Final Research Performance Progress Report

The Northeast Center for Occupational Health and Safety: Agriculture, Forestry and Fishing

Center Cycle: 9/1/2016-8/31/2022

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NEC Final RPPR Table of Contents

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: The Northeast Center for Occupational Safety and Health: Agriculture, Forestry and Fishing</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 9/1/2016-8/31/2022</td></tr>
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B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Aim 1: *Monitor AgFF occupational health and safety trends (Burden).* The NEC has made considerable progress mining existing passive surveillance systems for data on AFF injury trends. We have learned that multiple data systems combined with algorithm-directed searches can provide the most accurate and efficient data on injury trends. In this coming cycle, we will building on this surveillance foundation to include new passive data sources (i.e., trauma registries and fishing injury data); expand into additional NE states (MD, NJ, CT, MA); utilize surveys to provide more detailed data on factors contributing to injury; conduct detailed injury and worker health assessments in the forestry sector; and partner with the Nebraska Center (CS-CASH) to lead a cross-Center effort to improve AgFF surveillance. Data will be used to drive NEC activities and disseminate OSH updates to NEC researchers, AFF workers, industry partners, government agencies, advocacy groups, and other stakeholders.

Aim 2: *Address priority AgFF worker health and safety hazards (Need).* The NEC's prioritization process identified a number of prominent AgFF worker hazards to address in the coming cycle: the development of improved grain-bin entry technology (grain production has increased by 23% in the Northeast over the last 10 years); the assessment of user-friendly and readily accessible fishing stability technology (roughly 60% of Northeast fishing deaths were related to a vessel loss due to instability); and the continued development of tractor sensors that will considerably reduce the incidence of run-overs, which account for 12% of tractor-related deaths on farms. Additional projects will complete the public health trajectory from prior NEC studies: expanding efforts to increase power take-off (PTO) shielding on NY farms using evidence-based, marketing strategies (PTOs contribute to 1/3 of farm injuries in the US[4]); and using injury data from the NEC lobster fishing study to address wrist injuries, which contribute to roughly 25% of lobster fishing injury. Annual feasibility grants will supplement these activities by funding research translation pilot interventions.

Aim 3: *Increase awareness of AgFF hazards and evidence-based solutions (Need).* The NEC will continue to prioritize information dissemination, which is guided by a detailed marketing and promotions strategy plan and includes worker trainings provided by NEC staff or through local experts and partners, such as the Fishing Partnership Support Services (FPSS). These trainings will be evaluated and then improved and refined based on evaluation results. NEC's expansive partnership network, which includes insurance companies, advocacy groups, and community health providers, will also participate in the training, material development, and dissemination process. Outreach efforts will be targeted using data from NEC surveillance and evaluation activities to ensure these efforts are responsive to the NE region, and address OSH issues and AFF worker needs and preferences.

Aim 4: *Measure the impact of Center activities on AgFF outcomes (Impact).* Each NEC core and scientific project will follow their respective logic models (see Appendices of individual grants). The evaluation team will monitor each logic model to track progress on intermediate and end outcomes. Center evaluators will also ensure research projects adhere to timelines, address barriers in a timely fashion, and disseminate outcomes within the Center to synergize new findings, methods, and approaches as they are developed. Evaluators will provide constructive feedback to each core/research project to achieve these aims.

B.2. What did you accomplish under these goals?

Worker Training and Worksite Improvements: Over the past six years, the NEC has conducted 2,603 trainings and outreach events, trained 34,864 AgFF workers (including vulnerable workers such as immigrants and Anabaptist groups) and developed curriculum for over 60 training topics. Additionally, small safety grants and worksite industrial hygiene technical consults have led to the following AgFF worksite improvements:

installation of 79 animal handling systems, 41 installations of safety-related equipment such as eye-wash stations, improved lighting, silo repairs, manure tank covers, ergonomic weeding tools, and emergency preparedness equipment. The NEC has also offered financial and logistical support to ensure over 2,300 ROPS installations on tractors in the NE and the distribution of $107,000 in PPE supplies (respirators, PFDs, hearing protection, etc…) to AgFF operations in the NE and nationally. The NEC has also partnered with other researchers and industry experts to develop health and safety training materials that have been adopted by industry. For example, a collaboration with The National Milk Producers Federation led to the adoption of safety training materials that can be easily and widely disseminated to the dairy industry. The NEC has also coordinated training and research dissemination activities for agricultural health and safety educators throughout the NE. This group, entitled the NE Agricultural Safety and Health Coalition (NEASHC) meets monthly to share information on health and safety curriculum, demonstration projects and new evidence-based research on injury and illness prevention best practices. The group also receives data from NEC surveillance to prioritize training topics and meets in-person annually at the NEC for health and safety training and networking. The NEC also offers respiratory fit-testing to assist farms with Worker Protection Standard compliance. Over the past six years 1,360 workers have been trained on how to use respiratory protection appropriately and have been fitted and provided with N95s, half-face elastomeric respirators and PAPRs. *Additionally,* safety training was provided for nearly 400 fishermen and 353 loggers. Evaluations indicated 80-90% were likely or very likely to change behaviors or adopt safety technology. NEC research collaborators from Penn State have worked for the past several years to identify solutions for safe grain bin entry for NE farms. However, after considerable research it has been determined that many grain bins cannot safely support an anchor point and lifeline system. The group has reached the conclusion that grain bin anchor points should be verified by the grain bin manufacturer or be evaluated by a professional (e.g., structural engineer), and finding this assistance can be very difficult for farms due to liability issues. However, the group found that the major goal of reducing on-farm, grain bin entrapments remains valid and they have explored two approaches for reducing the potential for entrapment. The first is to provide guidelines and specifications for the evaluation of grain bins to determine whether they can safely accommodate an anchor point and lifeline systems. The second is to explore emerging technologies to reduce the need to enter a grain bin therefore reducing the potential for an entrapment incident. Researchers are also exploring barriers to the adoption of safe grain bin entry systems and methods to overcome these barriers and hope to finish this work in 2022.

Social Capital in AgFF Communities: Over the past few years the NEC has worked to expand the exchange of information and collaboration between safety researchers and industry. These efforts have sought to maintain a bi-directional flow of information. For example, NEC researchers regularly share what they have learned with workers to facilitate adoption of evidence-based practices. They are also actively seeking feedback from AgFF industries on a regular basis to ensure that health and safety efforts are responsive to the shared sense of identity, understanding, norms and values of these industry groups. As a result, the NEC has produced health and safety programs that are embedded in AgFF communities to produce public goods for a common purpose. For example, the logging industry injury and health surveillance project has led to an expansive set of self-reported injury, health and hazard exposure data, as well as health assessment data from a representative sample of logging industry workers. Key health indicators tracked in these health assessments and survey questions included in quarterly surveys were selected in coordination with the logging industry. Subsequently this information has been shared and discussed with industry partners to identify their intervention priorities. These priorities formed the basis for the intervention that is included in the 2022-2027 application. More immediately, these efforts have led to industry data that encouraged policymakers to include loggers in the last COVID relief bill, a best practice/research methodology information exchange with Kynd Wellness from New Zealand and a request from the UN Food and Agriculture Organization (UN FAO) to provide input on the future of health and safety in logging. The NEC is also partnering with the *Building an Inclusive and Comprehensive Network for Farm And Ranch Stress*

Assistance in the NE Coalition to develop and increase awareness of stress management resources for farmers. Lastly, the NEC has also participated in RF-DASH (Rural Firefighters Delivering Agricultural Safety and Health) trainings developed by the Upper Midwest Agricultural Safety and Health Center. The program provides farm safety tools and training for local fire departments, insurance companies and community colleges, so they can share safety messaging with rural communities. Our decades-long relationship with rural firefighters was leveraged to increase RF-DASH uptake in rural communities.

Technical Innovation: NEC research and collaborations have also led to innovation in the field of occupational safety and health. For example, NEC trials of accelerometers demonstrated that these devices can be used to monitor worker use of personal flotation devices (PFDs) and could be used to document worker adoption of PPE in other industries.[3] The NEC has also used Python language programming to scan narratives in passive injury surveillance datasets to accurately identify AgFF injuries. Clearly this methodology can be applied to a wide variety of occupational and non-occupational surveillance efforts. Additional NEC innovations include the application of behavioral economics principles to improving safety on dairy farms. This strategy incorporates an understanding of human cognitive systems to redesign the worksite to "nudge" individuals towards safer behaviors (https://necenter.org/portfolio/dairy-safety-nudging-project/). Additionally, NEC and UMASS Lowell researchers working to address ergonomics hazards in the lobster fishing industry have developed a "Boat Hacks for Better Backs" resource, which features do-it-yourself ergonomics solutions for lobster fishermen (https://necenter.org/portfolio/boat-hacks-for-better-backs/). These solutions are featured in four videos, that visually demonstrate simple ergonomic solutions developed by lobster fishermen, for lobster fishermen with the guidance of the lobster ergonomics team.

Identification of Emerging Issues: **COVID-19**-2020 was a challenging one for AgFF workers. These essential workers maintained the integrity of the food supply chain while implementing infection control practices in an environment where global markets and distribution systems were changing rapidly. Infection control was particularly problematic as AgFF worksites provide distinct infection control challenges, such as social distancing in farmworker housing or on fishing vessels. NEC COVID pandemic response included:

-CDC guidance for Agricultural Employers- this collective effort among the NIOSH AgFF Centers resulted in the development of COVID prevention recommendations for agricultural employers. A checklist was also developed for agricultural employers to provide an abbreviated list of COVID prevention best practices.
-The NEC developed training videos in English and Spanish on topics such as the importance and proper use of cloth face coverings, how to clean and disinfect half-face elastomeric respirators to prevent the spread of COVID and how to properly don and doff N95 respirators and conduct seal-checks.
-NEC surveys were conducted with farmworkers throughout the NE to assess their knowledge of COVID, how to prevent infection, worksite changes and social determinants of health impacts of COVID. Information was shared with agricultural stakeholders and will inform future outreach to the farm community.
-NEC surveys were conducted with the NE logging community on the same outcomes. Over 3,000 surveys were distributed to logging operations in six states. Information is used to provide assistance to loggers.
-The NEC also conducted interviews with commercial fishermen and stakeholders across the country to assess the impact of COVID. Results were published in a Journal of Agromedicine special edition.
-In collaboration with a researcher from George Mason University in Virginia, the NEC developed an online tool to demonstrate how infection control practices can markedly reduce infection in farmworker housing.
-The NEC drafted a letter to Vice President Pence and Agriculture Secretary Purdue to alert them of the possible impact of respiratory protection shortages in agricultural communities.
-The NEC partnered with Agrisafe Network to provide a webinar on different types of COVID testing, their accuracy and their utility in identifying COVID positive AgFF workers.
-Outreach- in addition to these efforts, the NEC continued to provide health and safety training to agricultural workers in online, virtual training sessions and through videos. COVID prevention training

curriculum was also developed and protocols created to ensure workers would not contract COVID by attending trainings. Free face coverings, sanitizer and one-pagers were distributed in English and Spanish.

Other emerging issues identified by NEC advisory boards and partners included opioid addiction, toxic stress and tick-borne diseases (TBDs). Emerging issues funding allowed the NEC to combat these health and safety priorities by offering: 1) opioid specific resources (naloxone training and counseling, as described previously) for commercial fishing and logging industry workers, 2) a "Whole System in the Room" event to combat toxic stress in the dairy industry by developing a blueprint for addressing stressors in dairy farming, and 3) the creation of a customer relations database to track and streamline NEC services such as respiratory fit-testing, the NEC PPE program, worksite safety walk-throughs and technical assistance.

Expanding NEC Expertise / Research Innovation: Over the past six years, the NEC has invested considerable time and effort in the training and mentorship of new occupational health and safety specialists. These individuals have the potential to contribute markedly to the NIOSH mission. Dr. Erika Scott successfully defended her PhD in 2015 and was promoted to senior staff in 2016. Since then she has made significant strides in the use of passive surveillance systems to monitor AgFF injury trends, the use of machine learning to streamline surveillance data processing and the identification of occupational injury and health issues in NE logging industries. Most notably, she is providing leadership on national AgFF surveillance coordination among the NIOSH AgFF Centers and is working with NIOSH intramural leadership (Dr. Paul Schulte and Dr. Pana-Cryan) to analyze the broad impacts of OSH injuries and illnesses in AgFF industries. Dr. Pam Tinc completed her PhD in 2019 and has been leading national AgFF implementation research efforts. Dr. Tinc has organized conference panels on implementation research with Dr. Schulte, co-authored papers with NIOSH implementation researchers and is first author on several pioneering AgFF implementation publications. She has also been integral in the application of contribution analysis to the evaluation of NIOSH tractor overturn interventions. Lastly, Dr. Scott Fulmer completed his PhD in 2020. Dr. Fulmer has been active in the development of ergonomic solutions for commercial fishermen and has generated the only known injury rate data for lobster fishermen. In addition to supporting the next generation of OSH principal investigators, NEC Research Coordinator, Jessica Echard has recently been accepted as a PhD candidate at SUNY Albany to pursue a doctorate in anthropology. Mrs. Echard plans to explore social determinants of health factors and their impact on vulnerable AgFF populations. Research Coordinator Liane Hirabayashi is receiving training in Systems Science Research, which she hopes to pursue as a PhD student.

AgFF Occupational Health and Safety Leadership: In the past funding cycle, the NEC took on leadership of the NIOSH AgFF Centers group for several years. In this capacity, the NEC represented the NIOSH AgFF Centers in communications and negotiations with national AgFF industry groups, such as the USDA, ASHCA, NIOSH and the USCG. The NEC also restructured meetings to include monthly Center presentations to encourage cross-center research collaboration. The NEC partnered with NIOSH and Memorial University of Newfoundland to host IFISH5, the largest international conference on commercial fishing health and safety efforts in the world. The conference was attended by the FAO, the ILO and other high profile commercial fishing organizations. The NEC has also convened an international consortium of PFD researchers who meet regularly to discuss efforts in PFD adoption in commercial fishing. Meetings are attended by researchers, regulators and trainers from 4 countries and 24 organizations.

Multidisciplinary NEC Research: As detailed in the overview of NEC activities over the past five years, the NEC has been active in expanding partnerships and research expertise. In the past cycle, the NEC has contributed considerably to the fields of Surveillance, Implementation Research, Behavior Change Science (social marketing, social network analysis, nudging), Mental Health, CBPR, Policy initiatives, Systems Science, Objective measures of worker behavior, Economic analyses, Tech/Engineering, Contribution analysis and Sleep studies [please see NEC research biosketches]. NEC research has been highlighted in high impact journals as the gold-standard for research implementation and received national recognition in publications, such as Forbes, for its expertise developing health and safety solutions.

B.3. Competitive Revisions/Administrative Supplements
N/A

B.4. What opportunities for training and professional development did the project provide?
N/A

B.5. How did you disseminate the results to communities of interest?
Centrality of the NEC Brand-Over the past six years the NEC has succeeded in expanding recognition of the NEC in the NE commercial fishing and logging industries. This is partly due to programs like the NEC Lifejackets for Lobstermen project, the Participatory Ergonomics in the Lobster Fishing Industry project, the Fishing Vessel Apps project, and various partnerships with Professional Logging Contractors, Fishing Partnership Support Services (FPSS), the Massachusetts Lobstermen's Association, the Maine Lobstermen's Association and other logging and fishing industry partners. The NEC has also launched social media sites for both industries and has completely redeveloped its website to increase engagement with AgFF populations (www.necenter.org). In addition to these dissemination improvements, the NEC transitioned all of its outreach, training, technical assistance and personal protective equipment (PPE) distribution to a Salesforce customer relations management system. Salesforce is a database management platform that was originally designed for marketing, sales and commerce. The new customer relations management system (affectionately referred to as 'NERD'-NEC Events Reporting Database) allows us to document and track every worker and industry group interaction. This has greatly enhanced our customer service. For example, if we provide respiratory fit-testing services to a farm, we are able to enter information on the number of workers trained and the respirators and equipment used, so future trainings are easy to schedule and replacements can be automatically supplied.

The NEC has also published over 50 peer-reviewed publications on topics as diverse as the use of wearable technology for tracking worker PPE compliance to the use of machine learning in AgFF injury surveillance. Other promotional efforts include 28 newsletter updates to 3,383 recipients and 149 newspaper and trade magazine articles in national papers and news outlets, such as Forbes and Politico. Additional noteworthy activities include participation in a press conference held by former Governor Cuomo regarding federal immigration crackdowns in agriculture and a feature in the "Social Fishtancing" podcast, on COVID impacts to fishermen.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?
N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations
Publications:

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C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org
www.ifishconference.ca/home/

C.3. Technologies or techniques
Social Network Analysis
Logic Modeling
Photovoice
Lobster Fishing Ergonomic Improvements (https://necenter.org/portfolio/boat-hacks-for-better-backs/)

C.4. Inventions, patent applications, and/or licenses
N/A/

C.5. Other products and resource sharing
Survey Instruments
Recruitment Materials
Data Collection Protocols
Study Protocols
COVID-19 Information Booklet, Needs Assessment Surveys/Publications
Marketing and promotional materials for PTO shields
Articles on augur safety and lockout/tag out
ICD-10-CM to OIICS crosswalk available on NEC website

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Julsor	S/K	Julie Sorensen	PhD	Director	2.4				USA	

Erisco	S/K	Erika Scott	PhD	Dep. Director	1.9				USA		
Anngad	S/K	Anne Gadomski	MD, MPH	Evaluator	.6				USA		
PauJen	S/K	Paul Jenkins	PhD	Biostatistician	1				USA		
Pamtin	S/K	Pam Tinc	PhD	Senior Researcher	.8				USA		
Amaroo	S/K	Amanda Roome	PhD	Senior Researcher	.8				USA		
		Stephen Clark		Admin Director	.8				USA		
		Sue Ackerman		Center Manager	3				USA		
		Pauline Boyer		Outreach Coordinator	2.1				USA		
		James Carrabba		Safety Specialist	1.9				USA		
		Deb Dalton		Librarian	2.7				USA		
		Kevin Luschen		Project Coordinator	3.6				USA		
		Liane Hirabayashi		Outreach Coordinator	6.3				USA		
		Christina Day		Safety Specialist	1.5				USA		
		Melissa Scribani		Evaluator	.2				USA		
		Nancy Tallman		Evaluator	.4				USA		
		Lucinda Levene		Admin Coordinator	5.3				USA		
		Judy Graham		Nurse Researcher	.2				USA		
		Rebecca Weil		Research Coordinator	2.4				USA		
		Andrew Demma		Research Coordinator	2				USA		
		Jessica Echard		Research Coordinator	3.2				USA		
		Tristin VanValkenburgh		Research Assistant	1				USA		
		Maryellen Driscoll		Marketing Coordinator	4.1				USA		
		Kayla Johnson		Research Assistant	2.9				USA		
		Nicole Krupa		Data Analyst	.6				USA		
		Nicole Blanchard		Data Coordinator	1.2				USA		
		Rosemary Broderson		Receptionist	.1				USA		
		Sheehan-Yassin		Research Assistant	2.1				USA		

		Jessica Eckert		Research Coordinator	2.1				USA		
		Silva Hansen Ruez		Research Assistant	6.1				USA		
		Megan Goodspeed		Research Assistant	2				USA		
		Ryan Todd		Research Assistant	.1				USA		
		Becky Menninger		Research Coordinator	.2				USA		
		Duane Martin		Research Assistant	.6				USA		

D.2 Personnel updates N/A

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

Center aims and objectives will address the following list of NORA priorities: Strategic Goal 1 - Surveillance, Strategic Goal 2 - Vulnerable Workers, Strategic Goal 3 - Outreach, Partnerships, and Communications, Strategic Goal 4 - Agriculture Safety, Strategic Goal 5 - Agriculture Health, Strategic Goal 6 - Forestry Safety, Strategic Goal 7 - Forestry Health, Strategic Goal 8 - Fishing Safety.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
None

G.2 Responsible Conduct of Research
None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects

G.4.a Does the project involve human subjects? No

G.4.b Inclusion Enrollment Data: N/A

G.4.c ClinicalTrials.gov

N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement
Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)
Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals
Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? Yes

G.11 Program Income
Is program income anticipated during the next budget period?
No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets.Note: project outcome information will be made public in NIH RePORTER

Over the prior six year funding cycle, the NEC has been considerably productive. NEC efforts have led to advancements in AgFF passive injury surveillance; the collection of one of the most comprehensive data sets of logger risk exposures, injuries and health conditions in the country; the assessment of various options for addressing one of the most significant drivers of farm injury (PTO entanglements); collaborative work with the lobster fishing community to co-create ergonomic solutions and the exploration of options for safe grain bin entry. These and other NEC activities have culminated in a number of notable successes which include: 1) a Forbes feature article highlighting the NEC's Lifejackets for Lobstermen intervention as a "fitting strategy" to reduce falls overboard deaths in thefishing industry, 2) an American Journal of Public Health editorial that highlighted NEC's work on tractor safety prevention as the "gold-standard for research implementation", 3) demonstrated reductions in injuries, deaths and cost-savings related to injuries and deaths averted as noted in publications and testimonials, 4) active engagement in international research collaborations such as the IFISH 5 and IFISH 6 conferences, 5) the organization of agricultural stakeholders to develop a collective strategy to address work-related stress on dairy farms, and 6) efforts to address opioid addiction in logging and fishing communities by supporting naloxone and recovery coach training.

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: The Northeast Center for Occupational Safety and Health: Agriculture, Forestry and Fishing: Planning and Evaluation</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 9/1/2016-8/31/2022</td></tr>
<tr><td>Reporting Period: 9/1/2016-8/31/2022</td><td>Date Submitted: 1/13/2023</td></tr>
<tr><td>Program Director/ Principal Investigator
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stephen.clark@bassett.org</td></tr>
<tr><td>Change of Contact PD/PI:
N/A</td><td></td></tr>
<tr><td>Human Subjects:
No</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:
N/A</td><td>Inventions/Patents:
None</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The NEC PLANNING AND EVALUATION (P&E) utilizes a combination of evaluation approaches to create a comprehensive picture and story of the impact of NEC activities on AFF outcomes in the NE region. These P&E approaches include utilization focused techniques (logic models, theory of change, etc.), community-based participatory methods (Photovoice) for needs assessment), and developmental evaluation (conceptual framework, responding to emerging needs, particularly the COVID-19 pandemic) as described in the following specific aims (SA):

SA 1: Clarify, periodically revisit and refine the NEC theory of change (TOC) to assure alignment with performance and evaluation measures over the funding cycle. A conceptual framework of the NEC was designed to depict how the NEC's TOC leads to impact and how NEC activities contribute to intended outcomes. Ultimately, the goal is not to just demonstrate NEC impact, but to use impact assessments to improve its outputs. This model is reviewed quarterly in order to plan and evaluate the NEC's impact, and make mid-course modifications as needed.

SA 2: Conduct evaluative data collection, analysis and feedback on a quarterly basis. Evaluators will monitor each logic model to track progress on all outcomes and adherence to the timeline, and then provide constructive feedback to each core/research project. These processes have aided the NEC to monitor progress in pushing logic models to the right, make mid-course corrections, and address barriers in real time. Refinements this year include: 1) formally meet with the operational base (P&E core) to strategically discuss these data quarterly, 2) make the data reports more user-friendly, succinct and useful to the end user, and 3) evaluate the activities of the Outreach Core. We will continue this quarterly schedule in the coming grant year.

SA 3: Utilize performance measures to monitor adaption to changing context, situations, resources and unanticipated consequences over the funding cycle. Center evaluators will monitor whether: research projects adhere to timelines, outreach activities achieve their objectives, NEC partnerships are evolving and each core implements its planned activities. Performance monitoring (PM) and evaluation will be contiguous data collection processes for the Research, Outreach and P&E cores. Monitoring PM for these cores will allow the operational base (P&E core) to proactively identify problems, implement solutions, identify good practices and success stories and disseminate these.

SA 4: Conduct cost inclusive evaluation. At the onset of the project, we work with each project team to help them identify and collect relevant economic data. We will include cost questions as part of the quarterly evaluation review discussed in SA 2, and as a component of the Performance Measures collected in SA 3.

SA 5: Respond to evolving and emerging needs in AFF worker safety and health. Various information feedback loops through surveillance research, Outreach, Photovoice needs assessment, ongoing case studies, advisory groups and other research projects will inform the NEC of these emerging issues. NEC will provide seed money to fund innovative projects and/or to address emerging issues using a well- tested prioritization and funding process. Intermediate outcomes for these projects (funding leveraged, presentations, publications, etc.) will be monitored and evaluated.

SA 6: Develop common metrics for evaluating the AFF centers across the US. Our proposal includes participation in a meta-evaluation meeting across the AFF centers as a post-award process in order to generate an evaluative approach that represents the centers as a whole. The NEC evaluation team will bring its lessons learned in evaluating the NEC to the post-award meta-evaluation meeting of all AFF centers and

will continue to contribute to this common metrics project. The NEC is an active participant in the cross-center contribution analysis effort spearheaded by NIOSH (begun in late 2019).

B.2. What did you accomplish under these goals?

The NEC PLANNING AND EVALUATION (P&E) core utilized a combination of evaluation approaches to create a comprehensive picture and story of the impact of NEC activities on AFF outcomes in the Northeast (NE) region. These P&E approaches included utilization focused techniques (logic models, theory of change, etc.), community-based participatory methods (Photovoice) for needs assessment), realist techniques (use of existing data, cost analysis, etc.), and developmental evaluation (conceptual framework, responding to emerging needs, etc.). This section lists the specific aims of the previous project period, underscores the importance of the findings, and explains how findings led toward projects and studies developed for the next cycle. The most significant change to the prior specific aims was due to the occurrence of the COVID19 pandemic in March 2020 in the NE. The pandemic led the NEC in new directions, i.e. adapting to pandemic conditions, addressing workforce PPE and fit testing needs, and measuring the impact of the pandemic on agriculture and logging workers. None of the studies described in this section met the NIH definition for clinical research, therefore participant enrollment is not reported.

SPECIFIC AIM 1: Clarify, periodically revisit and refine the NEC theory of change (TOC) to assure alignment with performance and evaluation measures over the funding cycle. A conceptual framework of the NEC has been designed to depict how the NEC's TOC leads to impact and how NEC activities contribute to intended outcomes. In the past funding cycle, logic models were constructed for all the NEC scientific projects in order to monitor and document the short, intermediate, and long-term outcomes of the NEC and its projects. Through the past cycle, CERI assisted the information specialist, Deborah Dalton, in project tracking, evaluation, and NIOSH reporting. Most important, evaluation results produced by CERI were used for improving or adapting scientific study design, uncovering needs for technical assistance, articulating the impacts and outcomes of scientific projects, improving the annual retreats, refining training objectives and training evaluation methods, addressing barriers, reporting to NIOSH, and assuring accountability.

Recognizing annual retreats with PIs, NEC staff and consultants as a learning opportunity, CERI presented logic models, intermediate outcomes, measures of impact, and need for dissemination and r2p at each NEC annual retreat. CERI encouraged critical thinking and reflection among NEC PIs about logic modeling to increase understanding of the Theory of Change (TOC). Given the onset of the pandemic in March 2020, in-person retreats were replaced by three shorter Zoom meetings. For example, at the virtual retreat held on January 23, 2020, project PIs, NEC administration and the P&E Core, as well as guest researchers attended. To assist them in meeting their objectives, PI's submitted their timelines for Planned Project Output such as manuscript submission and conference presentations for each of the scientific projects. These were discussed collectively so that PI's could learn from each other, problem solve and/or form partnerships as needed.

SPECIFIC AIM 2: Conduct evaluative data collection, analysis and feedback on a quarterly basis. Every quarter, CERI surveyed all PI's to track and report results for timeline adherence, outputs and impacts. CERI made these quarterly reports more user-friendly, succinct and useful to the end user. These reports were then disseminated to all the NEC project PIs, NEC administration and the NEC Scientific Advisory Panel. In addition, we also adopted a monthly meeting schedule in order to increase attention to performance targets, namely publications, but also tracking project success stories, presentations, and awards. Solutions to timeline delays and recruitment issues were discussed in P&E meetings, and then used to improve or modify program designs, address barriers, assure accountability and allow for mid-course corrections by the PI or with assistance from the NEC Planning and Evaluation (P&E) Core. Quarterly reports highlighted NEC's professional relationships that enabled translation from research into practice. One example includes a shoe gripper that is currently being promoted by the Professional Logging Contractors (PLC). HAIX, a German boot

manufacturer, reached out to the NEC Maine Logging Workers study team because HAIX heard about their study data. HAIX was looking to improve the design of their forestry boots. An example of a success story includes a partnership between the NEC Maine Logging Workers study team and Earl Dotter, a well-known occupational photo-journalist, on a photo series about logging in partnership with PLC. https://www.earldotter.com/.

CERI also evaluated the educational activities of the Outreach Core. For example, the Yates Mennonite Evaluation of farm safety training activities for school aged children started over more than a decade in a Mennonite community in Western New York. This study measures knowledge gained in order to identify ways trainings and evaluation methods might be improved within the Anabaptist community, a vulnerable population in the Ag sector. Evaluations of school-based farm safety trainings in 2020 and 2021, delivered to 564 students in 25 schools, indicated a high level of farm safety knowledge among school-aged youth; average knowledge scores exceeded 90%. A series of focus groups were conducted in January 2022 with community members to discuss the findings and gain insight into farm safety behaviors since the project's inception in 2010. Results from that survey have been presented to safety educators and Anabaptist communities at the Amish and Plain Peoples conference in Shipshewana, IN.

Dr. Sorensen's PTO project found that in person interaction is important for Ag populations given that farmers appear to be hands on learners. A subsequent scoping review of dairy farm worker training showed that training was not evaluated rigorously so this is an evidence gap that needs to be addressed.[1] CERI has trained NEC personnel to state objectives for training clearly at the outset, make sure that the training methods align with these objectives, then evaluate if the objectives were met. Next step includes using these data to improve training or remove a farm hazard. For example, Plan Do Study Act (PDSA) cycles would then follow as a quality improvement strategy. This approach in part led to our REA-PDSA pilot proposal in the next cycle, where REA will identify safety culture issues at worksites followed by PDSA cycles to evaluate solutions.

SPECIFIC AIM 3: Utilize performance measures to monitor adaption to changing context, situations, resources and unanticipated consequences over the funding cycle. CERI monitored whether: research projects adhere to timelines, outreach activities achieve their objectives, NEC partnerships are evolving and each core implements its planned activities. The P&E Core met monthly to discuss progress, emerging issues, address problems, feedback results and plan solutions. This primary feedback loop kept the NEC project PI's, NEC administration and the NEC Scientific Advisory Panel informed of evaluation results, research progress, outreach activities and partnership development thus enabling relevant recommendation from these entities.

CERI has conducted implementation science research in order to expand its areas of expertise and methods used in AgFF research. Dr. Pam Tinc, a NEC researcher, and Dr. Gadomski have presented their implementation science research results at the Academy Health Dissemination and Implementation annual conference. In 2019, Dr. Tinc presented her work titled "*Media advocacy as an implementation strategy in public health: Lessons from the implementation of a farm safety program".* This presentation focused on the scale-up of a farm safety program (the Rollover Protection Structure Rebate Program) using informal media advocacy campaigns to benefit implementation in seven states and at the national level. They have also published their implementation science research as it pertained to agricultural safety and health, and to the National Rollover Protection Structure Rebate Program.[2] [3]

To assess whether NEC partnerships are evolving, CERI has used social network analysis (SNA) for the past 10 years to map its network and plan its expansion. By trending SNA from year to year, CERI has been able to document the evolution of the NEC social network, which is an important measure of the NEC's social capital within the AgFF community. Annual on-line surveys with excellent response rates (Table 1) were conducted to assess key communication and collaborations among NEC participants as well as identify

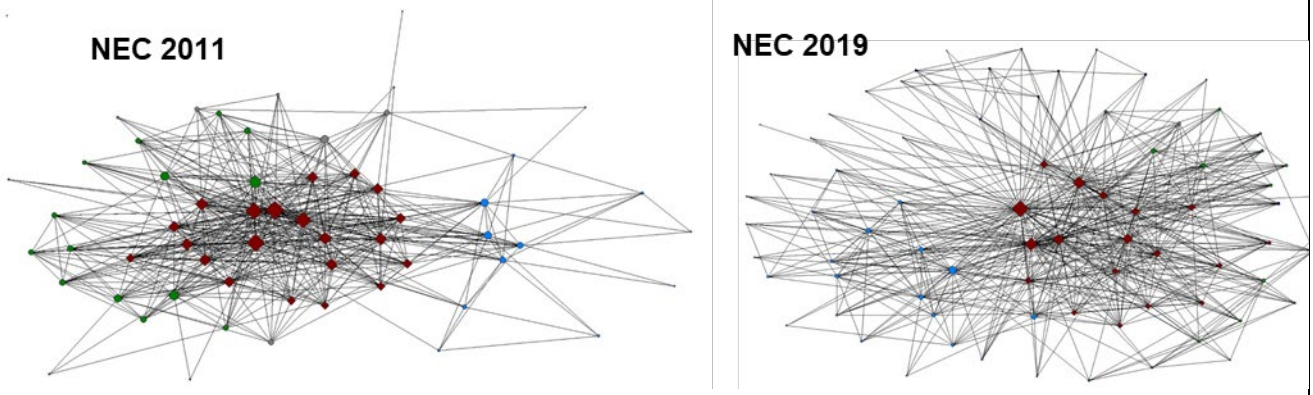
emerging issues. In past funding cycles, sequential SNA of the NEC has demonstrated how communication and collaboration evolved over a ten year period and publish these results.[4] These sequential sociograms map the expansion of the NEC network as evidenced by the following SNA metrics: 30% increase in membership from baseline, an increase in total relational ties, and an increase in both degree and closeness centrality of the NEC in this network supporting the notion of increased center identity and stability.

Table 1. NEC Social Network Analysis – Summary 2011-2020

Year of Data Collection	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
Roster members	59	61	71	76	74	72	84	76	76	85
Survey response rate (%)	81.0	88.5	93.1	85.7	87.8	90.3	86.6	84.2	84.2	85.9
Total ties (any contact)	795	840	1039	1194	945	925	1098	910	832	986
Extramural ties	129	191	243	388	287	250	329	225	178	290
% of total ties extramural	16.2	22.7	23.4	32.5	30.4	27.0	30.0	24.7	21.4	29.4

In network theory, strong ties are defined in terms of frequency of communication. Centrality measures, by both closeness (position in the sociogram) and degree (size of nodes), have evolved from the first year (see Figure 2). In 2011, NEC staff were the most active in the network (their nodes were centrally located and were the largest), and this has changed to a more decentralized pattern over the following years. The overall form of the sociogram has approached a more circular, or wheel-like shape, indicating interaction among those outside the very center of the network. The number of extramural ties (non-NEC staff) was consistently over 20%, indicating that NEC leadership has both fostered collaboration and included new roster members that are well-connected within their sectors. Notable developments have been made in partnerships across all three AgFF sectors; fishing and forestry sub-networks have formed and have been maintained over time.

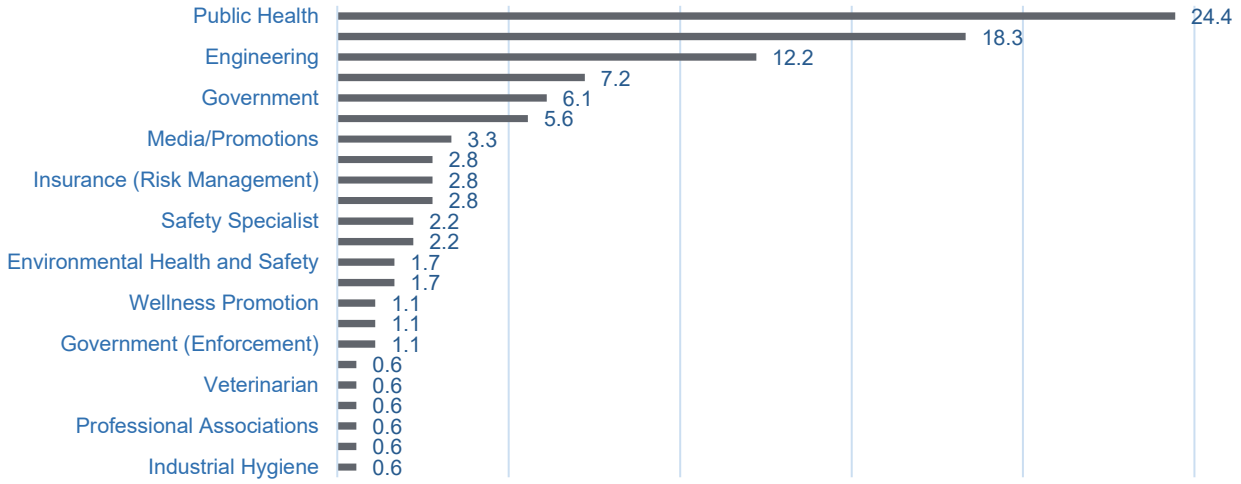
Figure 2. Evolution of NEC social network, excerpt sociograms from 2011 and 2019



Legend: Maroon = AgFF; Green=Agriculture; Light blue=Fishing; Bright blue=Forestry; Gray=Other (general occupational health) Diamond=NEC staff; Circle=non-NEC

The NEC comprises a transdisciplinary network representing 23 separate disciplines, including public health researchers and practitioners, occupational health outreach professionals, engineers, employers/business owners, government employees, social scientists, and various other disciplines (Figure 3).

Figure 3. Percent of NEC social network members by discipline, 2011-2020



Beginning in 2018, CERI performed an annual SNA with Northeast Ag Safety and Health Coalition(NEASHC), a safety trainers coalition, coordinated by the NEC in partnership with Penn State University (https://necenter.org/portfolio/training-for-trainers/).The purpose of this SNA was to track changes in collaboration and program sharing over time.[5] CERI provided post-presentation evaluations for a series of monthly coalition trainings held by Zoom, with results from these evaluations shared with coalition coordinators. Additionally, CERI developed a needs assessment survey for NEASHC members that was completed by 18 coalition members from nine states. Nearly three-quarters (13/18, 72.2%) of participating members stated that the most valuable thing they received through the Coalition was networking; the remaining 27.8% reported a mix of cooperation across the states, collaborations with safety personnel and sharing of ideas as the most valuable. The needs assessment captured the challenges experienced by Coalition members due to COVID-19, particularly travel restrictions, inability to visit farms or hold gatherings to deliver programming, as well as barriers to providing programming online (e.g., poor internet connectivity, lack of engagement from farm community in virtual events). A work group session was held in August 2020 to discuss the results of the needs assessment. Participants (n=12) brought forward ideas for adapting training delivery during the ongoing pandemic and beyond, including dissemination of single-page training documents to agricultural producers as well as development of short-format trainings for delivery in informal settings.

SPECIFIC AIM 4: Conduct cost inclusive evaluation. Timothy Kelsey, PhD, an economist from Penn State (see Bio, E&P) led an economic workshop for PIs and NEC staff at one of the NEC annual meetings in order to develop NEC's capacity to perform cost-inclusive evaluation.[6] CERI has worked with Dr. Kelsey in the past to study the random OSHA inspections of dairy farms. We conducted mixed-methods evaluation of 16 dairy farms (4 OSHA inspected, 12 not inspected) to describe farm-level financial costs and overall farmer perspectives related to these OSHA inspections.[7] We found that the overall impact of the NY OSHA inspections was positive, leading to physical changes on the farm and increased worker trainings, but farmers' views were mixed. The cost of compliance was a small proportion of production costs.

Two additional economic analyses were completed in collaboration with Dr. Kelsey. [8 9] An economic analysis of Rollover Protective Structures (ROPS) was published in October 2018 in the American Journal of Public Health".[8] More than $4 million dollars has been saved to date as a direct result of this program which shows that social marketing was cost-effective for reducing injuries from tractor overturns. A cost effectiveness analysis of the PTO shielding program was published in October 2021 in JASH.[9]

SPECIFIC AIM 5: Respond to evolving and emerging needs in AFF worker safety and health. Various information feedback loops through surveillance research, Outreach, Photovoice needs assessment, ongoing

case studies, advisory groups, and other research projects inform the NEC of emerging issues. NEC provided seed money to fund emerging issues projects that were selected using a well-tested prioritization and funding process.

In Years 5 and 6, by far, the Covid-19 pandemic was the most significant emerging issue. The pandemic has forced us to find alternative ways of getting the research work done. During the pandemic, we could not interact in person with study subjects, we had to maintain social distancing and/or we had difficulty contacting our study subjects who are sheltering in place and/or have limited availability. For example, during the pandemic, the spring logger trainings in Maine were cancelled which meant that the Logging Workers study team could not collect health assessment data. In addition, NEC was called upon to provide PPE, FIT testing, vaccines, educational outreach as well as conduct surveys to assess the impact of the pandemic on farm workers and loggers.

In Year 1, NEC funded the "Fishing Partnership Support Services (FPSS) Narcan Training Course for Commercial Fishing Captains in the Northeast" to address opioid addiction and overdose among commercial fishermen. In Year 4, NEC partnered with Professional Logging Contractors of Maine (PLC) and FPSS to address the same problem among loggers. An opioid awareness and Naloxone training was due to be delivered at PLC's annual in spring 2020, but unfortunately, the spring safety trainings were cancelled due to the COVID-19 pandemic. These were instead delivered at their safety training series in 2022.

In Year 3, the Stakeholders Team Up for Action in New York Dairy-Farmers Mental Health workshop was funded to develop a joint strategy for moving toward improved wellbeing for the farm community. Overall, this workshop led to greater collaboration between stakeholders and specific action items to help improve the wellbeing of dairy farmers. In addition, an AgriSafe webinar on the STAND meeting was held in January 2019 to share results and methodologies with a wider audience. A video was produced highlighting the benefits of the workshop and the process used to facilitate the meeting. A peer-reviewed article, published in the Journal of Agromedicine details both the process and outcomes of the workshop (see www.NYCAMH.org/programs-and-services/stand.php).

In Year 6, because tick-borne diseases regularly makes the list for emerging issues, we completed a seroprevalence study of forestry workers. This emerging issue also led to the inclusion of prevention research for tick-borne diseases among agricultural workers in the next cycle proposal.

In Year 2, in order to better respond to service requests and more efficiently deliver NEC services, NEC purchased a Customer Relations Management System, called NERD. Changes in Worker Protection Standard requirements exponentially increased requests from the farm community for respiratory fit-testing training and assessments. Additionally, the NEC's list of services had considerably expanded over the past few years. NERD streamlines these requests and facilitates tracking and monitoring.

CERI encouraged researchers to use Photovoice for hazard identification. Not all projects utilized Photovoice as an initial study method to identify hazards or new problems among AgFF workers. However, the Maine Logger Health and Safety Study successfully completed a Photovoice project for foresters to share firsthand what foods they eat to get through a typical workday (see Photovoice – Northeast Center for Occupational Health and Safety (necenter.org). The team used Photovoice results to triangulate the Maine Logger Health and Safety Study posts and the health survey data. This study, in part, led to the inclusion of the transdisciplinary *Total Worker Health*® approach to improve chronic health and CVD risk in the US logging industry in this proposal.

SPECIFIC AIM 6: NEC has worked with all NIOSH AgFF Centers to develop collaborative projects designed to address crosscutting AgFF problems nationwide through the AgFF Evaluators, Coordinators, and Outreach (ECO) group as well as specific projects with northwest and southern AgFF centers. In 2012, the ECO group launched with the goal to enhance cross-center collaboration through: 1) sharing resources and learning, and 2) workgroups focused on collective outreach campaigns. With a membership of 74 center personnel

across all currently funded Centers and select NIOSH representatives, the ECO group meets regularly and functions as a foundation for center collaboration and public communications for the national AgFF safety and health initiative. Workgroups include Awareness – safety campaigns promoted through two nationally recognized events: National Farm Safety and Health Week and Ag Safety Awareness Program Week and YouTube Channel - a peer-reviewed channel for AgFF produced educational videos.[10]

In 2013, the NIOSH AgFF Centers collaborated to initiate a joint YouTube channel in order to raise awareness of AgFF occupational hazards; provide information to prevent AgFF injuries and illnesses; increase the visibility and sphere of influence of the AgFF Centers; and establish a model of collaborative work that can be replicated by other organizations. The collaborators sought to produce a structured channel with high scientific standards. Policies, procedures, and a standard review process were established for the channel. Representatives from the AgFF Centers coordinate submission reviews, site maintenance, and reporting on the channel analytics. A marketing plan was established that includes a press release and ideas to promote new videos. From August 2013 to March 2021, the channel has grown from the original 48 videos to 166 videos with over 23,000 cumulative watch time hours. The channel is promoted by the AgFF Centers through email, social media, conference presentations and outreach exhibits. Promotions are targeted to agricultural Extension agents, educators, producers, owners, operators, first responders, families and community organizations. The channel is also publicized during coordinated national outreach events. AgFF Centers have benefitted from increased exposure of their content and the collaboration provided an opportunity to achieve labor efficiencies. YouTube metrics demonstrated that coordinated marketing increases views, watch time, and subscriptions. In addition, the success of the channel communicates the benefits to collaboration among organizations with common missions.

The ECO group also coordinates response efforts related to significant emerging issues like the COVID-19 pandemic, natural disasters and mental health. The NEC P&E team worked closely with other NIOSH funded AgFF centers to assess the impact of COVID-19 on agriculture, migrant farm workers and regional farm populations. NEC Outreach and E&P cores contributed to these activities including shared COVID-19 pandemic impact surveys disseminated with regional focus. Based on Heather Riden's farm worker survey in California (COFS), this survey captured information on infection control measures implemented on farms, access to healthcare, training and social determinants of health measures. NEC launched a farm workers needs assessment adapted to the NE in July 2020. This was a multimodal survey (paper, interview, REDcap link) was adapted to the NE by CERI and conducted by the Outreach staff. The main findings of the farmworker needs assessment included: i) a high rate of personal compliance relating to COVID-19 related PPE usage, ii) 12% of respondents reported having underlying health conditions that placed them at increased risk of COVID-19 morbidity and mortality, iii) almost half of the respondents who answered questions about financial status were worried about getting enough work hours, and iv) 21% were concerned about having enough income to pay bills, v) most respondents relied on the internet or their employer for preparedness training and personal protective equipment (PPE). Detailed survey results can be found at https://necenter.org/wp-content/uploads/2021/05/Farmworker-Needs-Assessment_2021.pdf.

Dr. Erika Scott conducted a similar pandemic related survey with logging workforce throughout the NE region ("Northeast Logger Executive Summary: The impact of COVID-19 on loggers in the Northeastern United States"). The survey included 61 questions derived from two sources—the NEC's "Farmworker Needs Assessment: The impact of COVID-19 on farmworker populations in the Northeastern United States" (described above) and the Maine logger health and safety study surveys. NEC worked with partners across the NE to distribute this survey. The COVID-19 impact survey responses revealed that the pandemic has had a significant impact on NE loggers. The impact was exacerbated—and in the case of Maine loggers, eclipsed—by a paper mill explosion in Maine, April 2020.

Other examples of cross-center collaboration include surveillance research, the National Tractor Safety Initiative, the Retrofitting ROPS national program led by NEC. The Surveillance Working Group (SWG) is a cross-center and beyond- collaboration of 30 researchers, hailing from AgFF Centers, NIOSH, and other

institutions working on AgFF surveillance. Dr. Erika Scott has led this effort and will continue in this role and host quarterly calls. This SWG has seven subcommittees, along with the NIOSH Office of Ag Health and Safety, and has recently begun the process of reviewing NIOSH strategy for surveillance and mapping a plan for the future.

Although a common metric by which to compare the 11 AgFF centers to date has not been identified, perhaps a better measure would be quantifying the number of cross-center collaborations, as proposed in the next cycle.

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B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

N/A

B.5. How did you disseminate the results to communities of interest?

Centrality of the NEC Brand-Over the past six years the NEC has succeeded in expanding recognition of the NEC in the NE commercial fishing and logging industries. This is partly due to programs like the NEC Lifejackets for Lobstermen project, the Participatory Ergonomics in the Lobster Fishing Industry project, the Fishing Vessel Apps project, and various partnerships with Professional Logging Contractors, Fishing Partnership Support Services (FPSS), the Massachusetts Lobstermen's Association, the Maine Lobstermen's Association and other logging and fishing industry partners. The NEC has also launched social media sites for both industries and has completely redeveloped its website to increase engagement with AgFF populations (www.necenter.org). In addition to these dissemination improvements, the NEC transitioned all of its outreach, training, technical assistance and personal protective equipment (PPE) distribution to a Salesforce customer relations management system. Salesforce is a database management platform that was originally designed for marketing, sales and commerce. The new customer relations management system (affectionately referred to as 'NERD'-NEC Events Reporting Database) allows us to document and track every worker and industry group interaction. This has greatly enhanced our customer service. For example, if we provide respiratory fit-testing services to a farm, we are able to enter information on the number of workers trained and the respirators and equipment used, so future trainings are easy to schedule and replacements can be automatically supplied.

The NEC has also published over 50 peer-reviewed publications on topics as diverse as the use of wearable technology for tracking worker PPE compliance to the use of machine learning in AgFF injury surveillance. Other promotional efforts include 28 newsletter updates to 3,383 recipients and 149 newspaper and trade magazine articles in national papers and news outlets, such as Forbes and Politico. Additional noteworthy activities include participation in a press conference held by former Governor Cuomo regarding federal immigration crackdowns in agriculture and a feature in the "Social Fishtancing" podcast, on COVID impacts to fishermen.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

D. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

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C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org
www.ifishconference.ca/home/

C.3. Technologies or techniques
Social Network Analysis
Logic Modeling
Photovoice
Cost Benefit Analyses

C.4. Inventions, patent applications, and/or licenses
N/A/

C.5. Other products and resource sharing
Survey Instruments
Data Collection Protocols
Study Protocols

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Julsor	S/K	Julie Sorensen	PhD	Director	1				USA	
Erisco	S/K	Erika Scott	PhD	Deputy Director	.4				USA	
Anngad	S/K	Anne Gadomski	MD, MPH	Evaluator	.6				USA	

Paujen	S/K	Paul Jenkins	PhD	Biostatistician	.25				USA	
		Stephen Clark		Grants Administrator	.8				USA	
		Susan Ackerman		Center Manager	3				USA	
		Melissa Scribani	ABD	Evaluator	.2				USA	
		Nancy Tallman		Evaluator	.4				USA	
		Deb Dalton		Librarian	1.5				USA	
		Liane Hirabayashi		Outreach Coordinator	2				USA	
		Rebecca Weil		Research Coordinator	.15				USA	
		Nicole Blanchard		Data Analyst	.6				USA	

D.2 Personnel updates N/A

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

By performing the above activities across the AFF sectors, the Evaluation and Planning core will address the following NORA strategic goals: STRATEGIC GOAL 3 – Outreach, Partnerships, and Communications, NORA intermediate Goal 3.1 - Form collaborative efforts with key stakeholders to: 1) quarterly assess current and emerging major occupational health and safety concerns and solutions; and 2) prioritize interventions for implementation; Intermediate Goal 3.2 - Identify practical and proven occupational safety and health interventions, then encourage new studies to meet needs where proven strategies do not exist.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
None

G.2 Responsible Conduct of Research
None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects

G.4.a Does the project involve human subjects? No

G.4.b Inclusion Enrollment Data N/A

G.4.c ClinicalTrials.gov

N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? Yes

G.11 Program Income
Is program income anticipated during the next budget period?
No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets.

Over the prior six year funding cycle, the NEC has been considerably productive. NEC efforts have led to advancements in AgFF passive injury surveillance; the collection of one of the most comprehensive data sets of logger risk exposures, injuries and health conditions in the country; the assessment of various options for addressing one of the most significant drivers of farm injury (PTO entanglements); collaborative work with the lobster fishing community to co-create ergonomic solutions and the exploration of options for safe grain bin entry. These and other NEC activities have culminated in a number of notable successes which include: 1) a Forbes feature article highlighting the NEC's Lifejackets for Lobstermen intervention as a "fitting strategy" to reduce falls overboard deaths in the fishing industry, 2) an American Journal of Public Health editorial that highlighted NEC's work on tractor safety prevention as the "gold-standard for research implementation", 3) demonstrated reductions in injuries, deaths and cost-savings related to injuries and deaths averted as noted in publications and testimonials, 4) active engagement in international research collaborations such as the IFISH 5 and IFISH 6 conferences, 5) the organization of agricultural stakeholders to develop a collective strategy to address work-related stress on dairy farms, and 6) efforts to address opioid addiction in logging and fishing communities by supporting naloxone and recovery coach training.

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: The Northeast Center for Occupational Safety and Health: Agriculture, Forestry and Fishing: Outreach Core</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 9/1/2016-8/31/2022</td></tr>
<tr><td>Reporting Period: 9/1/2016-8/31/2022</td><td>Date Submitted:
1/13/2023</td></tr>
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<tr><td>Change of Contact PD/PI:
N/A</td><td></td></tr>
<tr><td>Human Subjects:
No</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:</td><td>Inventions/Patents:</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

As outlined in the Center Overview, the primary Aims of the Center are to: 1) continue to identify and track AFF injuries and fatalities, 2) address AFF issues that have been prioritized in the previous cycle of funding, 3) bridge gaps in knowledge or programming on these issues, 4) evaluate these approaches and 5) translate evidence-based improvements into the AFF workplace. The proposals that are included in the Research and Planning / Evaluation Components of the Center application will address Aims # 1-4. However, the Outreach Program and associated activities described in this section of the application, will be focused on increasing awareness / adoption of AFF OSH knowledge, technologies and practices (Aim #5).

The long-term goal of the Outreach Program is to translate NEC and AFF OSH research and programs into the workplace, so that evidence-based OSH solutions have a substantive impact on worker health and safety. The objective of this application is to utilize a multi-faceted promotions and outreach strategy that leverages stakeholder relationships and resources to increase knowledge of AFF OSH hazards and solutions and facilitates positive changes in workplace practices. To be specific, the strategy will focus on:

Aim #1- Piloting a Northeast Agricultural Safety Trainers Initiative to facilitate improvements in worker trainings. Training individuals in AFF work safety practices is a challenging enterprise and most trainers are unaware of advances in safety training practices or technological platforms that can assist with safety instruction. We propose to gather Northeast agricultural safety trainers annually, to discuss new and innovative training methods, participate in training demonstrations and identify / practice improved methods of worker safety training delivery. Information will be shared with other Centers, land grant universities, advocacy groups and extension agents who provide safety trainings in other U.S. regions.

Aim #2- Increasing worker knowledge of safety technologies and OSH best practices. In addition to improving training approaches, the Outreach Program will focus on providing face-to-face, hands-on AFF worker training opportunities and will incorporate training best practices identified in Aim #1. NEC will expand programs that have proven to be popular and effective with AFF communities. Trainings will include: 'Safety at Sea', which will be provided by Fishing Partnership Support Services in different Northeastern Ports, 'Game of Logging'-which will be provided by certified GOL trainers , and 'Safe Farm' trainings provided by Northeast trainers residing in various Northeastern states.

Aim #3– Increasing Center and OSH AFF visibility using a detailed and organized Promotions and Marketing Plan. The NEC marketing plan, will rely on the following 'marketing mix' to increase the reach and repetition of NEC and AFF OSH messaging - paid advertising; stakeholder outreach; tailored materials; outreach events; print, radio and TV journalism (earned media) and branding (increasing recognition by developing a certain 'look and feel' for Center promotions) to increase awareness of the Center, NEC programs / resources and AFF OSH issues.

Aim #4- Evaluating promotions and training activities. Given the relatively large region that the NEC covers and the diversity of AFF populations and needs, it will be very important to maximize the resources dedicated to AFF Outreach. To do this, we will use NEC surveillance data to target priority issues and populations. Promotion outcomes such as Center and Center program recognition, # of contacts/ inquiries and utilization of surveys will also be tracked to evaluate the costs/benefits of various promotions activities. Additionally, AFF training programs, which will incorporate technologies and best-practices from NEC and AFF OSH research activities, will be evaluated using participant surveys and social network analysis. Evaluation activities are described separately for each proposed aims in the Approach section.

B.2. What did you accomplish under these goals?

Aim #1- *Piloting a NE Agricultural Safety Trainers Coalition to facilitate improvements in worker trainings and trainer expertise.* In the prior cycle, the NEC partnered with Pennsylvania State University to create a coalition of agricultural health and safety trainers from Northeastern states. The Coalition included 20 trainers from ten states who regularly participated in annual in-person NEC conferences and monthly NEC coalition meetings. *The goal of the Coalition was to offer safety trainers an opportunity to meet regularly to share training ideas, curriculum, resources and innovations.* The following list provides an annual overview of NEASHC workshop topics:

- In 2017 NEASHC trainers gathered in Cooperstown at a two-day workshop focused on health and safety considerations relating to agritourism. The workshop was attended by 20 trainers from eight northeastern states. Marsha Salzwedel from the National Children's Center for Rural and Agricultural Health and Safety provided an introduction to the hazards of agritourism operations, followed by on-site hazard audits at two NY agritourism operations. The second day of the training workshop featured presentations on the new EPA Worker Protection Standard, an overview of Northeast Coalition objectives and a review of safety training resources available through the NEC.
- In 2018, NEASHC trainers assembled in Cooperstown to learn about a variety of agricultural health and safety topics. The event was attended by 19 trainers and safety professionals, representing five states and one agri-business. Educational strategies and teaching tools for various agricultural safety and health topics were the primary focus of the event. Participants learned that understanding why and how we teach a specific topic impacts the adult learners' ability to understand, retain and use the information. The coalition had the opportunity to host staff from Farm Credit East, and these representatives interacted with staff to increase their awareness of farm safety and the services provided by agricultural safety and health professionals in the Northeast.
- In 2019, trainers assembled once again in Cooperstown with 24 trainers representing eight Northeastern states in attendance. The two-day training featured presentations on: a) Onboarding for new employees, b) Animal and livestock handling, c) Demonstrations and resource sharing, d) Whole system in a room for creating systemic change, e) Prevention and mitigation of ag emergencies and best practices, f) the Farm medic program and g) Rural firefighters delivering agricultural safety and health.
- In 2020, it was not possible to host our annual in-person workshop for coalition members due to the pandemic. In its place, however, the NEASHC Coordinator organized monthly Zoom-based presentations starting in May to address new and emerging topics as well as to plan for topics for the 2021 in-person training. Twenty-four coalition members from 10 Northeastern states regularly attended these monthly sessions. An overview of topics includes: a Webinar entitled "Behavioral Health Planning: A Key to Farming in the Era of COVID-19". This event was coordinated with AgriSafe Network and featured the coalition's first international Webinar. Mike Rosmann was a key presenter and 122 people

Figure 1: NEASHC Trainers at Annual NEC Meeting

attended. Additional monthly Zoom presentations included: a) June – "The Ticking Time Bomb: Tick-Borne Diseases in Agricultural Workers"-which generated considerable interest and underscored the need for the TBD proposal included in the current NEC application, b) July – "Safety Training for Packing House Workers and Safety Hazards in Packing Houses", and c) August – A session on needs assessment and Coalition plans.

- In 2021, the annual NEASHC meeting was again held as a virtual meeting with several sessions planned around the co-development and distribution of tailgate trainings. Eighteen members from nine states completed the annual meetings survey. These "Tailgate Trainings" are short, simple, training sessions that a farm owner or manager can use with a small group of workers. Each training sheet provides visuals, key training points, and review questions to generate conversations about the safety topics. Training topics included a) Ground level Slips, Trips, & Falls b) Cattle Handling and c) Tractor side overturns. Coalition participants also participated in a needs assessment looking at the challenges Coalition members had experienced due to COVID-19. These included travel restrictions, an inability to visit farms or deliver programming, and issues with programming online (e.g., poor internet connectivity and lack of engagement from farm community in virtual events). The needs assessment also brought forward ideas for adapting training delivery during the ongoing pandemic and beyond, including dissemination of single-page training documents to agricultural producers and the development of short-format trainings to be given in informal settings.

In addition to meetings, Coalition members also received a quarterly coalition e-newsletter with information on emerging AgFF OSH issues, late-breaking research updates, innovative ideas for agricultural safety demonstrations and farm injury / fatality trends for the Northeast. Coalition membership steadily increased over the past few years, from 20 members the first year to 30 members by 2021. Evaluation of meetings and coalition activities were very positive. Participant evaluations from meetings and annual workshops indicate that coalition members consistently scored the training workshops highly in relation to increasing their training abilities, knowledge of factors contributing to injury/fatality trends in the NE and the utility of training materials and techniques (an average of "1" on a scale of 1 to 5, "1" being the best score). Evaluations also indicated that shared training curriculum and program ideas were a very important aspect of coalition member interest. Evaluations also indicated that the Coalition Coordinator played a key role in establishing connections and engagement with coalition members. Social Network Analysis (SNA) also offered evidence of diffusion of occupational safety and health best-practices, concepts and materials throughout the coalition. Trainers reported utilizing NEC coalition demos and materials in NJ, NY, NH, MD, VT, PA, and ME, with several instances of coalition-related cross-state collaboration noted. Coalition programming on adult education strategies was adopted and/or shared by 41.7% of respondents. Coalition members also stated that the most valuable things they received through the Coalition were networking opportunities and sharing of ideas. Ninety-four percent of the respondents agreed or strongly agreed that their time with coalition activities was well spent and that participation in coalition activities had been beneficial to their work.

Aim #2- *Increasing worker knowledge of safety technologies and OSH best practices and* **Aim #4-** *Evaluating promotions and training activities.* Despite the pandemic, the NEC offered a wide variety of worker trainings, services and materials over the past cycle (for information on programs visit www.necenter.org). In total, 1,458 training events and worksite consultations were provided from 2016-2020 and 31,366 workers were trained (see **Table 1** for a breakdown by AgFF sector of the types of trainings and services provided). Agricultural safety and health training topics included tractor safety, animal handling, machinery safety, first aid/CPR[1], and many other topics. Game of Logging trainings, (in-person and hands on), offered guidance on safe chainsaw handling, use of proper Personal Protective Equipment (PPE) and safer felling practices. The NEC also contracted with Fishing Partnership Support Services (FPSS) to provide 'Safety and Survival' and 'Drill Conductor' courses to fishermen all along the NE Coast. These trainings provide a full day of hands-on instruction on survival suits, firefighting procedures and many other topics. From 2016-2020, the NEC also

initiated a small safety grants program in NY that provides a 50% cost share for farm safety upgrades (https://www.nycamh.org/programs-and-services/john-may-farm-safety-fund.php). Almost $450,000 has been distributed for 113 safety projects. Safety improvements included installation of animal handling equipment, safety harnessing, improved lighting and installation of eyewash stations. Program impact is being evaluated in hopes that this model can be replicated in other NE states.

Table 1: Total NEC Outreach Services and Trainings – 9/1/2016-8/30/2020

NEC OUTREACH ACTIVITIES	*2016-2017*	*2017-2018*	*2018-2019*	*2019-2020**	**TOTALS**
Agricultural Outreach					
On-farm consultations	113	79	43	49	*284*
Farm safety trainings in English	165	131	122	71	*489*
Farm safety trainings in Spanish	160	168	121	101	*550*
# of farmworkers trained	4521	3505	3296	2593	*13915*
Young farmer trainings	94	108	64	36	*302*
# of young farmworkers trained	3718	4408	4503	488	*13117*
# of Anabaptist workers trained	179	202	262	***PC****	*643*
Emergency preparedness trainings	24	36	8	32	*100*
# trained in emergency preparedness	121	549	123	290	*1083*
# of workers resp. fit-tested	630	242	488	***PC****	*1360*
Logging Outreach					
Game of Logging courses	10	17	18	***PC****	*45*
# of loggers trained	87	106	160	***PC****	*353*
Fishing Outreach					
Safety at Sea trainings	4	4	3	***PC****	*11*
# completing Safety at Sea course	147	85	55	***PC****	*287*
Drill Conductor trainings	4	4	3	***PC****	*11*
# completing Drill Conductor course	40	28	38	***PC****	*106*
Miscellaneous Outreach Activities					
Outreach events (i.e. industry expos)	66	76	120	49	*311*
PPE sold	$25,573	$26,226	$26,617	$28,492	*$106,908*

**2020 trainings were impacted by the pandemic*
***PC=Pandemic Cancellation*

In addition to the Outreach services listed in **Table 1**, the NEC was able to develop and offer a number of specialized services using *Emerging Issues* Funding resources. These included:

Opioid Outreach Services: Feedback from various NEC advisory groups and NEC researchers identified opioid overdose in the commercial fishing industry to be a primary health concern, with overdoses being the most frequent cause of death on NE commercial fishing vessels according to the USCG (unpublished data). In response, the NEC provided funding for FPSS to develop and offer Naloxone administration training for commercial fishing crews.[2] These training sessions were essential for fishing crews who are often miles from shore and lack access to emergency services when overdose events occur. The program also offered access to addiction recovery coaches who could assist fishermen seeking addiction treatment. Fifteen training sessions were offered throughout New England (Massachusetts, Maine, New Hampshire, Connecticut, and Rhode Island) to roughly 150 fishermen. Attendees were also trained in CPR / First Aid.

Pandemic Outreach Services. NEC staff were also very active over the course of the pandemic, developing and disseminating materials (printable posters, fact-sheets and videos in English and Spanish) to raise awareness about COVID-19. These materials were featured on a COVID-19 section of the NEC website (https://necenter.org/covid-19-resources/), which also offered news updates and opportunities to sign up forvirtual trainings. An example of one the instructional videos, developed in Spanish and English, can be found online at https://www.youtube.com/watch? v=kMh84BN4ua4. The NEC COVID webpage also featured a COVID infection simulator to demonstrate the spread of COVID infection in farmworker housing (see **Figure 2**), as well as the impact of prevention control measures. COVID prevention training curriculum and protocols were also developed and staff published weekly articles, on practical solutions for AgFF businesses. *A*nother novel, pandemic related, pilot program launched by the NEC was the "Stop COVID on Your Farm" initiative. Using pilot funds from the Community Foundation for South Central New York, the program provided up to $1,500 in matching funds to assist farmers with projects focused on reducing the spread of COVID-19 on their farms. Participants also received an on-site visit from the NEC's industrial hygienist or farm safety specialist, who offered farms suggestions on how to improve COVID prevention plans.

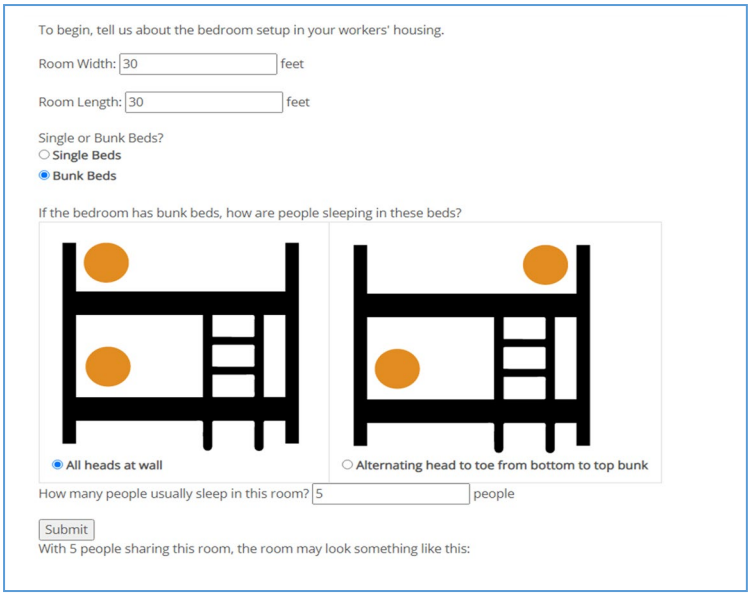

Figure 2: NEC COVID Simulator-Room for Improvement

Salesforce Customer Relations Management System: Due to the considerable expansion in NEC programs and outreach services from 2016-2021, as well as the increasing demand for services, the NEC implemented a customer relations management system to organize worker and industry interactions. This system allows us to track requests for PPE, trainings, onsite safety assessments, farmer safety projects, fit-testing services and technical assistance and has considerably streamlined the process of facilitating services, scheduling trainings and tracking respiratory fit-testing medical clearance status. NEC resources are also managed in the system to ensure equipment and staff are available for Outreach activities. Evaluation is also embedded in the system, improving the speed and accuracy of data collection.

The NEC PPE Program: This program offers AgFF industry groups access to a variety of safety products that are affordable and tailored to AgFF industries. Interested workers or industry groups can contact the toll-free NEC "hotline" to order a wide variety of PPE from the program. Inventory includes respiratory, hearing or eye protection, protective clothing for using chemicals, chaps, non-slip deck boots, power-take off shields, slow moving vehicle signs and other crucial AgFF PPE. Individuals can speak to a qualified safety specialist or industrial hygienist to learn about various PPE options and get advice on which is most appropriate for their specific operation. PPE can be shipped directly to AgFF operations or delivered by NEC staff when this is logistically feasible. As demonstrated in **Table 1**, the COVID pandemic increased AgFF industry PPE needs and we also noted a significant increase in requests for technical assistance.

NEC Counseling and Case Management: The NEC also employs a full-time social worker who offers case-management and counseling services to AgFF workers. In the next cycle, the NEC social worker will be involved in the NEC's farmers' mental health research project to address anxiety and depression on farms. Dr. Tinc will also regularly coordinate NEC mental health research and Outreach services in bi-weekly

meetings. NEC safety specialists will also receive mental health first-aid trainings and will offer NEC mental health train the trainer resources to the NEASHC groups of NE trainers on an annual basis.

Aim #3– *Increasing Center and OSH AgFF visibility-the NEC Promotions and Marketing Plan*. The NEC has also expanded its promotions platform to include social media through a Center specific Facebook page (1,227 followers), as well as separate project Facebook pages 1,752 followers. We have developed YouTube videos on a wide variety of safety topics (31 videos with 3,744 views) and have written 149 articles and press releases. NEC researchers have presented at over 100 industry and academic conferences. The NEC also completely revised its website to make it more accessible and appealing to AgFF populations (see www.necenter.org). The new website features videos, testimonials, downloadable materials and a host of additional resources. Individuals visiting the site can search by industry, resources or topics. In addition to the website, the NEC has completely upgraded our branding identity, with a new logo and color scheme. **Figure 3** provides a screen shot of the new NEC landing page. In addition to these activities, the NEC has been hosting the IFISH conference website. The IFISH site features information on the recent IFISH5 international fishing safety conference, including program proceedings, presenters and the special Journal of Agromedicine issue dedicated to research topics presented at the event. The NEC will work with NIOSH once again in the planning of the upcoming IFISH6 conference and webpage updates.

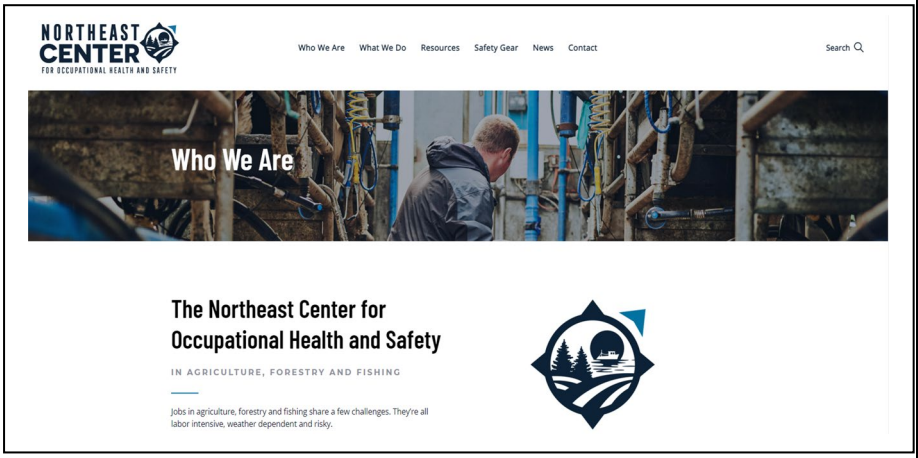

Figure 3: New NEC Website

In the past cycle, the NEC has also authored over 50 peer-reviewed OSH publications in AgFF research and outreach!

Fishing Forward Podcast: NEC is also leading a NIOSH and AgFF Centers partnership to develop a podcast series entitled "Fishing Forward" (see **Figure 4**). The podcast will feature 12 thematic episodes broken down into two 20-30 minute recordings to be released bi-weekly in conjunction with Coastal Routes Radio. Podcast topics will be focused around the collective theme of encouraging fishermen to look at themselves as "Industrial Athletes". In other words, like professional athletes who use their bodies to make a living, fishermen need to build a solid foundation of good health to keep themselves and their businesses sustainable. Sub-topics include diet, sleep, how to use caffeine effectively, crew-relationships, mental health and addiction. Podcast partners include NIOSH, the University of Guelph, Fishing Partnership Support Services, ME Coastal Fishermen's Association, Alaska Marine Safety and Education Association, Oregon State University (PNASH) and others. Each episode will feature a subject matter expert and a fishermen who will interview the subject matter expert and provide relevant commentary and observations from a fishermen's perspective.

NIOSH Ag Centers YouTube Channel: Lastly, the NEC has also participated in the NIOSH AgFF Centers YouTube channel initiative, which seeks to raise awareness of AgFF occupational hazards; provide information to prevent AgFF injuries and illnesses and increase the visibility and sphere of influence of the AgFF Centers. From 2013 to 2021 the channel has grown from the 48 videos to 166 videos with over 23,000 cumulative watch time hours. The channel is promoted via email, social media, presentations and outreach.

Figure 4: Podcast Cover

Aim #4- *Evaluating promotions and training activities.* Much of the data gathered in the evaluation of NEC Outreach activities has been provided under Aim #2 in the Outreach Past Performance section. However, Emerging Issues Funding was also a primary activity undertaken by the NEC Evaluation and Planning Team. The following section provides an overview of ***Emerging Issues*** activities and outcomes:

YEAR 1 EMERGING ISSUES- [*Opioid Addiction in NE Fishing Communities*] As described previously, in 2017 NEC advisory board members shared increasing concerns about opioid overdose deaths among commercial fishermen in the first year of our prior funding cycle. Fishermen are often introduced to painkillers as a method of addressing often occupationally related musculoskeletal pain. However, prescription opioid use can also lead to illicit opioids including heroin, which had taken a heavy toll on commercial fishing workers and fishing ports in Massachusetts. In New Bedford, which has the highest number of commercial fishing landings in America, the number of confirmed unintentional/undetermined opioid related overdose deaths between 2012 – 2015 had more than doubled, with 48 opioid related deaths in 2015 compared to 26 deaths in 2012. Unfortunately, if fishermen overdose at sea, emergency services personnel are often unable to assist. In response, the NEC offered funding to FPSS to provide training for nonmedical professionals including friends, family members and work colleagues to recognize when an overdose is occurring and to administer Naloxone. Services also included the provision of peer support through community based recovery coaches that played an essential role in supporting addiction treatment. Over the course of this program, FPSS offered 15 training programs in five NE coastal states. These programs were held in coordination with the New England States' Departments of Public Health and attendees were also trained in CPR and First Aid.

YEAR 2 EMERGING ISSUES- [*Customer Relations Management System*] In 2018, a number of external and internal factors made the need for a customer relations management (CRM) system increasingly clear. To be specific, changes in Worker Protection Standard requirements exponentially increased requests from the farm community for respiratory fit-testing training and assessments. Additionally, the NEC's list of services had considerably expanded over the past few years, with the recent addition of onsite worker training opportunities in all three industries and a personal protective equipment sales program, as well as a small grants program for safety upgrades on small and midsize farms. The CRM system was launched in the spring of 2018, allowing us to track requests and services for individuals and business owners in a central location, so that all staff could enter data, provide updates to AFF partners and flag requests or issues for follow-up. Center resources were also managed within the system to ensure that equipment and staff were available for Outreach events, trainings and health screenings. Evaluations and service data are also being entered into the system to improve the speed and accuracy of Center reporting.

YEAR 3 EMERGING ISSUES- [*Stakeholders Team Up for Action in New York Dairy-Farmers Mental Health*] In 2019, NEC researchers along with partners at New York FarmNet, Cornell Cooperative Extension, Sowing the Seeds of Hope, and Community Memorial Hospital in Madison County, NY joined together to host a collaborative action-planning workshop called Stakeholders Team Up for Action in New York Dairy (STAND). The workshop was facilitated using Future Search methodologies and aimed to develop a joint strategy for

moving toward improved wellbeing for the farm community. Participants from eight sectors interested in the topic of producer wellbeing were invited to participate in the three-day workshop. This included: male and female farmers, health, mental health, government, agricultural, and dairy-specific organizations, and processors. Future Search, which is also referred to as "Whole System in the Room" in some circles, was developed as a method for, "transforming a system's capability for action," quickly. The meeting focused on engaging the "whole system," and working based on shared visions rather than the differences between stakeholders.

Together, the group worked through activities dealing with the past, present and future. These activities led to the development of common ground, goals and action steps to create change in nine areas: peer support and social networks; environment; healthcare; business planning; regulations; milk pricing; marketing and consumer education; education, research and technology; and workforce.

Overall, the STAND workshop led to greater collaboration between stakeholders and specific action items to help improve the wellbeing of dairy farmers. In addition, an AgriSafe webinar on the STAND meeting was held in January 2019 to share results and methodologies with a wider audience. Also, a video was produced highlighting the benefits of the workshop and the process used to facilitate the meeting. A peer-reviewed article was published in the *Journal of Agromedicine* detailing both the process and outcomes of the workshop.[3] These and other updates are maintained at www.NYCAMH.org/programs-and-services/stand.php.

YEAR 4 EMERGING ISSUES- [*Opioid Awareness and Naloxone Training for Loggers*] In the fall and winter of 2019, logging industry representatives noted similar concerns regarding addiction in the logging community, as those noted by fishing colleagues in relation to fisheries workers. To address these concerns, the NEC partnered with Professional Logging Contractors of Maine (PLC) and FPSS to craft an opioid awareness and Naloxone training tailored for logging workers. This training was due to be delivered at PLC's annual spring safety training series in spring 2020. FPSS assisted PLC in the tailoring of educational content, as they had extensive experience in delivering similar training in the fishing community. Unfortunately, the spring safety trainings were cancelled due to COVID-19. The Northeast Center anticipates re-assessing its ability to support PLC in delivering this training at their next safety training series in 2022.

YEAR 5 EMERGING ISSUES – The NEC is in the preliminary stages of working with fishing community representatives to explore the potential for worker health tracking and the development of tailored mental health counseling services for NE fishermen.

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B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

N/A

B.5. How did you disseminate the results to communities of interest?

Centrality of the NEC Brand-Over the past six years the NEC has succeeded in expanding recognition of the NEC in the NE commercial fishing and logging industries. This is partly due to programs like the NEC Lifejackets for Lobstermen project, the Participatory Ergonomics in the Lobster Fishing Industry project, the Fishing Vessel Apps project, and various partnerships with Professional Logging Contractors, Fishing Partnership Support Services (FPSS), the Massachusetts Lobstermen's Association, the Maine Lobstermen's Association and other logging and fishing industry partners. The NEC has also launched social media sites for both industries and has completely redeveloped its website to increase engagement with AgFF populations (www.necenter.org). In addition to these dissemination improvements, the NEC transitioned all of its outreach, training, technical assistance and personal protective equipment (PPE) distribution to a Salesforce customer relations management system. Salesforce is a database management platform that was originally designed for marketing, sales and commerce. The new customer relations management system (affectionately referred to as 'NERD'-NEC Events Reporting Database) allows us to document and track every worker and industry group interaction. This has greatly enhanced our customer service. For example, if we provide respiratory fit-testing services to a farm, we are able to enter information on the number of workers trained and the respirators and equipment used, so future trainings are easy to schedule and replacements can be automatically supplied.

The NEC has also published over 50 peer-reviewed publications on topics as diverse as the use of wearable technology for tracking worker PPE compliance to the use of machine learning in AgFF injury surveillance. Other promotional efforts include 28 newsletter updates to 3,383 recipients and 149 newspaper and trade magazine articles in national papers and news outlets, such as Forbes and Politico. Additional noteworthy activities include participation in a press conference held by former Governor Cuomo regarding federal immigration crackdowns in agriculture and a feature in the "Social Fishtancing" podcast, on COVID impacts to fishermen.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

E. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

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52. Tinc PJ, Sorensen JA, Goodspeed MM, Jenkins PL. Do Cialdini's "Principles of Influence" motivate safe practices on farms? A study of NY farmers' PTO shielding behaviors. *J. Agromedicine*. 2021;26:1-12. doi: 10.1080/1059924X.2021.1950591

C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org
www.ifishconference.ca/home/

C.3. Technologies or techniques
Social Network Analysis
Logic Modeling
Photovoice
Lobster Fishing Ergonomic Improvements (https://necenter.org/portfolio/boat-hacks-for-better-backs/)

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
Survey Instruments
Recruitment Materials
Data Collection Protocols
Study Protocols
COVID-19 Information Booklet, Needs Assessment Surveys/Publications
Marketing and promotional materials for PTO shields
Articles on augur safety and lockout/tag out

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Julsor	S/K	Julie Sorensen	PhD	Director	.4				USA	

		Pauline Boyer		Outreach Coordinator	2.1				USA	
		James Carrabba		Safety Specialist	1.9				USA	
		Deb Dalton		Librarian	1.2				USA	
		Christina Day		Safety Specialist	1.5				USA	
		Liane Hirabayashi		Outreach Coordinator	2.8				USA	
		Anna Meyerhoff		Bilingual Safety Specialist	1.7				USA	
		Maryellen Driscoll		Marketing Coordinator	4.2				USA	
		Nicole Blanchard		Data Analyst	.6				USA	
		Rosemary Broderson		Receptionist	.1				USA	
		Dahilia Sheehan-Yassin		Research Assistant	1				USA	
		Rebecca Meinneger		Research Assistant	.2				USA	
		Duane Martin		Outreach Assistant	.6				USA	

D.2 Personnel updates N/A

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

Although NEC Outreach Program activities address many of the action steps outlined in all nine of the NORA Strategic Goals, it will particularly advance the following NORA objectives: Intermediate Goal 3.3 – 'Use innovative and proven communication, education, and social marketing techniques to influence knowledge, attitudes and practices of agricultural workers, loggers and commercial fishermen.' Intermediate Goal 3.4 – 'Use innovative educational techniques and certification programs to improve the safety practices of

agricultural workers, loggers and commercial fishermen.' Intermediate Goal 6.5 – 'Build future capacity in safety and health for the forestry sector via advanced training programs.'

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them
None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
None

G.2 Responsible Conduct of Research
None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects

G.4.a Does the project involve human subjects? No

G.4.b Inclusion Enrollment Data N/A

G.4.c ClinicalTrials.gov

N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? Yes

G.11 Program Income
Is program income anticipated during the next budget period?
No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets.

Note: project outcome information will be made public in NIH RePORTER
Over the prior six year funding cycle, the NEC has been considerably productive. NEC efforts have led to advancements in AgFF passive injury surveillance; the collection of one of the most comprehensive data sets of logger risk exposures, injuries and health conditions in the country; the assessment of various options for addressing one of the most significant drivers of farm injury (PTO entanglements); collaborative work with the lobster fishing community to co-create ergonomic solutions and the exploration of options for safe grain bin entry. These and other NEC activities have culminated in a number of notable successes which include: 1) a Forbes feature article highlighting the NEC's Lifejackets for Lobstermen intervention as a "fitting strategy" to reduce falls overboard deaths in thefishing industry, 2) an American Journal of Public Health editorial that highlighted NEC's work on tractor safety prevention as the "gold-standard for research implementation", 3) demonstrated reductions in injuries, deaths and cost-savings related to injuries and deaths averted as noted in publications and testimonials, 4) active engagement in international research collaborations such as the IFISH 5 and IFISH 6 conferences, 5) the organization of agricultural stakeholders to develop a collective strategy to address work-related stress on dairy farms, and 6) efforts to address opioid addiction in logging and fishing communities by supporting naloxone and recovery coach training.

A. COVER PAGE

Project Title: Participatory Ergonomics for the Lobster Industry	
Grant Number: 6 U54OH007542-20-01	**Project/Grant Period**: 09/01/2016-08/31/2022
Reporting Period: 09/01/2016-08/31/2022	**Date Submitted**:
Program Director/ Principal Investigator Bryan Buchholz, PhD Professor and Chair Biomedical Engineering University of Massachusetts Lowell 1 University Ave Lowell, MA 01854 phone: 978-934-3241	**Administrative Official Information** Patricia O'Neill Senior Grants & Contracts Administrator Office of Research Administration University of Massachusetts Lowell 600 Suffolk Street, Suite 212 Lowell, MA 01854 Phone: 978-934-3230
Change of Contact PD/PI: **N/A**	
Human Subjects: **Yes**	**Vertebrate Animals:** **N/A**
hESC: **N/A**	**Inventions/Patents:** **None**

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The ***long-term goal*** of the approved application is to develop feasible ergonomic interventions in the lobster industry to reduce the overall rates of musculoskeletal disorders in the general population of lobster harvesting workers.

This investigation was designed to evaluate the changes in ergonomics of lobster boats and the capacity of lobstering communities to respond to the challenges of exposures to risk for musculoskeletal disorders. Ergonomic evaluations were made via measurement techniques in accordance with the type of exposure and intervention implemented on a given lobster boat. Boats subject to evaluation are operated by lobstermen volunteering to engage with the investigators and supportive community stakeholders in a participatory ergonomics research cycle of meetings aimed at reducing risk and improving ergonomics on their boat. The overall structure, process, and outcome was designed to be guided by a community-academic partnership focused on the goals and objectives of the investigation. Some developmental research was conducted in response to intervention ideas proposed by participating lobstermen.

Aim #1 – Organize a steering committee to guide development and implementation of a participatory ergonomics approach to reduce exposures for musculoskeletal disorders in lobstering.

Aim #2 – Through this participatory ergonomics approach, generate ideas, translate ideas into action, and implement interventions to reduce exposure to risk factors for musculoskeletal disorders.

Aim #3 – Evaluate the participatory process and the efficacy and effectiveness of the implemented ergonomic interventions.

Aim #4 – Develop the shore-based infrastructure for translation of ergonomic ideas into practice in the lobstering industry.

B.2. What did you accomplish under these goals?

The long-term goal of this proposal is to develop feasible ergonomic interventions in the lobster industry in order to reduce the overall rates of musculoskeletal disorders in the general population of lobster harvesting workers. There have been eleven participants engaged in five separate, systematic, participatory research cycles with project researchers. Several ergonomic intervention ideas have been explored, developed, and described, below.

Aim #1 – Organize a steering committee to guide development and implementation of a participatory ergonomics approach to reduce exposures for musculoskeletal disorders in lobstering.
This aim was achieved in the first year of the investigation, but were discontinued until year 5. The format was changed to facilitate participation of lobstermen in the steering committee. The steering committee was then comprised of only lobstermen and its activities were individualized to eliminate time conflicts in scheduling.

Aim #2 – Through this participatory ergonomics approach, intervention ideas were generated and translated into action. Interventions were implemented to reduce exposure to risk factors for musculoskeletal disorders.

The research with participating resulted in the three following intervention projects, and six boat interventions:

Improving mechanical assistance for the task of hauling traps onto the boat.
Three iterations of student design team projects were pursued to develop ergonomic improvement while meeting the robust demands of the operation. The first two results were proofs of concept of two design ideas. The third team designed and prototyped equipment to assist manual handling of traps at the side of a lobster boat. This intervention was intended to reduce exposure to biomechanical risk for back and shoulder pain and discomfort. There was a raised section of the side of the boat to reduce back flexion and the hauler for the trap line was assumed to be relocated to reduce need for shoulder extension. After the prototype was designed, a convenience sample of 15 student subjects was recruited to measure, using bioinstrumentation, the biomechanical exposures when the hauling equipment was actually relocated.

The second intervention idea was to install a conveyor belt at a local lobster pier. This project was initiated and delayed by several factors, including a lobsterman's death and COVID restrictions, and ultimately ended after a vote by the participating crew's pier association to withhold funding for the conveyor belt.

The third intervention idea was to produce short videos about ergonomic ideas lobstermen have translated into practice. There have been five videos produced and posted on the Northeast Center webpage (https://necenter.org/portfolio/boat-hacks-for-better-backs/).

Each of the participating boats was the subject of an ergonomic analysis. The analysis was used to help guide intervention idea brainstorming. An ergonomic analysis of each boat was completed. Based on these analyses, the participating crews completed the following interventions:

- Raised washboard 8.5" (reducing trunk flexion)
- Resized tank dimensions so tank can hold stackable lobster crates (reducing trunk flexion, and forceful exertion)
- Installed raisable bottom tank for storing lobsters to reduce trunk flexion when removing lobster
- Removed toe-rail to improve coupling and material handling of traps
- Relocated block to reduce trunk twisting
- Sound proofed engine compartment to reduce noise exposure

Participating lobstermen identified the task of hauling in a trap to be a high priority for intervention, the lack of a forum to discuss their own ideas on improving ergonomics as a priority for improving conditions across the industry, and the need for better mechanical assistance in general.

Aim #3 – Evaluate the participatory process and the efficacy and effectiveness of the implemented ergonomic interventions.
The first two implemented interventions were reported as case studies in a peer-reviewed manuscript. Extracted lessons from the participatory process are described in a manuscript in progress. The ability to personalize intervention ideas was a facilitator for implementation. Time needed to research and personalize an intervention idea was an inhibitor, in that changes made to lobster boats were observed to take about a year from conception to actual change. Ergonomic best practices were generalized, allowing for personalized adaptation.

Aim #4 – Develop the shore-based infrastructure for translation of ergonomic ideas into practice in the lobstering industry.

Three examples of infrastructure development were community involvement in the improvement of the lobstermen's dock, engagement of a hydraulic engineer in design discussions about hauler and hydraulic control, and the construction of the mockup boat to evaluate design prototypes and equipment configurations. The data are descriptive, qualitative data providing insight into characteristics to help improve or better facilitate the translation of ideas into practice.

B.3. Competitive Revisions/Administrative Supplements
N/A

B.4. What opportunities for training and professional development did the project provide?
Training and professional development for the research subjects was not a focus of the project. Nevertheless, each participating lobsterman went through a research orientation that was consistent with and equivalent to an ergonomics training for fishermen.

The project provided a focus for student capstone projects engaged in engineering design teams. These students earned full academic credit for their work on this project.

The project manager completed a doctoral dissertation using data from this project, August 2020.

B.5. How did you disseminate the results to communities of interest?
Five articles were published in *Landings,* the newsletter of the Maine Lobstermen's Association:
Back pain: https://mlcalliance.org/2021/02/01/to-your-health-dealing-with-lower-back-pain/
Hand-wrist pain: https://mlcalliance.org/2021/01/05/to-your-health-hand-wrist-injuries-can-be-avoided/
Shoulder pain: https://mlcalliance.org/2021/03/25/to-your-health-you-can-prevent-shoulder-injuries/
Wound care: https://mlcalliance.org/2020/03/28/to-your-health-pay-attention-to-wounds-at-sea/
Pain and opioid overdoses: https://mlcalliance.org/2021/08/03/to-your-health-overdose-leading-cause-of-preventable-death-among-fishermen/
Two episodes of the Fishing Forward Podcast:
Pain and Disorder Parts 1 & 2 (Episodes 12, 13): https://soundcloud.com/fishingforwardpodcast/
Presentations to local associations: Gloucester Fisheries Commission, Boston Lobstermen's Association, Scituate Heritage Day
Videos of lobstermen's intervention ideas: https://necenter.org/portfolio/boat-hacks-for-better-backs/
Local newspaper: https://www.bostonglobe.com/2022/10/11/metro/loberstermen-bear-pain-profession/

B.6 - What do you plan to do during the next reporting period to accomplish the goals?
N/A

F. PRODUCTS

C.1. Publications, conference papers, and presentations
Publications:

1. Fulmer S, Buchholz B, Jenkins P, Scribani M. Work-time exposure and acute injuries in inshore lobstermen of the northeast United States. *J. Agromedicine*. 2016;21:190-9. doi: 10.1080/1059924X.2016.1143431.
2. Fulmer S, Buchholz B, Scribani M, Jenkins P. Musculoskeletal disorders in northeast lobstermen. *Saf Health*. 2017;8(3):282-289. doi: 10.1016/j.shaw.2016.12.004.
3. Fulmer S, Buchholz B, Jenkins P, Scribani M. Injuries and exposure to time lobstering in northeast US inshore lobster fleet. *J. Agromedicine*. 2019;24:333-340. doi: 10.1080/1059924X.2019.1645780.

4. Fulmer S, Jain S, Kriebel D. Commercial fishing as an occupational determinant of opioid overdoses and deaths of despair in two Massachusetts fishing ports, 2000-2014. *New Solut.* 2021;3:252-258. doi: 10.1177/10482911211023476.
5. Fulmer S, Scott E, Punnett L, Buchholz B. Using participatory ergonomics to improve health and safety in commercial lobstering in the United States: 2 case studies. New solutions: a journal of environmental and occupational health policy. 2022 May 3. doi: 10.1177/10482911221096774.

C.2. Website(s) or other Internet site(s) – include URL(s)
https://necenter.org/portfolio/boat-hacks-for-better-backs/

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
Survey Instruments N/A
Recruitment Materials N/A
Data Collection Protocols N/A
Study Protocols N/A
Videos https://necenter.org/portfolio/boat-hacks-for-better-backs/

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
		Fulmer, Scott	ScD	Project Manager	12				USA	
Buchholz3241		Buchholz, Bryan	PhD	PI			0.45 in-kind		USA	
		Gore, Rebecca	PhD	Biostats	0.24				USA	
		Vivaldi, Andrea	MS	Research Assistant		1.5	3		USA	

D.2 Personnel updates N/A
a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?
N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.
Public health relevance and impact

- Findings of ergonomic intervention ideas, implementation, and evaluation in commercial lobstering addresses the challenge of a high rate of injuries and high prevalence of pain that was recently found in prior research.
- No prior research on reducing the risk to exposure for pain and injury in lobstering
- Evaluation of equipment improvements, engineering solutions to exposure to biomechanical risk provide useful information to lobstermen considering how to improve their work environment
- Disseminating the idea that the lobstering work environment can be improved ergonomically with careful consideration and measured changes should help people to develop their own interventions. The idea that lobstermen tend toward "do-it-yourself" actions was a key finding in this research. Equipment designs should allow for lobstermen to adapt the equipment to best suit their own boat. The series of short videos was proposed to push the idea of ergonomic intervention while also allowing the research subjects to speak with their own voice and tell their own story in their own way.
- The use of video to analyze work technique was proposed by lobstermen as a very basic tool for lobstermen to begin thinking about ergonomics.

The research promoted the use of the NIOSH Sound Level Meter smart phone application to evaluate the soundproofing intervention. The use of technology to measure exposure to health risks is an innovative use of technology to impact public health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
The steering committee was not active for three years. The committee members shifted from support agency personnel to lobstermen. The reason for the change was to more closely understand and get guidance from the lobstermen about the impact of the research.

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them
None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
None

G.2 Responsible Conduct of Research
None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects

G.4.a Does the project involve human subjects?
Yes

G.4.b Inclusion Enrollment Data

Table G.4.A – Participatory Ergonomics Subjects

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	0	0	0	0	0	0	0	0	0	
Asian	0	0	0	0	0	0	0	0	0	
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	
Black or African American	0	0	0	0	0	0	0	0	0	
White	2	9	0	0	0	0	0	0	0	
More than One Race	0	0	0	0	0	0	0	0	0	
Unknown or Not Reported	0	0	0	0	0	0	0	0	0	
Total	2	9	0	0	0	0	0	0	0	

Table G.4.B – Mock Hauling Study Subjects

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	0	0	0	0	0	0	0	0	0	
Asian	0	0	0	0	0	0	0	0	0	
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	
Black or African American	0	0	0	0	0	0	0	0	0	
White	0	0	0	0	0	0	0	0	0	
More than One Race	0	0	0	0	0	0	0	0	0	
Unknown or Not Reported	0	0	0	0	0	0	2	12	1	
Total	0	0	0	0	0	0	2	12	1	

G.4.c ClinicalTrials.gov
N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement
Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
Andrea Vivaldi
Varun Kaushik

G.6 Human Embryonic Stem Cells (HESCS)
Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals
Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance
$14,061.91

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?
No.

G.11 Program Income
Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs
Is there a change in performance sites that will affect F&A costs?
No.

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets. Note: project outcome information will be made public in NIH RePORTER.

The participatory ergonomics in lobstering project was an inquiry into exposure and mitigation of risk to musculoskeletal disorder in the lobster industry. Eleven participants identified multiple risks that matched prior assessments of health outcomes to the population and objective ergonomic exposure assessments by trained observers. Material handling of lobster traps was identified as a high risk, particularly during hauling, with considerations for seasonal variations and conditional complications like entanglements and environmental conditions. Ergonomic parameters were identified for “best practices”, including horizontal and vertical distances of hauling equipment from the hauler’s body. Several ergonomic interventions were implemented and evaluated on the participants’ boats, and data on barriers and facilitators to implementation were collected. Lobstermen valued experienced information from other lobstermen about work practices, were motivated through competition and self-improvement, but routine communication and focus on reducing risk exposure was not considered common enough to spread new ideas rapidly. Therefore, research and development was extended into two areas: video dissemination of lobstermen’s actual ergonomic intervention implementations, and a controlled biomechanical study of the effect of new design ideas on exposure to posture and force risks during trap handling.

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: Assessing Overall Health and Improving Injury Surveillance of Maine Logging Workers</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 09/01/2016-08/31/2022</td></tr>
<tr><td>Reporting Period: 09/01/2016-08/31/2022</td><td>Date Submitted: 1/13/2023</td></tr>
<tr><td>Program Director/ Principal Investigator
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stephen.clark@bassett.org</td></tr>
<tr><td>Change of Contact PD/PI:
N/A</td><td></td></tr>
<tr><td>Human Subjects:
Yes</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:
N/A</td><td>Inventions/Patents:
None</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Specific Aim 1: Assess and improve logging injury surveillance systems: We will measure the incidence of fatal and non-fatal injuries in the ME logging industry, including cumulative trauma and acute traumatic injuries. This will involve labor-intensive active surveillance, which will use quarterly surveys of a randomly recruited cohort to yield data to refine/improve a currently existing low-cost passive surveillance system [electronic searches of pre-hospital care reports (PCRs), hospitalization data], and workers' compensation.

Specific Aim 2: Conduct a total worker health assessment of the Maine logging workforce: We will examine the overall health and occupational exposures of Maine logging workers. The overall health assessment will include cardiac health, diabetes, obesity, hearing, musculoskeletal health, stress, and vibration sensitivity. These data will be gathered from a health screening and a pre-screening questionnaire performed on each member of the cohort referred to in specific aim 1.

Specific Aim 3: Identify factors related to injuries and worker health in the Maine logging workforce: We will identify factors contributing to worker health and injury such as safety practices and the work environment itself. These data will be gathered from cohort members reporting an injury during the quarterly surveys and also from the pre-screening questionnaire that will be administered as part of specific aim 2.When fully implemented, the aims of this proposal will: 1) establish the viability of collecting in-depth injury, health and exposure data from logging workers using quarterly surveys and health screenings, 2) provide an overall assessment of worker health and factors contributing health and safety in the Maine logging industry, and 3) assess the accuracy of passive injury surveillance systems. Based on what is deduced from this study, an R01 will be submitted to explore these methods in other active NE logging states (PA, VT, NH, and NY).

B.2. What did you accomplish under these goals?

At the Northeast Center, one of our jobs is to find solutions that support the health of loggers and reduce the rate of injuries in the industry. To do that requires understanding the everyday stories behind the statistics that make logging one of the most dangerous jobs in the country. For this study, we set out to learn specifically about the health and safety concerns of loggers in Maine, a state with more forest cover than any other contiguous U.S. state and with the largest logging workforce in the Northeast. We collected feedback from hundreds of Maine loggers through a series of questionnaires and in-person health screenings. Guided by an advisory board of industry insiders, including loggers themselves, this project aims to identify a practical path to ensuring logging remains a safe and prosperous career well into the future.

At the beginning of our last funding cycle (2016), we were relatively unknown in the Northeast logging industry. An enormous amount of work went into connecting with industry leaders, logging companies, and workers across the state of Maine, and beyond. Today, we have nearly 600 hundred followers on our study social media channel @Maineloggerhealthsafetystudy, have been featured in numerous industry trade magazines[1-5], and have successfully managed a longitudinal research study involving hundreds of Maine loggers over a nearly two year period. Moreover, we conducted on-site health assessments to loggers at five locations throughout the state of Maine, getting face-to-face time with hundreds of logging industry professionals throughout the process. Importantly, the results of our study have informed industry decision making; for example, North American Rescue used our data to help design a logging first aid and trauma kit that is now available on the retail market (see letter of support). The major goals of the Maine Logger Health and Safety Study were as follows:

Specific Aim 1: Assess and improve logging injury surveillance systems: We measured the incidence of fatal and non-fatal injuries in the ME logging industry, including cumulative trauma and acute traumatic injuries. This involved labor-intensive active surveillance, which used quarterly surveys of a randomly recruited cohort to yield data to refine/improve a currently existing low-cost passive surveillance system [electronic searches of pre-hospital care reports (PCRs), hospitalization data], and workers' compensation.

Specific Aim 2: Conduct a total worker health assessment of the Maine logging workforce: We examined the overall health and occupational exposures of Maine logging workers. The overall health assessment included cardiac health, diabetes, obesity, hearing, musculoskeletal health, stress, and vibration sensitivity. These data were gathered from a health screening and a pre-screening questionnaire performed on each member of the cohort referred to in specific aim 1.

Specific Aim 3: Identify factors related to injuries and worker health in the Maine logging workforce: We identified factors contributing to worker health and injury such as safety practices and the work environment itself. These data were gathered from cohort members reporting an injury during the quarterly surveys and also from the pre-screening questionnaire that was administered as part of specific aim 2. This proposal: 1) established the viability of collecting in-depth injury, health and exposure data from logging workers using quarterly surveys and health screenings, 2) provided an overall assessment of worker health and factors contributing health and safety in the Maine logging industry, and 3) assessed the accuracy of passive injury surveillance systems.

Building Industry & Logger Connections. To make inroads with the logging industry in Maine, we created a project advisory board comprised of advisors from a variety of backgrounds. The advisory board's role was to provide boots-on-the-ground guidance for logging-related research at the NEC. Collectively, the board ensured our research was timely and addressed the most pressing needs of the industry. They assessed research design, suggested changes or improvements to our plans, and helped us network with industry professionals. Members hail from the Professional Logging Contractors' of Maine (PLC), Certified Logging Professional (CLP) program, University of Maine School of Forestry, MEMIC Insurance, Acadia Insurance, Franklin Memorial Hospital Occupational Medicine, Maine Forest Products Council, Northeastern Loggers' Association, Maine Department of Labor, Northeast Forests, LLC, WFarrand Consulting, Higmo Logging, and Eric Vannah Logging.
We brought this board together in Bangor, Maine for the 2017 inaugural advisory board meeting, with the express task to plan enrollment into the study. Initially, we had wanted to enroll companies first, and then randomize the workers for enrollment, which was to be accomplished via telephone enrollment. Trying this method for several months, we came to realize that it was not an efficient way to enroll logging workers, and we adapted our strategy. Next, we enrolled participants via postal mail, given that we had a database of individual addresses for loggers and logging companies in the State of Maine.

We employed a series of seven surveys to gather information on this large cohort of Maine loggers. During study recruitment, a total of 393 loggers enrolled in the project, with good geographic representation across the state. Each survey contained a section on work-related injury and illness over the last 12 weeks, but other topics varied by survey. We saved sensitive topics, such as mental and emotional health, social support, and opioid use in the community for the latter surveys, seeing that trust needed to be established before delving into those topics. Other topics included work history, work role, company characteristics, individual demographics, healthcare utilization, insurance coverage, musculoskeletal pain, personal protective equipment (PPE), safety training, diet, overall personal health assessment, and specialty topics such as footwear choices and local public health concerns such as dermatitis from the browntailed moth caterpillar.

On average mechanized loggers worked longer days (11.8 hours vs. 9.7 hours) and had longer commutes from home to the woodlot (72.6 minutes. vs. 40.7 minutes) than conventional loggers. Both of these differences were statistically significant. The rate of loggers receiving safety training within twelve weeks of survey administration was also significantly different between mechanized and conventional loggers, with mechanized loggers much more likely to have had such training. Additionally, the probability of having an emergency action plan for each worksite was higher for mechanized loggers than conventional loggers (marginally statistically significant).

For health factors, mechanized and conventional loggers had similar responses. Nearly two- thirds of both mechanized and conventional loggers had an annual physical in the previous year, and 36.3 percent had seen a health specialist during that same period (specialist physician, physical therapy, chiropractor, etc.). Twenty-two work-related injury/illness events were reported in this initial survey (6.5 percent of mechanized loggers and 7.6 percent of conventional). The resulting overall work-related injury and illness rate is therefore 6.8/100 workers for this group. Rates of health insurance coverage were similar between conventional and mechanized loggers, with 79.8 and 74.3 percent, respectively. Rates of employer provided workers' compensation coverage differed dramatically between mechanized and conventional loggers ($p<.0001$) with mechanized loggers more likely to have workers' compensation coverage. Between a quarter to a third of loggers have filed a workers' compensation claim or had one filed for them throughout their career. Additionally, twenty-three percent (23%) of workers have been injured on the job but not filed a claim due to a variety of reasons. Detailed results of this work were published in the American Journal of Industrial Medicine.[6]

Another core component of the study was conducting logger health screenings or physical exams. The study team brought the doctor's office right to the machinery garages of logging companies throughout Maine. Screenings were held during full-day safety training sessions, and loggers participated at their convenience throughout the day. Health screenings were conducted by occupational health specialists and included: cardiac risk assessment, blood pressure, glucose, and cholesterol tests, hearing screening, lung capacity test, carbon monoxide assessment, and vitals such as height, weight, waist/hip ratio, vision screening and a physical exam. Every logger received a scorecard of their results. We referred loggers without health insurance to an insurance navigator in their area. We also connected loggers without a primary care doctor or insurance to free and/or sliding-scale clinics in their area if they needed follow-up care. We were able to accomplish this by working collaboratively with local medical professionals and community members.

Seventy-five (75) loggers participated in a health screening. The loggers who participated in the health screening were statistically similar to the overall cohort in many dimensions, including but not limited to: company size, gender, age, type of logging (e.g. cut-to-length, whole tree harvest, conventional), percentage of work time involved in transportation and business administration, work-related injury and illness rates, reported musculoskeletal pain, medical insurance coverage, filing of workers' compensation claims, and start/stop times of the workday.[7]

The majority of those participating were men (97.1%) and the median age was 46. The mean body mass index (BMI) among screened loggers was 30.6 kg/m2 (SD 4.9) with a waist-hip ratio of 0.95 (SD 0.07). While 68.9 percent of loggers self-reported having normal blood pressure, measuring blood pressure using an automated cuff revealed that only 10.8 percent had normal blood pressure at the time of the screening. Further, nearly half of those screened (45.9%) had blood pressure at the level of stage II hypertension. The percentage of loggers with hypertension was significantly higher than comparable groups within NHANES ($p=<0.0001$)[8] however, there was no statistically significant difference in obesity rates ($p=0.3758$).[9] This group of loggers had a much lower rate of high cholesterol compared to the national data ($p=0.0075$).[10]

Mean resting heartrates were within normal range at 72 beats per minute (SD 12.3). Further, mean measures for non-fasting glucose, total cholesterol, high-density lipoprotein (HDL), and cholesterol ratios were all within normal ranges.

Cardiac risk factors are a top concern in this cohort, based on our findings of obesity, hypertension, Mallampati scores and self-reported diet. Our results are consistent with data showing a higher prevalence of hypertension among blue-collar workers.[11] The financial impact of chronic disease to US employers is also substantial, with additional costs per employee with hypertension or obesity estimated to exceed $1,729 and $1,369, respectively (adjusted to 2021 dollars).[12,13] Beyond financial impact, such risk factors also greatly contribute to absenteeism.[14]

The percentage of loggers with at least a single joint abnormality (e.g. warm/swollen, deformed, crepitus, or decreased range of motion), as determined by a health care provider, was 38.4%. Musculoskeletal disorder (MSD) issues are also prevalent in this population, as evidenced by self-report[4] and by the clinician's exam during the health screening. Interestingly, self-reported MSD and abnormal joints (documented in the health screening) were similar with approximately four out of every ten loggers experiencing issues. These rates are lower than those reported among logging equipment operators in the Deep South[15] and Intermountain range of Montana and Idaho.[16]

The majority of mechanized loggers' work takes place inside the cab, and rarely do they leave, except to check the proper operation of equipment and to change saw chains, often eating and taking breaks within the cab.

While much of the work is now sedentary, logging requires a great deal of skill and high mental acuity to properly and safely fell trees. Paradoxically, many loggers have reported working outdoors and being independent contributes to their well-being but the remote work locations, long work hours, and lack of access to services can act as barriers to healthy living. Previous research found that many loggers felt satisfaction with their chosen profession, but they would not recommend it to their children.[17,18] Taken together these contribute to a need to work with the community on transforming logging into a safer and healthier profession for the current workforce, as well as the workforce of the future. The need to have an industry based, and community embraced approach is the center of this current application.

WEARABLE TECHNOLOGY FIELD TRIAL

Given what we learned through the data collection period of the Maine Logger Health and Safety study, it was evident that chronic health should be a focus for mechanized logging equipment operators. We knew there were ways to gather health data using wearable technology, but what was not known is if these technologies could be relied upon in areas with limited or no cellular network connection, or if loggers would be receptive and comfortable wearing them during work and free-time. To answer these questions we pilot tested our ability to use wearable technology to measure CVD risk factors among Maine's mechanized loggers. In July 2021, we traveled north of Bangor, Maine with Insoo Kim, PhD of the Center for the Promotion of Health in the New England Workforce (CPH-NEW), University of Connecticut Health Center (UCHC), to trial several wearables on active woodlots. Kim's custom-designed armband continuously monitors pulse transit time (PTT), a biomarker of systolic blood pressure. In addition, we tested the Empatica E4 wristband, and a Hexoskin sensor shirt, which gather similar data related to activity, heart rate, and sleep. We tested these devices at two separate sites (Enfield and Greenbush, ME), with loggers between ages 18 and 66.

Loggers wore two devices (the armband plus either the Empatica E4 or Hexoskin) for a 24 hour period. When we arrived to fit the loggers with the devices, we also took their blood pressure using a traditional

cuff (Welch-Allyn sphygmomanometer), as well as recorded their height and weight. Loggers were asked to complete a diary, accounting for their activities for the 24-hour period. When we returned to the woodlot the next day, we collected their activity diaries, the wearable devices, and completed an exit survey. This survey asked about the safety and comfort of the devices both at work and during non-work activities. We sought to understand the experience of filling out the diary, and if the loggers thought other loggers would be willing to wear these devices while taking part in a research study.

The feedback on the custom-designed armband and Hexoskin was very positive in terms of comfort and safety. While loggers generally found the Empatica E4 acceptable, there was a minor concern about long-term comfort and the wrist device catching on equipment. The wearable devices recorded properly in the field and feedback from the loggers will make the next version of the armband even more suitable for remote, outdoor workers, for example making the band longer for larger biceps and reinforcing soldered connections. This trial confirmed our ability to capture continuous health data in remote areas. In addition, the loggers were interested in their personal results and agreed that CVD is an important issue for mechanized workers.

The data we gathered from the armband, hexoskin, and E4 produced expected signals and worked well under the occupational and non-work conditions. We obtained PTT and blood pressure for a logger's daytime and sleep duration from the custom BP armband. In addition, we obtained heart rate, heart rate variability, and sleep metrics from this device. As for the Hexoskin smart shirt, the device recorded very well, and was found to be easy to work and sleep in. In addition, we can download all the data files to directly compare with the custom armband by syncing via the UNIX timestamp.

Lastly, for the loggers who wanted, we set up video conferencing sessions and reviewed their personalized data with them using screen share. This afforded us the chance to have an in-depth conversation about health and revealed potential ideas for a future intervention.

COVID-19 LOGGER SURVEY

Two events have had devastating economic impacts on the industry: 1) the COVID-19 pandemic and 2) the industrial pulp digester explosion on April 15, 2020 at the Pixelle mill in Jay, Maine. To understand these events better, we undertook a large-scale survey of logging workers across the Northeast. In late 2020, we mailed paper surveys to loggers in six states (Maine, New Hampshire, Vermont, New York, Pennsylvania, and West Virginia). Four hundred eighty four (484) loggers responded to the survey, yielding a response rate of 13.3%. Most knew someone who tested positive for COVID-19 (71.9%). Less than half (43%) received employer training about COVID-19 prevention measures, though 73% received some form of COVID-19 PPE from their employers. The health department, Centers for Disease Control and Prevention (CDC), and health care providers were the most trusted sources of health information. Nearly half acknowledged significant change in their home lives and work responsibilities due to the pandemic. The explosion of the Androscoggin Mill affected the business of 80% of Maine loggers, and 18% of loggers that resided outside Maine. The full report is on our webpage.[19]

EXPLORATION OF LOGGER DIETARY HABITS THROUGH PHOTOVOICE

Like all workers, loggers need proper nourishment to maintain health and energy for demanding daily activities. For loggers in particular, it is extremely important to maintain a sharp focus while operating logging equipment and tools in inherently dangerous environments. There is a strong connection between mental health, wellbeing and dietary patterns. Research has shown that proper nutrition and physical interventions in workplace settings improve health factors and decrease the rate of absenteeism.[20,21] Diet patterns imbue long-term health consequences, as research has shown that consistent diet patterns as opposed to nutritional intake are most important to long-term health outcomes. Some diet patterns, such

as the Mediterranean diet—also known as the "prudent diet"—are shown to be highly reliable for controlling risk associated with cardiovascular disease (CVD) and non-cancer, non-cardiac inflammatory diseases.[22]

We utilized photovoice methodology[23-25] to gather images and commentary to answer the question: "What do you typically eat on a work day and where do you get it? Consider: What makes it hard to eat healthier? If you feel you eat healthy, how do you do it?" We found that time and family were significant influential factors affecting loggers' attitudes and ability to eat healthfully. Food choice and diet were modulated by multifaceted outside forces, which may make improving diet a complex task.
Maine loggers cope with the same struggles that many workers face, with the added hardship of extremely long work hours and commutes, which leave little time for anything else. Improving diet is not a straightforward task. Historic traditions of food preparation and consumption may have a greater influence on modern day diets and diet patterns of this cohort. These factors will be considered as we embark on this proposed research.[26]

OUTREACH AND DISSEMINATION ACTIVITIES
We have spent a significant amount of time in Maine connecting with logging workers and industry stakeholders, and continue to do so. The Northeastern Logger Association's Logger Expo (Bangor, ME and Essex Junction, VT) brings us into contact with a wide spectrum of logging industry professionals, from front-line workers, managers, owners, insurers, trade professionals, and researchers. We routinely bring our mobile occupational health clinic to these events and provide cholesterol and glucose testing, blood pressure checks, and audiometric screenings. We have also provided study information, health and safety resources, and cholesterol and glucose screenings at the 2018 and 2019 Woodmen's Field Day at the Fryeburg Fair, one of the premier logger events within Maine. We have had several full-length articles featured in Northern Logger and Timber Producer Magazine and the Loggers' Voice, in addition to being interviewed for several podcasts with the Northern Logger Podcast series. In addition, we attended the Professional Logging Contractors of Maine annual meetings and joined their annual spring safety trainings to conduct health assessments. We were incredibly honored to be presented with the Professional Logging Contractors' of Maine 2021 Supporting Member of the Year Award, which recognized our research impact in the logging community.

CURRICULUM DEVELOPMENT AND LOGGER HEALTH CLASSES
Our team developed customized training to provide information on a broad range of health risks specific to the logging community. As CVD is one of the largest negative health factors impacting this cohort, we focused extensively on its mitigation. The trainings stressed the importance of quality sleep, ergonomics, stretching, and physical activity as factors influencing CVD risk. We also provided examples of how to incorporate these lessons into daily life. Lack of access to high quality, healthy foods is a pressing concern with this cohort. For this reason, nutrition information made up the bulk of these trainings. Our team broke nutrition concepts into concise, easily followed pieces, including a "rule of thumb" for identifying the healthiest food choice available at non-traditional food sources, such as gas stations. In all, we trained 670 loggers across eight locations in the state of Maine. Evaluations were returned by 423 loggers, with 93% feeling the training was either very useful or useful. Long hours and the sedentary nature of mechanized logging were identified in the evaluations as the two key factors loggers believed reduced their quality of life.

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ahead of print. PMID: 34954304

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

The project results were packaged in a specialized curriculum as training for professional loggers.

B.5. How did you disseminate the results to communities of interest?

OUTREACH AND DISSEMINATION ACTIVITIES

We have spent a significant amount of time in Maine connecting with logging workers and industry stakeholders, and continue to do so. The Northeastern Logger Association's Logger Expo (Bangor, ME and Essex Junction, VT) brings us into contact with a wide spectrum of logging industry professionals, from front-line workers, managers, owners, insurers, trade professionals, and researchers. We routinely bring our mobile occupational health clinic to these events and provide cholesterol and glucose testing, blood pressure checks, and audiometric screenings. We have also provided study information, health and safety resources, and cholesterol and glucose screenings at the 2018 and 2019 Woodmen's Field Day at the Fryeburg Fair, one of the premier logger events within the state of Maine.

We have had several full-length articles featured in Northern Logger and Timber Producer Magazine and the Loggers' Voice, in addition to being interviewed for several podcasts with the Northern Logger Podcast series. In addition, we attended the Professional Logging Contractors of Maine annual meetings and joined their annual spring safety trainings to conduct health assessments. We were incredibly honored to be presented with the Professional Logging Contractors' of Maine 2021 Supporting Member of the Year Award, which recognized our research impact in the logging community.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

G. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

1. Scott E, Bell E, Hirabayashi L, Krupa N, Jenkins P. Trends in Non-Fatal Agricultural Injury in Maine and New Hampshire: Results from a Low-Cost Passive Surveillance System. *J. Agromedicine*. 2017;22:16-20. doi:10.1080/1059924x.2017.1282908
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3. Scott E, Hirabayashi L, Graham J, Franck K, Krupa N, Jenkins P. Health and safety in the Maine woods: Assemblage and baseline characteristics of a longitudinal cohort of logging workers. *Am. J. Ind. Med*. 2020;63:907-916. https://doi.org/10.1002/ajim.23165
4. Scott E, Hirabayashi L, Graham J, Krupa N, Jenkins P. Not quite out of the woods: Overall health and chronic disease risk factors among Maine logging workers. *J. Occup.Environ*. 2021; doi: 10.1097/JOM.0000000000002403
5. Graham J, Scott E, Tinc P, Hirabayashi L. The modern gut-hammer: Understanding the eating habits of loggers through Photovoice, Appetite, Volume 171, 2022, 105882, ISSN 0195-663, https://doi.org/10.1016/j.appet.2021.105882.
6. Scott E, Hirabayashi H, Graham J, Hansen-Ruiz C, Luschen K, Sorensen J. (2022). The Impact of COVID-19 on Northeast and Appalachian Loggers. Journal of Agromedicine. https://www.tandfonline.com/doi/abs/10.1080/1059924X.2022.2068717.

7. Shishavan H, Garza J, Henning R, Cherniack M, Hirabayashi L, Scott E, Kim I. Wearable Sensor for Assessing the Impact of Work-related Stress and Workplace Violence. IEEE Journal of Biomedical and Health Informatics. Accepted November 11, 2022.

Presentations:

1. Cardiovascular Risk Factors Among Maine's Logging Workforce. Cristina Hansen Ruiz. American Public Health Association Conference. Boston, MA. 11/16/2022 (poster)
2. Not Quite Out of the Woods: Overall Health and Chronic Disease Risk Factors among Maine Logging Workers. Kevin Luschen. Northeast Epidemiology Conference. Virtual. November 3, 2022.
3. Using wearable technology to track logging and fishing workers health and sleep. NIOSH Centers Meeting (Virtual). Research and Outreach Quick Take Session. Dr. Jennifer Lincoln, Moderator. Presented with Julie Sorensen, PhD. July 27, 2022.
4. Timber! Forest Mechanization and the Impact on Logger Injury, Health, and Wellness. Bassett Medical Center, Research Grand Rounds. Cooperstown, NY. June 14. 2022.
5. Documenting and Assessing Fatigue in the Northeast Forestry Industry. National Occupational Injury Research Symposium (NOIRS). Virtual. May 11, 2022.
6. The impact of COVID-19 on the social connectedness of Maine loggers, American Public Health Association Annual Meeting, Denver CO, October 25, 2021. Presented by Liane Hirabayashi, Coauthors: Erika Scott, Judith Graham, Nicole Krupa, and Paul Jenkins.
7. The Impact of COVID-19 on the Northeast and Appalachian Logging Industry, Council of Forest Engineering Annual Conference, September 28, 2021.
8. Shift Work, Fatigue and Cardiovascular Risk Factors among Maine's Logging Workforce, Council of Forest Engineering Annual Conference, September 27, 2021.
9. COVID-19 Stakeholder Needs - Farming, Forestry, Fishing. April 20, 2021. NIOSH Ag Center Director's Meeting Panel Discussion Series. (Presented with Matthew Beacom, Jennifer Lincoln, and Heather Riden).
10. Total Worker Health for Maine Loggers: Research Findings from Active Surveillance. International Society for Agricultural Safety and Health (ISASH) Virtual Conference 2020. July 2020. (Presented with Liane Hirabayashi).
11. Tales from the Maine Woods: Initial Results from a Longitudinal Cohort Study of Logging Workers. Research Grand Rounds, Bassett Medical Center, Cooperstown, NY, April 21, 2020.
12. Engaging with New Research Populations: Considerations and Challenges from the Maine Logger Health and Safety Study. Bassett Research Seminar, Clark Auditorium, August 21, 2018, Cooperstown, NY.
13. Assessing Overall Health and Improving Injury Surveillance of Maine Logging Workers. 41st Annual Council on Forest Engineering Meeting, Williamsburg, Virginia, July 15-18, 2018.

C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org

C.3. Technologies or techniques
Photovoice, surveying, health assessments

C.4. Inventions, patent applications, and/or licenses
N/A/

C.5. Other products and resource sharing
Survey Instruments
Recruitment Materials
Data Collection Protocols
Study Protocols
COVID-19 Information Booklet, Needs Assessment Surveys/Publications

Logger Health Curriculum
Infographics

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Erisco	S/K	Erika Scott	PhD	Dep. Director	.75				USA	
PauJen	S/K	Paul Jenkins	PhD	Biostatistician	.25				USA	
		Kevin Luschen		Project Coordinator	1.8				USA	
		Judy Graham		Nurse Researcher	.2				USA	
		Cristina Hansen-Ruiz		Research Assistant	3				USA	
		Liane Hirabayashi		Research Assistant	.5				USA	
		Rebecca Weil		Research Assistant	.75				USA	
		Andrew Demma		Research Assistant	1				USA	
		Tristan VanVlkenburgh		Research Assistant	1.1				USA	
		Megan Goodspeed		Research Assistant	1				USA	
		Dahlia Sheehan-Yassin		Research Assistant	1.1				USA	

D.2 Personnel updates N/A

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

NORA priorities[6] addressed: *Strategic Goals 1* (Surveillance), 6 (Forestry Safety), and 7 (Forestry Health). *Intermediate Goal (IG) 1.1* - Improve national and state-level illness, injury, hazard, and exposure surveillance by utilizing existing data systems or creating new databases. *IG 6.1* - Reduce logging related

deaths and traumatic injuries by 50% by 2018, through collection and analysis of injury data and evidence-based safety improvements. *IG 6.3* - Identify factors that limit the adoption of safe logging practices and the treatment of logging-related injuries and propose interventions to address these factors. *IG 7.4* - Assess the health conditions of forestry workers to improve work design and work practices for workers entering the sector and those at later career stages.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them
None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
None

G.2 Responsible Conduct of Research
None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects
G.4.a Does the project involve human subjects? Yes

G.4.b Inclusion Enrollment Data

	Survey 1		Survey 2		Survey 3		Survey 4		Survey 5		Survey 6		Survey 7	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Number of Loggers Invited	1811	100.0	314		305		301		300		287		275	
Loggers Enrolled/Included in Analysis	392	21.6%	243	77.4%	216	70.8%	204	67.8%	188	62.7%	171	59.6%	154	56.0%

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement
Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)
Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No
G.7 Vertebrate Animals Does this project involve vertebrate animals? No
G.8 Project/Performance Sites No
G.9 Foreign Component N/A
G.10 Estimated Unobligated Balance G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? **Yes**
G.11 Program Income Is program income anticipated during the next budget period? No
G.12 F&A Costs Is there a change in performance sites that will affect F&A costs? No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets. Note: project outcome information will be made public in NIH RePORTER

Historically, the logging profession is one of the most dangerous professions in the United States. The industry has become significantly safer over the past few decades, as logging shifts from traditional chainsaw methods to modern mechanized tree felling. Despite this general increase in worksite safety, new hazards have cropped up, namely cardiovascular disease (CVD) and related chronic illnesses.

The Northeast Center delved into the health of Maine loggers through in-person health assessments and a series of research surveys. We have gained a deep understanding of the many factors that contribute to logger health and safety. We had an opportunity to share these findings with nearly 700 loggers across Maine through a series of in-person safety trainings with the Professional Logging Contractors of Maine (PLC) in spring 2022.

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: Using Influence Strategies to Increase the Efficacy of the NY PTO Shielding Intervention</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 09/01/2016-08/31/2022</td></tr>
<tr><td>Reporting Period: 09/01/2016-08/31/2022</td><td>Date Submitted: 1/13/2023</td></tr>
<tr><td>Program Director/ Principal Investigator
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julie.sorensen@bassett.org</td><td>Administrative Official Information
Stephen Clark
Bassett Healthcare Network
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607.547.3048
stephen.clark@bassett.org</td></tr>
<tr><td>Change of Contact PD/PI:
N/A</td><td></td></tr>
<tr><td>Human Subjects:
Yes</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:
N/A</td><td>Inventions/Patents:
None</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The long-term goal of the proposed study is to gain a better understanding of how agricultural workers and business owners may be persuaded to adopt best practices that they have been previously resistant to accept. Based on previous research conducted in the farm community, farmers are aware of entanglement dangers, but lack the appropriate motivation to replace missing or broken shields. The objective of this application is to build on previous research and intervention development efforts conducted by the research team, in order to facilitate a 20% increase in NY PTO shielding sales from Y1-Y5.

Specific Aim #1: Implement an influence strategy in six distinct agricultural communities to serve as a booster to an existing, statewide PTO shielding social marketing campaign. In each of these communities, researchers will organize activities that are geared towards a particular influence strategy. For example, in one agricultural community, researchers may focus on 'consensus' by distributing posters, lawn signs and mobilizing community organizations to show support for PTO shielding. While in another community, activities would focus on 'authority' by recruiting opinion leaders to promote PTO shields. Although the launch of these interventions was delayed by approximately one year, we are on target to launch each influence campaign in the first quarter of 2019. Following a one year application of influence campaigns, the research team will conduct follow-up assessments of PTO shielding behavior and attitudes to identify which influence campaign has the greatest impact.

Specific Aim #2: Evaluate the impact of these influence strategies by measuring changes in opinion (as outlined in Kelman's 'Processes of Opinion Change') and changes in PTO sales. The impact of influence strategies on opinions of PTO shields will be measured in surveys designed to score pre to post differences in the opinion change processes identified by social psychologist Herbert Kelman (compliance, identification, internalization). Changes in PTO shield sales will also be monitored via PPE sales conducted through the Northeast Center and long established relationships with NY equipment dealers. The study team is close to completing baseline assessments, while the final evaluation is expected to be completed by Y4-Q3.

Specific Aim #3: Enhance the impact of an existing, statewide PTO social marketing campaign. The research team has already demonstrated considerable progress in identifying user-friendly, cost-effective PTO shield designs. Results from the trial of influence strategy boosters will serve to markedly enhance the success of the existing NY PTO shielding program. The most successful intervention (determined in SA #2) will be implemented statewide beginning in Y5-Q1.

B.2. What did you accomplish under these goals?

In an effort to address a prominent source of fatalities and severe injuries on Northeast farms, the NEC worked to develop effective strategies for addressing machinery entanglements. Entanglements are among the top three causes of death in New York and Pennsylvania, two states that account for roughly two-thirds of the Northeast farming populace. The use and maintenance of driveline shields has been shown to be an effective strategy for addressing entanglement hazards. However, regular use and replacement of machinery shields would need to be substantially increased to reduce entanglement rates. Unfortunately, in the previous round of Center funding, randomized findings from on-farm audits of PTO driveline shielding indicated that, out of 1,470 driveline implements, only 57% were adequately shielded.

To address this issue, the NEC began to build on a PTO shielding, social marketing campaign that was launched in the prior Center cycle. This social marketing campaign had attempted to increase the use of PTO driveline shields using tailored social marketing messages, improved shield designs and a promotional

campaign channeled through popular farm media publications. Unfortunately, the campaign did not sufficiently motivate farmers to replace missing or broken PTO driveline shielding. Qualitative interviews demonstrated that farmers' long-standing, negative experiences with prior PTO shield designs were a major impediment to persuading them to try new, user-friendly PTO shields.

In response, NEC researchers launched a 'Principles of Influence' campaign in 2016. This campaign served as a "booster" to the existing social marketing program by using R. Cialdini's strategies for engaging authority figures, family members and friends in efforts to encourage behavior change. This booster campaign was designed in collaboration with farmers and agri-service providers (via focus groups) and launched in the winter of 2018-2019 in agriculturally dense counties in NY. Each county was randomly assigned to receive either a Principles of Influence strategy or to serve as a control county. Influence strategies implemented in each of the intervention counties entailed the following:

1) Scarcity – Farmers in this county received a weeklong PTO shield promotion that includes free shipping and incentives for purchasing multiple shields, but with a limited time to take advantage of the campaign.

2) Liking – In this county, PTO shielding events were scheduled with farmers and resembled a social gathering, with a brief educational segment offered, followed by a PTO shield installation competition.

3) Social proof – In this county, researchers lead a social norming campaign featuring the high proportion of local farmers who were satisfied with improved PTO shield designs once they tried them.

4) Reciprocity –Farmers in this county, received small gifts to encourage them to call the NEC team to learn more about inexpensive and effective PTO shielding options.

5) Authority – In this county, PTO shielding was promoted by local emergency responders.

6) Consistency –Family farm safety contracts were distributed in this county at youth events, followed by ads encouraging farmers to install PTO shielding.

In addition to these interventions, one county received an intervention unrelated to Principles of Influence strategies. This intervention involved inviting farm wives to social gatherings to discuss PTO safety.

To assess changes in farmers' intentions to install or replace driveline shields and in farmers' actual shielding behavior, the research team has conducted baseline and follow-up surveys in each of the seven intervention and seven control counties. A total of 673 surveys were collected prior to the launch of the Principles of Influence campaign. The baseline surveys indicated 59.44% of farmers felt that their PTO drivelines were adequately shielded. A total of 228 baseline survey participants noted improper PTO shield maintenance.

Following the launch of the influence campaign in the winter of 2019, follow-up surveys were sent to 665 participants (eight participants were lost to follow-up). Based on survey responses, roughly 10% of participants replaced missing or broken PTO shielding because they felt it was required, while very few respondents replaced PTO shielding because others feel it is important (less than 2%). Just under half of respondents replaced PTO shielding because it aligns with their core beliefs. Thirty-nine individuals could not be classified as they did not respond to one or more of the applicable questions.

In addition to assessing shielding behavior, these surveys also served to measure the impact of each of the seven strategies that were tested. Unfortunately, none of these strategies resulted in a significant change in PTO shielding over the course of the intervention.

B.3. Competitive Revisions/Administrative Supplements
N/A

B.4. What opportunities for training and professional development did the project provide?
N/A

B.5. How did you disseminate the results to communities of interest?
Promotion - A key component of the initiative involves promoting the use of PTOs and the dangers of entanglements. These promotional activities facilitated the sharing of materials and information with the target population, equipment suppliers and project partners-such as Cooperative Extensions, FFA Chapters and Farm Bureau members. In this process, information about PTO shields was distributed primarily through mailings and campaigns designed around word-of-mouth messaging. Final study results will be shared with project partners and community stakeholders. Dissemination of methods, our intervention approach, and evaluation of the intervention has occurred in four, peer-reviewed published manuscripts.

NIOSH Extramural Agriculture, Forestry and Fishing (AFF) Safety Research Centers- As Director of the Northeast Center for Occupational Health and Safety, the project PI is well connected with Directors and staff from the various NIOSH Extramural AFF Centers. Interactions between the Director and these other Centers include monthly participation in Center Director calls and numerous, annual in-person meetings with AFF Directors and staff. Collaborations on various topical AFF activities such as outreach or evaluation provide additional interaction opportunities. The project PI uses these opportunities to share study methods, results, materials and approaches with AFF Center staffers who are likewise working on farming safety endeavors.

Data Sharing – A priority of the research is to work with manufacturers and equipment dealers to facilitate and encourage PTO shield use. Collaboration with these groups as well as other local farming organizations has provided numerous data sharing opportunities.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?
N/A

H. PRODUCTS

C.1. Publications, conference papers, and presentations
Publications:

1. Sorensen JA, Tinc PJ, Dalton D, Scott *EE*, Jenkins PL. A Comparison of Interventional Approaches for Increasing Power Take-off Shielding on New York Farms. *J. Agromedicine.* 2017;3:251-258.
2. Tinc P, Sorensen J. Marketing farm safety: using principles of influence to increase PTO shielding. *J. Agromedicine*. 2019;24:101-109. doi:10.1080/1059924X.2018.1539421
3. Tinc PJ, Goodspeed MM, Sorensen JA. Examining the utility of Kelman's processes of change to understand trends in agricultural safety. *J. Agromedicine*. 2020;25:193-198. doi:10. 1080/1059924X.2020.179503
4. Tinc P, Goodspeed M, Sorensen J. Understanding trends in PTO shielding using Kelman's processes of change. *J. Agromedicine*. 2021;26:193-198. doi: 10.1080/1059924X.2020 .179503
5. Tinc P, Sorensen J, Jenkins P, Kelsey T. Cost analysis of a PTO driveline shielding program: Are effective programs cost-effective? *J Agric Saf Health*. 2021;27:205-214.

6. Tinc PJ, Sorensen JA, Goodspeed MM, Jenkins PL. Do Cialdini's "Principles of Influence" motivate safe practices on farms? A study of NY farmers' PTO shielding behaviors. *J. Agromedicine*. 2021;26:1-12. doi: 10.1080/1059924X.2021.1950591

C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org
www.ifishconference.ca/home/

C.3. Technologies or techniques
None

C.4. Inventions, patent applications, and/or licenses
N/A/

C.5. Other products and resource sharing
Survey Instruments
Recruitment Materials
Data Collection Protocols
Study Protocols
Marketing and promotional materials for PTO shields

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Julsor	S/K	Julie Sorensen	PhD	Director	1				USA	
PauJen	S/K	Paul Jenkins	PhD	Biostatistician	.25				USA	
Pamtin	S/K	Pam Tinc	PhD	Senior Researcher	.8				USA	
		Liane Hirabayshi		Research Coordinator	.5				USA	
		Rebecca Weil		Research Assistant	.75				USA	
		Jess Echard		Research Assistant	3.2			USA	USA	
		Ryan Todd		Research Assistant	.1			USA	USA	
		Kevin Luschen		Research Coordinator	.8			USA	USA	
		Rachel Eckert			2.1			USA	USA	

D.2 Personnel updates N/A

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

NORA Priorities addressed: Strategic goal 3 (outreach, communication, partnerships) and strategic goal 4 (agricultural safety). Expected outcomes/impact on the research field: The expected outcomes of this research include a formal evaluation of targeted, social norm campaigns, increased driveline shielding and a reduction in PTO entanglement morbidity and mortality.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

None

G.2 Responsible Conduct of Research

None

G.3 Mentor's Research Report or Sponsor Comments

None

G.4 Human Subjects

G.4.a Does the project involve human subjects? Yes

G.4.b Inclusion Enrollment Data. No changes since previously reported enrollment in prior RPPR

G.4.c ClinicalTrials.gov
N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement
Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)
Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? **Yes**

G.11 Program Income
Is program income anticipated during the next budget period?
No

G.12 F&A Costs
Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets. Note: project outcome information will be made public in NIH RePORTER.

This study aimed to increase adequate PTO shielding on NYS farms. While the methods applied in this study have successfully motivated behavior change in other areas, including safety and health topics, they were unsuccessful in this setting. The study team hypothesizes that while PTO entanglements are a leading cause of agricultural injuries and deaths, these events are still relatively rare. In addition, "close calls" (or instances in which a PTO entanglement nearly occurred but didn't) are often difficult for even the individual to notice or identify, as they may simply involve a shirt-tail brushing up against an improperly shielded PTO. These realities continue to make PTO shielding a low-priority for many farmers, especially in light of other health

and safety concerns. In particular, farmers in this study often included statements to the effect of, “I know PTO shields are important, but I have much more urgent problems to deal with” in surveys as well as verbally during focus groups. In particular, these comments alerted the study team to growing and significant mental health concerns among farmers and workers, prompting the team to initiate new studies and programs pertaining to this topic.

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: Improving Methods for Traumatic Injury Surveillance in Agriculture, Forestry and Fishing</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 09/01/2016-08/31/2022</td></tr>
<tr><td>Reporting Period: 09/01/2016-08/31/2022</td><td>Date Submitted: 1/13/2023</td></tr>
<tr><td>Program Director/ Principal Investigator
Erika Scott
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<tr><td>Change of Contact PD/PI:
N/A</td><td></td></tr>
<tr><td>Human Subjects:
Yes</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:
N/A</td><td>Inventions/Patents:
None</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The long-term goal of this study is to improve the low-cost injury surveillance methods for the agricultural, forestry and commercial fishing industries in the Northeast. This will enhance understanding of the causes of traumatic injuries, identify high risk groups, and allow for ongoing program evaluation. If successful, similar methods can be employed to capture data in other areas of the country and for other occupational groups. To achieve the overarching aims of this proposal, several data sources will be combined. Short-term goals include optimizing narrative keyword searches, investigating state and regional trauma databanks, and exploring the utility of ICD10 E-Codes for AgFF injury identification. Lastly, the study will collect injury and illness data using a survey designed by the Central States Center for Agricultural Safety and Health (CS-CASH), which will permit regional comparisons of injury data. The proposed research is innovative as it takes a multi-faceted, low-cost approach to identifying and classifying occupational injuries.

Specific Aim 1: To broaden the geographic scope of the current NEC surveillance. Maintaining the partnerships fostered previously, researchers will add two states to the study, Massachusetts and Connecticut.

Specific Aim 2: To broaden the industry scope of the surveillance to include commercial fishing. This will involve the development of a list of keywords for electronic searching of text strings and will utilize ICD10 codes, which currently contain codes related to fishing.

Specific Aim 3: To refine electronic search methodology for agricultural, forestry and fishing injuries in administrative data sets. Researchers will electronically identify and code injuries from free-text strings using Bayesian methodology, employing both naive and informative priors. Results of this methodology will be validated against those obtained from visual inspection. The newly available ICD10 codes also have new levels that will assist in the identification of forestry injuries that were not available in the ICD9 codes.

Specific aim 4 has been replaced with an effort to create a crosswalk between ICD10CM E-codes and Occupational Injury and Illness Classification System (OIICS) codes.

B.2. What did you accomplish under these goals?

Over a decade of Northeast Center (NEC) injury surveillance experience supports this proposal. Given the inadequacies of a national injury surveillance system for the underserved industries of AgFF, we are best positioned to fill this critical gap in tracking injury and disseminating key results to the community at large for our region. Our efforts have centered on utilizing passive surveillance methods through existing databases to identify AgFF injury. Unlike surveys or active surveillance, our methods do not burden healthcare or emergency response workers with additional reporting that takes time away from patient care. We also understand that surveys of the AgFF community are costly and response rates have dwindled over time unless bolstered by intense recruiting and retainment efforts. We set out to create a surveillance system that could identify injury trends, adding new states as data became available, to provide enough detail to be useful to safety specialists. We specialize in finding the “needle in a haystack”, developing unique ways of sifting through vast volumes of big data to find AgFF-specific occupational injury records. These efforts are foundational to the public health interventions and programming we have successfully implemented throughout the northeast.

History of Surveillance at the Northeast Center

The groundwork of this system was laid over a decade ago, before the National Emergency Medical Services system (NEMSIS) made the transition to electronic reporting. That foundational work showed that different data sources (e.g. hospital records vs. active surveillance vs. pre-hospital care reports [PCRs]) captured different types of injury records, in terms of severity, injury types, and completeness. For instance, pre-

hospital care reports (PCRs), also known informally as ambulance reports, were integral in representing a wide variety of traumatic injuries and fatalities. Less serious injuries for which a farmer could be driven to the emergency department (ED) in a personal vehicle would be absent in a PCR database, but likely present in the hospital ED data. Particularly memorable injuries, either for the victim characteristics (e.g. a child) or injury type/severity (badly injured or required extensive extrication), were most frequently reported in the active surveillance conducted with law enforcement and emergency responders.[1]

While the quality of administrative data systems have improved greatly since the late 2000's, we learned the importance of using multiple data sources in our surveillance system. Further, our research showed that even if we found a patient's record in, for example, both the PCR database and the hospital inpatient database that did not mean that both records would indicate an agricultural injury.[2] Often, we could identify the agricultural injury through the free-text narrative description or the farm location code in the PCR, and match it to the patient's subsequent hospital record via date of birth (DOB), zip code, injury date, and hospital code. Frequently, the matching hospital record would not indicate an agricultural injury (no appropriate analogous external cause of injury code [E-code]). This highlighted the unique perspective that PCRs brought to this system, which became even more robust when electronic reporting became standard in the early to mid 2010's. The narratives were written by professionals who actually surveyed the scene, and recorded valuable details about the injury event, including the type and source of injury, and often, important contributing factors, such as pre-events, weather conditions, etc.[3-8]

Aim 1: States Currently Part of Our System
We have active data use agreements and have published results in Maine, New Hampshire, Vermont, Massachusetts, and New York.[2,6,7,9,10] These data use agreements include pre-hospital care reports with full narratives in Maine, New Hampshire and Vermont. Hospitalization data is utilized for the surveillance system in Maine, New Hampshire, Vermont, Massachusetts, and New York. Further, we have close relationships with the state-based occupational health programs across the Northeast through the Northeast Occupational Health Network (NEON). We are in continuing discussions with West Virginia regarding access to the state's PCRs and have established a relationship with Pennsylvania, and their newly funded state-based occupational health and safety surveillance program.

Aim 2: Identification of Fishing Injuries
In addition to the expansion of surveillance sources, researchers tested the system's ability to identify commercial fishing injuries in PCR data. A list of fishing keywords has been developed with input from the NEC's commercial fishing advisory board, the NORA dictionary of AgFF, and NEC fishing safety researchers. To begin, a single year of data (2008) from Maine was subset to PCR records with an incident location within twenty-five miles of the coastline. These records were then scanned for 198 fishing related keywords in 14,640 records. All records have been reviewed, identifying 82 possible fishing-related, injury events. These events will be carefully reviewed by the study team to: 1) assess the utility of the keywords, and 2) to construct the final case definition for commercial fishing. Though we identified a number of possible fishing related incidents, we suspect this to be an undercount, due to the fact that many traumatic and acute events at sea are intercepted by the United States Coast Guard (USCG) rather than an ambulance.

Aim 3: Refining Electronic Search Methods
To achieve the study's third specific aim, the research team wanted to improve the algorithm for searching the narrative field of EMS records using Bayesian methodology. In simple terms, Bayesian methodology identifies the statistical probability of an event occurring given certain conditions. In this study, the event is the probability of an EMS record being an AFF injury, given the presence or absence of keywords, farm location, matching hospital data, and other conditions. In its unimproved form, the current search process requires visual inspection of all EMS records returned by the keyword search, which is costly in terms of labor and time. The team anticipates that the successful application of Bayesian methodology will reduce the

reliance on visual inspection by increasing the specificity of the search method. The research team has set a goal of reducing the need for visual inspection from 281/10,000 records to 140/10,000 records.

The basis for the improved search algorithm is the development of a gold standard dataset, one that is the most accurate and reliable in terms of its identification of AFF injuries. We achieved this gold standard through visual inspection of the records returned from the keyword search. Injury and acute events are tagged using the following criteria: 0 – not a case, 1 – true case (definitely AgFF, definitely traumatic/acute), 2 – traumatic, AgFF industry suspected, and 3 – AgFF industry confirmed, traumatic/acute status suspected. The gold standard dataset is divided into a training dataset, which is used to create the improved search algorithm, and a validation dataset, which is used to evaluate how well the algorithm performs. Creating the gold standard dataset was time-consuming and difficult, as we completed this process for nearly 50,000 PCR records.

Searching Free Text

A critical part of our research rests on the use of unformatted free-text data fields. Few datasets contain industry and occupation variables, and when they do, they are often sparsely populated.[11,12] Therefore, we needed to develop a method to search for AgFF descriptions (work task, job role, and place of injury, for example) within the written notes of these medical datasets. In our current cycle of funding, we began to explore the role of machine learning to enhance our ability to filter and sort records. Utilizing pre-hospital care report data from two New England states, our team assigned AgFF case determinations to 50,000 pre-hospital care reports (PCR) records containing keywords of interest to create a gold standard dataset.[13]

Next, we used the tagged corpus of data to develop a Naïve Bayes machine learning algorithm. Our algorithm was trained on PCR datasets from 2008-2010 from Maine and New Hampshire and tested on newer data from those states between 2011 and 2016.[14] The AUC (Area Under the Curve) of .95 established that the algorithm has high levels of both sensitivity and specificity. Further analyses were devoted to establishing the generalizability of the model across various states, and various years. Dual visual inspection was used to verify the records that were identified as true cases of occupational morbidity and mortality by the algorithm. The Naïve Bayes machine learning algorithm reduced the volume of cases that required visual inspection by 69.5 percent over a keyword search strategy alone. Coders identified 341 true agricultural injury records (Case class = 1) (Maine 2011-2016, New Hampshire 2011-2015). In addition, there were 581 records (Case class = 2 or 3) that were suspected to be agricultural acute/traumatic events but lacked the necessary detail to be definitive.

We recently added Vermont PCR data to the system and nearly 200 farm and logging injuries were identified in these 2017-2018 data. Our previous research showed that PCRs yield a higher proportion of occupational injury records than other types of existing administrative records, such as hospital data.[7] By moving from simple keyword searches to employing the use of machine learning techniques, we have advanced our capacity for NE surveillance, moving much closer to an operational, sustainable system using existing data. Speeding up the process of identifying cases without sacrificing accuracy is a significant advancement in the field of injury surveillance for agriculture.

Visual Inspection and Coding of Identified Cases

We are experts in coding schemes including the Occupational Injury and Illness Classification System (OIICS) and the Farm and Agricultural Injury Classification (FAIC). Through detailed protocols, we abstract information from the free-text related to intentionality and location. Our coders' accuracy in selecting OIICS, FAIC, intentionality, and location codes was calculated using kappa scores and percent agreement. We determined that double coding is no longer necessary to maintain the rigor of the system. Further, there is a high level of detail in free-text, allowing us to frequently code to the third or fourth digit of OIICS. Having such detail allows these data to be more useful for injury prevention efforts.

Alternative Aim 4: Crosswalks for Coded Data

Aim 4 was initially intended to conduct a survey of agricultural injury across the Northeast, using the process developed by surveillance researchers at the Central States Center for Agricultural Safety and Health (CS-

CASH).[15] Their initial work was done in collaboration with the National Agricultural Statistics Service (NASS), and in December of 2016, Drs. Rautiainen, Baccaglini and Scott visited the NASS office in Lincoln, NE to discuss the planned survey. Due to major changes in how NASS could assist in administering the survey, it quickly became apparent that the cost was out of scope of either of the center's budgets. While CS-CASH continued their survey work with the help of FarmMarketID, we decided to focus our efforts on harnessing the power of expanded External Cause of Injury coding in the ICD10CM system.

We developed and tested a crosswalk between ICD-10-CM E-codes for AgFF and OIICS.[16] By using this crosswalk, we can efficiently process hospitalization data and quickly assemble relevant cases of AgFF injuries useful for epidemiological tracking. All 6,810 ICD-10-CM E-codes were double-reviewed and tagged for AgFF-relatedness. Of the 6,810 E-codes available in the ICD-10-CM scheme, 263 different E-codes were ultimately classified as true cases, traumatic/acute and suspected AgFF cases, or AgFF and suspected traumatic/acute cases.

For New York, Massachusetts, and Vermont, the crosswalk mapping identified 9,969 patient records confirmed to be or suspected to be an AgFF injury out of a total of 38,412,241 records in the datasets, (combined 2016-2017). Of these, 963 were true cases of agricultural injury. The remaining 9,006 were suspected AgFF cases, where the E-code was not specific enough to assign certainty to the record's work-relatedness. For the true agricultural cases, the most frequent combinations presented were contact with agricultural/garden equipment (301), non-roadway incident involving off-road vehicle (222), and struck by cow or other bovine (150). For suspected agricultural cases, the majority (68.2%) represent animal-related injuries.

The crosswalk provides a reproducible, low-cost, rapid means to identify and code AgFF injuries from hospital data. The use of this crosswalk is best suited to identifying true agricultural cases; however, capturing suspected cases of AgFF injury also provides valuable data. Fellow researchers at Oregon State University (OSU) have used the crosswalk, and we have connected with the NIOSH Center for Workers' Compensation Studies (CWCS) about working on future refinements.

Examples of Injury Records
As shown in Tables 3 and 4, the detail we obtain from these records is such that we can use these data for injury prevention activities. Below are just two examples of the thousands of AgFF injury records we have identified through our system.

Agricultural Injury PCR Narrative Example (Redacted to remove personal information): Service #[redacted] Dispatched by [redacted] to [redacted] RD for a 39 Y/O male c/c left foot injury. Pt foot trapped in a corn chopper. Arrived on scene pt self extricated foot. Found pt sitting on the corn chopper. Pt state – c/p-sob, -dizzy, -nausea, -vomit, -h/a, s-left foot injury, a-see above, m-see above, l-breakfast, e-was out side chopping corn, went to pick a piece of wood out of the way and the corn chopper grabbed his foot and pulled it in, | o – [sic] dcapbtls on all ext with the exception of swelling and deformity to the left foot, ankle still intact…

citations

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3. Scott EE, Krupa NL, Sorensen J, Jenkins PL. Electronic merger of large health care data sets: Cautionary notes from a study of agricultural morbidity in New York State. *J Agromedicine*. 2013;18(4):334-9. doi:10.1080/1059924X.2013.826608
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agricultural and logging injury in New Hampshire using electronic administrative data sets. Article. *J Occup Environ Med*. 2015;57(8):866-872. doi:10.1097/JOM.0000000000000482
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9. Jones NM, Scott EE, Krupa N, Jenkins PL. Estimating the cost of agricultural morbidity in Maine and New Hampshire. *J Agric Saf Health*. 2018;24(1):3-11. doi:10.13031/jash.12146
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11. Taylor JA, Frey LT. The need for industry and occupation standards in hospital discharge data. *J Occup Environ Med*. May 2013;55(5):495-9. doi:10.1097/JOM.0b013e318293af12
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14. Scott E, Hirabayashi L, Levenstein A, Krupa N, Jenkins P. The development of a machine learning algorithm to identify occupational injuries in agriculture using pre-hospital care reports. *Health Inf Sci Syst*. 2021/07/29 2021;9(1):31. doi:10.1007/s13755-021-00161-9
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B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

N/A

B.5. How did you disseminate the results to communities of interest?

Dissemination

A collaboration with the Vermont Department of Health (VDH), Bureau of Emergency Medical Services (EMS) highlights the surveillance system's utility to an end-user. Leveraging funds awarded from a farm health and safety grant from the VDH, we are collaborating on a tailored continuing education curriculum for emergency medical technicians (EMT) related to response to agricultural injury. The data for curriculum development was identified by our surveillance system, after completing a data use agreement with VDH EMS. This partnership will provide valuable surveillance data for agricultural safety specialists in reducing

workplace hazards and enhance EMS response to farm injury, ultimately influencing outcomes for injury victims.

We routinely respond to internal and external data requests for custom queries. Summarized surveillance data is shared with the Northeast Agricultural Safety and Health Training Coalition (NEASHC), data partners, occupational health and safety researchers, and policymakers. In addition, we are using our newly redesigned webpage https://necenter.org/portfolio/surveillance/ to share our crosswalk code and other surveillance resources. We have also created visually appealing infographics that summarize our research for a broader audience.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?
N/A

I. **PRODUCTS**

C.1. Publications, conference papers, and presentations
Publications:

1. Scott E, Bell E, Hirabayashi L, Krupa N, Jenkins P. Trends in Non-Fatal Agricultural Injury in Maine and New Hampshire: Results from a Low-Cost Passive Surveillance System. *J. Agromedicine*. 2017;22:16-20. doi:10.1080/1059924x.2017.1282908
2. Scott E, Bell E, Krupa N, Hirabayashi L, Jenkins P. Data processing and case identification in an agricultural and logging morbidity surveillance study: Trends over time. *Am. J. Ind. Med.* 2017;60:811-820. doi: 10.1002/ajim.22751
3. Jones NM, Scott EE, Krupa N, Jenkins PL. Estimating the cost of agricultural morbidity in Maine and New Hampshire. *J. Agric. Saf. Health.* 2018;24:3-11. doi: 10.13031/jash.12146.
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5. Hirabayashi L, Scott E, Jenkins P, Krupa N. Occupational injury surveillance methods using free text data and machine learning: Creating a gold standard data set: SAGE Publications Limited. 2020. https://books.google.com/books?id=6cBlzQEACAAJ
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7. Weichelt B, Gorucu S, Shutske J, et al. What about the rest of them? Their lives mattered too: Fatal agricultural injuries not captured by BLS/CFOI. *J. Agromedicine*. 2020;25:263-263, DOI: 10.1080/1059924X.2020.1765612
8. Scott E, Hirabayashi L, Levenstein A, Krupa N, Jenkins P. The development of a machine learning algorithm to identify occupational injuries in agriculture using pre-hospital care reports. *HISS.* 2021;9:31. doi: 10.1007/s 13755-021-00161-9
9. Scott E, Hirabayashi L, Graham J, Krupa N, Jenkins P. Using Hospitalization Data for Injury Surveillance in Agriculture, Forestry and Fishing: A crosswalk between ICD10CM External Cause of Injury Coding and the Occupational Injury and Illness Classification System. *Inj. Epidemiol.* Published online February 15, 2021. doi: 10.1186/s40621-021-00300-6.
10. Scott E, Hirabayashi L, Luschen K, Krupa N, and Jenkins P. Ensuring Data Quality and Maximizing Efficiency in Coding Agricultural and Forestry Injuries: Lessons to Improve Occupational Injury Surveillance. Journal of Safety Research. 2022, ISSN 0022-4375, https://doi.org/10.1016/j.jsr.2022.09.006.

11. Scott E, Weichelt B, and Lincoln J (2022) The Future of U.S. Agricultural Injury Surveillance Needs Collaboration, Journal of Agromedicine, DOI: 10.1080/1059924X.2022.2148032. Accepted November 7, 2022.

Presentations

1. Creating a Naive Bayes Machine Learning Algorithm to Identify Agricultural Occupational Injuries. Council of State and Territorial Epidemiologists (CSTE) Annual Meeting. Louisville, KY. June 21, 2022.
2. Using Machine Learning Techniques to Supplement Occupational Injury Surveillance for Undercounted Industries. Northeast Occupational Health Network Meeting. May 17, 2022.
3. Why Agriculture Remains Undercounted in Fatal and Non-Fatal Occupational Injury Surveillance Systems. Southeastern Coastal Center for Agricultural Health and Safety, University of Florida, Gainesville, FL, March 9, 2022. https://www.youtube.com/watch?v=-SKCbGdu-_M
4. Understanding Injury and Illness Disparities to Achieve Health Equity, State of the Science Meeting 2021: Pathways to Health Equity in Agriculture, Fisheries and Forestry. Southeastern Coastal Center for Agricultural Safety and Health. September 9, 2021. Presented with Risto Rautiainen and Marcy Harrington.
5. Injury Surveillance and Coding: What are the implications for safety programming? April 28, 2021. Professional Development Series, ISASH. (Presented with Serap Gorucu, Bryan Weichelt, and Mahmoud Nour. Michael Pate, Moderator).
6. Future Directions for AgFF Occupational Safety and Health Surveillance. February 16, 2021. NIOSH Ag Center Director's Meeting Panel Discussion Series. (Presented with Risto Rautiainen, Steve Browining, and Marizen Ramirez).
7. Advancements in Occupational Injury Surveillance: Making the haystack smaller to find the needle. February 16, 2021. Bassett Medical Center Research Grand Rounds.
8. Agricultural Safety and Health. Family Medicine Grand Rounds. University of Vermont, Larner College of Medicine. January 11, 2021. (Presented with Dan Baker, PhD & Katie Wells, MD, MPH)
9. Improving Injury Surveillance of Agriculture, Forestry, and Fishing Industries Through Application of Machine Learning with Electronic Health Records. International Society for Agricultural Safety and Health (ISASH) Virtual Conference 2020. July 2020. (Presented with Liane Hirabayashi).
10. The Utility of Existing Administrative Databases for Agricultural Injury Surveillance. Scientific Seminar (virtual), Marshfield Clinic Research Institute, National Farm Medicine Center, Marshfield, Wisconsin. June 10, 2020.
11. Analyses of Agricultural Injury Data from Administrative Databases. Panel: Surveillance of AgFF Injury, Illness and Economic Impacts. Western Ag Safety and Health Conference, University of Washington, Pacific Northwest Agricultural Safety and Health Center (PNASH), Seattle, WA, August 8, 2019.
12. Utility of Free-Text Data in an Occupational Injury Surveillance System for Agriculture, Forestry and Commercial Fishing. Harvard T.H. Chan School of Public Health, NIOSH Education and Research Center, Environmental and Occupational Medicine and Epidemiology Program, Monday Seminar Series, Boston, MA, December 17, 2018.
13. Using Maine and New Hampshire PCRs to Create a Gold Standard Injury Dataset in Agriculture, Forestry, and Fishing. Northeast Epidemiology Conference. Manchester, VT. November 1, 2018.
14. Enhancing Agriculture, Forestry, and Fishing Injury Surveillance Using Free Text Data. National Occupational Injury Research Symposium (NOIRS 2018), Morgantown, WV, October 16, 2018.
15. Commercial Fishing and Processing Health and Safety Surveillance Informing Intervention Development. IFISH 5 Conference (International Fishing Industry Safety & Health Conference), Panel with Samantha Case, U.S. National Institute for Occupational Safety and Health (NIOSH); Erika Scott, Northeast Center for Occupational Health and Safety; Laurel Kincl, Viktor Bovbjerg, and Jasmine Nahorniak, Oregon State University; Laura Syron and David Sweet, NIOSH, June 11, 2018, St. John's, NL

16. The Needle in the Haystack – Occupational Injury Surveillance in America's Most Dangerous Industries, New York Medical College Public Health Spring 2018 Seminar Series, January 24, 2018, Valhalla, NY
17. NYCAMH and NEC Initiatives, New York Farm Bureau Board of Directors Meeting, August 24, 2017, Albany, NY (Presented with Dr. Julie Sorensen)
18. Injury Surveillance in Agriculture and Logging (Lecture), April 2017, Columbia Mailman School of Public Health, NYC, NY
19. Injury Surveillance in Agriculture and Forestry: Chasing the Ambulance to the Hospital (Lecture), December 12, 2016, University of Nebraska Medical Center, Central States- Center for Agricultural Safety and Health, and the Great Plains IDeA Center Network, Omaha, NE.

C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org

C.3. Technologies or techniques
Machine Learning

C.4. Inventions, patent applications, and/or licenses
N/A/

C.5. Other products and resource sharing
Data Collection Protocols
Study Protocols
ICD-10-CM to OIICS crosswalk available on NEC website
Leading Surveillance Working Group (SWG)

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Erisco	S/K	Erika Scott	PhD	Dep. Director	.75				USA	
PauJen	S/K	Paul Jenkins	PhD	Biostatistician	.25				USA	
		Nicole Krupa		Data Analyst	.6				USA	
		Liane Hirabayashi		Data Analyst	.5				USA	
		Kevin Luschen	MA	Research Coordinator	1				USA	
		Cristina Hansen-Ruiz	PhD	Research Assistant	3.1				USA	
		Andrew Demma		Research Coordinator	1				USA	
		Rebecca Weil		Research Assistant	.75				USA	
		Megan Goodspeed		Research Assistant	1				USA	
		Kayla Johnson		Research Assistant	2.9				USA	

D.2 Personnel updates N/A **a. Level of Effort**: **b. New Senior/Key Personnel**: **c. Changes in Other Support**: **d. New Other Significant Contributors**:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A
E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health. NORA priorities15 addressed: Strategic Goals 1 (Surveillance)

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures **None**
F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them **None**
F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents **None**

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements **None**
G.2 Responsible Conduct of Research **None**
G.3 Mentor's Research Report or Sponsor Comments **None**
G.4 Human Subjects G.4.a Does the project involve human subjects? No G.4.b Inclusion Enrollment Data N/A G.4.c ClinicalTrials.gov N/A Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA? No
G.5 Human Subject Education Requirement Are there personnel on this project who are newly involved in the design or conduct of human subject's research? No
G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals
Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? Yes

G.11 Program Income
Is program income anticipated during the next budget period?
No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

Occupational injury surveillance systems have increasingly begun to rely on computer learning methods to get the job done. These programs have enabled surveillance systems across the country to more accurately identify work-related injuries in industries such as agriculture and forestry. With injuries in these industries are historically undercounted, we have developed machine-learning algorithms to more precisely capture these statistics using existing administrative datasets such as hospital records and pre-hospital care reports. .

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: Grain Bin Safe Entry Retrofit: An Intervention Assessment</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 09/01/2016 – 08/31/2022</td></tr>
<tr><td>Reporting Period: 09/01/2016-08/31/2022</td><td>Date Submitted: 1/13/2022</td></tr>
<tr><td>Program Director/ Principal Investigator
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110 Technology Center Building
University Park, PA 16802-7000
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osp@psu.edu</td></tr>
<tr><td>Change of Contact PD/PI:
N/A- PI was originally Serap Gorucu but switched to Ms. Fetzer in 2020.</td><td></td></tr>
<tr><td>Human Subjects:
Yes</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:
NIH Number: 1246000376A1</td><td>Inventions/Patents:
None</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Based on the research results from Years 1 – 3, it has been determined that a standardized recommendation tool for the use of an anchor point and lifeline system is not feasible. The ASABE standard related to anchor points and lifeline is a recommendation and not a requirement. Therefore, if a grain bin was constructed since 2018, the owner of the bin should consult with the bin manufacturer to obtain verification that the bin was built and installed with the necessary specifications to safely accommodate the anchor point and lifeline system.

Specific Aim 1: Assess intervention recommendations to establish retrofit safe entry systems for on-farm grain bins. The ASABE standard for grain bin manufacturers is valid from 2018 but is voluntary. Each bin built after 2018 bin should be verified by the manufacturer that it was built to the specifications recommended for the anchor point and lifeline system. Grain bins built prior to 2018 should be evaluated by a professional (e.g., structural engineer) to assure that the bin can safely accommodate the anchor point and lifeline system. Research gained in Years 1-3 of the project will be used to provide guidelines and specifications for these professionals.

Specific Aim 2: Explore new technologies and best safety practices to reduce grain bin entries. Due to the new voluntary ASABE standard, most grain bins pre-2018 may not safely accommodate an anchor point and lifeline system. In addition to development of guidelines for professionals to inspect grain bins, the team will explore emerging technologies and practices to reduce the need to enter the grain bin. Educational materials were developed based on these the best practices.

Determining implementation strategies for establishing safe entry systems for on-farm grain bins will be completed through online surveys with people who work around or own a grain bin. The primary survey audience is from Maryland, New York, and Pennsylvania. While promoting the survey in the three states, responses were also received from other states. Data collection will be completed in March 2021 and survey results will be analyzed and submitted to a professional journal.

The strategic focus of project activities will address the following priority action steps of the NORA for AgFF:
• Enhance/expand safety interventions with farmers and farm families, including resources such as safety videos, hazard identification kits, and best practices guidelines. Incorporate information regarding economic issues/benefits of maintaining a safe working environment (lost family income, medical costs, lawsuits and legal issues, and tax benefits). (Action Step 4.3.1).
• Conduct studies to determine the most cost-effective and practical strategies for eliminating fatalities, including engineering design (such as sensors), information technology (such as GPS), incentive programs, and guidelines or policies. (Action Step 4.3.2).

B.2. What did you accomplish under these goals?

There are approximately 35 (known and additional suspected unreported) grain bin related fatalities per year. The ANSI/ASABE S624 – Grain Bin Access Design Safety standard was published in August 2018. This standard recommends that grain bins manufactured after 2018 be built to accommodate a bin entry lifeline system. The recommended system includes two anchor attachment points with one located near the roof peak and one near the roof access. Each anchor point must support a minimum ultimate load of 2,000 pounds. The main goal is reducing on-farm grain bin entrapments remains valid and this was approached in two ways. First, provide guidelines and specifications for the evaluation of grain bins to determine whether they can safely accommodate an anchor point and lifeline systems.

The major goal of this project was reducing the number of on-farm grain bin entrapments on farms that are exempt from the Occupational Safety and Health Administration (OSHA) grain handling facilities standard. Penn State University combined computer modeling and experimental measurements to examine safe use of anchor points on a pre-2018 grain bin. Vertical roof deflection of the bin was measured using a precision phase-comparison laser measuring device while applying incremental dead loads to retrofitted rescue anchor points. Those deflections were then compared to deflections predicted by finite element analysis within a SolidWorks computer model created specifically for the tested bin. The measured defections were compared to the deflections predicted by the computer model. Note that this model only applies to one specific grain bin and cannot be generalized to bins with differing designs, sizes, material thicknesses, or bins with damage or degradation. Based on the research findings, the project team recommends that the suitability of any bin to safely accommodate a lifeline and anchor point system needs to be verified on a case-by-case basis by consulting the manufacturer or the bin being evaluated by a professional such as structural engineer. This recommendation includes all grain bins including post-2018. Special attention must be given to any bin that has been modified, damaged, or has signs of degradation and preferably inspected and evaluated by a structural engineer. The research team has developed inspection guidelines that can be used by professional engineers to assist in the determination whether a grain bin can safely accommodate a lifeline and anchor point system. Secondly, explore existing and emerging technologies and techniques to reduce the need to enter a grain bin therefore reducing the potential for an entrapment incident.

Secondly, researchers explored barriers to the adoption of safe grain bin entry systems and methods to overcome these barriers. With this information, researchers hope to determine successful best safety practices and adoption strategies for safe entry handling. Based on the study results, barriers to the use of safety equipment or personal protective equipment included cost, access, and convenience. Some study participants recognized grain bin hazards, but others were not aware of the hazards and were interested in learning more about safety measures and rescue procedures. Educational efforts focused on technologies and best practices that when implemented can reduce the need for grain bin entry. Presentations and educational materials provide an overview of the research approach, recommendations on grain bin inspections for anchor points and lifeline systems, and the use of emerging technologies and best practices to reduce the need to enter grain bins.

If best practices are implemented by producers and owners, there will be a reduction in the need to enter or climb a grain bin which results in reduced grain bin entrapment incidents and falls from grain bins. Agricultural safety and health professionals benefited from this research, presentations, and engineering criterion as we change the approach these professionals take when doing grain bin safety. Not all grain bins can safely accommodate an anchor point and lifeline system and professionals now have some data that supports the need to individually inspect grain bins.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

Research team members attended national conferences including America Safety and Health Council of America, International Society for Agricultural Safety and Health (multiple years), National Occupational Injury Research Symposium, and American Society of Agricultural and Biological Engineers (multiple years) for professional development opportunities. Team members presented at these conferences but also had the opportunity to attend related sessions and discuss the project with other professionals to better the project.

Members of the research team provided trainings and professional development presentations. Presentations and exhibits about the research project were provided at PSU Extension events such as crop days, agricultural rescues trainings, county fairs, multiple times at Penn State's Ag Progress Days, PA State Farm Show, and PA Farm Bureau Annual Conference. Grain safety was the focus of Penn State Ag Safety and Health's demonstration during the Penn State College of Agricultural Sciences Ag Progress Days in 2019, 2020, and 2022. "Best Practices for Safe Grain Handling Demonstration" on Tuesday and Thursday (3 times each day, each lasted 30 min), and the demonstrations on Wednesday focused on "Best Practices for Grain Bin Rescue" two times which lasted approximately 30 minutes. During the 2019 demonstrations, Michael Dyer talked about the project and the importance of anchor point retrofit system for safe entry into grain bins. Volunteers from Williamsburg and Martinsburg County assisted with the grain rescue demonstrations, and the rescue event was shown live on two TV screens on demonstration area. The 2020 Ag Progress Days was virtual and included a video by Michael Dyer and Stephen Brown about grain bin safety. Grain and grain bin safety were the focus of the Ag Safety and Health demonstration during Ag Progress Days (August 9 – 13, 2020). The 2020 Ag Progress Days was a virtual event so a video demonstration was recorded and located at the following website: https://extension.psu.edu/grain-bin-safety-rescue. The content for the 2022 APD highlighted the grain bin safety best management practices, provided demonstrations and information about the grain bin project and products, and presented grain bin anchor point recommendations based on the research project. Linda Fetzer completed a television interview on PCN about the project.

Events range from county-level, multi-county, state, or regional events. Additionally, staff presented findings to professionals to conferences including the American Society of Agricultural and Biological Engineers conference, the National Occupational Injury Research Symposium, and twice at the International Society of Agricultural Safety and Health conference. Due to COVID and travel restrictions some events which are normally in-person were moved to virtual. Some of the professional meetings were virtual in 2020 and 2021 but the virtual venue did provide an opportunity to do a Facebook Live event with the Penn State Crops team.

Specific articles generated through this grant listed in Section C.2 were included in the Penn State's Field Crop News (newsletter) which is sent to over 10,000 people on the Penn State Agronomy listserv.

B.5. How did you disseminate the results to communities of interest?

For this grant project, the dissemination of results focused on two main communities of interest including producers and then agricultural safety and health professionals. Providing information about the project, research findings, and best management practices were provided to producers through new articles on the Penn State Extension website and the promotion of those articles; in-person events such as county, state, and regional in-person events; and presentations for producers at county, state, and regional events. More information about events is outlined in Section B.4.

For agricultural safety and health professionals, the disseminate of results was done primarily through journal articles or technical papers and presentations (poster or oral) at professional conference including Agricultural Safety and Health Council of America, National Institute for Occupational Safety and Health, American Society of Agricultural and Biological Engineers, and International Society for Agricultural Safety and Health. A list of professional publications, papers, and presentations are outlined in Section C.1.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?
N/A

I. **PRODUCTS**

C.1. Publications, conference papers, and presentations

Publications:

1. Gorucu, S., Pate, M., Fetzer, L., and Brown, S. (2022) Farmers Perceptions of Grain Bin Entry Hazards. Journal of Agricultural Safety and Health 28(1): 19-30 (doi: 10.13031/jash.14662). Retrieved from https://elibrary.asabe.org/abstract.asp?aid=53014.
2. Gorucu S, Dyer M, Bock R, Thomas R, Fetzer L, and Brown S. (2022). Modeling a Grain Bin for Safe Entry Retrofit. Journal of Agricultural Safety and Health. (under review).

Technical papers

1. Gorucu S, Dyer M, Bock R, Thomas R, Fetzer L, and Brown S. (2022). Modeling a Grain Bin for Safe Entry Anchor Point Retrofit. ASABE Annual International Meeting. Paper No: 22-00697. Houston, TX, July 17-20, 2022.

Poster presentation

1. Michael Dyer, Stephen Brown, Michael Pate. 2019. Modeling Retrofit Anchor Points for On-Farm Grain Bin Structures. Presented in 2019 ASABE Annual International Meeting, July 7-10, 2019, Boston, Massachusetts.
2. Gorucu S, Dyer M, Bock R, Thomas R, Fetzer L, and Brown S. (2022). Existing On-farm Grain Bin Structures: Feasibility of Safe Entry Anchor Point Retrofit North American Agricultural Safety Summit – ASHCA, Las Vegas NV. March 28-30, 2022.

Presentations:

1. Gorucu S, Brown S, Dyer M. 2020. Hazards associated with Grain Bin Entry - Farmers' Perceptions. ISASH Day of Learning: Day 2 - Session 5. July 29. Video presentation located at the following link: https://youtu.be/7J0z_HFO-Qg
2. Fetzer L., Dyer M., and Gorucu S. (2022) Confined Space: Reducing Grain Bin Related Injuries and Fatalities. National Occupational Injury Research Symposium. Virtual meeting. May 10-12, 2022.
3. Fetzer L., Dyer M., and Gorucu S. (2022) Retrofitting Safe Entry Technology onto On-Farm Grain Bin Structures. International Society for Agricultural Safety and Health. Fort Collins, CO, June 12-16, 2022.
4. Gorucu S, Dyer M, Bock R, Thomas R, Fetzer L, and Brown S. (2022). Modeling a Grain Bin for Safe Entry Anchor Point Retrofit. ASABE Annual International Meeting. Paper No: 22-00697. Houston, TX, July 17-20, 2022.

C.2. Website(s) or other Internet site(s) – include URL(s)

www.necenter.org
https://www.psu.edu/news/research/story/grant-will-support-grain-bin-safety-research-penn-state/
https://extension.psu.edu/grain-auger-safety
https://extension.psu.edu/lockout-tag-out-to-reduce-ag-injuries-and-fatalities
https://extension.psu.edu/grain-bin-safety-rescue
https://extension.psu.edu/retrofitting-on-farm-grain-bins
https://extension.psu.edu/best-practices-and-products-to-reduce-grain-bin-entry
https://extension.psu.edu/on-farm-grain-bin-inspection-guidance-for-safe-entry-lifeline-and-anchor-point-retrofit
https://www.morningagclips.com/grain-storage-hazards-the-focus-of-ag-progress-days-farm-safety-demonstrations/
https://www.psu.edu/news/agricultural-sciences/story/grain-storage-hazards-focus-ag-progress-days-farm-safety-demonstrations/
https://blog.umd.edu/agronomynews/2021/02/18/retrofitting-safe-entry-technologies-and-grain-bins/

C.3. Technologies or techniques

The research team assessed the feasibility of a safe entry anchor point retrofit by using finite element analysis (FEA). A grain bin owned by Penn State was used for 3D FEA modeling in SolidWorks to predict if the structure could withstand when subject to loads to support the person entering the grain bin. When the 3D model was created, it was conducted using surface modeling techniques in SolidWorks to accurately model the forces in a grain bin during an entrapment incident, while ensuring the bin is simple enough to be parametrically driven. The deflection testing process was used to validate the 3D model and FEA simulations using a precision phase-comparison laser while applying incremental static loads to the retrofitted rescue anchor points. Then the team compared the predicted deflections from the FEA model and actual experimental measured deflections. The SolidWorks simulation FEA model successfully estimated the loading scenarios in a safe and non-destructive way. Even though the FEA model predicted the deflections, there are numerous modifications and weather effects on the material properties that the results cannot be generalized for all grain bins. The FEA can be used by engineers to assess the structural properties of grain bins to determine whether a grain bin can safely accommodate a lifeline and anchor point system.

C.4. Inventions, patent applications, and/or licenses

N/A

C.5. Other products and resource sharing

Survey Instruments

Survey instruments included Solidworks and a laser measuring device were used when testing the deflection of the grain bin and anchor point. Gas meters were used to collect gas levels in a grain bin. For the perception survey, Qualtrics was used to gather the online survey data and SPSS was used for the data analysis.

Recruitment Materials

For the perception study, participants were invited to the original plan was to involve focus groups and surveys. participants were invited to an agricultural or grain safety training or event located in Pennsylvania and New York. Due to COVID-19 and restrictions on in-person meetings, the survey was moved to an online system and promoted by organizations and outlets such as the Delmarva Farmer, Maryland Grain Producers, Maryland Soybean Board, and extension educators in Maryland and Pennsylvania shared the survey link to their constituents. The survey was promoted via social media by AgSafety4U on their Twitter and Facebook pages three times between February 19, 2021, and March 9, 2021. This promotion of the link by AgSafety4U and regional organizations enabled the team to collect additional data from other states.

Data Collection Protocols

For the participants who completed the survey in-person their survey responses were entered into Qualtrics. When COVID-19 travel restrictions were implemented, the remaining survey part of the study was moved to Qualtrics and completed online between March 2020 and March 2021.

Study Protocols

For the perception study, descriptive statistics and bivariate correlation analysis were used to analyze the data. Independent-samples t-tests were used to determine if there were any significant differences between the online and paper surveys. Chi-square analysis was used to determine if there were any differences between participants from the northeast region and responses from other states.

For the grain bin testing, a grain bin owned by Penn State was used for 3D FEA modeling in Solidworks to predict if the structure can withstand when subject to loads to support the person entering the grain bin. When the 3D model was created, it was conducted using surface modeling techniques in Solidworks to

accurately model the forces in a grain bin during an entrapment incident, while ensuring the bin is simple enough to be parametrically driven. The deflection testing process was used to validate the 3D model and FEA simulations using a precision phase-comparison laser while applying incremental static loads to the retrofitted rescue anchor points. Then we compared the predicted deflections from the FEA model and actual experimental measured deflections. The SolidWorks simulation FEA model successfully estimated the loading scenarios in a safe and non-destructive way. Even though the FEA model predicted the deflections, there are numerous modifications and weather effects on the material properties that the results cannot be generalized for all grain bins. The FEA can be used by engineers to assess the structural properties of grain bins to determine whether a grain bin can safely accommodate a lifeline and anchor point system.

Articles and educational materials on augur safety and lockout/tag out
Online and journal articles were promoted during presentations, through social media, and included in Field Crop News. Educational handouts were distributed at in-person events at county, state, and regional events. These articles and educational materials will be used past the grant project to continue to promote best management practices related to grain bin safety, safe entry, technologies and techniques, and grain bin inspections.

Engineering Criterion
The engineering criterion is available on the Penn State Extension website can be downloaded for free as a PDF or a hard copy can be purchased for a nominal fee.

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
12227004	K	Fetzer, L.	MS	PI	3.0				USA	
		Brown, S.	BS	Co-PI	5.0				USA	
		Bock, R.	MS	Co-I	2.0				USA	
		Thomas, R.	PhD	Co-I	1.0				USA	
		Dyer, M.	BS	Grad student	3.0				USA	
		Haskins, J.		Undergrad Student	7.0				USA	
	S	Gorucu, S.	PhD	Subcontract	1.0				USA	
		Snell, K.	BS	Staff	5.0				USA	

D.2 Personnel updates

a. Level of Effort: N/A
b. New Senior/Key Personnel: N/A
c. Changes in Other Support: N/A
d. New Other Significant Contributors: N/A

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A
Findings could change how educational training related to grain bin safety and the use of anchor points and lifeline systems on grain bins is provided to the agricultural community. Educational trainings will need to focus on best practices to reduce the need to enter a grain bin.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.
Project findings have the potential to reach beyond this project in the following ways:
Change educational content and strategies regarding the use of anchor point and lifeline systems.
Promote grain and grain bin best practices to reduce the need to enter a grain bin rather than use of anchor point and lifeline system.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
The approach and reasons for change are based on the research findings and further investigation into the liability issues related to the anchor point and lifeline systems.

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them
N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
None

G.2 Responsible Conduct of Research
None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects

G.4.a Does the project involve human subjects? Yes

G.4.b Inclusion Enrollment Data
For the grain bin perception study there were a total of 162 responses. Of those responses, 52 were paper-based and 110 were online submissions. Those who responded via paper-based surveys were completed by participants who attended an agricultural or grain safety training or event located in Pennsylvania and New York. Due to the COVID-19 pandemic and travel limitations, the research team used online survey responses in the study and those results were collected between March 2020 and March 2021. Organizations and

outlets such as the Delmarva Farmer, Maryland Grain Producers, Maryland Soybean Board, and extension educators in Maryland and Pennsylvania shared the survey link to their constituents. The survey link was promoted on social media by AgSafety4U on their Twitter and Facebook pages three times between February 19, 2021, and March 9, 2021. This promotion of the link by AgSafety4U and regional organizations enabled the team to collect additional data from other states. When the participant completed the survey, they were permitted to enter a drawing for the potential to win one of three Visa gift cards valued at $75 as an incentive for completing the survey. Sixty-three percent of the responses (*n* = 102) were from the northeast region. Remaining surveys were from people located in other U.S. states. The age range of respondents were between 18 – 78 years old with a median age of 40 and 85% of the participants were male.

G.4.c ClinicalTrials.gov

N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)
Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals
Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance
$464.38

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?
No

G.11 Program Income
Is program income anticipated during the next budget period? No

G.12 F&A Costs
Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets. Note: project outcome information will be made public in NIH RePORTER.

There are approximately 35 (known and additional suspected unreported) grain bin related fatalities per year. The ANSI/ASABE S624 – Grain Bin Access Design Safety standard was published in August 2018. This standard recommends that grain bins manufactured after 2018 be built to accommodate a bin entry lifeline system which includes two anchor attachment points with one located near the roof peak and one near the roof access. Each anchor point must support a minimum ultimate load of 2,000 pounds. The main goal of this research project was the reduction of on-farm grain bin entrapments. Penn State University combined computer modeling and experimental measurements to examine safe use of anchor points on a pre-2018 grain bin. Vertical roof deflection of the bin was measured using a precision phase-comparison laser measuring device while applying incremental dead loads to retrofitted rescue anchor points. Based on the research findings, the project team recommended that the suitability of any bin to safely accommodate a lifeline and anchor point system needs to be verified on a case-by-case basis by consulting the manufacturer or the bin being evaluated by a professional such as structural engineer. This recommendation includes all grain bins including post-2018. The research team developed inspection guidelines that can be used by professional engineers to assist in the determination whether a grain bin can safely accommodate a lifeline and anchor point system. Secondly, the team explored existing and emerging technologies and techniques to reduce the need to enter a grain bin therefore reducing the potential for an entrapment incident. Educational materials about technology and best management practices were developed and presented to both agricultural producers and agricultural safety and health professionals and will continue to be used in our educational outreach efforts.

A. COVER PAGE

<table>
<tr><td colspan="2">Project Title: The Northeast Center for Occupational Safety and Health: Agriculture, Forestry and Fishing-NEC Pilot Projects</td></tr>
<tr><td>Grant Number: 6 U54OH007542-20-01</td><td>Project/Grant Period: 09/01/2016-08/31/2022</td></tr>
<tr><td>Reporting Period: 09/01/2016-08/31/2022</td><td>Date Submitted: 1/13/2023</td></tr>
<tr><td>Program Director/ Principal Investigator
Julie Sorensen
Northeast Center for Occupational Health and Safety
Bassett Healthcare Network
One Atwell Road
Cooperstown, NY 13326
607.547.6023, ext. 2210
julie.sorensen@bassett.org</td><td>Administrative Official Information
Stephen Clark
Bassett Healthcare Network
One Atwell Road
Cooperstown, NY 13326
607.547.3048
stephen.clark@bassett.org</td></tr>
<tr><td>Change of Contact PD/PI:
N/A</td><td></td></tr>
<tr><td>Human Subjects:
Yes</td><td>Vertebrate Animals:
N/A</td></tr>
<tr><td>hESC:</td><td>Inventions/Patents:</td></tr>
</table>

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The overarching goal of the NEC Pilot/Feasibility Program will be to: 1) expand NEC research networks and 2) advance the field of injury R2P by exploring innovative ways of addressing AFF priorities. The NEC will inform these efforts by identifying barriers to progress, expanding researcher networks, gathering and identifying promising proposals, tracking progress and documenting outcomes. The following specific aims have been developed to ensure pilot program success: Aim #1: Expanding researcher network/interest. NEC advisory board members will be queried annually for lists of research contacts. Literature reviews will also be conducted annually to identify individuals publishing on injury research in the Northeast. Funding notices will be distributed through the NEC, APHA Injury, ASABE and ISASH listservs, as well as NEC social media sites. Aim #2: Identifying annual Pilot/Feasibility Program priorities. The priority setting process will utilize NEC researcher/partner knowledge to identify regional barriers to AFF injury prevention. Through this priority setting process, NEC researchers will identify 2-3 priority Pilot/Feasibility Program topics. Aim #3: Identifying high impact proposals. Pilot/Feasibility Program applications will be systematically reviewed by the NEC Scientific Advisory Panel. Prioritized applicants will be discussed with the Columbia University Injury Center Program to identify proposals that are of equal importance to both Centers and which could benefit from pooled pilot research funding. Aim #4: Ensuring NEC Pilot/Feasibility Program success. Funded programs will be carefully tracked by the NEC Deputy Director (who will serve as the Pilot/Feasibility Program Director) and the NEC Evaluation team using the Pilot/Feasibility Program timeline. Aim #5: Documenting NEC Pilot/Feasibility Program outputs/outcomes. Documentation of Pilot/Feasibility program outputs and outcomes will be facilitated through quarterly NEC Evaluation team reports and through a final summary report and presentation that will be provided at the annual NEC Research Investigators retreat. All Pilot/Feasibility Program awardees will coordinate with the NEC Promotions Coordinator to develop a plan for project information dissemination to workers and non-NEC researchers.

B.2. What did you accomplish under these goals?

<u>2017 -2018</u>

"Biologically-active exposures as potential risk factors for respiratory function among farm workers and their children"

PI: Meghan Davis, DVM MPH PhD
Johns Hopkins Center for a Livable Future

We have identified coagulase-positive staphylococci, which includes S. aureus, from workers, adolescents and livestock. We are in process to confirm S. aureus bacterial species among these isolates.

We have collected settled farmhouse dust among the groups, as well as settled dairy barn dust which should serve as a positive field sample, and have ordered and received Bos d 2 (cow allergen) kits. We are in process to test dust for cow allergen.

We have built a repository of settled and airborne dust from the farmhouse and barn environments and of upper respiratory swabs from worker-adolescent pairs for later assessment of other biologically-active exposures (bacterial and fungal communities, endotoxin, other allergens).

We enrolled eight participants representing all target farm types: dairy farm, beef (non-dairy) farm, and crop farm and have completed sample collection. We also sampled two control sites (not farms) in proximity to the farms that were enrolled.

We identified that five (63%) of eight participants carried coagulase-positive staphylococci (CPS), with three (100%) of primary adult workers enrolled colonized. CPS isolates were also detected from at least one farm animal on all farms where animals were kept. We are in process to identify these CPS to species, which will confirm *S. aureus* isolates (*S. aureus* are CPS but not all CPS are *S. aureus*).

Since a motivation of this work was to build a foundation towards identification of how biological exposures of dairy origin relate to respiratory and allergic outcomes among farmers, we also queried participants regarding respiratory outcomes and use of personal protective equipment (PPE). Seven of eight participants completed surveys; one participant, who did not work directly with the farm animals, was too busy to complete the survey. Among the participants, one (14%) reported a history of asthma, and another (14%) reported a history of eczema, which can be associated with both *S. aureus* and allergic conditions. Both were adolescent workers. Five (71%) reported a history of rhinitis, with four (57%) reporting rhinitis symptoms in the past year, and two (29%) reported a history of wheeze, with none (0%) reporting wheeze symptoms in the past year.

2018-2019

"Determining the Occupational Health and safety needs of farmers over 60"
PI: Richard Brzozowski, PhD
UMaine Cooperative Extension

We met as a research team on three occasions. The team met to develop our overall research plan. This involved creating succinct farmer surveys for four different types of farmers (dairy, wild blueberry, apple and potato). We also worked together to develop an agenda for the focus groups. The Principal Investigator (PI) communicated with the respective Extension specialist to identify farmers over the age of 60. The PI followed up and invited a small subset of farmers to focus groups meeting.

We developed the farmer survey for farmers. Each survey was 2-pages in length and was similar in the type of questions asked. These surveys were paper surveys that farmers at the focus groups responded to in person.

We submitted the IRB application for approval. Once the surveys were finalized, an application was submitted for IRB approval. All members of the research team had human subjects certification with the exception of one. She successfully completed the human subjects training online.

We developed the agenda for the focus group session. We designed a 2-hour meeting with farmers for each focus group gathering. These meetings were held near mid-day in different parts of the state.

We held three focus groups. All focus groups were held in October and November. One focus group, the one for potato growers, is still planned. Poor weather conditions have hampered scheduling this meeting.

An update report of the project was presented to funders at the annual retreat. In mid-January, the PI traveled to Cooperstown, NY to present an update of the project thus far.

The survey results in themselves revealed expected declines in stamina and health in this aging farmer cohort. However, the group interview revealed that aging farmers were not just concerned with their bodies but rather with aging out of the economic context of farming as it has changed and become more corporatized.

The PI plans to meet with potato growers for their input. In the meantime, the PI will communicate with the farmers with whom we have already met and set up some times to visit their farming operations. The purpose of the individual farm visits is to "drill down" a bit deeper in possibly identifying issues that the older farmers are facing on their farms.

2019-2020

"Training Techniques for Teaching Ag Safety and Health to a Multigenerational Workforce"
PI: Linda Fetzer and Serap Gorucu
PennState Extension

The goal of the study was to determine the preferred learning styles of the different generations working on the farm. Specific objectives of the proposed research study were to: (1) survey multi-generations of agricultural workers on their preferred learning styles; and (2) determine possible crossovers on preferred learning styles among generations. This study had the long-term goal of using research findings to improve agricultural safety and health training practices.

The study team conducted surveys via web (Qualtrics) and paper, using agricultural trade shows, conferences, meetings, social media, and other agricultural-specific venues to recruit participants. Study participants were asked to rank their preference of six types of safety and health information delivery systems: (1) Electronic (apps, videos, online sources), (2) One-on-one training, (3) Printed materials (books, fact sheets, manuals, etc.), (4) Demonstrations, (5) Observing a co-worker, parents, etc. and (6) Classroom type presentation.

A total of 211 participants responded to the survey, spanning three generations: Baby Boomers, Millennials, and Generation X. Over all, participants preferred demonstrations and one-on-one trainings over information delivery modes. Between generations, significant differences were seen as Baby Boomers were more likely to show preference to printed materials or classroom-style learning than either Millennials or Generation X ($p<0.05$). In addition, Generation X was least likely to indicate preference toward printed materials ($p<0.05$). In terms of frequency of use, electronic methods and observation were most common, while classroom style education was least common. Millennials and Generation X both reported significantly higher use of electronic methods than Baby Boomers ($P<0.05$). Finally, study participants reported that demonstrations were the most effective learning method, though Baby Boomers also reported that print materials were highly effective.

The results of this study highlight the need to focus educational efforts on demonstrations as well as one-on-one instruction across the board. Though true, the study also reveals that print materials could still be valuable in educating Baby Boomers, while electronic materials could be helpful in educating younger generations.

"An air quality baseline assessment onboard commercial fishing vessels in the New England states"
PI: Christian Salmon, D.Sc, MSEM, CPEM, PMP, RMP
Western New England University

The goal of the study was to collect preliminary data related to environmental toxin exposures (i.e. fumes or other aerosol particulates) on fishing vessels in order to inform future research priorities. The initial research plan focused on using gas and particulate matter monitors on vessels, with the bulk of data collection taking place by the study coordinator between March and July 2020. Due to COVID, it was not possible for the PI to travel or accompany fishermen on their vessels in order to collect data.

To address this, the sampling protocol was updated to allow study participants to collect data without the study coordinator present. While some data was collected, not enough data was able to be collected to develop meaningful hypotheses for future research. Despite this, the study team learned more about the sampling protocol and was able to refine this in order to continue with a similar study after COVID restrictions are lifted. In addition, in developing the sampling protocol and beginning participant recruitment, the study team developed a number of new professional relationships.

2020-2021

"COVID-19 Plain Community Activity Booklet"
PI: Kay Moyer
PennState Extension

This research study aimed to increase members of the Plain Community Individual knowledge, awareness, and understanding of how a person is likely exposed to and infected with the new COVID-19 virus. The project included creating and distributing a culturally appropriate educational booklet.

The booklet provides vital information about colds, flu, and COVID virus respiratory infections so that families armed with key medical information could choose preventative behaviors to decrease respiratory illnesses and deaths.

A one-page survey (instead of 2 surveys—pre and post as proposed) was created and provided to key Plain Community contacts, local community agencies, and individuals working with Anabaptist families. It was evident that we were not going to get many surveys back and having only one survey would help us get more returned forms.
Key contact individuals were provided self-addressed stamped envelopes, or surveys were picked up at an agency or home. Home school leaders and other contacts were emailed and called multiple times. But these attempts only received 50 completed surveys.

The COVID-19 pandemic limited opportunities to connect with the Plain Communities at meetings or safety day events. Working at home and not providing face-to-face educational programs limited the chance of getting surveys completed while folks attended my outreach programs. The pandemic forced educators to offer educational programs via virtual social media, which is impossible with the Plain Community. Since March 2020, programs were not provided at one-room schools or home school groups. It is unknown when educational programs will be provided, hopefully this fall.

Although we did not get many surveys back, we did distribute almost all 23,000 books. Booklets were distributed to well over 24 counties in PA with a majority in Lancaster County and in 10 states. The books were provided to Amish, Old Order Mennonites, car driving Mennonites, and other interested individuals or educators.

This research project utilizing a booklet about Covid that could be read by families together and which was talked about at home and in school addressed the need to bring awareness to rural communities who do not view news and other media in electronic versions. The research created new knowledge, led others to act on findings, and promoted practical intervention around Covid-19: how to stay safe, precautions to take, the value of hand washing and the safe use of sanitizer.

2021-2022

“The effect of tread patterns on slip resistance of footwear outsoles based on composite materials in icy conditions”
PI: Shaghayegh Bagheri, PhD, P. Eng.
George Mason University

Falls on icy surfaces are the leading cause of injuries for outdoor workers. Footwear outsole material and geometrical design parameters are the most significant factors affecting slips-and-falls. Recently, composite materials have been incorporated into outsoles to improve traction, yet the best design parameters are not fully understood. This study investigates the effects of four design parameters, including surface area, orientation, edge shape, and plug distribution, each at three levels, on slip-resistance properties using Taguchi orthogonal array design. Twenty-seven outsole prototypes were fabricated using our patented composite material and tested in a simulated winter condition. An analysis of variances (ANOVA) showed that surface area (*p=0.041*, *Contribution= 15.63%*) significantly affected the slip-resistance of our prototypes. The best performance was observed for the maximized surface area covered by composite material with circular and semicircular plugs laid obliquely, mostly in the forefoot area. These findings suggest that some tread design features of composite-based footwear can significantly affect slip-resistance properties.

“Heat Strain Risk Assessment of Field Workers: Integrating Wearable Physiological Sensing and Artificial Intelligence”
PI: Houtan Jebelli, PhD
Penn State University

This study set out to investigate the feasibility of assessing workers' heat stress exposure in advance through the integration and interpretation of sensory data acquired from environmental sensors and non-intrusive wearable biosensors. For this purpose, the study pursued two primary objectives: 1) developing a high-fidelity virtual testbed to simulate common physically demanding tasks in heat-vulnerable occupations safely and realistically to determine the relationships between workers' physiological variables and heat strain and to provide the datasets for training the predictive models, and 2) developing an interpretive data-driven framework for early recognition of workers' heat strain based on their physiological responses. According to the results, the developed immersive virtual environment (IVE) platform to simulate common physically demanding tasks in heat-vulnerable occupations safely had a high level of immersion. Further, the proposed worker-centered heat stress monitoring framework demonstrated a reliable performance for accurately and consistently estimating the likelihood of heat stress exposure.

In this project, there were not any glaring deviations from the logical model. During the course of the project, the logical model accurately represented the project in all its form. However, the progress of the project was impacted by the pandemic. Owing to the resurgence of the pandemic (as a result of the Omicron variant), it became difficult to recruit the subjects to participate in the experimental procedure for data collection. In response to such impediment, the schedule for the experiments (data collection) was revised so that recruiting subjects could be performed in a safe and efficient manner. As a result, it was possible to successfully complete the project, investigating the feasibility of assessing workers' heat stress exposure in advance through the integration and interpretation of sensory data acquired from environmental sensors and non-intrusive wearable biosensors.

The research was well conceived in investigating whether and how the physiologically bodily responses to heat can be leveraged to provide a transformative, individualized, and practical solution that can safeguard

vulnerable workers from the adverse effects of physical activity in hot weather. Numerous workers in field-oriented industries, such as construction, agriculture, forestry, and fishing, struggle with serious work-related injuries and health problems. One of the critical health issues in this context is workers' continuous exposure to heat stress. In such cases, the accumulation of heat in the body can adversely affect workers' overall safety, health, and productivity. Although heat stress is a substantial threat to workers' safety and well-being, the necessary preventive strategies are not adequately implemented at job sites. Such deficiencies motivated us to conceive the research in examining the feasibility of a state-of-the-art predictive framework that innovatively blends artificial intelligence and physiological sensing to determine distinct levels of workers' heat stress exposure according to the physiological and environmental data retrieved from the wearable biosensors as well as environmental sensors.

B.3. Competitive Revisions/Administrative Supplements
N/A

B.4. What opportunities for training and professional development did the project provide?
N/A

B.5. How did you disseminate the results to communities of interest?
As part of the pilot program, award recipients are required to submit manuscripts to peer-reviewed journals, and are strongly encouraged to present findings at various research conferences. In addition, pilot recipients present findings at the annual NEC retreat, which brings together NEC researchers.

In addition to disseminating research findings to collaborators, pilot projects are highlighted in NEC-driven media, including a quarterly newsletter, social media, and the NEC website. Additionally, award recipients are encouraged to disseminate their work through trade publications, events, and other targeted means.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?
N/A

I. PRODUCTS

C.1. Publications, conference papers, and presentations
Publications:

2019-2020

1. Fetzer et al. Agricultural Safety and Health Learning Methods for the Agricultural Workforce. 2020. *Manuscript under review.*
2. Fetzer. Training Methods for Teaching Ag Safety and Health to a Multigenerational Workforce. *Abstract accepted for presentation at the 2021 International Society for Agricultural Safety and Health Conference* (June 2021)

2021-2022

1. Sabrina Islam, Kunal Gide, Tilak Dutta, Z. Shaghayegh Bagheri. The effect of tread patterns on slip resistance of footwear outsoles based on composite materials in icy conditions**.** Journal of Applied Ergonomics. November 2022. *Manuscript under review.*

2. Heat strain research contributed to a Master Thesis titled *"Heat Strain Risk Assessment of Field Workers: Integrating Wearable Sensing and Artificial Intelligence,"* submitted at Penn State by Amit Oja. February 18, 2022.

C.2. Website(s) or other Internet site(s) – include URL(s)
www.nycamh.org
www.necenter.org
www.ifishconference.ca/home/

C.3. Technologies or techniques

2021-2022

"The effect of tread patterns on slip resistance of footwear outsoles based on composite materials in icy conditions"
PI: Shaghayegh Bagheri, PhD, P. Eng.
George Mason University

All of the composite plugs for this research were fabricated using a custom-made mold through plastic injection molding process, followed by abrading with an abrasion tester machine, evaluated via scanning electron microscopy (SEM) for their surface topography and then were utilized to create footwear outsole prototypes.

To fabricate the composite plugs through injection molding process, a house-made cylindrical mold with a diameter of 15.87 mm and a thickness of 38.1 mm was designed and manufactured. These dimensions were chosen to ensure the diameter of the final samples met the size required for the holder of the abrasion tester machine.

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
Survey Instruments
Recruitment Materials
Data Collection Protocols
Study Protocols
Educational Aids/Curricula –
Social Media
COVID-19 Informational Booklet for Plain People

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
		Lucinda Levene		Admin Coordinator	5.3				USA	

D.2 Personnel updates N/A

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable? N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

These aims will serve to expand NEC researcher/partner networks, foster innovation in research translation and improve AFF worker safety attitudes and practices by increasing the translation of research into AFF worksites.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

None

G.2 Responsible Conduct of Research

None

G.3 Mentor's Research Report or Sponsor Comments
None

G.4 Human Subjects

G.4.a Does the project involve human subjects? No

G.4.b Inclusion Enrollment Data N/A

G.4.c ClinicalTrials.gov

N/A
Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
No

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget? Yes

G.11 Program Income
Is program income anticipated during the next budget period?

No

G.12 F&A Costs
Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets. Note: project outcome information will be made public in NIH RePORTER

2017 -2018

"Biologically-active exposures as potential risk factors for respiratory function among farm workers and their children"
PI: Meghan Davis, DVM MPH PhD
Johns Hopkins Center for a Livable Future
Eight participants representing all target farm types - dairy farm, beef (non-dairy) farm, and crop farm - completed sample collection. Two control sites (not farms) in proximity to the farms that were enrolled were also sampled.

Five (63%) of eight participants carried coagulase-positive staphylococci (CPS), with three (100%) of primary adult workers enrolled colonized. CPS isolates were also detected from at least one farm animal on all farms where animals were kept.

To build a foundation toward identification of how biological exposures of dairy origin relate to respiratory and allergic outcomes among farmers, participants were also queried regarding respiratory outcomes and use of personal protective equipment (PPE). Seven of eight participants completed surveys; one participant, who did not work directly with the farm animals, did not complete the survey. Among the participants, one (14%) reported a history of asthma, and one (14%) reported a history of eczema, which can be associated with both *S. aureus* and allergic conditions. Both were adolescent workers. Five (71%) reported a history of rhinitis, with four (57%) reporting rhinitis symptoms in the past year, and two (29%) reported a history of wheeze, with none (0%) reporting wheeze symptoms in the past year.

The above pilot analysis was conducted to seek further funding based on findings. When the COVID-19 pandemic arrived, the team deferred on applying for more funding as it wasn't feasible to do the work under COVID restrictions. Their plan is to try again in 2023.

2018-2019

"Determining the Occupational Health and safety needs of farmers over 60"
PI: Richard Brzozowski, PhD
UMaine Cooperative Extension
The project involved creating succinct farmer surveys for four different types of farmers (dairy, wild blueberry, apple and potato). The team also worked together to develop an agenda for the focus groups. The Principal Investigator (PI) communicated with the respective Extension specialist to identify farmers over the age of 60. The PI followed up and invited a small subset of farmers to focus groups meeting.

The survey results in themselves revealed expected declines in stamina and health in this aging farmer cohort. However, the group interview revealed that aging farmers were not just concerned with their bodies, but rather with aging out of the economic context of farming as it has changed and become more corporatized.

2019-2020

"Training Techniques for Teaching Ag Safety and Health to a Multigenerational Workforce"
PI: Linda Fetzer and Serap Gorucu
PennState Extension
The team collected data through five events and two social media posts. Preliminary results from 165 participants indicate that almost 55% of them had agricultural safety and health training from either extension educators (66%), employers (44%), agricultural teachers (37%), parent/guardian (23%), or machinery dealers (20%). Demonstrations, one-on-one trainings and observations were the three strongly preferred learning methods (51%, 42%, and 39% respectively). The effectiveness of learning methods was rated as very effective for demonstrations (65%), one-on-one trainings (64%), and observations (53%). Electronic learning methods were reported as very effective by 22% of the participants and only 25% of them indicated that they strongly prefer electronic learning methods.

The results of this study highlight the need to focus educational efforts on demonstrations as well as one-on-one instruction across the board. Though true, the study also reveals that print materials could still be valuable in educating Baby Boomers, while electronic materials could be helpful in educating younger generations.

"An air quality baseline assessment onboard commercial fishing vessels in the New England states"
PI: Christian Salmon, D.Sc, MSEM, CPEM, PMP, RMP
Western New England University
The goal of the study was to collect preliminary data related to environmental toxin exposures (i.e. fumes or other aerosol particulates) on fishing vessels in order to inform future research priorities. The initial research plan focused on using gas and particulate matter monitors on vessels, with the bulk of data collection taking place by the study coordinator between March and July 2020. Due to COVID, it was not possible for the PI to travel or accompany fishermen on their vessels in order to collect data.

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Nearly 23,000 booklets were provided to Amish, Old Order Mennonites, car-driving Mennonites, and other interested individuals or educators. The book was intended to be read by families together and talked about at home and in school, addressing the need to bring awareness to rural communities who do not view news and other media in electronic versions. The research created new knowledge, lead others to act on findings, and promoted practical intervention around Covid-19: how to stay safe, precautions to take, the value of hand washing and the safe use of sanitizer. It also shared resources and numbers to call for more information, locations of vaccine administration and what to do if someone became ill.

2021-2022

"*The effect of tread patterns on slip resistance of footwear outsoles based on composite materials in icy conditions*"
PI: Shaghayegh Bagheri, PhD, P. Eng.
George Mason University
Falls on icy surfaces are the leading cause of injuries for outdoor workers. Footwear outsole material and geometrical design parameters are the most significant factors affecting slips-and-falls. Recently, composite materials have been incorporated into outsoles to improve traction, yet the best design parameters are not fully understood. This study investigated the effects of four design parameters, including surface area, orientation, edge shape, and plug distribution, each at three levels, on slip-resistance properties using Taguchi orthogonal array design. Twenty-seven outsole prototypes were fabricated using the team's patented composite material and tested in a simulated winter condition. An analysis of variances (ANOVA) showed that surface area (*p=0.041*, *Contribution= 15.63%*) significantly affected the slip-resistance of prototypes. The best performance was observed for the maximized surface area covered by composite material with circular and semicircular plugs laid obliquely, mostly in the forefoot area. These findings suggest that some tread design features of composite-based footwear can significantly affect slip-resistance properties.

"Heat Strain Risk Assessment of Field Workers: Integrating Wearable Physiological Sensing and Artificial Intelligence"
PI: Houtan Jebelli, PhD
Penn State University
This project incorporated the environmental variables into the interpretation process to improve the prediction accuracy. This novel approach to proactively detecting heat stress exposure addresses the drawbacks in the existing heat stress assessment techniques, such as their sole reliance on environmental parameters to infer workers' heat stress, their intrusive and intermittent nature that impedes their implementations in practice, and their retrospective nature that can reduce the reliability of the responses. By developing an enhanced worker-centered heat strain monitoring framework for consistently and accurately estimating the likelihood of heat strain among field workers, the research successfully addressed the need for a robust heat stress proactive safety monitoring system. This study can open new avenues to a non-intrusive biosensor-based heat strain monitoring system capable of proactively preventing concerning physical health conditions at job sites. In addition, the developed heat strain assessment process holds promise for heat-strain safety management, preventive practices, safety training, and safety planning at job sites. Eventually, such a safety monitoring system can promote the safety and well-being of field workers, especially those actively working in acute hot weather conditions.