for Maine's Marine Economy was born. It developed further when the University of Maine-led group was awarded the state bond contract in May 2016. Alliance partners have since gathered to affirm their commitment to the collaboration. They

have also begun to develop an associated grant program, which will target small and medium-sized marine businesses.

Alliance members bring more than $7.7M in matching funds to the capital investments, which will begin this year. As part of this investment, the UMS committed $1.8M in internal funds for upgrades to the laboratories at the University of Maine's Darling Marine Center and the sister lab at the Downeast Institute, which also serves as the marine field station for the University of Maine at Machias. In addition, a Biosafety Level 3 aquatic laboratory will be added to the Plant and Insect Disease Facility near the Orono campus. Other recipients of bond funds include Bigelow Laboratory, Cooke Aquaculture, Maine Fair Trade Lobster, and Cape Seafood.

Seaweed farmers Sarah Redmond and Seth Barker use UMaine's Darling Marine Center to access their crops in nearby Clarks Cove. Redmond, in her previous position as an extension agent with Maine Sea Grant, utilized UMS laboratory facilities throughout the Maine coast.

The Alliance's founding partners have identified additional projects and contracts estimated to attract another $50M of additional private sector and federal grant dollars to the marine economy over the next 10 years. Together, this evolving portfolio of investments in infrastructure, research and development, and workforce capacity will ensure that Maine marine industries are able to innovate and adapt their businesses as new opportunities and challenges emerge.

Founding partners of the Alliance include the University of Maine System (including the following UMaine entities: Darling Marine Center, Maine Sea Grant, School of Marine Sciences, Aquaculture Research Institute, Cooperative Extension, School of Food and Agriculture, Lobster Institute & the Office of Innovation and Economic Development and the UM-Machias and the UM-M marine field station at the Downeast Institute for Applied Marine Research & Education), and Gulf of Maine Research Institute, Cape Seafood, Bigelow Laboratory for Ocean Sciences, Coastal Enterprises, Inc., Maine Aquaculture Innovation Center, Maine Aquaculture Association, Island Institute, Penobscot East Resource Center, Maine Lobster Dealers' Association, Maine Lobstermen's Association, Downeast Lobstermen's Association, Downeast Institute, Maine Fair Trade Lobster, and Cooke Aquaculture.

"A changing Seafood Economy: Understanding China's Increasing Appetite for Gulf of Maine Seafood"
Principal Investigator: Fei Chai (Marine Sciences, UMaine)
Co-PIs: Joshua Stoll (Marine Sciences, UMaine); Ziwen Ye (Marine Sciences, UMaine)
External Collaborators: N/A
Budget: $ 4,985 Performance Period: 11/01/2015 – 6/30/2017
Economic Sector(s): Maine Fisheries, Seafood Processors and Distributors

Abstract: The purpose of this planning initiative is to develop a proposal to study the factors that are reshaping the seafood trade dynamic between the US and China, with a particular emphasis on Maine exports. This research is motivated by a recent federal policy decision that encourages seafood trade to China and, in Maine, the surge of seafood exports. In understanding the socioeconomic and cultural drivers behind this economic frontier, we aim to help Maine's seafood industry navigate this uncertain transition and anticipate future market shifts.

Planned Project Outcomes:

- Conduct preliminary scoping trip to southern China to meet and make connections with key informants in the industry, government, and academic sectors;
- Define core research questions based on exploratory trip and continued discussion with collaborators in China and the US;
- Develop a UMS RRF Seed Grant proposal and establish a partnership with NOAA Fisheries Office of International Affairs by way of a Cooperative Institute for the North Atlantic Region (CINAR) agreement;
- Work with the Continuing Education program to develop a complementary travel course, open to the fishing industry and all UMS campuses.

Notable Highlights to date:

- We completed a 14-day scoping trip to five cities in China. We went to 5 fish markets (Aberdeen Fish Market (HK), Yantian Seafood Market (SZ), Huangsha Seafood Market (GZ), Bashi local market (XM), and Tongchuan Seafood Market (SH)) and 3 university campuses, meeting with more than 20 fisheries experts.

- Our research team gave seminars at City University and Xiamen University, describing the scope of our project.

- We met with the Maine Lobstermen's Association, NOAA Fisheries Office of International Affairs, and several other relevant organizations/agencies to report back on our trip.

- Results of this project were presented at the School of Marine Sciences' annual symposium at the Darling Marine Laboratory.

- This project is being leveraged by Co-PI Stoll to work with collaborators at the Royal Swedish Academy of Sciences in Stockholm to conduct an analysis of global lobster trade.

- The director of the Lobster Institute has encouraged us to present our work at their US-

Canada lobster meeting.

- We will be providing a presentation on our work at the Industry Day associated with the International Conference and Workshop for Lobster biology and Management (http://www.11thicwl.com/) on June 4-7 (2017) in Portland, ME.

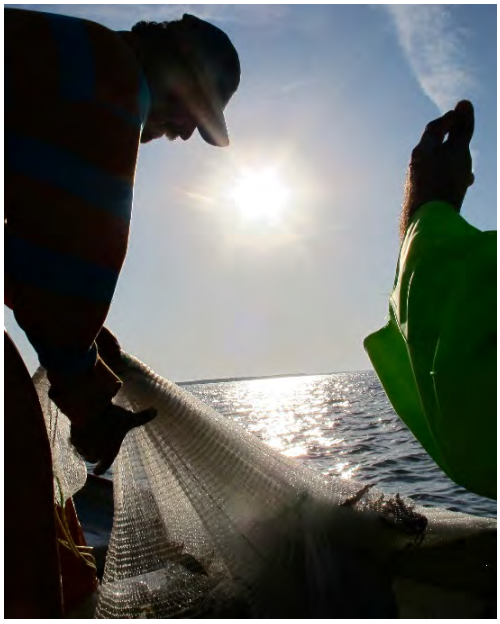
- We assisted with the organization of a workshop session related to market diversification called “Maine Seafood for Maine People” at the Maine Fishermen’s Forum on March 4, 2017 in Rockport, ME.

"Working Group on Incidental Catch and Discard Mortality of Groundfish in Gulf of Maine Fisheries"
Principal Investigator: Yong Chen (Marine Science, UMaine)
Co-PIs: Robert Boenish (Marine Science, UMaine); Jocelyn Runnebaum (Marine Science, UMaine)
External Collaborators: N/A
Budget: $4,610 Performance Period: 12/01/2015 – 3/31/2017
Economic Sector(s): Fisheries, Coastal Communities

Abstract: Groundfish (e.g. Cod, cusk, halibut) stocks in the Gulf of Maine (GOM) currently are at or near historically low population levels. Fishery closures and reductions of quota have caused the loss of thousands of fisheries jobs and stressed Maine's coastal economies. Recently there has been a surge of innovative fisheries research from a small collection of institutions in the Northeast, all independently directed at solving parts of this fisheries crisis. Fish stock rebuilding will depend on collaboration from the entire spectrum of stakeholders. We proposed and held a meeting of these institutions with industry leaders to form a working group to address this issue.

Planned Project Outcomes:

- The formation of a sustainable working group that communicates regularly and meets annually
- The working group cohesively working toward securing large multi-institutional grants to further research. Specifically, the working group could be very competitive for the NOAA Coastal SEES coastal ecosystem grant. The scope of this award involves 3-5 years of funding and awards $800,000-$2,000,000.
- The working group will contribute to the field by publishing findings in peer-reviewed journals.



Notable Highlights to date:

- Assembled a multi-institutional Working Group (WG) and held our first meeting.
- Members of our WG include representation from New England Aquarium, UMass Dartmouth, UMass Boston, University of New England, NOAA fisheries, Mass DMF, and industry.
- Produced a 13 page meeting report and disseminated it to all members of the WG
- Attracted 23 participants attending, ranging from research scientists, to graduate students, state officials, and industry.
- In addition, we placed a particular focus on student involvement by reaching out to some standout graduate students from the aforementioned institutions to help facilitate discussion for a portion of the day dedicated to developing new problem solving strategies related to bycatch and discards.
- The meeting has precipitated novel collaborations and grant proposals (pending).

- Graduate students, Runnebaum and Boenish have had articles featured in the Lobster industry publication *Landings* outlining results of recent bycatch work.
    - URLS:
        - http://mlcalliance.org/2017/02/08/cod-are-tougher-than-you-think/
        - http://mlcalliance.org/2017/02/06/cusk-bycatch-research-important-to-maine-lobster-fishery/

- Presentation and dissemination of preliminary cod and cusk bycatch studies to the Maine Lobstermen Association and Marine Department of Marine Resources in Fall, 2016.

- We have developed the collaborations with Dr. James Sulikowski of the University of New England during his attendance of the workshop and are in the stage of developing a joint proposal for studying cod discard mortality and its management implications.

An incidentally caught Cusk in a lobster trap.

Photo Credit: Jocelyn Runnebaum

Building a Collaborative partnership to Support K-12 Educator Professional Development in Maine"
Principal Investigator: Janet Fairman, Associate Research Professor, COHED, UM-Orono
Co-PIs: James Artesani, Professor of Special Education and Associate Dean of Graduate Education, Research, and Outreach, COEHD, UM-Orono, Courtney Pacholski, Lecturer, Special Education, COEHD, UM-Orono, Catherine Fallona, Professor of Education, School of Education and Human Development, USM, Pat Red, Lecturer, Special Education, School of Education and Human Development, USM, Brian Cavanaugh, Assistant Professor of Special Education, Dept. of Special Education, UM-Farmington
External Collaborators: Joint Standing Committee on Education and Cultural Affairs in the Maine State Legislature
Budget: $3,026 Performance Period: 01/11/2016 – 6/30/2016
Economic Sector(s): STEM Education, Professional Development, Improving K-12 student academic outcomes

Abstract: This proposal seeks to develop a collaborative partnership to strengthen the state's capacity to support K-12 educator professional development. More effective teaching will improve student learning outcomes, which will have long-term economic impacts for the state. Better prepared high school graduates will have stronger skills for work and improved readiness for post-secondary education and careers that pay good wages. Higher-performing schools can help make Maine even more attractive for in-migration and for investors seeking a skilled workforce for new business start-ups or expansions. Better employment opportunities can reduce "brain drain" and keep young workers in Maine.

Planned Project Outcomes:

- Plan for submission of a seed grant proposal and pilot project
- Provide a written report of progress toward the goals and outcomes at the completion of the planning grant and planned work after the grant.

Notable Highlights:
The immediate and proposed goals for the planning grant were achieved. The long-term goals of securing more funding through a seed grant, additional state funding, and external grants were not yet realized. The ultimate goal was to improve professional efficacy of educators, which should help produce better student outcomes, which are correlated with benefits to the state economy. Specific activities conducted during this project were:

- Inter-campus collaborative team development—
  The project team built on a pre-existing collaboration of three faculty members across three UMS campuses that had worked together in the field of special education. This project added three additional faculty: Drs. Fairman and Fallona from UM and USM respectively and Courtney Pacholski of UM.

- Building relationships with Maine Dept. of Education (MDOE) staff and state legislators

  Presentations to the Joint Standing Committee on Education and Cultural Affairs in the Maine State Legislature were conducted in spring 2015, spring 2016, and another is planned for spring 2017. Collaboration on a statewide project through Maine Dept. of Education began in fall 2015 and is continuing. This brings additional professional development to Maine schools.

Dates and presentation titles:

- 2/20/15: Fairman and Artesani of UMaine met with Education Committee co-chairs to present their "Proposal for Professional Development Collaborative"
- 3/30/15: Fairman, Artesani, and Boody of UMaine brief the Education Committee on "Evidence-based Professional Development Practices"
- 2/18/16: Fairman and Artesani of UMaine brief the Education Committee on their work on a MEPRI report "Using Evidence-Based Criteria for Block Grant Funding of Collaborative Time for Educator Professional Development"

- Building relationships with school district leaders
  Focus group meetings and discussions with district curriculum coordinators from one region in Maine were conducted in Jan. 2016. In addition, focus group meetings and discussions with district curriculum coordinators and superintendents from three regions were conducted in Maine in May 2016. An online professional development needs assessment survey of district leaders from three regions in Maine was also conducted in May-June 2016.

  Regional meeting dates and attendees:

  - 5/9/16: Central Maine group, 12 districts attended (see appendix for agenda)
  - 5/13/16: Western Maine group, 8 districts attended
  - 5/20/16: Southern Maine group, 12 districts attended

- Development of a seed grant proposal and Identification of grant funding
  We collected and analyzed data collaboratively and used this to inform our development of a draft proposal for a seed grant application. From this, we searched for and identified some potential sources for external grants to fund this type of work in the future.

"Planning for the Future of Shoreline Infrastructure of the Darling Marine Center to Enhance Capacity in Applied Marine Science Education"
Principal Investigator: Heather Leslie (Marine Science, UMaine)
Co-PIs: Jake Ward (Economic Development, UMaine)
External Collaborators: Shep Erhardt (Maine Coast Sea Vegetables), Patrice McCarron (Maine Lobsterman's Association)
Budget: $5,000 Performance Period: 4/01/2016 – 5/31/2017
Economic Sector(s): Marine Technology, Aquaculture/Food Production, Fisheries

Abstract: Researchers, industry professionals, and other stakeholders will meet to assess current and future needs for shoreline infrastructure at the Darling Marine Center (DMC), within the context of the University of Maine (UMS) system. As UMaine's marine laboratory, the DMC is a vital platform for applied marine research, workforce development, and K-20 education for the state and nation. To complement the strategic and master planning underway at the DMC, we propose to focus explicitly on shoreline infrastructure so as to ensure appropriate development and access to the facilities needed to conduct cutting-edge, industry-relevant research and education.

Planned Project Outcomes:

- Conduct a needs assessment in collaboration with research, education, industry and community representatives
- Identify potential funding for research infrastructure
- Establish contract with Pine Tree Engineering to develop three alternative for a future pier and associated shoreline infrastructure
- Draft a plan to secure funding for the shoreline infrastructure project
- At least two grant submissions are expected as an outcome

Notable Highlights:

In late February 2017, the Economic Development Administration (EDA) of the US Department of Commerce invited University of Maine to submit a Phase II proposal to support improvements at UMaine's marine laboratory, Darling Marine Center (DMC). The purpose of the EDA project is to strategically enhance the DMC waterfront infrastructure via three integrated construction projects: 1. Upgrades to the DMC's flowing seawater system and pumphouse; 2. Renovation of the flowing seawater laboratory; and 3. Replacement of the DMC pier.

A planning grant from the Research Reinvestment Fund (RRF) enabled DMC Director Heather Leslie and UMaine Vice President for Innovation and Economic Development Jake Ward to

Stakeholder meeting at the Darling Marine Center

pursue this opportunity. If successful, this EDA project will leverage $1.5M in non-federal funds and bring an additional $1.5M in EDA funds to midcoast Maine. With RRF funds, Leslie and Ward conducted a needs assessment and worked with engineers and DMC stakeholders to develop conceptual alternatives for the DMC pier in particular. This was a time-sensitive task, as 50 years' of use and corrosion led to the closure of the pier in August 2016.

Participants in the needs assessment included faculty and staff from UMaine, University of Maine at Machias, University of Southern Maine, and University of Maine at Farmington. Private sector users, including shellfish and seaweed farmers, also participated, affirming the importance of the DMC for their businesses. These activities culminated in the presentation of a replacement pier concept design to UMaine leadership by Appledore Marine Engineering in February 2017. Replacement of the DMC pier, and renovation of the flowing seawater laboratory and associated flowing seawater system, will enable expanded collaborative training and applied research, product development and business incubation activities at the DMC. These infrastructure investments will enable the DMC to build on its long tradition of supporting Maine's shellfish aquaculture and commercial fishing industries.

DMC researchers are generating knowledge critical to sustaining the thousands of marine resource-dependent jobs in Maine in traditional fisheries, aquaculture, and tourism, as well as in emerging sectors like biotechnology and offshore energy development. Faculty from UMaine and other institutions also use the DMC for workforce development programs related to Maine's marine economy, through both K-12 programs as well as university and professional level courses. Finally, the investments will enable the DMC to continue to support, and ultimately to expand, its business incubation program. In partnership with industry, DMC-based researchers are developing new value-added marine products, including methods for glass eel grow out, scallop farming, and sea vegetable culturing.

Engineering assessments of the DMC pier revealed extreme corrosion

Thanks to the RRF, UMaine and partners were able to move rapidly to address infrastructure challenges at this important facility and work collaboratively with industry and community partners to envision expanded opportunities for Darling Marine Center to contribute to health of Maine's marine economy and coastal communities and the marine ecosystems on which they depend. Staff in the Grant Development Office supported by RRF funds are providing grantwriting and proposal submission support for the Phase II proposal to EDA due 3/31/2017.

"Dynamics of Ocean and Coastal Acidification in Coastal Maine: Assessing the Potential Risks to Livelihoods and the Economic Opportunities for Adapting to and Mitigating Acidification"
Principal Investigator: Aaron Strong (Marine Sciences, UMaine)
Co-PIs: Damian Brady (Marine Sciences, Sea Grant, UMaine); Esperanza Stancioff (UMaine Extension, Maine Sea Grant, UMaine)
External Collaborators: N/A
Budget: $5,000 Performance Period: 5/01/2016 – 6/01/2017
Economic Sector(s): Marine, Aquaculture/Food Production, Fisheries

Abstract: Ocean and coastal acidification (OCA) is an emergent, potential threat to the communities and livelihoods of coastal Mainers. Building on the work of a recent state commission's study of the problem, we propose to convene a multi-disciplinary group of interested social and natural science researchers to develop and advance a comprehensive, applied research agenda focused on OCA in Maine. Specifically, the goal of this meeting is to produce an NSF Coupled Natural-Human Systems grant proposal that will focus on both advancing modeling and coastal monitoring to gain key insights into the dynamics of OCA, and increasing the resilience of aquaculture and fisheries to OCA in Maine.

Planned Project Outcomes:

- Conduct a two-day Research Symposium and Planning Meeting at the Darling Marine Center
- Plan to submit a grant proposal to NSF's Dynamics of Coupled Natural-Human Systems Program
- Plan to submit two additional proposals (NOAA Environmental Literacy Grant Program; NCEAS/TNC Science for Nature and People Partnership Working Grouped Award)
- Publication of conference report as a comprehensive review in a high impact journal e.g., Marine Policy
- Explore the incubation of businesses focused on mitigating OCA.

Notable Highlights:

With support from the RRF Planning Grant, we convened a two-day set of meetings in June 2016, including a full-day Symposium in Portland, ME and a research planning workshop at the UMaine Darling Marine Center the following day. The June 29th 2016 Maine Ocean and Coastal Acidification Symposium in Portland was a highly successful event, and was a touchstone moment for the community of scientists, marine industry representatives and state environmental managers working on addressing the economic and environmental impacts of this problem in Maine.

The Symposium was attended by over 100 people, including Maine oyster growers, lobstermen, scientists from around the state, the region and the country, numerous federal, state and local officials, NGO representatives, and interested members of the Maine public. Active participants included federal NOAA Ocean Acidification Program Director Libby Jewett, the lead OA scientist of EPA Region 1, Matt Liebman, and representatives from Global Ocean Health, a Washington-based NGO, as well as Dr. George Waldbusser, an active participant in west-coast initiatives to save oyster hatchery jobs, who flew in from Oregon.

The goal of the Symposium was to highlight progress on implementation of the goals and recommendations of the 2014 Maine legislative study commission on OA, to provide a comprehensive state "update" of progress on OA and to initiate a conversation about how to keep moving forward to advance progress on this issue. Sessions were structured around the 6 goals of the 2014 OA Report, and featured talks by UMaine faculty Aaron Strong, Damian Brady, Larry Mayer, and Rick Wahle, post-docs and students, Matt Gray and Jes Waller, and by University of New Hampshire's Joe Salisbury, and UMaine-Machias' Brian Beal. The keynote

address was given by Bob Steneck. Additional presenters included Maine's Department of Environmental Protection's Marine Waters lead (Angela Brewer), managers at Portland Water District (Scott Firmin), and the Director of the Casco Bay Estuary Program (Curtis Bohlen). The meeting was covered http://munjoyhillnews.net/ocean-acidification-threat-workinprogress/. The outcome of the Symposium was the production of a comprehensive update report, which was released and made available to the public, including being shared directly with Symposium participants and interested policymakers and scientists. This "Progress Report" represents a synthesized product from the meeting and a complement to the 2014 Legislative Commission's Report.

The following day, a smaller group of researchers met at the Darling Marine Center to discuss plans to develop proposals for a vulnerability assessment of ocean acidification in the state and for expanding monitoring and citizen science programs. Workshop participants included Aaron Strong, Damian Brady, Esperanza Stancioff, George Waldbusser, Larry Mayer, Rick Wahle, Joe Salisbury, Curtis Bohlen, and the Island Institute's Heather Deese and Susie Arnold. The group advanced discussions about key research needs relevant to connecting OA science to coastal communities and mapped out a series of key research questions and hypotheses related to the vulnerability of coastal communities to ocean and coastal acidification in the state. The workshop primarily centered around brainstorming a set of guiding research questions to be used in future proposals.

Proposal Submissions

The series of workshops and meetings has directly led to a series of internal and external funding proposals. Most directly was the $700,000 proposal from UMaine PIs Strong, Brady, Mayer and Townsend along with UNH PI Salisbury and Mike Doan from Friends of Casco Bay and Sarah Gladu from the Damariscotta River Association for a Maine OA vulnerability assessment submitted to a NOAA Ocean Acidification Program. The research proposed developed directly out of the discussions at the June 30 2016 workshop. A pre-proposal submitted in November was encouraged for full proposal submission. Vulnerability assessments *involve producing actionable information about the future economic impacts (#s of jobs and $)* from ocean acidification impacts on Maine's coasts. The full proposal was submitted in January 2017. Secondly, a 2017 NSF Dynamics of Coupled Natural and Human Systems proposal for $1.5 million will also be submitted later this year. Both of these proposals *directly involve partnerships with community stakeholders, including commercial oyster growers and commercial clammers.* Additionally, PIs Strong and Stancioff have submitted a NOAA mini-grant proposal ($10,000) and a UMaine Mitchell Center Sustainability Research Grant ($50,000) for citizen science training for OA monitoring, in partnership with NOAA and EPA, an opportunity which grew directly out of the conversations and networks that came together from the symposium and workshop funded by the RRF Planning-funded. PIs Strong, Brady and Stancioff have also submitted RRF proposals for support for graduate and undergraduate student assistantships to continue work on advancing our understanding of Maine's coastal and ocean acidification management and the impacts of ocean chemistry changes on

Figure 1 Maine Ocean and Coastal Acidification Mini-Symposium, November 15, State House in Augusta with representatives from Maine's oyster industry, lobstermen, scientists, state agency representatives, NOAA and EPA representatives.

Maine's coastal communities.

Subsequent Events and Proposal Submissions

The two events in late June – supported by the RRF Planning Grant – have also initiated a wave of subsequent events, meetings and research proposals on how best to manage ocean acidification in Maine. One of the outputs of the June 29th meeting was a plan to convene more frequent symposia in the state to present updates and organize discussions focused on particular subsets of issues. On November 15, 2016, the same group that formed to organize the June symposium organized a full-day meeting at the state house in Augusta to discuss experimental work using kelp aquaculture for OA-remediation and to discuss future OA-policy directions in the state, including the potential development of water quality criteria. A photo from this event, attended by representatives from NOAA, EPA, DMR, DEP, Maine coastal Program, as well as numerous state legislators, is included in this report. The event was covered by the Associated Press and published in San Francisco Chronicle, Houston Chronicle, the Washington Times and other newspapers. As a result of this event, RRF Planning Grant PI Aaron Strong was invited on January 17, 2017 to present to the Maine Coastal Caucus, a bipartisan group of state legislators from coastal communities, to discuss current knowledge about OA impacts on Maine's coastal economy. Finally, PI Strong presented at the 2017 Aquatic Sciences Meeting in Hawai'i on March 1, 2017 about Maine's unique approach to ocean and coastal acidification management.

Economic Impacts of Work

One of the most salient outputs of the RRF Planning process has been to identify a framework for assessing the economic vulnerability of Maine's coastal fisheries to ocean and coastal acidification. Vulnerability assessments to ocean acidification have been performed for the scallop fishery in the Gulf of Maine and for Alaska's fisheries and are being used increasingly in driving fishery management decisions and coastal resource management decisions. Legislators in Maine have asked for information on the economic risks of our coasts to ocean and coastal acidification and, thanks to the RRF Planning Grant, we are now in a position in this state to create a socioeconomic vulnerability assessment for Maine's shellfisheries to ocean and coastal acidification.

"Addressing Emergent Threats to the Maine Lobster Fishery through an Expanded and Improved Community-Based Systems Dynamic Model Co-Developed by Lobster Harvesters"
Principal Investigator: Esperanza Stancioff (UMaine Extension, Sea Grant, UMaine)
Co-PIs: Samuel Belknap (Climate Change Institute, Anthropology, UMaine); Aaron Strong (Marine Science, UMaine)
External Collaborators: N/A
Budget: $4,942 Performance Period: 8/01/2016 – 9/29/2017
Economic Sector(s): Marine, Fisheries

Abstract: Maine's iconic lobster fishery, providing 81% of Maine's marine resource income (DMR 2015), faces the dual threats of an aging generation of lobstermen and a rapidly changing Gulf of Maine. Building on recent work that brought together lobster harvesters, researchers, and managers to develop climate change scenarios to help improve management actions, we propose to convene a multi-stakeholder workshop to further expand develop and refine a community based system dynamics (CBSD) computer model that addresses these two threats to the Maine lobster fishery. Specifically, our workshop will form a new leadership collaborative for CBSD model expansion and development focused on increasing the flexibility in the fishery.

Planned Project Outcomes:

- Conduct two single day workshops at the UMaine Darling Marine Center
- Successful formation of a research and model development team, including members of the MLLI and Maine Department of Marine Resources.
- Successful grant proposals to NOAA Fisheries Saltonstall-Kennedy 2017 (pre-proposal due September 20, 2016) and NOAA CSI Climate Impacts (expected for 2017)
- Successful establishment of a dialogue with continued engagement throughout the process among the research team, young lobster harvesters, the lobster zone council leaders and Maine's Department of Marine Resources to facilitate the discussion of policy applications for the model.

Notable Highlights:

At the first of two proposed meetings the research team met with: Dr. Rick Wahle from the School of Marine Sciences, Mr. Kisei Tanaka and Mr. Kevin Staples, PhD students also from the School of Marine Sciences and Maine Department of Marine Resources (DMR) Carl Wilson, Director of the Bureau of Marine Science and Kathleen Reardon, Lead Lobster Scientist.

Based on previous research, our research team presented both the participatory process of community engagement with the lobstermen and the community-based coupled ecological and economic lobster model with targeted questioning aimed at eliciting potential intersections with attending researcher's areas of expertise. This was followed by a lengthy discussion with the DMR staff around potential applications of the model to lobster management and policy. The meeting provided the following next steps:

- Further Development of the model (Seed Grant submitted in January 2017)

- Continued data acquisition from other areas of Maine's coast to increase model representativeness (additional funding required)
- South Thomaston follow-up meeting in late February to late March to follow through with recommendations from DMR
- Planning Meeting with Maine Lobster Leaders Institute, Feb. 2 & 3, 2017. Northport.

The second meeting was the Maine Lobster Leadership Institute (MLLI) Stakeholder Workshop on Feb 2-3 at Point Lookout, Northport, ME. The MLLI began in 2014 as an effort to give younger lobstermen and women the tools they would need to become advocates for their fishery at all management levels. Working with the MLLI, we developed a second training workshop. At the workshop, fourteen young lobstermen and women representing 13 communities from York to Cutler began their two-day exploration.

Dave Cousens, Maine's Lobstermen's Association president began by stating, *"The average age of a Maine lobsterman is 50-plus, and my generation is going to step down at some point. We need these younger people to take our places."* Lobstermen know the everyday aspects of the business; what many don't know are the complex, inter-related elements that are part of the management and sale of those lobsters they catch. Compounding this is the complication of a rapidly-changing Gulf of Maine. *"It's a multifaceted fishery and the more you know, the better positioned you will be for the future,"* Cousens continued.

We conducted an in-depth discussion on: their current knowledge of the industry and changes made since the crisis in 2012, their questions and suggestions on the CBSD model. When asked if they would use the model themselves, all 14 lobstermen replied 'yes'. Several lobstermen said they would provide data for improvement of the model and expansion to other lobster zones. Next steps and accomplishments from this meeting were:

- Planning a meeting with the Spruce Head and South Thomaston lobstermen for late March
- Together with Aaron Strong, Esperanza Stancioff and Sam Belknap we submitted a 2017 UMS Research Reinvestment Fund Seed proposal: *A decision support tool for Maine lobstermen to adapt to environmental change.*
- We submitted a pre-proposal to NOAA Fisheries Saltonstall-Kennedy Grant Program September 20, 2016: *Addressing emergent threats to the Maine lobster fishery through an expanded and improved community-based, systems dynamics model co-developed by lobster harvesters.*
- An article, which included our collaboration for the MLLI Workshop, was written by Melissa Waterman for the Maine Lobster Institute's Landings Newsletter: Second Lobster Leadership Institute Launched in February http://mlcalliance.org/pdf/newsletter-march-2017.pdf, pg 17.
- Samantha O'Gorman, a University of Maine Honors Student advised by Dr. Robert Bayer of the Lobster Institute is now utilizing our model to test the impact of a marine disease on lobster populations and subsequent economic impacts in Maine.

"Strengthening Maine's Eldercare Workforce"
Principle Investigator: Sandra Butler, Ph.D. (Social Work; UMaine)
Co-PIs: Mariella Passarelli, Ph.D. (Chemistry, UMF), Tanya Sleeper, Ph.D. (Nursing, UMFK), Vanessa Patenaude, M.S. (Physical Therapy, UMPI)
External Collaborators: NA
Budget: $4,979.04 Performance Period: 11/01/2016 – 9/29/2017
Economic Sector(s): Healthcare

Abstract: There is a large and growing demand for geriatric health care providers and direct care workers in Maine and nationally. Preparing and encouraging students to meet this need has significant workforce implications. This RRF Planning Grant application grows out of the UMS Aging Initiative and specifically the Health and Human Services Work Group. Representing four campuses and four disciplines, we seek to explore potential research collaborations focused on training, growing, and improving the eldercare workforce. We anticipate using the planning grant to formulate one to three multi-discipline, multi-campus research projects for which we will apply for external or RRF Seed Grant funding.

Planned Project Outcomes:
The six-month planning period would take place from March 2017 through August 2017, accommodating the teaching schedules of team members.

- Explore potential collaboration among our existing individual efforts to prepare students for the eldercare workforce in Maine across the disciplines of nursing, pre-med curriculum, social work, physical therapy, and the training of direct care workers.
- Investigate collaborations with external partners, e.g., long-term care providers regarding workforce needs, retention, and training/education.
- Formulate one to three potential research projects for which to apply for internal or external funding related to advancing the eldercare workforce in Maine. Identify appropriate funding sources and key players for each proposed project so as to be prepared to begin the application process at the end of the 6-month planning period.

Notable Highlights to Date:

- The project was recognized in the December 2016 issue of the *UMaine Aging Research Update*.
- Three faculty from USM have agreed to join the research team as collaborators: Nadine Edris, Co-Director, Disability and Aging Program Area, at the Cutler Institute of Health and Social Policy; Tammy Bickmore, a faculty in the Department of Occupational Therapy; and Elizabeth Gattine, Senior Research Associate at the Cutler Center.
- The first meeting of the research team is scheduled for April 4th, 2017.

"A Facilitated Process to Establish the Alliance for Maine's Marine Economy (AMME)"
Principal Investigator: Paul Anderson (Sea Grant, UMaine)
Co-PIs: Heather Leslie (Darling Marine Center); Brian Beal (UMM)
External Collaborators: N/A
Budget: $5,000 Performance Period: 1/01/2017 – 3/31/2018
Economic Sector(s): Marine, Fisheries

Abstract: The intent of this proposal is to support the formation of the Alliance for Maine's Marine Economy (Alliance) in order to grow and sustain Maine's marine economy. The Alliance is an outgrowth of a successful process initiated during 2015 that enabled us to develop a $7 million proposal for infrastructure relating to marine jobs in Maine. The goal of this nascent Alliance is to catalyze targeted infrastructure, industry-driven research and development, and workforce development investments that facilitate business development, accelerate product innovation, assess and prevent risks to resource health, and forecast changes in product supply. Each investment has been identified as a pressing need by industry; this approach will continue and thus is directly in line with the intent of the RRF. The Alliance leverages capacity at multiple University of Maine System (UMS) campuses (particularly UM and UMM), and will deepen the impacts on Maine's marine economy and coastal communities of UMS signature initiatives in Marine Sciences and Marine Biology from Casco Bay to Eastport.

Notable Highlights:
In December 2015 the University of Maine submitted a proposal on behalf of this Alliance to secure funding for both immediate and long-term infrastructure needs through the State of Maine's RFP# 201507125 for the Maine's Marine Economy and Jobs Bond. In May 2016, the State of Maine notified the UMS that the Alliance's proposal was favorably received. The award is being managed through a partnership between the University of Maine and the Maine Technology Institute.

Contracts with the UMaine entities and other project partners are being finalized with MTI in 1Q 2017. The Alliance is a keystone element of this initiative and will foster the network that contributes to, and benefits from, this investment in Maine's marine economy. However, the approved Marine Bond proposal is solely for infrastructure; there are no funds for the planning, staff, or research and workforce development activities required to realize the Alliance's transformative, 10-year vision for advancing Maine's marine economy and the applied research and science-industry partnerships on which it will necessarily be founded.

With RRF support, UMS representatives – together with more than 25 partners in the public and private sectors vital to Maine's marine economy will formalize the Alliance's mission, structure, and strategic business plan. As part of this planning process, we will recruit additional members into the Alliance from business, resource management, and research and education communities. And, with support from a skilled facilitator, Carole Martin, we will articulate a governance structure for the Alliance that ensures institutional sustainability and engagement by the full set of stakeholders of Maine's marine economy.

This planning process has only just begun. The following activities have taken place:

1. January 20, 2017 – The first post-award Alliance planning meeting was held at the Hutchinson Center in Belfast, Maine. The meeting was organized with input from Paul Anderson and Heather Leslie and facilitated by Carole Martin. A total of 20 Alliance members attended and were given the chance to re-introduce themselves and to express their institutions' interest and commitment to this initiative moving forward.

2. A follow-up survey was developed and has been distributed to the Alliance members that will collect input about particular interests and priority needs of the members. These survey results are now being collated and will provide the foundation for the discussions at the next Alliance meeting to be held March 30, 2017 in Belfast.

3. A series of approximately 5 more meetings will be held to advance the Alliance in its organizational development and to put into motion the implementation steps required to advance the Alliance including the formulation of the tasks and job description for a support position that will be funded through the Office of the Vice President for Research at UMaine.

"Strengthening Higher Education Pathways for Eldercare Providers: Undergraduates"
Principle Investigator: Kenneth C. Elliot, Ph.D. (UMA Dept. of Social Sciences)
Co-PIs: Amber Howard, Ph.D. (UMA Dept. Of Biology), Christopher Howard, Ph.D. (Husson College Dept. of Psychology)
External Collaborators: Husson University
Budget: $5,000.00 Performance Period: 1/01/2017 – 12/31/2017
Economic Sector(s): Healthcare, education

Abstract: This proposal requested planning support to enhance collaborations throughout Maine to assess undergraduate student caregiving burdens and training of eldercare service providers in rural settings. The project builds on the Maine Council on Aging (MCOA) 2015 Report on eldercare research activities at Maine universities and national studies of elder caregiving. Two research challenges are addressed; i) knowledge gaps in attitudes and engagement specifically of rural undergraduate students providing elder care; and ii) the need to consolidate a multi-campus research team. The state's economy will be benefit by strengthening educational pathways for students and supports needed to become successful eldercare providers.

Planned Project Outcomes:

- Complete the plan for a descriptive study.
- Consolidate an emerging team of eldercare researchers, elders and community advocates affiliated with multiple universities.
- Assess undergraduate eldercare engagement
- Assess student attitudes about eldercare
- Study the impact of engagement on academic success
- Assess university methods for addressing these barriers to students' degree completion

Notable Highlights:

- An initial team planning meeting is scheduled for February 27, 2017.
- Five, undergraduate research assistants have been hired.
- The research team received an internal UMA award of $11k to continue work on this proposal in the fall of 2017, after the timeframe for this RRF Planning Grant closes.

"11th International Conference and Workshop on Lobster Biology and Management"
Principle Investigator: Richard Wahle, Ph.D. (School of Marine Sciences)
Co-PIs: Cathy Billings (Lobster Institute)
External Collaborators:
Budget: $5,000.00 Performance Period: 3/01/2017 – 9/29/2017
Economic Sector(s): Fisheries

Abstract: The ICWL is the gold-standard of lobster science meetings since 1977. UMaine will host the 11th meeting in Portland, June 4-9, 2017, the first time it will be held in the Maine. As a multi-billion dollar industry, the American lobster is a key driver of Maine's economy. This revised RRF proposal seeks funds to subsidize costs for the ICWL's special Industry Day to promote participation by Maine industry members in part to promote future RRF project development. The ICWL provides access to the latest developments in the business and management of lobsters globally, and catalyzes industry-scientist research collaborations.

Planned Project Outcomes:

- Formation of new collaborative research teams both internal and external to the UMaine System.
- Continue the ICWL's 40-year tradition of international sharing of information on the status of lobster resources and their management.
- Stimulate research by identifying common themes and critical knowledge gaps.
- Foster and strengthen collaborative research regionally and internationally.
- Publish proceedings in a professional peer reviewed journal

Private Sector Engagement:

- *Increasing the value of Maine's lobster fishery by improving shell quality and meat yield*. Investigators: R. Wahle (UM SMS), and C. Brown (Ready Seafood Co.).
- *Projecting Climate-related Shifts in American Lobster Habitat and Connectivity - Integrated Modeling to Inform Sustainable Management.* Investigators: D. Brady, R. Wahle, R. Steneck, H. Xue, Y. Chen, (UM SMS), B. Shank (NMFS), P. McCarron (Maine Lobstermen's Assn), C. Wilson (ME Dep. Marine Resources).
- *Maintaining vitality and yield of live American lobsters in international shipping*. Investigators: J. Bolton (UM FSA/Innovation Ctr), C. Billings (Lobster Inst.), J. Lavallee (Aqu. Sci. & Health Services, PEI, Canada), ME Lobster Dealers' Assn, and NZ Rock Lobster Industry Council.
- *Effects of shell disease on reproductive organs of the American lobster.* Investigators: UM's Dr. H. Hamlin (SMS) & D. Bouchard (MAAHL) and ME & MA Lobstermen's Assns.

APPENDIX IV.C: Planning Grants | Rubric

Intellectual merit 35 POINTS	**Poor (0 POINTS)**	**Good (15 POINT)**	**Very Good (25 POINTS)**	**Excellent (35 POINTS)**	**Score**
Evaluation Criteria for Intellectual merit	Proposal has no compelling evidence that the intellectual merit of the research and development area proposed for the new collaboration is sufficient to eventually lead to an extramurally funded and successful project.	Proposal has some evidence that the intellectual merit of the research and development area proposed for the new collaboration is sufficient to eventually lead to an extramurally funded and successful project.	Proposal has good evidence that the intellectual merit of the research and development area proposed for the new collaboration is sufficient to eventually lead to an extramurally funded and successful project.	Proposal has strong evidence that the intellectual merit of the research and development area proposed for the new collaboration is sufficient to eventually lead to an extramurally funded and successful project.	
Relevance to Maine's economy 30 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (30 POINTS)**	**Score**
Evaluation Criteria for Relevance to Maine's economy	No clear link of the proposed activities to Maine's economy. Likelihood of job creation, workforce and economic development low	Proposed activities somewhat linked to Maine's economy. Likelihood of job creation, workforce and economic development moderate	Proposed activities well linked to Maine's economy. High likelihood of job creation, workforce and economic development	Proposed activities intimately linked to Maine's economy. Likelihood of job creation, workforce and economic development very high	
Likelihood of additional funding 20 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (15 POINTS)**	**Excellent (20POINTS)**	**Score**
Evaluation Criteria for Likelihood of additional funding	Proposed research unlikely to lead to external funding	Proposed research somewhat likely to lead to external funding; Targets lacking	Proposed research likely to lead to external funding; Targets given	Proposed research highly likely to lead to external funding; specific RPG targets given	
Extent of Collaboration 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Extent of Collaboration	Proposal has no evidence of collaboration across the UMS and/or external partners, collaborations are not clearly linked to the proposed activities, roles and responsibilities are not clearly defined	Proposal has some evidence of collaboration across the UMS and/or external partners, collaborations are linked to the proposed activities, roles and responsibilities are somewhat defined	Proposal has good collaboration across the UMS and/or external partners, collaborations are well linked to the proposed activities, roles and responsibilities are defined	Proposal has strong evidence of collaboration across multiple and/or external partners, collaborations are clearly linked to the proposed activities, roles and responsibilities are clearly defined	
TOTAL POINTS					

APPENDIX V: RRF Graduate Assistant Grants | Round 1

Appendix V.A: GA Grants | Awardee List

Principal Investigator	Partners	Project Title
Jason Bolton (Food Science & Cooperative Extension, UMaine)	Maine Technology Institute	OIED RRF Proposal for 2 Graduate Assistantships
Damian Brady (Marine Sciences, UMaine)	Bureau of Public Health, Maine Department of Environmental Protection, Maine Shellfish Advisory Council	Modeling estuarine circulation on Maine mudflats to improve shellfish harvesting
Yong Chen (Zoology & Marine Science, UMaine)	Maine Department of Marine Resources	Estimating spatial non-stationarity of American lobster
Yong Chen (Zoology & Marine Science, UMaine)	Maine Department of Marine Resources, NOAA	RRF Graduate Assistant Proposal for PhD Candidate
Yong Chen (Zoology & Marine Science, UMaine)	Northeast Fisheries Science Center, NOAA, Gulf of Maine Research Institute	Incorporating environmental variability into assessment and management of American lobster (Homarus americanus)
Yong Chen (Zoology & Marine Science, UMaine)	Northeast Fisheries Science Center, NOAA	Development of a modeling framework to assess the effects of environmental heterogeneity in sea scallop (Placopecten magellanicus) abundance, distribution, and growth: Application to the Maine fishery
Yong Chen (Zoology & Marine Science, UMaine)	NOAA, Maine Department of Marine Resources	Facilitating Development of Statistical Models to improve estimation of incidental cod catch
Teresa Johnson (Marine Sciences, UMaine)	Northeast Fisheries Science Center	Marine Biology and Marine Policy MS student working to inform the management and planning efforts in the lobster industry
Lenard Kaye (Social Work, UMaine)	Scope of this project is across the UMS campuses	GA Support Request to Bolster Aging Research Connections across the UMS
Michael Mason (Chemical and Biological Engineering, UMaine)	EMMC	Variable Porosity Nanocellulose Solid Forms for Biomedical Applications
Krish Thiagarajan (Mechanical Engineering, UMaine)	General Dynamics Bath Iron Works	Advancing marine technology for naval and commercial ships using the Alfond W2 OCean Engineering Laboratory

The Office of Innovation and Economic Development (OIED) RRF Graduate Assistant Proposal
Principal Investigator: Jason Bolton (Food Science and Cooperative Extension, UMaine)
Co-PIs: Renee Kelly (UMaine), James Beaupré (UMaine), Kris Burton (UMaine)
External Collaborators: Maine Technology Institute
Students: Matt Hodgkin and TBA

Description of Project: The Office of Innovation and Economic Development (OIED) requested to create two graduate assistantships to provide research and commercialization assistance to UMaine researchers. The positions were created to increase the pipeline of students, faculty and staff interested in research commercialization and industry research partnerships. The long-term goal is to extend what is tested in Orono to the other UMS campuses. In particular, the graduate assistants will work with projects funded through initial RRF seed grant round in the aquaculture and related food sector to identify opportunities for commercial applications, further research and industrial partnerships. OIED staff has already connected with RRF projects in these areas to collaborate on commercialization of research to meet the desired economic development objectives of the RRF Fund.

Project progress to date: Matt Hodgkin has designed a plan of work in the first semester that has focused on three primary activities: *focused outreach with faculty and students; direct support of student/faculty researchers; and general awareness building and event planning*. He has worked on building relationships and educating faculty, administrators and students about commercialization and cooperative research. In particular, given this graduate student's academic and research areas, he has done significant outreach with food and animal science departments and organizations.

A delay and extension was requested for the second student position with hopes that an undergraduate who was graduating in December could fill the second assistantship. This student ended up not pursuing graduate school, but the post is currently being advertised. Having one of the students extended through Fall 2017 will help the overall success of the project in executing planned events, training and outreach.

Role and contributions of UMS campus and/or external partner(s) on the project: The role of external partners has been minimal in the first four months as Matt Hodgkin connected with campus partners. However, in planning training programs, the graduate students will work closely with Maine Technology Institute and other partners to develop the events and curriculum. For the graduate student event planned for the spring, several organizational and corporate partners are anticipated to participate as presenters. Collaboration with other campuses will occur to invite their faculty and students to events or to help develop local events based on the success of the events.

List of planned publications/presentations/grant funding targets related to the project: Since the first semester of work was primarily used to build relationships, it has helped lay the groundwork for successful events, training and outreach in the spring and fall. A graduate student event is

being planned with presentations on entrepreneurship and commercialization in the spring semester. Funding is being sought for the commercialization training program to be launched in 2017.

Modeling Estuarine Circulation on Maine Mudflats to Improve Shellfish Harvesting
Principal Investigator: Damian Brady, Assistant Professor in the School of Marine Sciences
Co-PIs: Brian Beal, (Professor, UMM); Bridie McGreavy (Assistant Professor, UMaine)
External Collaborators: Bureau of Public Health, ME DEP, Maine Shellfish Advisory Council
Student: Gabrielle Hillyer

Description of Project: Soft shell clam fishery is the second most valuable resource of all marine species harvested in Maine. However, the industry faces threats from pollution. Specifically, changes in water quality due to bacterial pollution have led to several fishery closures. This project partners with UMaine, NEST, UMaine -Machias, DMR, DEP, ShAC, and the Town of Waldoboro to develop better information on estuarine circulation in order to reclassify the Medomak River, one of Maine's most valuable shellfish harvesting sites. For this purpose, this application requests financial support for a GA who will develop a modeling platform capable of identifying conditional areas that might be opened for clamming with better information on residence time of bacterial pollution in this system.

Project progress to date: Graduate student, Gabrielle Hillyer from Boston University, was hired and she has used the Fall 2016 semester to complete three required courses and networked with all of the project partners. The Medomak Valley Land Trust submitted and received a $4,931 grant from Maine Sea Grant entitled, "Medomak River Task Force Water Quality Improvement Project," to explore microbial source tracking (a method to determine the source of bacterial pathogens). PI's have led multiple grant submissions that directly address tracking freshwater derived bacteria in the coastal environment (see below).

Role and contributions of UMS campus and/or external partner(s) on the project:
Hillyer's committee has been formed (Beal, Brady, McGreavy) which has led to an RRF Seed Grant submission to form a policy advisory group for shellfishermen to assess the economic impact of policy changes.

List of planned publications/presentations/grant funding targets related to the project:

- *Low pH in the coastal waters of the Gulf of Maine: What are the sources and vulnerabilities to coastal communities?* Townsend, D., Strong, A., Brady, D.C., Mayer, L., Salisbury, J., & Morrison, R. (pending) NOAA Regional Vulnerability Assessments for Ocean Acidification. Letter of Intent submitted on November 4th, 2016: Proposed Funding Level: $700,000
- *The Shellfishing Sustainability Project: Connecting science with decision making for water quality improvement, shellfish management, and pain prevention.* Investigators: McGreavy, B., Brady, D.C., Smith, S., Beard, K., Silka, L. (UMaine), Jones, S. (UNH), Fulmer, S. (UMass Lowell), and Randall, S. (Maine Clammers Association) Funding Agency: Integrating Human Health and Well-being with Ecosystem Service, EPA-G2016-STAR-A1. Proposed Funding Level: $598,855. Project Period: 9/1/2016-8/31/2019 (unfunded but still being pursued)
- *Citizen science validating ocean color products for the benefit of estuarine science and Maine communities.* Thornton, K., Brady, D.C., Boss, E., Mayer, L., Cole, K., Leslie, H., & Lasley-Rasher, R. (pending) NASA Citizen Science for Earth Systems Program. Proposed Funding Rate $3,000,000

- Simulating the transport of bacterial pathogens in Machias Bay, ME. Maine Coastal Program and Maine Department of Marine Resources. Brady, D.C. & Cole, K. 09/01/2016-08/31/2018 funded at $74,000 (funded)
- *Coastal Community Sustainability Innovation Toolbox (CC-SIT): Refine, expand, and deploy a series of coastal industry and natural resource management tools to promote business innovation and sustainability goals, including strengthening the economy, fostering resilient communities, and preserving the environment.* Diana Davis Spencer Foundation. $50,000 (funded) Co-Investigators: Hart, McGreavy, Brady, and Smith

Private sector engagement, investment, and advancement

The Medomak Water Quality Partnership made significant progress this past year, in part due to the support received through the Research Reinvestment Fund. Researchers involved in this project and supported through the RRF worked with collaborators from the Maine Department of Marine Resources, the Maine Department of Environmental Protection, the Waldoboro Shellfish Committee, and the Medomak Valley Land Trust to advance their pollution source detection efforts and understand the watershed and water quality dynamics within the river system.

From an economic standpoint, Waldoboro has the highest landings values in the State with approximately $2 million in clam landings last year. The river employs approximately 150 clammers who rely on this resource. The water quality issues are also some of the most pronounced as well, with frequent short and long term closures reducing harvesters' access to the resource and increasing the economic uncertainty in their lives. The river is designated as conditionally approved, which means that when the area receives more than an inch of rain in a 24-hour period, the entire river shuts down. This happens frequently, and increasingly given changes in precipitation due to climate change. A comparable study conducted in Machias indicates that in a ten year period, closures resulted in a loss of approximately 30% of total revenue (Evans et al., 2015).

Trying to reduce and avoid these economic losses is in large part what motivates our work in the region. We are making measurable progress in this regard, and we entered this project at a key moment when they had used up all their funding and needed new sources of support and expertise. We helped this group gain access to an innovative technology known as Microbial Source Tracking (MST), connecting them with our collaborators at the University of New Hampshire. The group used the grant that we helped write from Maine Sea Grant to conduct MST testing which allowed them to narrow in on potential human sources of contamination. This is represents a substantial cost savings, as the group now has a better understanding of where to focus its efforts.

In addition to supporting the water quality improvement efforts through the RRF, collaborators on this project are aggressively seeking grants to continue this work, as shown in the detailed list provided. As part of this we have advanced multiple successful grant applications, including a $50,000 private grant from the Diana Davis Spencer Foundation to advance the pollution detection and decision making tools. An important metric of success is that our partners are enthusiastically joining us in these proposals, including Glen Melvin, chair of the Waldoboro Shellfish Committee, on the Maine Shellfish Advisory Council, and a full time commercial clammer and Kohl Kanwit, Director of the Bureau of Public Health, who have both voiced their strong support and intention to participate in these efforts. We are able to build and maintain this support with our key partners because we are making demonstrated progress on building the knowledge that is essential to figuring out what is driving the pollution in the Medomak and to implementing on-the-ground solutions to improve water quality and reduce closures.

*Estimating Atlantic Cod (*Gadus morhua) *Bycatch in the Gulf of Maine Lobster Fishery*
Principal Investigator: Yong Chen (School of Marine Sciences, UMaine)
Co-PIs: Robert Steneck (UMaine), Kate Beard (UMaine), Joseph Zydlewski (UMaine)
External Collaborators: NOAA Northeast Fisheries Science Center, ME Department of Marine Resources
Student: Robert Boenish

Description of Project: The Atlantic cod stock in the Gulf of Maine is currently near historically low population levels. Fishery reductions have caused the loss of many fisheries jobs and stressed Maine's coastal economies. This project will research strategies to facilitate the development of statistical models to improve estimation of incidental Atlantic cod catch. These estimates will be incorporated into future stock assessments to aid in determining more sustainable fishing seasons and catch quotas to enable the rebuilding of the stock. The overall goal of this study is to develop methodologies to quantify estimates Atlantic cod (*Gadus morhua*) discards in the Maine commercial lobster fishery on a fixed spatiotemporal scale.

Role and contributions of UMS campus and/or external partner(s) on the project: The Maine Department of Marine Resources provided guidance in addition to Sea Sampling and landings data from the years 2006- 2013. These data included environmental covariates used in the modeling process. Dr. Yong Chen provided guidance concerning all aspects of this work.

Project progress to date: This report is to inform the RRF committee of the progress for the Fall Semester (2016) graduate assistantship award. Robert has been working expeditiously over the semester both in relation to lobster and cod bycatch population dynamics. There are current efforts to move ahead and publish the proceedings of the lobster standardized catcher per unit effort (CPUE) work, and efforts have been made to move ahead with the cod bycatch estimation work and public outreach.

<u>Spatially-explicit standardized catch rates:</u>

The general approach developed consists of three main parts. First, using a bootstrapped two stage generalized additive model (GAM) framework, Lobster catch rates from the Department of Marine Resources Sea Sampling program were standardized on a high spatiotemporal resolution. As outlined in the proposal, the impetus for this was to take into account the spatiotemporal uncertainty that is known to exist in the Maine lobster fishery. From the DMR, we obtained zonal-monthly lobster landings data for the extent of the study period (2006-2013). Confidence intervals were developed for standardized lobster CPUE via a novel bootstrapping approach, and subsequently were used with the landings data to generate a zonal-monthly confidence interval of effective effort, measured in individual trap hauls. Estimation of effective effort is novel in the Maine lobster fishery, but will serve as an important step in a more holistic understanding of the fishery.

A cod in a UMaine lobster trap. Photo credit: Robert Boenish

A similar bootstrap approach was used to generate confidence intervals (on the same spatiotemporal resolution) for Atlantic cod bycatch from the Sea Sampling program. This approach was facilitated by the fact that both the lobster and the cod data exist in the same dataset, over the same spatiotemporal resolution. With ranges of effective effort and cod bycatch rates now known, confidence intervals were constructed for zonal-monthly cod bycatch over the years of the study period.

A small proportion of data were interpolated due to either confidentiality or data gaps. These interpolated months tended to occur in projected months where bycatch was moderate or low. Interpolation was done by taking averages of effective effort from the bordering months.

Using cod length data from field work (funded by a NOAA SK grant), confidence intervals of cod size were constructed to characterize the typical ontongeny of bycaught cod in the lobster fishery. Length-weight keys were used from the 2014 Atlantic cod update assessment to produce confidence intervals of typical cod bycatch weights. In this area, there still stands to be more improvements. Overall, the field data collected are relatively sparse, and it is unclear if spatiotemporal differences exist and if they are significant. Assuming a realistic average size for cod bycatch over the study year and applying the derived weight to the bycatch estimates from above, cod bycatch was estimated.

Compared to the previous 2008 bycatch estimate from the Marine Stewardship Council, which was based on unsound statistical practices, bycatch levels were moderate. The overall highest bycatch rates occurred in the winter and spring months, consistent with literature on cod. The highest bycatch by weight, conversely, occurred in the months of lowest zonal monthly bycatch rates, suggesting that the overall number of encounters is dictated by the level of lobster effort. This result was unexpected, but remains consistent with the relative seasonal disparity of effort levels in the lobster fishery. In terms of bycatch mitigation, it is fortunate for the groundfish sector that the highest catch rates of cod occur in the months with the lowest effort levels for lobster.

A preliminary portion of this work was presented in an oral presentation at the 146th annual American Fisheries Society conference, in Kansas City, Missouri in August, 2016. This work was presented to the Maine Lobstermen's Association in December, 2016, a talk aimed specifically at the lobster dynamics of Maine was given at the Canadian Conference for Fisheries Research in Montreal, Canada, in January, 2017. Since January an article about the cod bycatch work was solicited by the Lobster industry journal "Landings", and appeared on the Front cover in February's issue. url: http://mlcalliance.org/2017/02/08/cod-are-tougher-than-you-think/. Two manuscripts are in process of being written, and further dissemination opportunities are being considered, including the Maine Fishermen's forum, and further presentation to industry and scientific bodies. Mr. Boenish's work is done closely alongside representatives of management bodies as well as industry. He is particularly interested in the capacity of industry knowledge to inform and improve the quality of his work, and strives to keep open and consistent dialog with management and stakeholders.

Estimating Spatial Non-stationarity of American Lobster
Principal Investigator: Yong Chen (School of Marine Sciences, UMaine)
Co-PIs: Richard Wahle (UMaine), Andrew Thomas (UMaine),
External Collaborators: Maine Department of Marine Resources
Student: Bai Li

Description of Project: The American lobster is one of the most important commercial fisheries in Maine. It is critical to examine the distribution of American lobster under a changing climate to achieve a better understanding and management of the lobster fishery. This projects seeks to develop season-, size-, and sex-specific models that predict the non-stationary spatial distribution of American lobster. The results derived from this study can reveal the relationships between American lobster and environmental variables locally, enhance the management of lobsters in Maine, and inform a proposal for developing our predicative capacity for the lobster population dynamics in a changing Gulf of Maine.

Project progress to date: The first phase of the study is to quantify lobster responses to oceanographic variables by using a geographically weighted regression (GWR) model, and the second phase of the study is to compare the GWR model with the generalized additive model (GAM) based on the predicted spatial distributions of lobster. During this reporting period, the first phase of the study was completed and the second phase of study is in progress. The method used in this study was novel in the marine science field and the results were different with previous studies of lobster distribution. The estimated relationships between lobsters and oceanographic variables from this study were varying between eastern and western Gulf of Maine, which suggests that regionalized management of lobster in the Gulf of Maine may be necessary for the future.

Role and contributions of UMS campus and/or external partner(s) on the project: The Maine Department of Marine Resources provided biological data of lobster density and oceanographic data for developing the models and gave advice on determining whether the estimated relationships between lobsters and oceanographic variables were reasonable. Dr. Richard Wahle provided expertise to understand the spatial distribution of lobsters. Dr. Andrew Thomas provided insights on the physical water structure in the Gulf of Maine and how these oceanographic variables relate to lobsters.

Planned publications/presentations/grant funding targets related to the project:
Publications: Estimating spatial nonstationary presence and density of species: a case study from American lobster in the Gulf of Maine (In Prep).
Presentations: 1) Estimating spatial non-stationarity of American lobster distribution in the Gulf of Maine. Canadian Conference for Fisheries Research. Montreal, Canada, January 5-8, 2017. 2) An evaluation of non-stationary spatial distribution of American lobster with respect to oceanographic variables in the Gulf of Maine. The International Symposium on Fisheries Oceanography. Shanghai, China, May 19, 2016.

Grant funding related to the project: Based on the work done in this study, Dr. Chen submitted a proposal to Maine Department of Marine resources on the optimization of Lobster Sea Sampling. This project has been funded in the amount of $25,000. “Understanding American lobster

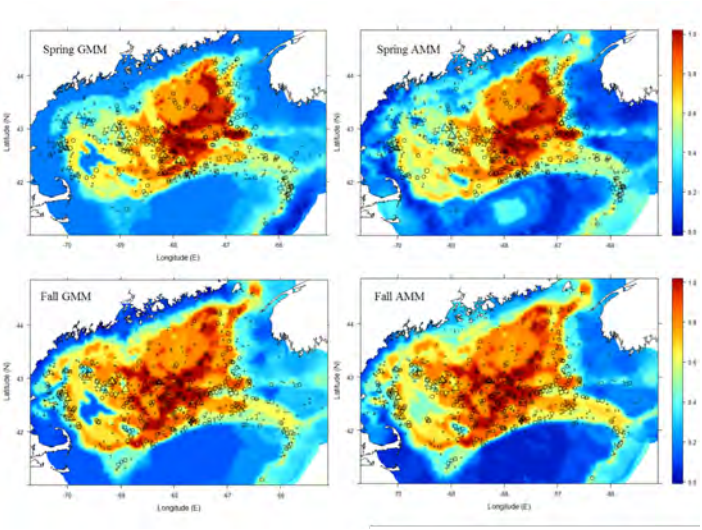
habitat, molting dynamics, groundfish interaction and subsequent management implications in a changing Gulf of Maine" Submitted to the 2017 Saltonstall-Kennedy Competitive Research Program in the amount of $220,084.

Understanding the Impacts of Cusk Bycatch in the Lobster Fishery
Principal Investigator: Yong Chen (School of Marine Sciences, UMaine)
Co-PIs: David Hiebeler (UMaine), Gayle Zydlewski (UMaine), Teresa Johnson (UMaine)
External Collaborators: NOAA Northeast Fisheries Science Center, ME Department of Marine Resources
Student: Jocelyn Runnebaum

Description of Project: There are an estimated 5,000 license holders contributing to Maine lobster landings, of which 30% are eligible to fish in federal waters. The timing and location of off-shore fishing leads to an increased likelihood of catching cusk as bycatch in the Maine lobster fishery. NOAA is interested in exploring proactive conservation measures for cusk. Jocelyn Runnebaum will assist in developing strategies for reducing cusk bycatch and discarded mortality rates in the lobster fishery by Nov. 2017.

Project progress to date: The objectives of this research are to (1) quantify the amount of cusk bycatch in the Maine lobster fishery; (2) incorporate survival estimates into the stock assessment for more accurate population estimates; (3) map suitable habitat for cusk; (4) estimate the potential economic cost to the fishery due to closures of critical habitat for cusk. To date, objectives one and three have been accomplished while objectives two and four are in progress. The range of cusk bycatch in the lobster fishery have been estimated by zone and month. Additionally, the quality of cusk habitat have been quantified in the Gulf of Maine and habitat hotspots have been mapped out.

Quantification of cusk bycatch in the Maine lobster fishery have been estimated based on methods established by Boenish and Chen (in prep). A standardized bycatch-per-unit-effort (BPUE) for cusk was based on bycatch data collected by the Maine Department of Marine Resources lobster sea sampling program (2006-2013). To standardize BPUE a two-stage GAM was used to first estimate lobster fishing effort (i.e. the number of traps fished in a given month and zone). A similar two-stage GAM was then used to estimate the number of cusk caught per trap in a given month and zone.



Habitat suitability maps for cusk in the spring and fall for the Gulf of Maine based on modeled-abundance

A model-based abundance index was established to improve habitat mapping of cusk. A spatio-temporal delta-generalized linear mixed model estimates the density field of cusk through the model years (1972-2015) to overcome potential biases from utilizing observed data only. This is a two stage model that first estimates the probability of encountering a species (i.e. presence/absence; C > 0) and then estimates species density given the presence of a species (Thorson et al. 2015). Modeled abundance is estimated by combining the NEFSC bottom trawl survey and longline survey to estimate cusk abundance over a generated grid in

the Gulf of Maine and Georges Bank. The increased spatial resolution that the modeled-abundance provides improved the habitat suitability models by providing information where the spring and fall trawl surveys did not sample.

Stock assessment simulations will be conducted in the coming semester in collaboration with NOAA stock assessment scientist Loretta O'Brien. These simulations will be conducted using a simulated population and the previous stock assessment model used for cusk in the last stock assessment, these tools are available through NOAA. The objective of the simulation is to understand how the inclusion of bycatch estimates into the stock assessment impacts the population dynamics.

Estimating the potential economic cost to the lobster fishery due to closures of critical habitat for cusk is in progress. To address this objective, the cusk habitat suitability maps will be overlaid with lobster habitat suitability maps to determine the locations where high quality cusk and lobster habitat overlap by zone. The proportion of area, by zone, with high quality habitat will be estimated.

Role and contribution of UMS campus and/or external partners on the project:

Robert Boenish, PhD candidate, at UMaine provided assistance in estimating cusk bycatch estimates. Ms. Kathleen Reardon from Maine DMR provided the lobster sea sampling data for the bycatch estimations. Ms. Loretta O'Brien of NOAA's Northeast Fisheries Science Center provided the NMFS spring and fall bottom trawl survey and cusk spring and fall longline survey data for habitat mapping. Drs. Jie Cao and Lisha Guan provided advice and expertise on the delta-GLMM for model-based abundance estimates that were utilized in the habitat mapping. Ms. Loretta O'Brien has also provided expertise and advice on how to conduct cusk stock assessment simulations. Kisei Tanaka, PhD candidate at UMaine has provided the lobster habitat maps to evaluate the overlap of cusk and lobster habitat.

Private Sector Engagement, Investment, and Advancement:

This research was presented to the Maine Lobstermen's Association in November 2016 as an industry specific outreach initiative and was published in the MLA Landings News Letter (http://mlcalliance.org/2017/02/06/cusk-bycatch-research-important-to-maine-lobster-fishery/). This research was also presented to the Maine Department of Marine Resources in October 2016. Habitat mapping of cusk bycatch could have a significant impact on lobster management if cusk were to be listed on the Endangered Species List. This research will keep Maine DMR aware of potential future implications to the Maine lobster industry. Outreach was conducted on March 2 – 4th, 2017 at the Maine Fishermen's Forum to provide pamphlets on correlated (on-going) cusk bycatch research.

List of planned publications/presentations/grant funding targets related to the project:

Presentations: Runnebaum, J. and Y. Chen. (2016). Using modeling approach and fishermen's knowledge to define suitable habitat for cusk (*Brosme brosme*) and evaluate potential economic impacts of conservation. ICES Annual Science Conference accepted abstract. 19 – 23 September, 2016. Riga, Latvia.

Runnebaum, J., L. Guan, J. Cao, L. O'Brien, Y. Chen, K. Tanaka. (2016). Using modeling approach and fishermen's knowledge to define suitable habitat for cusk (Brosme brosme) and evaluate potential economic impacts of conservation. 13 October, 2016. Portsmouth, New Hampshire.

Runnebaum, J., L. Guan, J. Cao, L. O'Brien, and Y. Chen. (2016). Habitat suitability modeling based on a spatio-temporal model: an example for Cusk (Brosme brosme) in the Gulf of Maine. Canadian Conference for Fisheries Research. 5-8 January, 2017. Montreal, Canada

Manuscripts and grant proposasl: Runnebaum, J., L. Guan, J. Cao, L. O'Brien, and Y. Chen. (In Prep). Habitat suitability modeling based on a spatio-temporal model: an example for Cusk in the Gulf of Maine.

Grant: 2017 Saltonstall-Kennedy Competitive Research Program (Pre-Proposal Number: 082)

Incorporating Environmental Variability into Assessment and Management of American Lobster
Principal Investigator: Yong Chen (School of Marine Sciences, UMaine)
Co-PIs: Lawrence Jacobson (UMaine, NOAA), Damian Brady (UMaine), Richard Wahle (UMaine)
External Collaborators: NOAA Northeast Fisheries Science Center, Gulf of Maine Research Institute
Student: Kisei Tanaka

Description of Project: American lobster supports the most valuable fishery in the state of Maine, with annual estimated revenue in excess of $464 million in 2014. The Gulf of Maine (GoM) lobster stock accounts for approximately 94% of total U.S. landings, and has experienced significant expansion in both effort and landings over the last 60 years. This goal of this study is the development of a modeling framework to incorporate environmental variability into assessment and management of GoM lobster stock using both modeling and simulation studies

Project progress to date: A bioclimate envelope model was developed to reconstruct spatiotemporal variability of suitable lobster in coastal waters of Maine and New Hampshire from 1978 to 2013, and the model results were summarized and published in a peer-reviewed journal. Tanaka applied a nonparametric statistical modelling approach to study spatiotemporal variability of lobster shell disease, and also developed a climate niche model for American lobster to quantify the spatiotemporal distribution dynamics of Gulf Maine lobster. The model results were presented at 2016 RARGOM Annual Science Conference.

Role and contributions of UMS campus and/or external partner(s) on the project: This project has been conducted in collaboration with Carl Wilson and Kathleen Reardon at Maine Department of Marine Resources. Dr. Richard Wahle has provided expertise to understand the spatial distribution of lobsters. Dr. Larry Jacobson and Dr. Jui-Han Chang from NOAA have advised Tanaka through the application of the lobster climate-niche model and statistical models. Dr. Damian Brady has provided insights on how outputs from a regional circulation model relate to lobsters. This study will be done based on the collaborations developed over other projects with Dr. Changsheng Chen's Ocean Dynamics Lab at UMASS Dartmouth and collaborators involved in our NSF Coastal SEEs project (Dr. Pershing, GMRI & Dr. Thomas, UMaine).

Planned publications/presentations/grant funding targets related to the project:
Manuscripts in Review: 1) K. Tanaka, S. L. Belknap, J. J. Homola and Y.Chen. In Review (2nd round). An ecological model for monitoring shell disease in inshore lobster fisheries: A case study in Long Island Sound. Submitted to PLOS ONE. 2) K. Tanaka, B. Li, D. Brady, A. Thomas and Y. Chen. In Review. Evaluating Spatiotemporal Reliability of Modeled Bottom Temperature in the Northeast Continental Shelf. Submitted to Journal of Marine Systems 3) M. Torre, K. Tanaka, and Y. Chen. In Review. Bioclimate envelope model to evaluate impacts of climate change on Placopecten magellanicus in the inshore Gulf of Maine. Submitted to Fisheries Oceanography.
Manuscripts in Progress: 1) K. Tanaka, J-H. Chang and Y. Chen. In Prep. Impacts of climatic variations on the spatial distribution of Homarus americanus in the inshore Gulf of Maine. Intended for Journal of Biogeography. 2) Y. Xue, K. Tanaka, H. Yu, Y. Chen, L. Guan, Z. Li, H. Yu, B. Xu and Y. Ren. In Prep. Developing a framework to incorporate prey abundance in species distribution models. 3) M. Torre, K. Tanaka, and Y. Chen. In Prep. Approach for permutational variable weighting and inclusion of biological parameters to refine bioclimate envelope model.
Grants Submitted: 1) "Incorporating Environmental Variables to Improve Assessment and Predictive Capacity for American Lobster in a Changing Gulf of Maine and Southern New England" 2 year $216,918 funding request submitted to the 2017 National Oceanic and Atmospheric Administration (NOAA) Fisheries and The Environment (FATE) Program 2)"Understanding American lobster habitat, molting dynamics, groundfish interaction and

subsequent management implications in a changing Gulf of Maine" submitted to the 2017 Saltonstall-Kennedy Competitive Research Program.

Evaluating the Spatial and Temporal Distribution of Sea Scallops in the Gulf of Maine
Principal Investigator: Yong Chen (School of Marine Sciences, UMaine)
Co-PIs: David Hiebeler (UMaine), Huijie Xue (UMaine), David Townsend (UMaine)
External Collaborators: NOAA – Northeast Fisheries Science Center
Student: Mike Torre

Description of Project: The federal scallop fishery has undergone a large recovery since the mid-1990s and now supports the most valuable fishery in the states. Improving stock assessment and management to maximize sustainable yield is highly important to the economies of coastal Maine areas where scallops are landed. The overall goal of this project is to develop a modeling framework to understand environmental variability as it relates to scallop biology, and to incorporate these relationships into the assessment and management of the Gulf of Maine (GoM) scallop population.

Project progress to date: Using a habitat suitability index model (HSI), Torre evaluated a range of environmental factors that are biologically important with respect to the distribution and abundance of sea scallops and characterized their variability within the GoM system. The developed HSI model shows how the spatial distribution of scallop habitat changes over time in response to climate variability and can aid in the future development of climate based hypotheses for predicting future trends in the GoM scallop fishery. A second part of this study was the design, implementation, and analysis of the 2016 Northern Gulf of Maine (NGOM) Scallop Survey. Total exploitable stock biomass/abundance for each survey area was determined and a recommended total allowable catch (TAC) was provided to the scallop plan development team in August 2016.

Role and contributions of UMS campus and/or external partner(s) on the project: Kevin Kelly, and Mike Kersula at the ME DMR provided biological data of scallop abundance within the inshore and offshore Gulf of Maine from various surveys conducted in these waters. In addition, Torre worked closely with them in the development and implementation of the 2016 Northern Gulf of Maine Survey as well as the analysis of results. David Townsend and Dvora Hart (NEFSC) have provided advice on determining whether relationships between scallops and oceanographic variables were realistic.

Planned publications/presentations/grant funding targets related to the project:
Publications: 1) Torre, M. P., Tanaka, K., Yong, C. (In review) An evaluation of spatiotemporal changes in habitat for Placopecten magellanicus in the Gulf of Maine using a bioclimate envelope model. Fisheries Oceanography. 2) Torre, M. P., Tanaka, K., Yong, C. Generalized additive model to predict distribution of Placopecten magellanicus in the Gulf of Maine. (In prep)

Presentations: 1,2) An evaluation of spatiotemporal changes in habitat for Placopecten magellanicus in the Gulf of Maine using a bioclimate envelope model. ICES ASC meeting. Riga, Latvia, September, 2016. And Montreal, Canada, January 5-8, 2017. 3)- 2016 Northern Gulf of Maine Scallop Survey results. Scallop Plan Development Team meeting, Woods Hole, Massachusetts, August, 2016.

Grant funding related to the project: Maine Sea Grant Fellowship (Funded), 2016 Sea Scallop Research Set-Aside (RSA) Program (Submitted), 2017/2018 Sea Scallop Research Set-Aside (RSA) Program (Submitted).

Marine Sciences Graduate Assistant Support
Principal Investigator: Teresa Johnson (School of Marine Sciences, UMaine)
Co-PIs: Yong Chen (UMaine), Keith Evans (UMaine), Lawrence Jacobson (NEFSC)
External Collaborators: Northeast Fisheries Science Center
Student: Mackenzie Mazur

Description of Project: The American lobster fishery is vital to Maine's economy. There is a pressing need to evaluate how a possible reduction in fishing effort may influence fisheries yield and the economic value of the this fishery and how fishermen can improve their resilience, or their ability to respond to social and ecological changes that increase their vulnerability. Graduate Assistant Mackenie Mazur will modify and use an individual based model (IBM) that had been previously developed for the Gulf of Maine lobster to evaluate how yield may change with different levels of fishing efforts (i.e., traps hauls). Long-term research goals include: (1) identifying ways to maximize economic value of the Maine lobster fishery through improved fishery efficiency; and (2) improving the social resilience of lobster fishermen to future threats by preserving social memory and understanding generational differences as they affect the fishery's vulnerability.

Project progress to date: Ms. Mazur switched from the dual Master's degree program to the Ph.D. program in marine biology. Ms. Mazur has expanded her research to include evaluation of the effects of different 1) molting frequencies, caused by a change in water temperature; 2) natural mortalities, caused by a change in predator abundance; 3) fishing effort levels; and 4) conservation compliance levels on the lobster fishery, lobster population, and therefore the marine environment with the use of an individual-based model previously developed for American lobster. Additional objectives include, examining levels of resilience that characterize lobster fishing communities, as well as, the generational differences that may affect resilience. During the fall semester, Mazur worked simultaneously on both the fishery modeling and social resilience components of the RRF-funded research.

Role and contributions of UMS campus and/or external partner(s) on the project: Dr. Jui-Han Chang, Dr. Larry Jacobson, and Dr. Burton Shank, stock assessment scientists at the NEFSC have helped modify the IBM. ME DMR scientists, Carl Wilson and Kathleen Reardon, have helped with methods for finding the relationship between fishing effort and catch. Maine DMR submitted a letter of support for a NOAA Saltonstall-Kennedy grant that was submitted to support the research on social resilience.

Planned publications/presentations/grant funding targets related to the project: To advance the work proposed as part of this RRF, Mazur submitted an application to the Dr. Nancy Foster Scholarship of the National Marine Sanctuaries Program in December. Dr. Johnson also submitted a proposal to the NOAA Saltonstall-Kennedy Grant program in December 2016, along with Dr. Chen and Dr. Evans from the School of Marine Sciences.

Ms. Mazur gave a poster presentation on her research modeling Maine lobster fishing effort at the Regional Association for Research on the Gulf of Maine Annual Science Meeting in October. An abstract has been submitted to present at the 11th International Conference and Workshop on Lobster Biology and Management, which will take place in June 2017 in Portland, Maine. An abstract to present at the American Fisheries Society meeting in August will also be submitted.

Bolstering Aging Research Connections Across the UMS
Principal Investigator: Lenard Kaye (Social Work, UMaine)
Co-PIs: Jason Charland (UMaine), Steven Quackenbush (UMF), David Neivandt (UMaine)
External Collaborators: Multiple UMS campuses
Student: Jeremy Robichaud

Description of Project: The implications for the country's economic well-being stemming from the growing population of older adults in the US is well documented. In the spirit of the *One University* concept, the UMS Aging Initiative promotes research collaborations across the UMS by bringing expertise, resources, laboratories and facilities, and the differentiated missions of all seven campuses together to address rural-aging in innovative ways that will positively impact Maine's economy. The funded GA, Jeremy Robichaud, serves as a centralized, organizational and logistics coordinator for aging related research collaborations within the UMS.

Project progress to date: Jeremy Robichaud's graduate assistantship to support the UMS Aging Initiative was announced at the 2016 UMS Aging Initiative Workshop, an event that Mr. Robichaud's support helped make successful. He assisted with the coordination and facilitation of the August event and his ongoing responsibilities includ:

1. *Leading in the recruitment of researchers* and management of event participants. Mr. Robichaud drafted the event invitation, managed responses in a database, and personally responded to questions submitted prior to the event. Mr. Robichaud recruited participants by compiling a contact list constructed from the Center on Aging's (CoA) email database, the roster of the 2015 Aging Symposium, and through recommendations from Aging Initiative co-leads.
2. *Drafting, sending, and collecting the post-event evaluation*. Additionally, Mr. Robichaud analyzed the survey and reported the results to the Initiative's co-leads.
3. *Coordinating three post-Workshop meetings* with the Initiative's co-lead focused on the suggestions that emerged from the Workshop and evaluations.
4. *Creating an Aging Initiative Basecamp account* to help with project communications, collaboration, networking, and organization. Mr. Robichaud presented Basecamp to the co-leads in a brief tutorial and supports ongoing meetings of the Aging Initiative workgroups

Role and contributions of UMS campus and/or external partner(s) on the project: The nature of Mr. Robichaud's position requires him to work closely and communicate frequently with faculty from multiple UMS campuses to promote collaboration and explore funding opportunities.
List of planned publications/presentations/grant funding targets related to the project: Mr. Robichaud has been involved with numerous grants and other projects related to the UMS Aging initiative. Thus far in AY 16 – 17, Jeremy has assisted with approximately $926,000 worth of aging-related grant applications. These grants include: NIH R18--Advancing Safe Medication Use, NIH R21--Fall Prevention Research, and 3 RRF Planning grants (2 of which were funded).

Variable Porosity Nanocellulose Solid Forms for Biomedical Applications
Principal Investigator: Michael Mason (Chemical and Biological Engineering, UMaine)
Co-PIs: Douglas Bousfield (UMaine), Ian Dickey (Colorado Limb Consultants)
External Collaborators: Colorado Limb Consultants
Student: David Holomakoff

Description of Project: Dehydrated cellulose Nano-fiber (CNF) has several biomedical functions. In solid form, this includes the mimicking of natural bone. David Holomakoff is assisting in the investigation of solid-form CNF efficacy in order to generate the data needed to seek continued extramural funding, including commercialization opportunities within the Maine business community. The project goal is to develop the enabling technology necessary to generate controlled homogeneous and variable porosity CNF solid forms, mimicking natural bone.

Project progress to date:

- A physical method has been developed to dewater Cellulose nanofiber (CNF) slurries in a more rapid and controlled manner using capillary action. The end product is of significant mass and dimensions.
- A method has been developed for dewatering and freeze drying CNF slurries into CNF solids of a controlled and desired porosity.
- 3 point bend tests have been performed that strongly suggest a relationship between strength and flexural modulus of CNF to CNF porosity. The less porous and more dense the sample, the larger flexural modulus is measured.
- CNF machinability has been confirmed. It can be milled, lathed, drilled, and tapped.
- SEM images strongly suggest CNF fibers can be coated with Iron oxide (Fe2O3) nanoparticles, creating MRI contrast for a material that would regularly lack this implanted in a biological system. Material supervision is essential for any biomaterial after implantation.

Role and contributions of UMS campus and/or external partner(s) on the project:

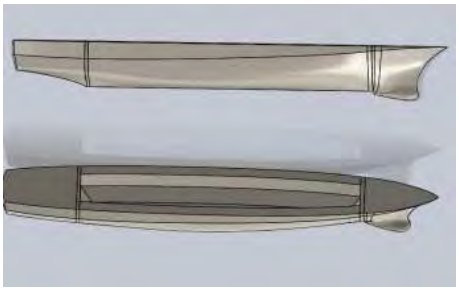
- UMaine's Forest Bioproducts Research Institute (FBRI) whom produces and provides 3% by weight Nanocellulose slurries; made right on the UMaine campus.
- FBRI provided financial support for Grad student tuition.
- Dr. Mehdi Tajvidi of UMaine has provided material consultation along with use of the INSTRON 5500R instrument for three point bend testing of the CNF material.
- Dr. Ian Dickey met twice to discuss the status of the current material as well as potential applications based on current and desired material properties.

Planned publications/presentations/grant funding targets related to the project:
Holomakoff has delivered a seminar presentation on campus, "Nanocellulose Fibers as Potential Biomaterial for Implantation," in December 2015 and April 2016. A provisional patent has been completed and filed as "Controlled Porosity Structural Material with Nanocellulose Fibers." This provisional patent can be publicly found and is currently being processed and transferred into a full patent. Other provisional patents are being pursued as well, all of which have the goal of industrial application which can be beneficial to the state of Maine.

Advancing Marine Technology for Naval and Commercial Ships Using the Alfond W2 Ocean Engineering Laboratory
Principal Investigator: Krish Thaigarajan (Mechanical Engineering, UMaine)
Co-PIs: Wilhelm Freiss (UMaine), Andrew Goupee (UMaine), Michael Davis (USM)
External Collaborators: General Dynamics Bath Iron Works
Student: Razieh Zangeneh

Description of Project: Naval and commercial boat building industries form the backbone of the State of Maine's marine economy. This project seeks to eliminate unpredictable, natural factors by testing a US Navy Combatant model in wind and waves at UMaine's Harold Alfond W2 Ocean Engineering Laboratory. This measurement will complement the wind wave tests of an ocean tanker model currently being tested at W2. Results disseminated through published products will establish confidence in the boat building industry both in Maine and beyond for performing experiments at the W2. This will enable new collaborations with boat builders and create opportunities for the proposers to seek funding from state, federal, and private industries for research that can improve the competitiveness for numerous Maine boat-building.

Project progress to date: Razieh Zangeneh worked on the scaling factor for the model, based on fitting the model into planned tow carriage requirements/limitations as well as collecting background articles and papers on the model and testing requirements. Zangeneh prepared a model hull requirement summary including the table of model ballasting in terms of the center of gravity (CG) and moment of inertia. She also prepared and submitted the test plan on the Destroyer model including the run types and the available peer-review published data to compare the result data as a part of validation. She is responsible for managing the model construction and instrumentation as well as testing.



Role and contributions of UMS campus and/or external partner(s) on the project: Bi-weekly meetings with project partners have been ongoing since June 2016. Senior naval architects from Bath Iron Works confirmed the advantages of using the geometry of the DTMB 5415 hull form and the appropriate scaling factor for the design of the model was chosen. Dr. Viselli, the manager of the UMaine Wave and Wind Lab showed interest to collaborate in the model construction and testing procedure. Therefore the model will be utilized to provide validation data for the tow carriage that is to be implemented at the W2 facility. The model is going to be built utilizing the new CNC router available at ASCC.

Planned publications/presentations/grant funding targets related to the project: It has been discussed that the results of tests could be presented as a conference paper in 30th American Towing Tank Conference (ATTC), 3-5 October 2017 in Carderock, MD. It will be a great opportunity to introduce the UMaine Wave and Wind Lab.

Appendix V.B: GA Grants | Rubric

Intellectual merit 25 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (25 POINTS)**	**Score**
Evaluation Criteria for Intellectual merit	Proposed research has significant deficiencies which compromise its likelihood of success	Proposed research has minor deficiencies but is likely to be somewhat successful	Proposed research is well conceived and is likely to be successful	Proposed research is very well conceived and is highly likely to be successful	
Relevance to Maine's economy 30 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (30 POINTS)**	**Score**
Evaluation Criteria for Relevance to Maine's economy	No clear link of the proposed activities to Maine's economy. Likelihood of job creation, workforce and economic development low	Proposed activities somewhat linked to Maine's economy. Likelihood of job creation, workforce and economic development moderate	Proposed activities well linked to Maine's economy. High likelihood of job creation, workforce and economic development	Proposed activities intimately linked to Maine's economy. Likelihood of job creation, workforce and economic development very high	
Mentoring Plan 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Mentoring Plan	Advisory committee composition and/or background are not appropriate, advisor/co-advisors lack experience, location and coursework are not well conceived and/or day-to-day advising is not available	Advisory committee composition and background are largely appropriate, advisor/co-advisors are somewhat experienced, location and coursework are somewhat problematic and/or day-to-day advising is generally available	Advisory committee composition and background are appropriate, advisor/co-advisors are experienced, location and coursework are well conceived and/or day-to-day advising is available	Advisory committee composition and background are highly appropriate, advisor/co-advisors are very experienced, location and coursework are very well conceived and day-to-day advising is available	
Extent of Collaboration 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Extent of Collaboration and Appropriateness of the Participants	Proposal has no evidence of collaboration across the UMS and/or external partners, collaborations are not clearly linked to the proposed activities, roles and responsibilities are not clearly defined	Proposal has some evidence of collaboration across the UMS and/or external partners, collaborations are linked to the proposed activities, roles and responsibilities are somewhat defined	Proposal has good collaboration across the UMS and/or external partners, collaborations are well linked to the proposed activities, roles and responsibilities are defined	Proposal has strong evidence of collaboration across multiple and/or external partners, collaborations are clearly linked to the proposed activities, roles and responsibilities are clearly defined	
Continued Support 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Plans for Student Support Beyond the Funding Period	No plan for continued student support beyond the funding period	Decent plan for continued student support beyond the funding period with some likelihood of success	Strong plan for continued student support beyond the funding period with high likelihood of success.	Comprehensive plan for continued student support beyond the funding period with very high likelihood of success.	
TOTAL POINTS					

APPENDIX VI: RRF Graduate Assistant Grants | Round 2 | AY 2018-2019

Appendix VI.A: GA Grants | Awardee List

Principle Investigator	Partners	Project Title
Damian Brady (School of Marine Sciences, UMaine)	Brian Beal (Environmental & Biological Science, UMM) Bridie McGreavy (Communication and Journalism, UMaine)	Modeling estuarine circulation on Maine mudflats to improve shellfish harvesting
Yong Chen (Department Marine Resources, UMaine)	Maine Department of Marine Resources Larry Jacobson (NOAA Northeast Fisheries Science Center) Richard Wahle (School of Marine Sciences, UMaine) Andrew Pershing (Gulf of Maine Research Institute)	Evaluating the effectiveness of Gulf of Maine lobster fishery resource monitoring programs under different climate change scenarios
Mindy Crandall (School of Forest Resources, UMaine)	Tora Johnson (UMM) Anica Miller-Rushing (Down East Research and Education Network)	The Value of Conservation Lands in Down East Maine
Adam Daigneault (School of Forest Resources, UMaine)	Ryan D. Wallace (Maine Center for Business and Economic Research) Mindy Crandall (School of Forest Resources, UMaine)	An Integrated Approach to Realizing the Value of Maine's Forest Resources
William Gramlich (Chemistry, UMaine)	Basile Tarchini (The Jackson Laboratory)	Norbornene functionalized carboxymethyl cellulose hydrogels for organotypic cochlear culture
Caitlin Howell (Chemical and Biological Engineering, UMaine)	Sandra Rieger (MDI Biological Laboratory) Douglas Currie (USM)	Vascularized Polymers for Spatially and Temporally Controlled Cell Stimulus
Melissa Landon (Civil & Environmental Engineering, UMaine)	Aaron Gallant (Civil & Environmental Engineering, UMaine) Richard Akers (Maine Marine Composites) Krish Thiagarajan (Mechanical Engineering, UMaine) Andrew Goupee (Mechanical Engineering, UMaine)	Assessing Novel Helical Anchor Design Capacity in Soils for Marine Renewable Energy and Aquaculture Applications
Michael Mason (Chemical and Biological Engineering, UMaine)	Douglas Bousfield (CHEME, UMaine) Ian Dickey (Colorado Limb Consultants)	Variable Porosity Nanocellulose Solid Forms for Biomedical Applications
Becca Matusovich (Muskie School of Public Service, Cutler Institute, USM)	Elise Bolda (Muskie School of Public Service, USM) Alireza Geshnizjani (Community Health Education Department, UMF)	SmilePartners: oral health as an economic development strategy
Principle Investigator	Partners	Project Title
Alessio Mortelliti (Wildlife Fisheries and Conservation Biology, UMaine)	Joseph Zydlewski (USGS) Aaron Weiskittel (School of Forest Resources, UMaine) Brian Roth (CFRU) Laura Kenefic (U.S. Forest Service)	Optimizing stand composition and forest regeneration strategies by improving understanding of important biological controls.

Balunkeswar Nayak (School of Food and Agriculture, UMaine)	Jinwu Wang (U.S. Forest Services) Douglas J. Gardner (FBRI, ASCC and School of Forest Resources, UMaine) Mehdi Tajvidi (School of Forest Resources, UMaine) Douglas Bousfield (Chemical and Biological Engineering, UMaine)	Value-addition of cellulose nanofibers (CNF) by developing food packaging materials and assessment on food safety.
Sarah Nelson (School of Forest Resources, UMaine)	Hamish Greig (School of Biology and Ecology, UMaine) Amanda Klemmer (Ecology and Environmental Sciences and School of Biology and Ecology, UMaine) Collin Eagles-Smith (U.S. Geological Survey) Colleen Flanagan Pritz (National Park Service)	Graduate student support to continue UM's lead role in the Dragonfly Mercury Project across US National Parks
Thomas Schwartz (Chemical and Biological Engineering, UMaine)	G. Peter van Walsum (Department of Chemical & Biological Engineering, UMaine) Scott J. Eaton (Maine Maritime Academy)	Biobased Lubricants and Fuels: Integration of Chemical Catalysis with Mixed Culture Fermentation
Rosemary Smith (Laboratory for Surface Science and Technology, UMaine)	Douglas Sawyer, MD (Maine Medical Center) Scott D. Collins (LASST and Chemistry, UMaine)	3D Printed Microfluidics for Directing Cardiomyogenesis on Chip

Modeling estuarine circulation on Maine mudflats to improve shellfish harvesting
Principal Investigator: Damian Brady (School of Marine Sciences, UMaine)
Co-PIs: Brain Beal (Environmental and Biological Sciences, UMM), Bridie McGreavy (UMaine)
External Collaborators: Kohl Kanwit (ME Dept. of Marine), Phil Gard (ME Dept. of Environmental Protection), Glen Melvin (ME Shellfish Advisory Council)
Economic Sector(s): Fisheries

Project Abstract: The soft-shell clam (*Mya arenaria*) fishery is the second most valuable resource of all marine species harvested in Maine, with an annual landing value of more than $22 million in 2015 (in fact, each of the last 3 years has been a record for the value of soft-shell clam landings). This intertidal fishery faces several threats, including frequent and widespread mudflat closures due to land uses that impact water quality and threaten public health. These closures that are related to high bacterial counts in seawater that clams filter negatively affect the approximately 2000 commercial shellfish harvesters who rely on this resource, many of whom work in coastal areas of Maine with few other employment opportunities. This project propose a collaboration between UMaine, UMaine Machias, Maine DMR, Maine DEP, clammers, and local citizens to develop a hydrodynamic model of the Medomak River Estuary (the most productive clam flat in Maine despite considerable water quality issues). A recently hired graduate student will be using the model to attempt to reclassify prohibited and conditional areas based on the best available data to expand harvest potential. This approach also represents an important model for how other clam flats and coastal economies in the state could take advantage of tools developed within the University of Maine System.

Planned Project Outcomes:
In consultation with regulators and clammers, we are developing metrics such as dilution zones, residence time, and flushing time that will give managers an indication of the zone of influence of a potential pollution source. As a result, targeted closures of conditional areas can go into effect after a precipitation event instead of a blanket closure of the entire estuary.

Since beginning this project in 2016, several exciting steps have been made: (1) a graduate student, Gabrielle Hillyer from Boston University, was hired and she has used the Fall 2016 semester to complete three required courses and networked with all of project partners; (2) the Medomak Valley Land Trust submitted and received a $4,931 grant from Maine Sea Grant entitled, “Medomak River Task Force Water Quality Improvement Project,” to explore microbial source tracking (a method to determine the source of bacterial pathogens); and, (3) PI’s have led grant submissions that directly address tracking freshwater derived bacteria in the coastal environment.

Evaluating the Effectiveness of Gulf of Maine Lobster Fishery Resource Monitoring Programs Under Different Climate Change Scenarios
Principal Investigator: Chen Yong (School of Marine Sciences, UMaine)
Co-PIs: Richard Wahle (School of Marine Sciences, UMaine)
External Collaborators: Kathleen Reardon (ME Dept. of Marine Resources), Larry Jacobson (NOAA Northeast Fisheries Science Center
Economic Sector(s): Marine Fisheries

Project Abstract: American lobster in the Gulf of Maine supports the most valuable fisheries in the USA and state of Maine. The spatio-temporal distribution of lobster population and landings has shown large changes over the last three decades and is projected to continue changing, which may result in large impacts on the performance of current monitoring programs that provide critical information for the assessment and management of lobster stock in the Gulf of Maine. This study is designed to evaluate the performance of the key lobster monitoring programs in the changing Gulf of Maine. The information derived in this study will provide critical information for developing a full proposal for improving lobster monitoring programs for the NOAA and State of Maine in a changing Gulf of Maine.

Planned Project Outcomes: The Maine-New Hampshire Bottom Trawl Survey (MENH-BTS) and the Lobster Sea Sampling (LSS) program play a primary role in providing precise estimates of lobster abundance indices and biological information for assessment and management of the GoM lobster stock. A recent study accomplished by the Chen Lab showed that the current design of the MENH-BTS can effectively capture the temporal lobster density dynamics in the GoM (Cao et al., 2014). However, the effectiveness of the LSS program has not been evaluated, and climate-driven shifts in lobster population may compromise the effectiveness of existing lobster stock monitoring programs (Cao et al., 2014). Accurate stock assessment with a well designed resource monitoring program can provide a representative view of the lobster stock and assist managers to make informed decisions. Thus, it is critical to evaluate the effectiveness of MENHBTS and LSS designs in capturing lobster population dynamics in the climatically-altered GoM environment. To this end, the objective of this study is to evaluate the effectiveness of MENH-BTS and LSS designs by projecting how well the current space-time frame of the MENH-BTS and LSS programs can capture the GoM lobster population dynamics under different climate change scenarios. This study will be divided into two tasks. First, a climate-niche model for American lobster will be used to simulate lobster abundance distribution under three different climate change scenarios. Second, simulated lobster abundance distribution will be used to project the proportion of GoM lobster stock which falls within the current space-time frame of MENH-BTS and LSS programs to evaluate their effectiveness in monitoring the GoM lobster under each climate scenario.

The approaches and results derived in this study will be used to develop a full proposal for improved monitoring and assessment of lobster fishery in the GoM submitted to Maine State and NOAA funding programs. The results will be presented to Maine Fishermen's Forum, Maine Department of Marine Resources and Maine Lobstermen's Association. This study will also report to Atlantic States Marine Fisheries Commission which is responsible for the assessment and management of the GoM lobster fishery.

The Value of Conservation Lands in Down East Maine
Principal Investigator: Mindy Crandall (School of Forest Resources, UMaine)
Co-PIs: Tora Johnson (UMM),
External Collaborators: Anica Miller-Rushing (Down East Research and Education Network
Economic Sector(s): Natural Resources

Project Abstract: Maine's economic growth has long been reliant on exploitation of our abundant natural resources. Historically, that has meant that much of our economic activity took place in dispersed, rural communities, places where residents and jobs were closely tied to the land base and local land use. As the national and global economy shifts to a service base from a manufacturing and resource base, the fates of small, rural Maine communities are increasingly uncertain.
This project will estimate the value of conservation lands in a two-county area of Maine greatly affected by changes in land use between forestry, agriculture, aquaculture, conservation, and tourism. In addition, updated GIS information on current land status and socio-economic characteristics of the region will be compiled and made publicly available. This information, along with the final report estimating both market and non-market values of conservation lands, will empower local leaders in the conservation community and in local planning to make wise decisions and to advocate for a cohesive strategy that will promote holistic development for a region struggling with areas of high unemployment and low incomes.
This project harnesses the expertise of two of Maine's public universities for the needs of local communities. Outreach to local communities will be made possible by drawing on extensive project partner networks. The stakeholder-driven research and outputs will be instrumental in providing timely information to an area that can benefit from cohesive, knowledge-driven economic development.

Planned Project Outcomes: The study will produce three major outputs developed in close collaboration with stakeholders on the DEREN steering committee. First, an updated, detailed GIS layer of the current status of land in the two Down East counties (Hancock and Washington) will be compiled. This information will be freely and publicly available through UMM's web-based, interactive mapping system and incorporated into existing online maps used for local and regional planning. Second, the valuation of conservation lands will be assessed, drawing on economic and social science research. Following up-to-date peer-reviewed standards and research, an ecosystem services (ES) framework will be applied to assess the relative provision of both market and non-market ES from the land in the two county area. Valuation of lands will be determined by both a benefits transfer methodology as well as a standard input-output methodology for non-market and market goods and services, respectively. The use of an ES framework will allow for this work to be expanded upon in future research, with potential benefits to the entire state. Finally, a report on the status of Down East Maine with respect to land use and conservation land value will be produced. In a series of community discussions both before and after the drafting of the preliminary report, we will present results, facilitate discussions, and ask for feedback. This collaboration with local communities will provide guidance on how to best disseminate the results, and the two-way communication approach followed here will be crucial to maintaining open channels with local stakeholders. The final report will help citizens create informed plans for the future by incorporating best available knowledge about the economic value of different land uses and the potential impacts of land use change in the region. By giving local people knowledge and agency to make informed decisions, we aim to improve local outcomes in both absolute economic terms as well as improve local outcomes in both absolute economic terms as well as improve local communication and buy-in for future development and/or land use coordination and planning.

An Integrated Approach to Realizing the Value of Maine's Forest Resources
Principal Investigator: Adam Daigneault (School of Forest Resources, UMaine)
Co-PIs: Ryan Wallace (USM), Mindy Crandall (UMaine)
Economic Sector(s): Forest Resources

Project Abstract: Forests provide many critical ecosystem services, including production of fiber resources, carbon sequestration, protection of freshwater, and preservation of cultural values. In Maine, the economy depends heavily on the resource, which faces increasing pressure from shifts in ownership, declining markets, disturbance agents, and climate change. There is a continuing interest in determining the value of emerging markets and opportunities for Maine's forest product industry and identifying cost-effective policies to achieve its market potential. Despite ample opportunities for better utilizing Maine's forest resources, many uncertainties remain about how to translate pilot projects and proven ideas into commercialized entities, positive financial returns, and tangible socio-economic benefits. In addition, the current array of research associated with the forest products industry within the University of Maine System could benefit from a more integrated and systematic effort. To address this, researchers will collaborate to develop an integrated approach to realizing the value of Maine's forest resources. The research has two key objectives: (1) Develop an interactive database that tracks key indicators of the Maine forest products industry and a larger set of forest ecosystem services; and (2) Identify policy options to facilitate efficient and cost-effective pathways for transforming UMS' forest products research into commercial-scale investments, improved land management activities, and sustainable business practices that enhance Maine's economy. This project will serve as the basis for further funding for research that expands the University of Maine Systems' capacity and capability to develop effective and cost-efficient decision support tools to facilitate more efficient and effective utilization of Maine's forest resources.

Planned Project Outcomes: The project intends to produce the following outputs/outcomes:
1. Interactive database containing key indicators of the Maine forest products industry forest ecosystem services developed and made available to forest resource stakeholders.
2. A series of fact sheets on current trends, relevant policy, and emerging markets related to Maine's forest economy that are made available to the general public and frequently updated.
3. Publications submitted to peer-reviewed journals.
4. Research seminars and/or professional presentations to publicize work efforts and ascertain stakeholder interest.
5. Integrated framework for maximizing on the value of Maine's forest resources developed and utilized by the University of Maine System and greater forest products industry.

Norbornene Functionalized Carboxymethyl Cellulose Hydrogels for Organotypic Cochlear Culture
Principal Investigator: William Gramlich (School of Biomedical Science and Engineering, UMaine)
External Collaborators: Basile Tarchini (The Jackson Laboratory)
Economic Sector(s): Biotechnology and Forest Bioproducts

Project Abstract: Biomedical researchers studying cochlear development desire 3D cell and organ culture materials that mimic the spatiotemporal nature of the native extracellular matrix (ECM). In the proposed work, norbornene functionalized carboxymethyl cellulose (NorCMC) hydrogels will be investigated to retain the structure and viability of cochlea explants during culture. Chemistry will be developed to spatiotemporally modify the NorCMC hydrogel to mimic changes to the ECM during cochlea development. By completing these tasks, NorCMC hydrogels will be validated for cell and organ culture, creating a possible high value product for Maine forest bioproducts and preliminary data for future federal funding. Moreover, a senior chemistry Ph.D. student will gain valuable biomedical experience through this interdisciplinary project that will prepare her for a career in biotechnology.

Planned Project Outcomes: The specific aims of the proposed work are 1) formulate NorCMC hydrogels for cochlear explant culture and 2) develop methods to spatiotemporally change hydrogel properties during culture. By completing these specific aims, the NorCMC hydrogel system will be validated for use in biomedical laboratories, providing researchers with a new matrix to effectively study cellular and organ behavior.

Vascularized Polymers for Spatially and Temporally Controlled Cell Stimulus
Principal Investigator: Caitlin Howell (Chemical and Biological Engineering, UMaine)
Co-PIs: Douglas Currie (USM)
External Collaborators: Sandra Rieger (MDI Biological Laboratory)
Economic Sector(s): MTI's Maine Technology Sector of Biotechnology

Project Abstract: Nature uses vascular systems to facilitate and control many adaptable and dynamic responses of living tissue surfaces. A new approach will be used to create polymer surfaces designed to control cell stimuli both spatially and temporally using an approach inspired by natural vascular systems. The support requested here will be used for Kayla Marquis (B.S. Biological Engineering, UMaine 2017) as she pursues her Master's degree. The result will a new set of materials for use in tissue culture, which will contribute to Maine's economy through (1) the expansion of a currently patented technology held by SLIPS Technologies, Inc, who would be interested in further commercializing and marketing the product to Maine-based biotechnology firms such as IDEXX and Corning Life Sciences in Kennebunk and (2) the development of research capabilities at MDI Biological Laboratory as well as the Universities of Maine and Southern Maine, which will serve to attracted both more talented researchers and more research dollars to the state.

Planned Project Outcomes: With the data generated here, we will be able to convincingly demonstrate the potential of applying the vascularized polymer concept patented by Dr. Howell to tissue culture. Furthermore, development of this approach will lead to further applications, including the potential use of this system to deliver compounds currently patented by Dr. Rieger which prevent sensory axon degeneration and promote regeneration under conditions of chemotherapy. We expect to produce at least 1 publication to demonstrate our success as collaborators, as well as optimized material prototypes. This will allow us to submit for large-scale funding from e.g. the Department of Defense (Military Medical Research and Development Fund), the NIH (BRAIN Initiative), or even a Maine Space grant through NASA for the application of this technique to other applications such as biofilm control. The combined bio/liquid interface expertise of the Howell Lab, the neural regeneration expertise of Rieger Lab, the neural toxicity expertise of the Currie Lab, as well as the support of SLIPS Technologies, Inc. will also ensure that the advances made as part of this work are translated into Maine's biotechnology and high-level sectors as soon possible, further increasing the likelihood of an ultimately successful economic/commercial impact.

Assessing Novel Helical Anchor Design Capacity in Soils for Marine Renewable Energy and Aquaculture Applications
Principal Investigator: Melissa Landon (Civil and Environmental Engineering, UMaine)
Co-PIs: Aaron Gallant (UMaine), Krish Thiagarajan (UMaine), Andrew Goupee (UMaine)
External Collaborators: Richard Akers (Maine Marine Composites)
Economic Sector(s): Marine, Composites, Marine Renewable, Energy, Aquaculture

Project Abstract: This project aims to assess a novel composite helical anchor for marine renewable energy and aquaculture applications by partnering with a Maine-based company, Maine Marine Composites (MMC). The objectives of this research are to evaluate the complex soil-structure interaction and geotechnical capacities that can be obtained with helical anchor systems for offshore applications, and aid in development of a new composite helical anchor that will provide an economic alternative to traditional offshore foundation types.

Planned Project Outcomes: The Ph.D. student will use parametric studies to inform initial composite anchor designs by MMC. Following the first year, additional sources of funding will be sought to support instrumented bench and field scale tests to update and validate numerical analyses based on observed performance. Differences between predicted (numerical analyses) and observed performance (physical testing) will be reconciled by evaluating the validity of assumed soil constitutive parameters, composite properties, loading, and inherent limitations with numerical models. Physical testing and numerical simulations will be used to develop typical design charts that consider required geotechnical capacity, anchor depths, helical plate size, and anchor spacing/efficiency based on composite material strength and soil properties. In addition to regular engagement and training alongside a Maine based engineering company (MMC) that's associated with marine industries, including offshore renewable energy and aquaculture, the chosen graduate student will acquire a broad, 21st century engineering skillset and experience in geotechnical, structural, and material engineering. These skills are currently in high demand by Maine companies/industries. An aging workforce will soon result in even higher demand as engineering professionals leave the workforce and enter retirement. Collaborative research by this team directly supports the mission of the U.S. DOE. The proposed research is directly linked to current Office of Energy Efficiency and Renewable Energy (EERE) solicitation aimed at Marine and Hydrokinetic Technology Development and Advancement seeking to "develop innovative technologies that have the potential to significantly advance MHK technologies and the state of the MHK industry." This work additionally has potential with external funding organizations like the National Science Foundation (NSF) and Bureau of Ocean Energy Management (BOEM), who are interested in resilient and sustainable advancement of geotechnical and marine technology. Proposals are planned for submission to U.S. DOE and NSF in year 2.

Maine Marine Composites

Variable Porosity Nanocellulose Solid Forms for Biomedical Applications
Principal Investigator: Michael Mason (Chemical and Biological Engineering, UMaine)
Co-PIs: Douglas Bousfield (UMaine)
External Collaborators: Ian Dickey (Colorado Limb Consultants)
Economic Sector(s): Biotechnology

Project Abstract: Biomedical and material scientists and engineers are constantly seeking to develop new materials, or new applications of existing materials, that address existing and emerging challenges in human health. Dehydrated cellulose Nano-fiber (CNF), produced here at UMaine, is one such material, which in solid-form, could have a number of potential biomedical applications. Under the appropriate processing conditions, CNF solid-forms can be produced with impressive mechanical properties (porosity, strength-to-weight ratios, modulus, machinability, durability, etc.). Recent work suggests that non-treated CNF based materials cause no toxic effects on fibroblast cell membranes or during DNA proliferation and cause no effect on the inflammatory response in mouse or human macrophages. These properties, for example, implicate CNF as a potential synthetic bone or surgical bone scaffold. Leveraging the support of the RRF assistantship, we propose to continue to investigate the efficacy of CNF solid-forms for this application, generating the data we need to seek continued extramural funding, including commercialization opportunities within the Maine business community. Specifically, we propose to develop the enabling technology necessary to generate high porosity (large pore size), and variable porosity CNF solid forms, mimicking natural bone.

Planned Project Outcomes: Based on input from our medical/surgical collaborator (Dr. Ian Dickey), we have specifically targeted bone grafting devices (spacers/plugs) as one such promising application area. These devices specifically require high porosity large pore size, yet strong material systems, with and without an external low porosity 'skin'. While we have had some success, it remains a challenge to reliably produce materials exhibiting adequately large pore sizes, and large porosities while still preserving the desired mechanical properties. We believe that this technology could have significant economic impact for Maine, provided additional studies are conducted that generate data necessary for specific biomedical markets. In addition to continuing to assess the mechanical and material properties, including the possibility of tissue ingrowth, of our homogeneous CNF solid forms, the proposed project will continue to improve upon our current method used to produce large pore volume and variable porosity materials.
The goals will be to 1) controllably and reproducibly generate produce CNF based synthetic bone with high porosity and high pore volume and 2) expand the process to include the ability to generate a dense outer layer mimicking real bone.

SmilePartners: Oral Health as an Economic Development Strategy
Principal Investigator: Becca Matusovich (Muskie School of Public Service, USM)
Co-PIs: Elise Bolda (USM), Alireza Geshnizjani (UMF)
Economic Sector(s): Economic development and workforce development across MEIF sectors

Project Abstract: Preventable dental disease is a major cause of lost school and work days, and one of Maine's leading causes of avoidable emergency room visits for pain and infection, especially among young adults. Year after year, this takes a serious toll on the financial stability of individuals who often end up with medical debt (the leading cause of unpaid collections and personal bankruptcy in the U.S.), and negatively impacts health insurance costs and business productivity. This project capitalizes on a unique opportunity to research an innovative systemic intervention, called SmilePartners, which provides new options for low-wage employees without dental benefits to restore and protect their oral health. It focuses on economic development drivers such as improving the health and stability of the workforce, reducing the cost of doing business, and over time promises positive impact on related measures of growth, especially those related to workforce development and employer health care costs. The project scope includes exploration of: employers' perceptions about the importance and value of improved oral health; factors driving interest in SmilePartners sponsorship among employers are unable to provide dental insurance; indicators of greatest value to employers to assess return on investment for sponsorship costs; options for engaging other stakeholders, such as hospitals and health systems, in sharing the costs of the intervention delivery; the appropriate scale and research design for a larger demonstration to test the proof of concept/prototype that will be developed during the project. The focus will initially be on identifying interested employers in the MEIF sectors, and then will expand to identify interested employers in other sectors as well.

Planned Project Outcomes: The GA will conduct a literature review, carry out a scan of the MEIF sectors and other business sectors to identify categories of employers least likely to be offering dental insurance to low-wage workers, develop and implement an outreach plan to identify and engage employers who might be interested in exploring a SmilePartners sponsorship model, and build a core group of employer partners to provide input into the design of the proof of concept/prototype for the SmilePartners sponsorship model. This project will help position the USM and UMF faculty/staff partners on the Advising Committee to pursue a future collaborative research grant to support evaluation of a larger demonstration, with the design to be developed over the course of this project. For example, several national funders, including Robert Wood Johnson Foundation, Kresge Foundation, Commonwealth Foundation, and Agency for Healthcare Resources and Quality (AHRQ), have regularly been offering funding opportunities for innovative health financing research, for which such a demonstration project could be a competitive. This project will set the team up to submit a proposal for a larger scale demonstration and evaluation in fall of 2018. Expanded support for the hired Grad and Undergrad assistants and/or additional future Grad/Undergrad assistants will be included in the budget for these proposals.

Optimizing stand composition and forest regeneration strategies by improving understanding of important biological controls

Principal Investigator: Allesio Mortelliti (Wildlife, Fisheries, and Conservation Biology, UMaine)
Co-PIs: Joeseph Zydlewski (USGS), Brian Roth (CFRU), Aaron Weiskittel (UMaine), Laura Kenefic (USFS)
Economic Sector(s): Forestry

Abstract: Forests and forest products play a major role in Maine's economy and 97% of the forest area in Maine is subject to natural regeneration. Because regeneration is natural, forest managers rely extensively on regeneration models and forest vegetation simulators to forecast stand composition and productivity under different management scenarios. These models play a critical role in modern day forestry, a role which is equivalent to simulation software in engineering or crop simulation models in agriculture. Currently, regeneration models mainly focus on physical rather than biological parameters. For example, the key role of small mammals is not included within model parameters; this is a major shortcoming because small mammals play a fundamental role in forest regeneration through seed predation. Empirical evidence shows that small mammals can prevent up to 95% of recruitment of their preferred tree species, such as the commercially valuable white pine and red spruce.

The overarching goal of this project is to improve the predictive performance of forest growth models by developing a module within existing software to quantify the effect of small mammals on seed predation and forest regeneration dynamics. The increased predictive performance in forecasting stand regeneration and in evaluating management scenarios is expected to lead to a) greater agreement between modeled outcomes and real world forest dynamics, b) more robust management decisions, c) increased profits for the forestry industry, and d) workforce development through specialist training in partnerships with stakeholders. This project involves 5 different institutions and is structured as a collaboration between the end-users of regeneration models (timber companies, forestland owners and managers), model developers (biometricians working in the School of Forest Resources) and specialists in the study of wildlife impacts and forest developmental processes (USGS, U.S. Forest Service, UMaine). The role of the undergraduate assistants will be to conduct experiments in the field. The results of these experiments will be used by the investigators to implement the small mammal module of the regeneration software. This will give leverage to the project, making additional funding more attainable and allowing for further modifications to regeneration software at a level where economic impact will be generated.

Planned Project Outcomes:

The specific objectives related to the grant activity are to: 1) Quantify seed predation rates of various commercial tree species and how these, in turn, affect their natural regeneration (seedling emergence). 2) Develop and implement the module of the regeneration model that includes the predation rates of small mammals.

Example of the grants to target are: 1) NSF 'Career' grant and NSF DEB-Core Programs (yearly calls), 2) Northeastern States Research Cooperative grants, 3) Importantly, funding will be solicited from the CFRU (partner in this project) whose members include all the major stakeholders in the forestry industry.

Value-Addition of Cellulose Nanofibers (CNF) By Developing Food Packaging Materials and Assessment on Food Safety
Principal Investigator: Nayak Balunkeswar (Chemical and Biological Engineering, UMaine)
Co-PIs: Douglas Gardner (UMaine)
External Collaborators: Jinwu Wang (USFS)
Economic Sector(s): Forestry and Agriculture, Composite Materials Technology

Project Abstract: This application proposes research-based training of a graduate student at UMaine. The student will engage in research and training in cross-disciplinary areas including food process engineering, cellulose nanocomposite and polymer science. The research component of the proposal focuses on the value-addition of cellulose nano-fibers (CNF) by developing food packaging materials and assessing their impact on food safety. Considering the duration of this assistantship application, the focus will be on studies on the migration of CNF from modified paper and polymer film into food materials. The objective of the proposed work is to apply standard food characterization protocols to measure the migration of CNF during food processing using simulated food materials. However, the complete and long-term scope of the study has been designed to include the potential of CNF on reduction of biofilm as well as an anti-microbial compound. We believe that application of CNF as packaging materials and polymer films can use Maine's abundant wood fiber supply and key to the commercialization of cellulose nanomaterials in the state and the country. The outcomes from this project will be used as the basis for a federal funding application to USDA-NIFA/Nanotechnology program, Industry based consortium and Advanced food safety challenge programs of USDA.

Planned Project Outcomes: The objective of this project is to study the migration of CNF using food simulant extraction protocols on two CNF modified materials (paper and polythene film) that can be used in food processing. This will be accomplished by migrating CNF into food and quantifying the migration. The migration protocols will also be used for CNF coated papers intended for repeated use.

Graduate student support to continue UMaine's lead role in the Dragonfly Mercury Project across US National Parks
Principal Investigator: Sarah Nelson (School of Forest Resources, UMaine)
Co-PIs: Hamish Grieg (UMaine), Amanda Klemmer (UMaine)
External Collaborators: Collin Eagles-Smith (USGS), Colleen Flanagan Pritz (National Park Servie)
Economic Sector(s): Maine's Natural Resources Economy

Project Abstract: The Dragonfly Mercury Project (DMP) engages citizen scientists in monitoring mercury contamination in National Parks across the US. The scientist team at the University of Maine (UM), US Geological Survey, and National Park Service (NPS) enlist park staff or community partners, who lead teams of citizen scientists in the collection of dragonfly larvae, effective biosentinels for mercury pollution. Dragonflies are analyzed at UM and USGS laboratories for mercury, a global pollutant that affects resources the NPS is charged with protecting. The DMP spans more than 200 unique locations across over 60 national parks throughout the US. Since 2011, when the project began as a UM pilot effort, parks have sampled dragonfly larvae for mercury to determine: (1) baseline mercury concentrations in national parks prior to implementation of national and international mercury use and emission controls; and, (2) which habitats and catchment characteristics influence vulnerability to mercury accumulation in foodwebs. This proposal requests funding for a graduate student who would strengthen UM's leadership in this project by serving as a central coordinator, and move the science forward through novel data analyses and synthesis. Further, the student and the project would benefit from a mini-exchange at the USGS Corvallis contaminants lab, among the top in our field. Dragonflies are charismatic biota that garner great interest from park visitors, students, and citizen scientists, over 2,500 of whom have participated in this nationwide project. This project supports broadening participation in STEM by the inclusion of citizen scientists, mainly high school students, and provides student recruiting opportunities for UM. The project engages citizens in science and supports Maine's nature-based tourism economy, our largest economic sector. This project directly supports UM because it would allow the project team to capture $104,500 in federal and partner funds that are available if non-federal match like this award can be secured. Continuation of the project's large-scale, temporally continuous dataset will allow the project team to compete for funds that would enable longer-term support of this research.

Planned Project Outcomes: The graduate student hired with this funding source would fulfill a key role by acting as lead coordinator for the project during 2017-2018. After five years of project implementation, the top priority for the research team is to have a single point of contact for all participating parks, who can assist with field and laboratory coordination nationwide. The student would also assist park staff at Acadia and the newly established Katahdin Woods and Waters National Monument with field sampling. The student would have access to the project database for their MS research in Ecology and Environmental Sciences (EES): one of the most comprehensive and largest Hg datasets available in the US. In coordinating with parks nationwide, the student would synthesize dragonfly Hg data with other, locally-collected datasets to allow the project to begin to make inferences about the effects of Hg on local and regional foodwebs. Further, the student would work with USGS partners and travel to their labs in a 'mini-exchange' to gain access to the top Federal laboratories and scientists in the field, as well as working with UM's high-quality Sawyer Laboratory.

Biobased Lubricants and Fuels: Integration of Chemical Catalysis with Mixed Culture Fermentation
Principal Investigator: Thomas Schwartz (Chemical and Biological Engineering, UMaine)
Co-PIs: G. Peter van Walsum (UMaine), Scott Eaton (Maine Maritime Academy)
Economic Sector(s): Forest Products, Agriculture, and Aquaculture

Project Abstract: Motivated by a shale-gas-driven shift to lighter (C1-C3) petroleum feedstocks, we propose to demonstrate that biomass is a suitable alternative for the production of high-carbon-number, value-added chemicals. In particular, we will focus on the synthesis of biobased lubricant base stocks. Our primary research goal is to convert local biomass to these base stocks using a combination of chemical and biological processing. Fermentation will be used to produce a mixture of medium-chain-length carboxylic acids that is suitable for further oligomerization using heterogeneous chemical catalysis. The end product will be a mixture of C20-C30 molecules that is analogous to existing synthetic lubricants.

Planned Project Outcomes: To achieve this research goal, the following objectives will be met:
1.Demonstrate mixed culture acidogenic digestion (AcD) of local feedstocks to yield a mixture of carboxylic acids
2.Demonstrate chain elongation during AcD by enrichment of the broth with ethanol
3.Demonstrate selective separation of medium-chain-length-acids (e.g., caproic acid) from the fermentation broth
4.Convert esters of these mixed acids to lubricant base-stocks using bifunctional metal/mixedoxide catalysts
5.Elucidate the nature of the active sites that are present on these catalysts
6.Design an improved catalyst for producing lubricants from esters of mixed carboxylic acids
7.Quantify industrially-relevant properties of the product oils

3D Printed Microfluidics for Directing Cardiomyogenesis on Chip
Principal Investigator: Rosemary Smith (Electrical and Computer Engineering, UMaine)
Co-PIs: Scott Collins (UMaine)
External Collaborators: Douglas Sawyer (Maine Medical Center)
Economic Sector(s): Precision Manufacturing Technology and Biotechnology

Project Abstract: This Graduate RA project will explore the application of 3D printing technology to realize microfluidic control of the chemical environment of pluripotent cell cultures, with application to directing cardiomyogenesis in vitro. This is a collaborative project between scientists and engineers at UMaine and MMCRI. Funding to support one PhD student, for one year, is requested for a feasibility study, which is expected to produce at least one publication, a demonstration device, and an extramural grant application. Continuation funding will be sought through grant and fellowship applications.

Planned Project Outcomes: The goals of this one year project will be to a) determine the ultimate resolution and surface roughness using manufacturer's materials, b) determine feasibility of using biomedical grade materials from OEM or other suppliers, c) test biocompatibility of materials with cell culture and d) fabricate and test a prototype device for imposing 3D chemical gradients within a 3D cell matrix. At the conclusion of this project, we expect to know if 3D printing is feasible for our studies of cardiomyogenesis on chip. The results of the biocompatibility studies will be the subject of a journal publication and/or conference presentation. If materials are compatible, this new approach will enable the fabrication of unique, highly functional and low cost designs that will be the subject of additional publications, grant proposals (to NSF and NIH), and patents.

Maine Medical Center
MaineHealth
centered around you

APPENDIX VII: RRF Undergraduate Assistantship Grants | Round 1 | AY 2017-2018

Appendix VII.A: UGA Grants | Awardee List

Principal Investigator	Partners	Project Title
Damian Brady (Marine Sciences, UMaine)	Bureau of Public Health, Maine Department of Environmental Protection, Maine Shellfish Advisory Council	Modeling estuarine circulation on Maine mudflats to improve shellfish harvesting
Jason Bolton (Food Science & Cooperative Extension, UMaine)	Maine Technology Institute	OIED RRF Proposal for 2 Graduate Assistantships
Yong Chen (Zoology & Marine Science, UMaine)	Maine Department of Marine Resources	Estimating spatial non-stationarity of American lobster
Yong Chen (Zoology & Marine Science, UMaine)	Maine Department of Marine Resources, NOAA	RRF Graduate Assistant Proposal for PhD Candidate
Yong Chen (Zoology & Marine Science, UMaine)	Northeast Fisheries Science Center, NOAA, Gulf of Maine Research Institute	Incorporating environmental variability into assessment and management of American lobster (Homarus americanus)
Yong Chen (Zoology & Marine Science, UMaine)	Northeast Fisheries Science Center, NOAA	Development of a modeling framework to assess the effects of environmental heterogeneity in sea scallop (Placopecten magellanicus) abundance, distribution, and growth: Application to the Maine fishery
Yong Chen (Zoology & Marine Science, UMaine)	NOAA, Maine Department of Marine Resources	Facilitating Development of Statistical Models to improve estimation of incidental cod catch
Teresa Johnson (Marine Sciences, UMaine)	Northeast Fisheries Science Center	Marine Biology and Marine Policy MS student working to inform the management and planning efforts in the lobster industry
Lenard Kaye (Social Work, UMaine)	Scope of this project is across the UMS campuses	GA Support Request to Bolster Aging Research Connections across the UMS
Michael Mason (Chemical and Biological Engineering, UMaine)	EMMC	Variable Porosity Nanocellulose Solid Forms for Biomedical Applications
Krish Thiagarajan (Mechanical Engineering, UMaine)	General Dynamics Bath Iron Works	Advancing marine technology for naval and commercial ships using the Alfond W2 OCean Engineering Laboratory

Appendix VII.B: UGA Grants | Abstracts and Updates | AY 2017 – 2018

Field and Laboratory Trials to Examine Growth and Survival of a New Bivalve Culture Candidate in Maine: Arctic surfclams, Mactromeris polynyma
Principal Investigator: Brain Beal (Environmental and Biological Sciences, UMM)
External Collaborators: Dianne Tilton (Downeast Institute for Applied Marine Research and Education)
Economic Sector(s): Aquaculture and Marine Technology

Project Abstract: Thanks to funding over the past five years from the National Science Foundation, MEIF-SCI, and USDA's SBIR program, Arctic surfclams, *Mactromeris polynyma*, are a new culture candidate in Maine. Work has progressed on the hatchery and nursery phases of this shallow-burrowing, suspension-feeding bivalve, so that we are confident that commercial-scale production of juveniles can occur. Pilot-scale field studies, however, have revealed difficulties in bringing cultured animals from a seed size (6-10 mm in shell length, SL) to a commercial size (40-50 mm SL). The main problem is overcoming predation on juvenile surfclams by decapod crustaceans - lobsters, rock crabs, and green crabs. The proposed work will be conducted in eastern Maine with our partner, the Downeast Institute for Applied Marine Research and Education. The work will focus on a variety of techniques to minimize the effectiveness of these crustaceans using field and laboratory experiments to examine the interactive effects of numerous factors (e.g., initial surfclam size; type and aperture size of protective netting; planting location and intertidal height; and, sediment type) over the summer and fall of 2017, and spring of 2018. Two undergraduate students from the University of Maine at Machias (junior or senior standing in the Marine Biology program) will participate in the research with the goal of producing results that can be presented in a research public forum similar to the SEA fellows program from 2016 as well as at least one manuscript that can be submitted to a peer-review journal for publication.

Planned Project Outcomes:
The goal is to produce work to be presented by students in a research forum or in a focused fisheries and aquaculture setting such as the Maine Fishermen's Forum. Ultimately, we want students to conduct high-quality work and author papers to be published in peer-review journals.

UMM students will be selected competitively. Those given preference will have completed both MAT 215 (Applied Statistics; 4 cr) and BIO/MAT 315 (Experimental Design and Analysis for Biologists; 4 cr).

Controlling Damaging Ciliates in Sea Vegetable Aquaculture with a Focus on Laver Culture

Principal Investigator: Susan Brawley (School of Marine Science, UMaine)
Co-PIs: Stephen Eddy (UMaine, Center for Cooperative Aquaculture Research (CCAR))
Economic Sector(s): Aquaculture and Marine Technology

Project Abstract: This project has two key aims: 1) developing protocols to eliminate ciliates from stock and production cultures of the sea vegetables alaria, dulse, and laver, and 2) establishing conchocelis cultures on oyster shells of summer "laver" species in order to expand the candidate crops to a 12 month period. Summer is an ideal time to begin this work since it is when ciliate problems most afflict work at the Center for Cooperative Aquaculture Research (CCAR), and because species needed for starting conchocelis culture are available then.

A series of compounds will be tested on ciliates + dulse/tetraspores, ciliates + laver/neutral spores, and ciliates + alaria gametophytes/zoospores in well-replicated experiments. A methodical approach to testing some of these compounds is needed, and it is ideal for the undergraduate RRF opportunity. Kyle Capistrant-Fossa, a UMaine senior beginning in spring semester 2017, is the ideal candidate due to his keen interest in doing aquaculture research on sea vegetables for his required senior capstone. Kyle's stated goal is to continue into graduate school for his M.S. in research on sea vegetable aquaculture. Zygotospores will be isolated from Wildemania and Boreophyllum to establish conchocelis, and we will determine in the ensuing fall semester what photoperiods and temperatures to use to release conchospores for net-seeding. Results will be shared frequently with commercial partners. Outreach to the public by Mr. Capistrant-Fossa will be aided by meetings with the Maine Sea Coast Vegetables (MCSV) outreach team, at their invitation, to reach adults and local school children in the greater Ellsworth area.

Planned Project Outcomes: Mr. Capistrant-Fossa will collect lavers that are present as blades and fertile only in summer in June-August. Zygotospores from these species will be established on autoclaved oyster shells at CCAR, and from the literature and the project's experiments over the supported year, work out the temperature and photoperiod for bringing conchospores to maturity for seeding nets. Results will be shared frequently with commercial partners. Outreach to the public by Mr. Capistrant-Fossa will be aided by meetings with the MCSV outreach team, at their invitation, to reach adults and local school children in the greater Ellsworth area.

Bee Hive Activity Monitoring System
Principal Investigator: Nuri Emanetoglu (Electrical and Computer Engineering, UMaine)
Co-PIs: Francis Drummond (Biology & Ecology, UMaine)
Economic Sector(s): Agriculture, Information Technologies

Project Abstract: A Doppler radar based bee hive activity monitoring system is proposed as an early-warning tool against colony collapse disorder (CCD). Bees pollinate up to 80% of US crops, including blueberries and other crops in Maine. The last decade has seen an increasing rate of CCD, which refers to worker bees abandoning a hive and leaving behind the queen to starve. Current bee hive monitors are either expensive, need to be built into the hive, or both. An inexpensive and portable beehive activity monitoring system would benefit both bee researchers and commercial and hobbyist beekeepers. Proof-of-concept experiments were carried out in summer 2016 to show that a Doppler radar based system could be used to determine bee activity levels, which were correlated to time of day, weather conditions and bee colony size. A rigorous study covering five or more hives of different size and health with will demonstrate the validity of this approach and position the team for an MTI or NSF I-Corps type proposal. An undergraduate student will help construct and deploy 10.5 GHz Doppler radar based beehive monitoring units at Rogers Farm. At least five hives of different colony size and health will be monitored during the summer of 2017. Results will be correlated with beekeeper observations and weather data during the academic year of 2017-2018 and a second generation prototype will be designed.

Planned Project Outcomes:
Five bee activity monitors using the 10.5 GHz HB-100 transceiver will be built and deployed at Rogers farm during the summer of 2017. Activity levels will be recorded to the SD card every second, over a period of three months. During the 2017-18 academic year, the data will be correlated with observations of colony size and health by Dr. Drummond's group, weather conditions, and time of day. The undergraduate assistant will be responsible for the construction and installation of the bee activity monitors, and weekly collection of the data during the summer, and data analysis during the academic year. The student will also assist in the design of a second generation 10.5 GHz bee activity monitor.

As prior work was partially funded by an NSF REU grant, the team is eligible to apply for an NSF I-Corps grant to start a new company based on this technology. Techstart and Seed grants from the Maine Technology Institute would be complementary grant opportunities to the NSF I-Corps program, along with SBIR and STTR grants from the NSF or the Department of Agriculture. Private organizations would be other sources for initial funding of the company. An alternative to creating a start-up would be for the University system to license the invention to a Maine based company such as Idexx (Westbrook) or Sensory Cyber Systems (Orono).

Two student presentations are planned. The first will be at the 2018 UMaine Student Symposium in April 2018. The second venue will be the 2018 Northeast Agricultural and Biological Engineering Conference.

SmilePartners: Oral Health as an Economic Development Strategy
Principal Investigator: Alireza Geshnizjani (Community Health Education, UMF)
Co-PIs: Clyde Mitchell (UMF), Becca Matusovich (USM)
Economic Sector(s): Economic and workforce development across MEIF and other sectors

Project Abstract: Preventable dental disease is a major cause of lost school and work days, and one of Maine's leading causes of avoidable emergency room visits for pain and infection, especially among young adults. Year after year, this takes a serious toll on the financial stability of individuals who often end up with medical debt (the leading cause of unpaid collections and personal bankruptcy in the U.S.), and negatively impacts health insurance costs and business productivity. This project capitalizes on a unique opportunity to research an innovative systemic intervention, called SmilePartners, which provides new options for low-wage employees without dental benefits to restore and protect their oral health. It focuses on economic development drivers such as improving the health and stability of the workforce, reducing the cost of doing business, and over time promises positive impact on related measures of growth, especially those related to workforce development and employer health care costs.
The project scope includes exploration of: employers' perceptions about the importance and value of improved oral health; factors driving interest in SmilePartners sponsorship among employers are unable to provide dental insurance; indicators of greatest value to employers to assess return on investment for sponsorship costs; options for engaging other stakeholders, such as hospitals and health systems, in sharing the costs of the intervention delivery; the appropriate scale and research design for a larger demonstration to test the proof of concept/prototype that will be developed during the project. The focus will initially be on identifying interested employers in the MEIF sectors, and then will expand to identify interested employers in other sectors as well.

Planned Project Outcomes:
The partners who developed SmilePartners aim to conduct a larger demonstration to further refine the business model, and this requires initial research to find out what it would take for employers to engage in supporting the costs of the intervention through employer sponsorships. One key priority is to partner with employers likely to see a positive value proposition in helping to support participation by employees who currently lack access to dental insurance coverage. The goals of this research include:

1) Engage interested employers in order to understand their priorities and interests related to gaps in their employees' access to dental care
2) Develop a proof of concept and/or prototype for employer-sponsored participation in SmilePartners

This project will help position the USM and UMF faculty/staff partners on the Advising Committee to pursue a future collaborative research grant to support evaluation of a larger demonstration, with the design to be developed over the course of this project. For example, several national funders, including Robert Wood Johnson Foundation, Kresge Foundation, Commonwealth Foundation, and Agency for Healthcare Resources and Quality (AHRQ), have regularly been offering funding opportunities for innovative health financing research, for which such a demonstration project could be a competitive. This project will set the team up to submit a proposal for a larger-scale demonstration and evaluation in fall of 2018. Expanded support for the hired Grad and Undergrad assistants and/or additional future Grad/Undergrad assistants will be included in the budget for these proposals.

Investigating Disease Transmission by Winter Ticks on Moose to Enhance Maine's Resource-Based Economy
Principal Investigator: Pauline Kamath (School of Food and Agriculture, UMaine)
Co-PIs: Anne Lichtenwalner (Cooperative Extension)
External Collaborators: Lee Kantar (Maine Department of Inland Fisheries and Wildlife)
Economic Sector(s): Natural Resources, Tourism

Project Abstract: Tick-borne diseases can have negative impacts on Maine's economy, including both through the direct effects to human and domestic animal health and the indirect effects on participation in outdoor recreation and tourism. Moose, in particular, are an important natural resource in the state and some moose populations in the Northeast have experienced dramatic declines due to winter tick infestations. The study will examine the pathogens carried by winter ticks on moose, the relationship between pathogen strains and moose health, and the potential for transmission to humans, livestock and other wild animals. It will also investigate the factors driving tick population dynamics and movement across the landscape. The results will provide data to inform the state's management of moose and to develop strategies for reducing tick-borne disease infection risks to humans and livestock. This project would also provide research training opportunities an undergraduate student and provide data to seed future research proposals.

Planned Project Outcomes: The proposed work will (1) provide research training to an undergraduate student, (2) generate preliminary data to support future grant proposals, and (3) result in peer-reviewed and extension publications that will identify the potential role of TBD on moose population health and risks to humans and livestock, as well as suggest risk reduction strategies. The undergraduate researchers will present the results of their work at the Maine Chapter of The Wildlife Society in Spring 2018. The results will also be shared with the agency partner (Inland Fisheries and Wildlife) with the goal of informing decisions in regards to moose population modeling and management.

Stakeholder-Engaged Hydropower Decision-Making
Principal Investigator: Sharon Klein (Economics, UMaine)
Co-PIs: Bridie McGreavy (UMaine),
Economic Sector(s): Energy

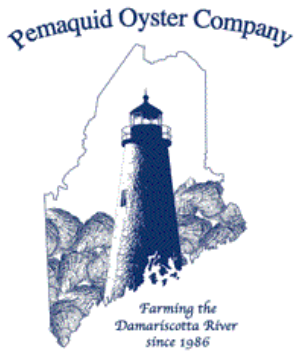
Project Abstract: An undergraduate research assistant will assist in a multi-scale, coupled-systems research project on the ecological, social, and economic trade-offs in decision making. The project is part of a multi-state, multi-institutional, interdisciplinary collaboration between the University of Maine, University of Southern Maine, University of New Hampshire, University of Rhode Island, and Rhode Island School of Design. The shared collaborative vision is to mobilize the collective capacity of New England universities and colleges to strengthen connections between science and decision making. The undergraduate research assistant will help to: 1) assess the costs and benefits of different hydropower technologies for Maine and New England; and 2) evaluate methods for participatory stakeholder-engaged multi-criteria decision analysis in hydropower decision-making. With two-thirds of Maine's net electricity generation coming from renewable energy resources, 30% being from hydropower, this information shows vast importance, and research needs to be done to ensure the right decisions are being made.

Planned Project Outcomes: The first objective will require an engineering-economic model of different hydropower technologies (e.g., conventional, micro, pico, run-of-river, hydrokinetic), operating under different stream conditions. The second objective will require surveys, interviews, and focus groups with a variety of different types of stakeholders engaged in or interested in hydropower decision-making (e.g., residents, power plant operators, mill owners, municipal, state and federal officials, citizen action and environmental groups, etc). It will also require developing a model of quantitative criteria for important decision attributes and stakeholder preferences to rank order decision alternatives. An undergraduate research assistant will be crucial to help the senior researchers and graduate students with these research activities (e.g., compiling literature reviews, assembling, cleaning, and entering data, writing & cleaning code, preparing for and helping administer interviews/surveys/focus groups, etc). The student will present their research at the 2018 UMaine Student Research Symposium as well as the 2018 Maine Sustainability & Water Conference.

Building Research-Industry Collaborations for Maine's Marine Economy
Principal Investigator: Heather Leslie (School of Marine Sciences, UMaine)
Co-PIs: Damian Brady (UMaine), Jeremy Rich (UMaine)
External Collaborators: Carter Newell (Pemiquid Oyster Company)
Economic Sector(s): Aquaculture

Abstract: With some of the nation's cleanest waters, a recognized brand, and a strong tradition of entrepreneurship and innovation, Maine is well poised to expand shellfish aquaculture into a larger industry. Close partnerships between scientists and Maine's shellfish entrepreneurs are vital to ensure that the industry grows in a socially, environmentally, and economically smart manner. With more than 50 years of investment in Maine's aquaculture industry, University of Maine's Darling Marine Center (DMC) is well positioned to contribute to this goal. Building on the successful SEA Fellows pilot program led by Profs. Heather Leslie of University of Maine and Brian Beal of University of Maine at Machias, applied research projects will be developed of direct relevance to Maine's oyster farming industry. An undergraduate researcher will be recruited from University of Maine's School of Marine Sciences (SMS) and co-advised by SMS faculty and industry professionals. Faculty, industry professionals, and the student involved in the project will have opportunities to learn from a wider community of aquaculture researchers and practitioners through the SEA Fellows Sumer Science Symposium in August 2017 at the DMC. In addition to generating knowledge that directly addresses needs identified by Maine's aquaculture industry, the proposed projects will train the next generation of aquaculture science and industry professionals. The project also complements those submitted by Dr. Beal of University of Maine at Machias. Together, these proposals will enhance the reputation and impact of the University of Maine System's marine science programs and contribute to the sustainability of the SEA Fellows program and allied research-industry partnerships throughout the state.

Planned Project Outcomes: The proposed program has two goals: 1. To catalyze innovative university-industry research partnerships of direct benefit to Maine's marine economy; and 2. To contribute to workforce development and enhance the technical and collaborative skills of the students, researchers, and industry professionals, engaged in the project. The undergraduate project is of direct relevance to the industry, investigating: 1. Biology and management of an oyster pest, the boring sponge (Cliona spp.), that impacts survival and marketability of oysters; 2. Environmental characteristics related to effective siting of new shellfish farms; and 3. Role of benthic diatoms in estuarine nutrient budgets, and the consequences of these microalgal population dynamics for oyster farm productivity and sustainability. Students will receive hands-on training opportunities that enable them to hone their hard and soft skills. The project also provides a model for an expanded collaborative research and workforce development program for Maine's marine economy in the future, one that we envision will engage 10 students, five faculty and at least five industry partners each future year. We will seek support from the NSF's REU program and private donors to support future development of this workforce development model and also leverage emerging opportunities within the UMS and also will reach out to other RRF awardees to invite their participate in the 2017 SEA Fellows Program and the Summer Science Symposium.



Identification of Apple Tree Varieties with Greater Adaptation to Freezing Stress
Principal Investigator: Renae Moran (Highmoor Farm, UMaine)
Co-PIs: Bryan Peterson (UMaine)
Economic Sector(s): Agriculture/Fruit Producers

Project Abstract: Cold temperature (freezing) injury occurs throughout temperate climates in which fruit crops are grown and causes extensive losses for fruit growers. Damage from freezing temperatures impacts the industry through reduced yield and fruit quality, greater susceptibility to canker diseases and insect pests, and high costs of tree replacement. Through this project, the survival of trees in apple orchards will be increased and profitability for apple growers as they adopt improved rootstocks. We will measure cold temperature tolerance in several important new rootstock varieties, G.214, G.4011, G.4814, G.935, V.6, G.41 and M.9. Trees for this project will be grown and acclimated to cold at Highmoor Farm, Monmouth, and lab work will be conducted at the University of Maine, Orono. Using a controlled programmable freezer, freezing tolerance to temperatures of 0 to -40C will be measured in 2-year-old shoot pieces during two periods of the season. Hardiness will be evaluated from early September to early December at 14-day intervals or until maximum hardiness occurs to determine which varieties are the first to become hardy. The rate and degree of hardiness loss will be evaluated in mid-March in shoot pieces held at 20C for 0, 2 and 4 days.

Planned Project Outcomes: These results will directly inform growers who are selecting new rootstocks for apple production in Maine's climate. The student will present results of the fall hardiness measurements at the Maine Ag. Trades Show in Jan. 2018 or at the University of Maine Research Expo in 2018. The student may present research findings at other stakeholder meeting if schedule conflicts occur.

Optimizing stand composition and forest regeneration strategies by improving understanding of important biological controls
Principal Investigator: Allesio Mortelliti (Wildlife, Fisheries, & Conservation Biology, UMaine)
Co-PIs: Joeseph Zydlewski (USGS), Brian Roth (CFRU), Aaron Weiskittel (UMaine), Laura Kenefic (USFS)
Economic Sector(s): Foresty

Abstract: Forests and forest products play a major role in Maine's economy and 97% of the forest area in Maine is subject to natural regeneration. Because regeneration is natural, forest managers rely extensively on regeneration models and forest vegetation simulators to forecast stand composition and productivity under different management scenarios. These models play a critical role in modern day forestry, a role which is equivalent to simulation software in engineering or crop simulation models in agriculture. Currently, regeneration models mainly focus on physical rather than biological parameters. For example, the key role of small mammals is not included within model parameters; this is a major shortcoming because small mammals play a fundamental role in forest regeneration through seed predation. Empirical evidence shows that small mammals can prevent up to 95% of recruitment of their preferred tree species, such as the commercially valuable white pine and red spruce.

The overarching goal of this project is to improve the predictive performance of forest growth models by developing a module within existing software to quantify the effect of small mammals on seed predation and forest regeneration dynamics. The increased predictive performance in forecasting stand regeneration and in evaluating management scenarios is expected to lead to a) greater agreement between modeled outcomes and real world forest dynamics, b) more robust management decisions, c) increased profits for the forestry industry, and d) workforce development through specialist training in partnerships with stakeholders. This project involves 5 different institutions and is structured as a collaboration between the end-users of regeneration models (timber companies, forestland owners and managers), model developers (biometricians working in the School of Forest Resources) and specialists in the study of wildlife impacts and forest developmental processes (USGS, U.S. Forest Service, UMaine). The role of the undergraduate assistant will be to conduct experiments in the field. The results of these experiments will be used by the investigators to implement the small mammal module of the regeneration software. This will give leverage to the project, making additional funding more attainable and allowing for further modifications to regeneration software at a level where economic impact will be generated.

Planned Project Outcomes:
The specific objectives related to the grant activity are to: 1) Quantify seed predation rates of various commercial tree species and how these, in turn, affect their natural regeneration (seedling emergence). 2) Develop and implement the module of the regeneration model that includes the predation rates of small mammals. Example of the grants to target are: 1) NSF 'Career' grant and NSF DEB-Core Programs (yearly calls), 2) Northeastern States Research Cooperative grants, 3) Importantly, funding will be solicited from the CFRU (partner in this project) whose members include all the major stakeholders in the forestry industry.

Northern Maine Wood Turtle Population Survey
Principal Investigator: David Putnam (Environmental Science and Sustainability, UMPI)
External Collaborators: Derek Yorks (ME Department of Inland Fisheries and Wildlife), Michael Jones (American Turtle Observatory)
Economic Sector(s): Forest Products Industry, Workforce Development

Project Abstract: Researchers from the University of Maine at Presque Isle, the Maine Department of Inland Fisheries and Wildlife, and the American Turtle Observatory will conduct wood turtle (*Glyptemys insculpta)* surveys along the rivers and streams of northern Maine's working forest with an undergraduate research assistant from the University of Maine at Presque Isle. Wood turtles are threatened, endangered, or have been extirpated over most of their range, but populations appear to be robust in the North Maine Woods. Systematic surveys will be conducted of prime wood turtle habitat to determine the size and nature of the populations prior to the possible listing of the species under the endangered species act. Working with forest landowners, management plans will be developed for the species in a working forest environment to preclude disruption to the forest products industry and protect the turtles. Using a variety of new technologies, including GPS, GIS, radio-telemetry, and aerial drone surveys and habitat mapping, the undergraduate assistant will be well positioned for graduate school and the future work environment.

Planned Project Outcomes: Work will begin in May 2017 with new and repeat/recapture surveys of existing research sites. An additional seven wood turtles will be fitted with radio transmitters at an agreed upon site within the working forest. Surveys will be conducted in May/June and September. Nesting surveys will occur from late June to mid-July. Only turtle tracking will occur from mid-July through August. The undergraduate student's time will be divided between working with the PI, collaborating biologists, and other students. Generally 2 days per week will be spent conducting surveys and 1 day tracking tagged turtles. Due to the remote nature of some of the study sites and methodology which involves wading rivers, the student will always be accompanied by a supervisory researcher in the field. An exception may be for turtle tracking, where student teams are appropriate in less remote settings. Fall 2017 will involve final turtle surveys and data analyses. The student will present results at the April 2018 Northeast Natural History Conference in Springfield, MA, or Albany, NY.

AMERICAN TURTLE OBSERVATORY

Assessing the Economics of Maine's Coastal Tourism Development: The Ecosystem Services of Schoodic Peninsula, Acadia National Park
Principal Investigator: Katherine Ruskin (Ecology and Environmental Sciences, UMaine)
Co-PIs: Arron Strong (UMaine), Tora Johnson (UMM)
External Collaborators: Nicholas Fisichelli (Schoodic Institute), Abraham Miller Rushing (National Park Service)
Economic Sector(s): Recreation and Tourism

Project Abstract: Tourism is an important and growing sector of Maine's economy. In 2016, Acadia National Park opened the Schoodic Woods Campground, its first new campground developed since 1936. The campground provides greater visitor access to Schoodic Peninsula, increasing the valuation of ecosystem services (economic benefits to humans provided by ecosystems) in terms of recreational experiences, but it may negatively influence other ecosystem services such as biodiversity. The economic impacts of new development on public lands is a critical question for assessing future economic growth in Maine, as the recreation industry grows and new public lands develop. This project will focus on these questions for the Schoodic Peninsula of Acadia National Park. Through the work of two undergraduate researchers, the project seeks to (1) quantify the valuation of ecosystem services provided by Schoodic Peninsula, (2) estimate the changes in valuation that have resulted from the development the campground, and (3) provide recommendations for how future development in the area can maximize economic benefits. Results will inform the trajectory of development on Schoodic Peninsula, providing an opportunity for strategic growth that optimizes the value of both market and non-market ecosystem services for local stakeholders such as business owners. Further, the two student researchers funded by this grant will work directly with undergraduates in EES 217, a weekend field course, to collect data for this project. As a result, a wide audience of undergraduates will engage with an active research project that is geared toward strategically improving Maine's economy while maintaining our natural resources. Thus, this project will build on the national reputations of both UMaine and the state of Maine as leaders in the study of recreation and natural resources.
Planned Project Outcomes: With this project, the value of ecosystem services of Schoodic Peninsula will be characterized as well as how they have changed as the result of new development. Further, the findings of this project will inform other developing areas of Maine's recreation industry, such as the Katahdin Woods and Waters National Monument. Finally, this project will serve as a model both for how research can be used to inform strategic development of tourism and how interdisciplinary research led by undergraduates can be combined with coursework. This project will also advance another growing field in Maine, higher education in environmental studies and outdoor recreation. Specifically, the two student researchers, as part of the project, will work in conjunction with undergraduates in Ecology and Environmental Sciences (EES) 217 to collect data that supports its objectives. In this way, a wider audience of undergraduates will engage with an active research project that is geared toward using environmental science to improve the economy of Maine. Additionally, the two student assistants will gain skills in conducting interdisciplinary research, including highly marketable skills in spatial analysis.

Carbon Policy and Energy Efficiency for Maine's Marine Industries
Principal Investigator: Aaron Strong (School of Marine Sciences, UMaine)
Co-PIs: Sam Belknap (UMaine)
Economic Sector(s): Fisheries, natural resources, energy economy

Project Abstract: Maine is one of nine northeastern states that is a member of the Regional Greenhouse Gas Initiative, one of the largest and longest functioning carbon markets in the world. Throughout 2016, RGGI has gone through a stakeholder outreach process as it develops a draft update plan to extend beyond 2020. Notably absent from that outreach has been any work with stakeholders in coastal natural resource communities. To fill this gap, in late 2016, a RGGI/Coasts Working Group was formed to bring together partners at the Island Institute, at the University of Maine and at other organizations to work to engage Maine's coastal natural resource users, fishermen and marine industry representatives around carbon policy and energy efficiency opportunities within their industries. This project will support an undergraduate assistant to contribute to (a) the development programming for education and outreach about Maine's carbon policy, and about economic opportunities through RGGI for improving energy efficiency in Maine's coastal communities and (b) to assess the effectiveness of such outreach at engaging natural resource user communities about carbon policy in Maine.

Planned Project Outcomes: In order to build on previous work and to fill the identified gap at the nexus of the maritime industry and energy efficiency programming in Maine, this project takes a working group and participatory approach to research that is done by- for- and with-community partner organizations and members of Maine's marine industries, including. The first meeting of the RGGI/Coasts Working Group took place in Rockland in December 2014, and one additional meeting is planned for Spring 2017. These first meetings are largely scoping-meetings to inform the design and development of new programming around carbon policy and energy efficiency in the marine industry sector. This programming will be developed and implemented over the course of Summer and Fall 2017 to coincide with broader state-level discussions of updating RGGI in Maine for the post-2020 era. The primary role of this undergraduate student will be to assist in the development and implementation of those outreach programming initiatives through the RGGI/Coasts Working Group in Summer and Fall 2017. The academic research component of this work involves conducting a series of pre- and post- assessments with RGGI outreach workshop participants to understand their motivations to participate, the learning outcomes of the outreach materials, and to help inform the development of future education and outreach materials.
The results of this undergraduate project will be presented at the 2018 Maine Sustainability and Water Conference on a session on energy efficiency and carbon policy to be held in March 2018. The student's work will also contribute to a publication to be submitted to Global Environmental Change or Climate Policy in Fall 2017, in conjunction with the advising team. The work for this project will begin in June 2017 and continue through Fall 2017, with the large fraction of the work to take place in Summer 2017.

Solutions to Ocean and Coastal Acidification that Support Maine's Coastal Communities
Principal Investigator: Aaron Strong (School of Marine Sciences, UMaine)
Co-PIs: Esperanza Stanicoff (UMaine Cooperative Extension), Damian Brady (UMaine)
Economic Sector(s): Fisheries and Aquaculture Industry

Project Abstract: Ocean and coastal acidification is an emergent threat to the communities and livelihoods of coastal Mainers, potentially risking hundreds of coastal jobs and millions of dollars in lost revenue to our coastal marine economy. In order to address this dual environmental/economic threat, an undergraduate student research project is proposed to help support a coupled participatory vulnerability assessment and solutions-barrier analysis to encourage the development of new business-based solutions and potentially job-saving adaptive management -responses to acidification in Maine. The student will work directly with the Maine Ocean and Coastal Acidification Partnership, PI Aaron Strong, and a School of Marine Sciences graduate student to conduct research and highlight pathways toward actionable solutions to acidification in Maine, including seaweed aquaculture, adaptations in oyster aquaculture, and decision-support tools for commercial fishermen.

Planned Project Outcomes: Through its potential economic impacts on fisheries and aquaculture, acidification has the potential to threaten coastal livelihoods, and understanding how to mitigate these losses and preserve livelihoods is the major economic contribution of this work. However, adapting to acidification and remediating acidification (both solutions studied in this project) will create opportunity for new for new oyster and seaweed aquaculture businesses that are built around scientific understanding of adaptation to and mitigation of acidification, in particular leveraging the business-incubation capacity of UMaine's Darling Marine Center.

The results of this undergraduate project will be presented at the 2018 Maine Sustainability and Water Conference, to be held in March 2018. The students work will also contribute to a publication to be submitted to Ocean and Coastal Management in Summer 2018. Results will also be disseminated to stakeholders at meetings hosted by the Maine Ocean and Coastal Acidification Commission.

Adipose Tissue Neural Innervation: Mechanisms and Therapies
Principal Investigator: Kristy Townsend (School of Biology and Ecology, UMaine)
Co-PIs: Len Kass (UMaine), Ali Abedi (UMaine), Nuri Emanetoglu (UMaine)
External Collaborators: Todd O'Brien (O'Brien Medical, LLC)
Economic Sector(s): Healthcare

Abstract: Currently obesity and diabetes are worldwide pandemics, and here in New England, Maine is the most obese state, thus negatively impacting the health and well-being of Maine's citizens, driving up healthcare costs, and resulting in decreased productivity. In addition, Maine has the oldest median age in the country, and given the association between aging and dysregulated metabolism and neuropathy, our state is also at greater risks for these conditions. This project seeks to combine both basic neurobiological research with innovative biotechnology product development to create novel therapies for obesity and diabetic neuropathy, thus improving these health situations for Maine's people and positively impacting Maine's economy.

Planned Project Outcomes:
The first translational/biotechnology aim of this project is to create a skin patch that can release a neurotrophic factor to subcutaneous adipose tissue and promote improved neural innervation and tissue function. The finding that adipose tissue undergoes neuropathy with increasing age or body weight, as well as the well-established knowledge that diabetes is associated with peripheral neuropathy of skin and limbs, warrant the creation of a device that allows the detection and monitoring of nerve activity in affected individuals. Such a device does not yet exist, and thus the design and creation of this device is the second translational and biotechnology aim of this project that will lead to commercialization and economic impact. A device will be designed that is capable of measuring nerve activity through the skin, including detection of underlying nerve activity in subcutaneous adipose tissues. This device will be utilized in clinical trials in humans in collaboration with Dr. Todd O'Brien, a podiatrist and biotech owner in Maine, and will be utilized in pre-clinical mouse model work in the Townsend Lab at UMaine. Both medical products to be created and tested under this award will be used to seek i.p. and to pursue either licensing or a spin-off company, thus providing economic impact. In addition, the work to be done in basic biology and mechanistic understanding of adipose tissue innervation will be compiled into a new grant application to be submitted to the National Institutes of Health (NIH) before November 1, 2019. An NIH R01 application is already under review for some aspects of this project and if awarded will be utilized to supplement the costs associated with this project. If it is not awarded, data from this RRF funding period will be used for resubmission. A new federal application before Nov. 1, 2019 will be pursued regardless, as it will cover the neuropathy aspects of this project that were not included in the original submission.

Increasing the Value of Maine's Lobster Fishery by Improving Shell Quality and Meat Yield
Principal Investigator: Richard Wahle (School of Marine Science, UMaine)
External Collaborators: Curtis Brown (Ready Seafood Co.)
Economic Sector(s): Marine Fisheries

Abstract: This project is a partnership between UMaine's School of Marine Sciences and Ready Seafood Co. of Portland, ME. The proposal seeks support for an undergraduate research assistant who will help initiate a pilot study to inform Maine's lobster wholesalers and processors how to enhance the value of lobster within their facilities, and set the stage for a more comprehensive proposal to NOAA's Saltonstall-Kennedy Program in 2018. Lobster price is directly correlated with shell hardness because the harder the shell the better it will survive long-distance shipping. The objective of the proposed project is to use Ready Seafood's new temperature controlled lobster holding facility to find the optimum combination of temperature and starting shell grade to maximize lobster shell quality while minimizing mortality during the holding period. The project has the potential to become an undergraduate Honors or Capstone project.

Planned Project Outcomes:
The experiment will be conducted between mid-May and the end of August 2017 while the student is on summer break and in residence at the Darling Marine Center, commuting to and from Portland to undertake the experiments. Data analysis will largely occur during the student's fall semester from September to December 2017, and final report writing and presentations will be done during the spring semester from January- April 2018.
Lobster shell quality will be measured after 10-day trials at three water temperatures (10, 13, 16°C) and three lobster shell quality grades (A, B, and C-grade). Lobsters are typically graded both qualitatively and quantitatively. Qualitative grading is done by squeezing the shell in a standardized way to determine shell rigidity. This is a rather subjective process and requires training to be consistent. A more quantitative proxy for shell hardness is to measure blood protein levels. By this method a small sample of blood is drawn with a syringe and is measured with a refractometer. Hard shell lobsters have higher blood protein levels, so the blood protein index is a way to quantitatively ground-truth the qualitative grading method. Before each trial equal grade numbers of Grade-A, B and C lobsters will be established. These lobsters will be placed in plastic trays designed specifically to hold multiple lobsters separated by partitions within the tank. Only one temperature can be run at a time. Between late May and August, two 10-d trials will run at each of the three temperatures for a total of 60 experiment days. 100 lobsters of each grade will be run in each trial for a total of 1800 lobsters (= 2 trials x 3 temperatures x 3 grades x 100 lobsters). At the conclusion of each 10-day trial mortality will be assessed and the change in shell quality of the survivors by the two methods. The resulting index of performance will be the product of the change in blood index times the proportion surviving. The combination of temperature and shell grade giving the greatest performance will be deemed the most profitable.

Working with the Alewife Harvesters of Maine to Assess Harvest Strategies for Sustainable and Expanding River Herring Harvests in Maine
Principal Investigator: Karen Wilson (Environmental Science and Policy, USM)
Co-PIs: David Hart (Mitchell Center, UMaine)
Economic Sector(s): Fisheries

Abstract: River herring (alewife and blueback herring) fisheries are a growing segment of Maine's fishing and bait industry, and expected to expand as restoration efforts continue to increase access to spawning habitat. In this project, an undergraduate student will work closely with the Alewife Harvesters of Maine, a non-profit organization representing alewife harvesters in the state, to (1) access current harvest strategies for application to new harvest operations, (2) investigate the possibility of new harvest operations in southern Maine, and (3) assist with the monitoring of a spawning run that helps scientists understand the natural year to year variability of river herring spawning runs in a non-harvested system.

Planned Project Outcomes:
The objectives of this project are to assist the Alewife Harvesters of Maine in (1) examining existing data from current harvests to determine if bi-directional trapping methods increase the run sustainability in contrast to blocking methods, (2) investigating ecological and social constraints to establishing harvestable runs in Southern Maine, and (3) ensuring the count of spawning adults in the Presumpscot River (Highland Lake) continues as a harvest-independent measure of year to year variability in river herring spawning runs.
The student will present results to the Alewife Harvesters of Maine at one of the regular board meetings as well as to members of the organization at the Maine Fisherman's Forum in Spring 2018, and write up the results of Objective 1 & 2 in a short report for the organization. The student will present the results of Objective 3 (analysis of trends in spawning adults) to both the DMR and the AHM in the form of a short report, and to scientific peers as part of the University of Maine Darling Marine Center's SEA Fellows Summer Science Symposium in summer 2017.
The student will participate in the Future of Dams NEST Project, an NSF EPSCOR Track II collaboration between University of Maine System researchers and researchers in New Hampshire and Rhode Island. Dr. Wilson is a member of this research team. Dr. David Hart will provide a connection to the Future of Dams project on the University of Maine campus.

Appendix VIII.B: UGA Grants | Rubric

Intellectual merit 25 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (25 POINTS)**	**Score**
Evaluation Criteria for Intellectual merit	Proposed research has significant deficiencies which compromise its likelihood of success	Proposed research has minor deficiencies but is likely to be somewhat successful	Proposed research is well conceived and is likely to be successful	Proposed research is very well conceived and is highly likely to be successful	25
Relevance to Maine's economy 30 POINTS	**Poor (0 POINTS)**	**Good (10 POINT)**	**Very Good (20 POINTS)**	**Excellent (30 POINTS)**	**Score**
Evaluation Criteria for Relevance to Maine's economy	No clear link of the proposed activities to Maine's economy. Likelihood of job creation, workforce and economic development low	Proposed activities somewhat linked to Maine's economy. Likelihood of job creation, workforce and economic development moderate	Proposed activities well linked to Maine's economy. High likelihood of job creation, workforce and economic development	Proposed activities intimately linked to Maine's economy. Likelihood of job creation, workforce and economic development very high	30
Mentoring Plan 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Mentoring Plan	Advisor/co-advisors lack experience, location and facilities are not well conceived and/or day-to-day advising is not available	Advisor/co-advisors are somewhat experienced, location and facilities are somewhat problematic and/or day-to-day advising is generally available	Advisor/co-advisors are experienced, location and facilities are suitable and/or day-to-day advising is available	Advisor/co-advisors are very experienced, location and facilities are highly appropriate and day-to-day advising is available	15
Extent of Collaboration 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Extent of Collaboration and Appropriateness of the Participants	Proposal has no evidence of collaboration across the UMS and/or external partners, collaborations are not clearly linked to the proposed activities, roles and responsibilities are not clearly defined	Proposal has some evidence of collaboration across the UMS and/or external partners, collaborations are linked to the proposed activities, roles and responsibilities are somewhat defined	Proposal has good collaboration across the UMS and/or external partners, collaborations are well linked to the proposed activities, roles and responsibilities are defined	Proposal has strong evidence of collaboration across the UMS and/or external partners, collaborations are clearly linked to the proposed activities, roles and responsibilities are clearly defined	15
Research Presentation 15 POINTS	**Poor (0 POINTS)**	**Good (5 POINT)**	**Very Good (10 POINTS)**	**Excellent (15 POINTS)**	**Score**
Evaluation Criteria for Research Presentation	Proposal has no plan for the student to present their research at an event with a state/regional focus	Proposal has a plan for the student to present their research at an event, but the scope of the event is primarily local	Proposal has a plan for the student to present their research at an event, but a specific event has not been identified, or support has not been budgeted/identified	Proposal has a plan for the student to present their research at an event whose scope is state/regional and the required funds have been budgeted/identified	15
TOTAL POINTS					100