NIOSH Close-out Report

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List of Terms and Abbreviations

AB-Advisory Board
AFF-Agriculture, Forestry and Fishing
ANSI-American National Standards Institute
ASABE-American Society of Agricultural and Biological Engineers
ASHCA-Agricultural Safety and Health Council of America
ASTM-American Society for Testing and Materials
BRI-Bassett Research Institute
CEU-Continuing Education Credits
CFD-Computational fluid dynamics
CPR-Cardiopulmonary Resuscitation
DOH-Department of Health
E-codes-external cause of injury codes
ECO-NIOSH Evaluation, Communication and Outreach Group
FARMHAT-Farm/Agriculture/Rural Management – Hazard Analysis Tool
FPSS-Fishing Partnership Support Services
FHI-Family Health International
GOL-Game of Logging
HCUP-Healthcare Cost and Utilization Project
HIV-Human Immunodeficiency Virus
ICD-9/10-International classification of diseases
MIT-Massachusetts Institute of Technology
MSD-Musculoskeletal Disorder
NASS-National Agricultural Statistics Service
NAWHS-National Agricultural Worker Health Survey
NE-Northeast
NEC-Northeast Center
NECSAP-Northeast Center Scientific Advisory Panel
NOAA-National Oceanic and Atmospheric Administration
NORA-National Occupational Research Agenda
NYCAMH-New York Center for Agricultural Medicine and Health
NYS-New York State
PCR-Prehospital Care Report
PTO-Power Take-off
PTSD-Post Traumatic Stress Disorder
RI-Rhode Island
ROPS-Rollover Protective Structures
OSH-Occupational Safety and Health
OSHA-Occupational Safety and Health Administration
UMASS-University of Massachusetts
USCG-United States Coast Guard

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Abstract

In 2010, the Northeast Center for Occupational Health and Safety proposed to address four primary, occupational health and safety aims. These included: 1) Improving Northeast surveillance to better profile occupational injuries and fatalities affecting AFF workers; 2) Improving the health and safety outcomes of vulnerable AFF workers; 3) Moving proven health and safety strategies into AFF worksites; and 4) Reducing the number, rate, and severity of traumatic injuries and deaths in AFF industries. Over the succeeding five years, NEC research, intervention and translation activities have both advanced the field of occupational research and reduced hazardous AFF worksite exposures. More specifically, much has been learned about prominent factors contributing to injuries in the Northeast lobster fishing industry and viable passive surveillance methods for collecting injury data. These studies have led to improved granularity in the definition and description of injury events, a finalized injury keyword search algorithm, and the ability to detect dispersion/trends in events through the use of control charts. Survey data collected quarterly in the lobster fishing study, demonstrates that these fishers experience comparatively low fatality rates, while specific body segments (wrist, hand, shoulder and back injuries) are associated with increased risk for injury as compared to other fishing industry workers.

Technologies and practices for mitigating occupational exposures have also been identified by NEC researchers and include tailored solutions for winch entanglements, improvements in PTO shielding technology and an online tool that to develop safe manure ventilation systems for livestock and dairy farms. In these studies, researchers were able to develop emergency winch shut-offs, tailored to Northeast fishing trawlers, improvements in PTO shield designs and PTO promotional materials and a curriculum for the online manure ventilation design system. NEC investigators have also made considerable progress in the development, improvement and dissemination of tractor stability warning systems. These systems have greatly improved researchers knowledge of alert systems and how these can best alert tractor drivers to potentially dangerous driving conditions. These projects, which have focused on improvements in hazard abatement technology, have benefitted greatly from close ties to manufacturers and industry groups. The expansion of ROPS rebate programs also continues with support from the NEC and National Tractor Safety Coalition members. In addition to these projects, Northeast Center outreach efforts have successfully shared evidence-based technologies and practices with AFF communities and researchers via multiple dissemination platforms. These include peer-reviewed journals, conferences, worker trainings, industry presentations, social media, advisory groups and partner collaborations.

Lastly, NEC pilot study projects have also led to advances in occupational safety and health, as well as improvements in AFF worksites and practices. Over the past five years, nineteen NEC pilot projects were funded. A few examples of pilot projects include: 1) the development of a free smart phone app that can be used by commercial fishing captains to conduct and track USCG fishing vessel drills; 2) the assessment of zoonotic infection risk and infection control practices for dairy workers and 3) the development of a fungal bioreactor to reduce farm worker exposure to pathogens that can be found in bioaerosols.

Section One: Core/Program Summaries

ADMINISTRATIVE AND PLANNING CORE:

The NEC has been a NIOSH-funded health and safety research center since 1993. The Center represents a network of OSH researchers and educators that cover a 12-state region from ME to WV. While researchers and trainers are located in various NE states, the administrative offices are located in Cooperstown, NY, at the New York Center for Agricultural Medicine and Health (NYCAMH). NYCAMH is a division of the Bassett Healthcare Network Research Institute (BRI), which has collaborative ties with Columbia University and conducts research on a wide variety of rural health and population health issues. In addition to linkages to Bassett and Columbia, NYCAMH is one of the NYS Department of Health's (DOH) eight Occupational Health Clinics. This clinical network provides specialized OSH prevention services, healthcare, and support for thousands of NY workers. Participating clinics report to progress to the NY Bureau of Occupational Health and meet quarterly to identify emerging OSH issues.

From 2010-2015, the aims of the Northeast Center Administrative and Planning were to coordinate various research and interventional activities in order to: 1) monitor AFF OSH trends in order to identify priority hazards and populations for research and intervention, as well as AFF OSH emerging issues (Burden); 2) Address identified priority AFF worker health and safety hazards by developing improved safety technology and practices (Need); 3) Increase awareness of existing AFF hazards and evidence-based solutions with AFF populations and stakeholders (Need) and 4) Measure the impact of Center activities on AFF outcomes and the progress of Center projects using project specific logic models, as well as an overall Center logic model (Impact).

Over the past five years, NEC administrative staff, PIs and Center evaluators have worked diligently to facilitate the success of the various NEC projects and cores, while expanding the Centers collaborative connections with industry, advocacy, research and healthcare organizations. Center administrators have also heavily invested in expansion of the Center's promotional activities, with upgrades to the Centers website, an increasing focus on social media promotion, the development of project specific websites, attendance at AFF outreach events and the utilization of stakeholder sponsored promotions.

NEC Management: The NEC is managed by an experienced team: NEC Director Julie Sorensen, PhD, oversees NYCAMH/NEC activities, which includes tracking progress and reporting to NIOSH, NYS DOH, NYS DOL, and Bassett; Deputy Director Erika Scott, PhD, provides assistance with these responsibilities; Center Manager Susan Ackerman, RN, who has worked in this capacity for nearly a decade, provides support with billing, contracts, and reporting activities; BRI Administrative Director Steve Clark coordinates contracting and budgeting activities between the NEC sub-contracted agencies, Bassett Grants Accounting, and NIOSH; and the NEC Evaluation Team and information services specialist Deborah Dalton provide considerable assistance with project tracking, evaluation, and NIOSH reporting.

NEC Advisory Boards: In addition to NEC administrative staff, the Center has a variety of advisory boards (ABs), which serve in different capacities and provide opportunities for academic, industry and worker input. The *NYCAMH AB* consists of representatives from state departments of health and labor, NYS Agriculture and Markets, farm and forestry workers, rural health researchers, and extension agents. The NYCAMH board meets quarterly to monitor Center activities, track progress on Center objectives, identify emerging OSH issues within the forestry and farming sector, and ensure that Center programs are responsive to the needs of business owners and workers. The *NEC Fishing AB* meets annually in New Bedford, MA, and enjoys representation from the National Oceanic and Atmospheric Administration, National Marine Fisheries Management Service, the NIOSH Commercial Fishing Safety Office, Harvard University, UMASS Lowell, FPSS, Tufts University, the US Coast Guard, the MA Lobstermen's Association, the MIT Sea Grant Program, the Marine Policy Center of the Woods Hole Oceanographic Institution, a MA lobster boat captain, and a RI freezer trawler captain. This highly engaged AB interacts regularly by email, phone, and on the NEC FISHSAFE site in between meetings. The NEC Fishing AB oversees NEC fishing research activities,

assists with the identification of emerging issues, and was integrally involved in the development of NEC objectives for the current round of funding. The *NEC Scientific Advisory Panel (NECSAP)* also meets annually and includes representatives from industry, marketing, and academic institutions (UMASS Lowell Total Worker Health Center Director L. Punnett, Nationwide Insurance Professor of Agricultural Safety & Health D. Murphy, FHI360 Director of Social Marketing Research J. Strand, Wake Forest University's Community Engagement Program Director T. Arcury, NYS DOH Bureau of Occupational Health and Injury Prevention Director K. Gelberg, NIOSH Alaska Pacific Office Director J. Lincoln, and HRHCare Director of Migrant Health J. O'Barr). NECSAP ensures the rigor of NEC research and translation of NEC research into the workplace. A new addition is the *NEC Forestry AB*, which will be organized in the coming cycle. This board will direct NEC forestry-related program objectives, identify emerging issues, provide networking opportunities, and ensure that programs are responsive to worker needs. Additionally, individual NEC projects have project ABs composed of industry or worker representatives that track program-specific objectives and activities.

NEC Research, Intervention/Prevention and Education/Translation Projects: In 2010, the Center successfully applied for funding to cover five, project-specific activities. The Research Core included two five year projects, one of which sought to improve and expand agriculture and forestry injury surveillance by combining existing sources of injury data and the other focusing on the capture of injury and exposure data for the Northeast lobster fishing fleet. In the Prevention/Intervention Core, interventional projects focused on directly addressing important hazards identified by NEC surveillance. One of these projects, sought to improve tractor stability technology by developing effective and inexpensive early warning systems, while the second project focused on developing a social marketing intervention to increase PTO shielding on PTO drivelines in NY, a leading source of farm injury in the Northeast. In the Education/Translation Core, researchers working on the NEC manure ventilation project sought to translate the technically dense ASABE standard ASABE/ANSI X607 into a user-friendly, computer application readily accessible to designers and contractors. Additionally, Harvard based NEC researchers sought to develop administrative and engineering controls, to launch a community-based prevention project focusing upon the reduction of winch entanglements in the Northeast fishing fleet.

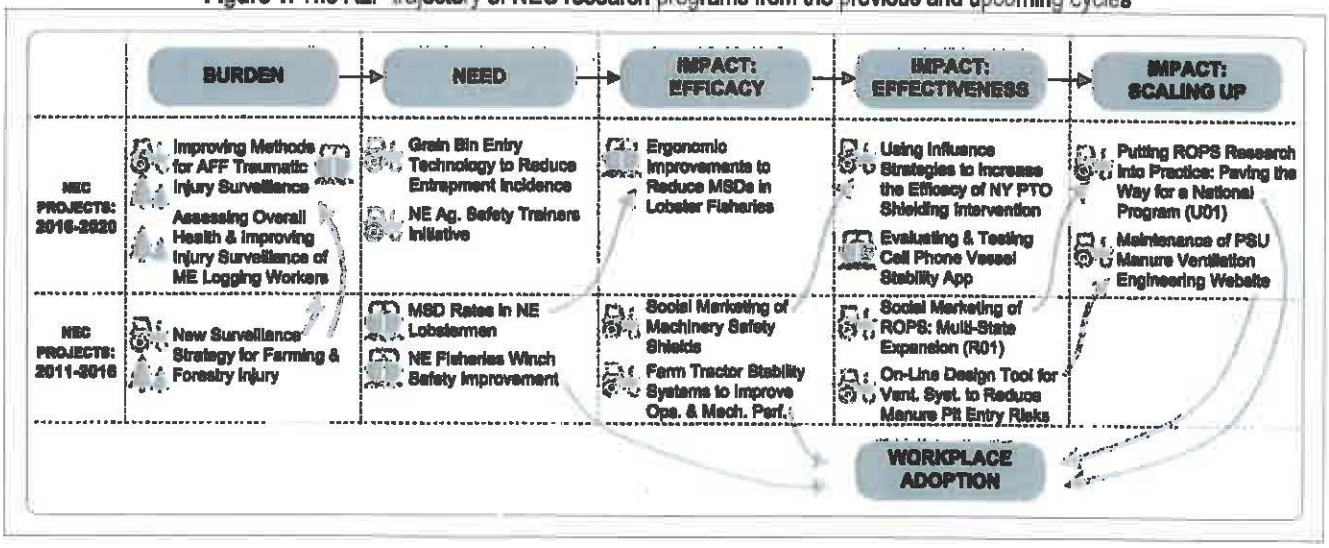
Facilitating the Success of Center Projects: In order to ensure the success of various center projects, the NEC organized an annual gathering of intra- and extramural NEC researchers for a two-day retreat. The retreat offered researchers the opportunity to report project progress and challenges. It also provided the opportunity to get multiple perspectives and to take advantage of useful resources and helpful partnerships. For example, an NEC extramural researcher presented on a study of harmful exposures to toxic emissions onboard commercial fishing vessels at the 2013 NEC retreat. The researcher documented a number of cases where these exposures occurred and indicated his desire to explore next steps in intervention development. Penn State engineers working on the project to mitigate toxic exposures using manure pit ventilation were able to provide numerous suggestions, resources, and opportunities for translating their work on toxic gas exposure mitigation from the farming sector to confined spaces on fishing boats. In addition to networking opportunities, annual retreats included one-day workshops for NEC researchers. In 2015, the NEC offered Center PIs a workshop on conducting cost-benefit analyses of research and intervention projects. NEC research projects have also benefitted considerably from 1) NEC surveillance data, which allows intra- and extramural researchers to identify emerging issues and to measure the impact of NEC interventions; 2) NEC evaluation team activities, which improve tracking NEC research outputs and outcomes, and 3) the Outreach core, which provides immediate opportunities to disseminate safety training best practices through promotional materials, social media, and workshops.

Expanding NEC Collaborative Connections: NEC administrators have also invested considerable time and energy in expanding the Center's connections to other researchers, students, industry groups, advocacy groups and healthcare practitioners. To be specific, collaborations with other NIOSH AFF Center researchers have increased, with NEC staff serving on the NIOSH AFF ECO group, the NIOSH AFF Promotions group, on NORA councils, on ASHCA committees, in OSH and AFF advisory groups and the NASD group. NEC administrators have also encouraged NEC researchers to participate in a variety of conference and educational events, including presentations for Agrisafe workshops and webinars, OSHA committee meetings, Farm Bureau

events and Lobstermen Association meetings. The NEC Director also participates in weekly meetings with the NIOSH Commercial Fishing Safety Office to share data, identify research/intervention priorities, and monitor NEC progress on fishing initiatives. Along with continued collaborations between NEC intra- and extramural researchers, the NEC has fostered relationships with many AFF worker advocacy, industry, governmental, and research groups. The following examples demonstrate how NEC/stakeholder partnerships have advanced NEC goals and objectives. 1) Over the past few years, NEC has built a productive partnership with FPSS, a non-profit organization that supports the health and well-being of New England fishing families. The NEC and FPSS have collaborated on research to assess the utility of hatch and door monitoring systems on NE fishing vessels, identify prominent OSH concerns in focus groups, provide commercial fishing safety trainings, and, most recently, organize a Fishing Industry Summit for Health (FISH), which gathered 60 NE coastal industry, health, governmental, and advocacy organizations to begin work on a NE commercial fishing total worker health program. 2) In 2014, OSHA announced random inspections of large NY dairy farms. To prepare farmers for OSHA inspections, NEC partnered with the NY Department of Labor (DOL) (see DOL E. Franko Letter of Support), the Northeast Dairy Producers Association, Pro-Dairy, Cornell, and NY Farm Bureau to conduct farm safety walkthroughs, develop templates for safety policies/procedures, and provide trainings. Materials were made available on the NEC website, while NEC trainers and staff visited a record number of farms to assist with preparations. Altogether, 39 on-farm consultations, 130 safety trainings in English, 258 safety trainings in Spanish, and 40 presentations were made to agricultural service providers. 3) Discussions and collaboration with the Empire State Forest Products Association facilitated promotion of NEC's GOL courses to NY forestry businesses and workers. Also, the NEC has been partnering with the organizers of Woodsmen's Field Days (46,000 attendees in 2015) and Empire Farm Days (68,000 attendees in 2015) to provide onsite health screening services and provision of personal protective equipment.

Outputs and Outcomes: *Translating Research into Practice (R2P).* As indicated by **Figure 1**, the NEC is committed to translating research into action. NEC has incorporated surveillance into identifying AFF OSH priorities and moved 2010-2015 projects through the R2P spectrum from research to interventions and from intervention development to translation. Dissemination activities were key to these efforts, by promoting technologies and best practices through media, trainings, meetings, and conferences, as well as through NEC partnerships.

Figure 1. The R2P trajectory of NEC research programs from the previous and upcoming cycles



Training. A partnership with the Northeast Dairy Producers Association, Pro-Dairy, Cornell University and NY Farm Bureau led to the development of safety curricula, protocols and train-the-trainer sessions for farm safety managers and trainers. NEC staff also provided safety trainings in both English and Spanish on topics that ranged from animal handling safety to first-aid and CPR. The development of a seven-session, six-hour educational workshop, entitled "An Online Tool for Designing Ventilation Systems to Reduce manure Pit Entry Risk", to assist engineers who are interested in using the online tool. Qualitative data gathered in the NEC / UMASS Lowell lobster fishing surveillance collaboration, indicated lobster fishermen's exasperation over

the lack of ergonomic advice or guidelines provided by their local healthcare providers. Using preliminary data from the study, UMASS researchers conducted a workshop on ergonomics for lobster fishermen at the Maine Fisherman's Forum in 2015. The workshop covered a basic overview of ergonomics, practical advice and equipment revisions that can reduce MSD injuries. NEC pilot project funding has led to the development of a free smart phone app that can be used by commercial fishing captains to conduct and track USCG fishing vessel drills. The app provides a list of drills that are required and allows users to check-off completed drills. Data are time-stamped and can be readily stored and printed to provide documentation of compliance with mandatory drills.

Information Dissemination. The NEC has used multiple platforms and media channels for promotion of services. Some notable efforts include print campaigns in trade publications, online promotions with various social media websites, such as Facebook – begun in 2011, YouTube in 2013, and direct mailings. Earned media opportunities, given in-kind, have been taken advantage of within the local networks in the form of radio and television interviews. NEC has also collaborated with the AFF Centers Evaluation, ECO group to develop cross AFF center dissemination plans and to incorporate some of NEC resources into the NASD website.

Expansion of Evidence-based Programs. Over the past few years, NEC researchers have led efforts to form a national coalition to address tractor overturn injuries. The National Tractor Safety Coalition is populated with representatives from more than 60 organizations representing multiple stakeholder groups, (i.e. manufacturers, advocacy groups, researchers, government organizations and healthcare organizations). The group gathered in Chicago in May of 2014 and outlined three-month and three-year action plans for promoting/enhancing tractor safety in the United States. Task force groups were also created and were charged with moving specific components of these action plans forward in the coming year. The NTSC has overseen the expansion of ROPS Rebate Programs into high-risk states and nationally http://blogs.cdc.gov/niosh-science-blog/2014/08/12/rops2/.3 NEC continues to partner with the NYS legislature in the NY ROPS Rebate Program, leveraging over $800K in the past 5 years for marketing and farmer rebates in this program that has now addressed over 1400 dangerous tractors. Building upon the NEC infrastructure, successful programs are now operating in VT, PA, MA, NH, WI and MN with several others in development.

Technology Development / Worker Adoption. The NEC / Harvard University collaboration to address winch entanglements has led to the development of an active pressure-sensitive winch guard, which can be retrofitted onto most Northeast commercial fishing vessel winch configurations. The device is designed to shut off the winch before individuals operating the equipment are dragged into the device. Three trawler captains in Gloucester and Point Judith have agreed to pilot the device and permit videotaping. The video, which is featured on the project website, can be found at http://www.hsph.harvard.edu/northeastern-winch-safety-improvement-project/. The video will serve to increase awareness and dissemination of the technology among Northeast commercial fishing vessels.

The NEC / Pennsylvania State University Tractor Stability Project has also made noteworthy progress in developing a stability display system (tractor operator interface), that will be used in concert with the tractor stability technology developed in a prior round of NEC research. The technology is designed to alert tractor operators when a side or rear overturn may occur and the information gathered will allow researchers to identify the optimal placement and type of warning alerts. Warning systems are incorporating visual, auditory, and haptic alerts. Ongoing collaborations with tractor manufacturers on the development of this technology will permit easy translation into manufacturing processes and through dealerships. This work has led to further technological innovation to detect human presence around tractors described in the research proposal "Development of Tractor Sensor Technology for the Reduction of Tractor Runovers" (See Research Core).

The NEC PTO Shield Installation program has been likewise successful in increasing use of PTO shields. Researchers conducted over 200 on-farm assessments of PTO driveline implements, 3,211 phone surveys and roughly 30 in-depth interviews with farmers on shielding behaviors. Researchers identified several key barriers to PTO shield adoption, which included difficulty with driveline maintenance when shields were engaged, difficulty finding shields that fit and cost given the lack

of shield durability. Project researchers partnered with PTO shield manufacturers and were able to identify a particular shield design that addressed all of farmers stated concerns with PTO shield usage. Farmers have been very enthusiastic about the PTO shield designs. Since introducing the improved shield through the PPE program in 2011, 32% of farmers have purchased shields on more than one occasion, and 61% have purchased more than one shield. 2014 PTO shields sales increased nearly 4-fold (3.9) over previous years. The next step in translating this research into practice includes increasing worker adoption through the use of special social marketing strategies described in the research proposal "Using Influence Strategies to Increase the Efficacy of the NY PTO Shielding Intervention" included in the Research Core.

Injury Tracking. In the 2010 NEC report, the need to combine multiple data sources to accurately capture agricultural injury and fatality data was identified. In response to this finding, NEC researchers have designed a surveillance system to track farm and forest injury using electronic match-merging of hospital data and pre-hospital care reports (PCR). Keyword search algorithms through narrative free text and location codes are used to subset the databases to injury cases of interest. These methods have been successfully used on data from Maine and New Hampshire. Refinements continue to be made, and additional states are being added to the research effort. This research strategy has now being extended to include forestry (See Research Core: "Forestry Injury and Total Worker Health Surveillance").

NEC Recognitions. NEC/NYCAMH has received considerable recognition over the past 20 years, including coverage in Wall Street Journal and USA Today, recognition as a NIOSH 'High Impact' project, ASABE Publication Awards, an Annals of Epidemiology Paper Award, a NIOSH Evaluation Excellence Award and a NORA Partnering Award for Worker Health and Safety. Deputy Director, Dr. John May was also named the 2015 Journal of Agromedicine "Leader in the Field." Heiberger S. Journal of Agromedicine "Leader in the Field" 2015: John J. May, MD. J Agromedicine. 2015;20(1):1-2.

PILOT FEASIBILITY PROJECTS AND EMERGING ISSUES PROGRAM:

The purpose of the Northeast Center's Feasibility Program has been to offer researchers, educators and safety experts' support for conducting preliminary research on OSH issues, methods or hazard solutions that have the potential to support the Center's mission and expand the OSH AFF knowledge base. In the past funding cycle, Center administrators focused on developing a user-friendly procedure for efficient soliciting, scoring and funding of appropriate proposals; providing sufficient support for investigators to optimize their likelihood of success; tracking project outcomes, translating significant outcomes to health and safety experts and using the funding platform as an opportunity to respond to emerging challenges in the NE region.

Pilot Feasibility and Emerging Issues Program Management: In response to these objectives, NEC administrators followed a proscribed process each year to prioritize and identify relevant pilot proposals for funding. This involved summarizing injury surveillance data to identify crucial hazards and populations in need of intervention, communicating with NEC advisory board members to further distill pilot program priorities and then using this information to craft requests for applications that were circulated via the NEC list-serve (all current & past NEC participants and numerous others interested in agricultural safety and health), several extension list-serves, relevant departments at most major universities in the region, participants in the NE state occupational surveillance group and others. Interested applicants were asked to complete a five page proposal that was modeled after the NIH application structure and to include a budget and biosketch. Each application was initially reviewed by the Center Manager to ensure all documentation had been provided and then proposals were sent to content experts in the NEC network. Proposals were reviewed by 2-3 reviewers and the highest scoring proposals that most closely matched NEC priorities were selected for funding. Funded applicants were asked to provide proof of IRB review and approval and a timeline. Progress on pilot projects over the course of the previous cycle was monitored collectively by the administrative and evaluation team. All applicants were asked to provide a project summary, a detailed plan for next steps (i.e. paper, funding, translation or some combination of these activities), and a final financial report. Pilot applicants were often and frequently took advantage of NEC mentorship and resources such as access to the biostatistics team, the NEC Information Specialist and the Promotions Coordinator.

Outputs and Outcomes: Table 1 provides a detailed list of outputs and outcomes for each of the projects fundedthrough the NEC Pilot Feasibility Program for years 2010-2015.

Table 1				Products						
Investigator	Project Title	Affiliation	AFF Sector	Paper	Pres.	Tools	Prop.*	Data	Article	EM**
NEC Feasibility Projects 2010-2011										
A. Freivalds	Ergonomic design of pruners for women in agriculture	PA State University	FARMING	X		X				
T. Fiske	An Ergonomic intervention to reduce stooped weeding postures	NYCAMH	FARMING		X	X				
K. Moyer	Amish and Mennonite farm safety outreach	PA Cooperative Extension	FARMING		X					X
B. Buchholz	Estimating MA commercial fishing injury rates	University of MA Lowell	FISHING				X	X		
J. Dennerlein	Northeastern trawler winch shut-off intervention project	Harvard University	FISHING				X	X	X	
J. Zhu	Dissemination of logging safety materials and hands-on training	NY Department of Health	FORESTRY		X					X
NEC Feasibility Projects 2011-2012										
T. Fiske	Piloting expanded manufacturing of tractor safety equipment	NYCAMH	FARMING	X				X		
M. Myers	Utilizing Crowdfunding platforms for ROPS funding	University of VT Extension	FARMING		X	X				X
T. Webler	Building a systems understanding of fishing hazards	Social and Environmental Research Institute	FISHING					X		
NEC Feasibility Projects 2012-2013										
P. Rabinowitz	Biosafety practices of Northeast swine workers	Yale University	FARMING					X		
A. Freivalds	Ergonomic design of long handled ag. tools for women	PA State University	FARMING		X	X				
NEC Feasibility Projects 2013-2014										
A. Chimside	Evaluation of a fungal bioreactor to remove E. Coli from manure	University of DE	FARMING		X	X				
C. Salmon	Assessing industrial refrigerant release on fishing vessels	Western New England University	FISHING					X		
NEC Feasibility Projects 2014-2015										
K. Pinto	Exploring hatch monitoring systems for Northeast vessels	Fishing Partnership	FISHING			X		X		
L. McCue-Weil	Refinement of FVdrills safety app	University of VA Tech	FISHING		X	X	X			X
S. Fulmer	Developing improved lobster banding tools	University of MA Lowell	FISHING			X	X	X		

*Funding application **Educational Materials

OUTREACH CORE:

NEC Outreach Program. The key objectives outlined in the 2010-2015 Center Outreach plan included: 1) Provide agricultural health and safety services to the NE farm community, 2) Focus outreach activities to high priority risk areas, and to 3) Pursue OSH collaboration opportunities. Prioritized OSH topic areas included machinery, entanglements, animal handling and OSH related conditions such as respiratory issues and skin cancer.

Despite the significant need to provide OSH services and programs to the AFF workforce, there are very few agencies or organizations that have the expertise or resources to provide direct OSH services, materials and training to AFF workers in the Northeast. In the past decade, land-grant university and Extension funding has declined considerably and many of the programs that still exist, do not have the access to health researchers, clinical professionals, epidemiologists or other healthcare professionals. The NEC Outreach program has addressed this need over the past five years, by providing AFF workers with access to a wide variety of healthcare specialists (physicians, nurses and social workers), industrial hygienists and individuals trained in providing respiratory fit-testing, hearing screenings and occupational health evaluations. In addition to these Outreach activities, a mobile, occupational health unit (N2G) was added to the list of NEC services in 2012, offering worksite health evaluations to AFF populations over the last three years of the grant cycle. Mobile unit health screening services included physicals, hearing testing, respiratory fit-testing, skin cancer screenings and a variety of additional services.

The NEC Outreach program also allows NEC staff to maintain a daily presence on Northeast farms. NEC agricultural trainers spend almost 100% of their work day on farms, providing feedback, training and personal protective equipment to farm workers and documenting farm owner concerns relating to emerging issues or potential improvements to NEC services. Follow-up phone calls to all farmers that utilize NEC services have also provided the NEC with opportunities for service improvement. These efforts have been considerably effective given the positive feedback and success stories the program has documented. Over the course of the five year funding cycle, customer feedback identified the need for additional Outreach services, included on-far, CPR and first aid training (in English and Spanish); access to discounted personal protective equipment, which was sold at farm shows, online or by phone and the development of protocols and farm-safety, walk-throughs to assist NY dairy farms preparing for random OSHA inspections. Game of Logging (GOL) trainings were also added to the list of NEC services towards the end of the five year funding cycle. GOL provides similar hands-on safety training opportunities for logging workers and farmers with woodlots, and the curriculum is widely acknowledged as one of the best safety and productivity programs in the country. In addition to worksite and hands-on trainings, the NEC has been a visible presence at many community outreach events. These include the NY Farm Show, the PA Agricultural Progress Days, the NH Farm and Forest Expo, the MA NOFA Conference, Woodsman's Field Days in NY, and the Northeastern Forest Products Equipment Expo in ME.

The reach and responsiveness of NEC Outreach Program services is greatly expanded by our network of stakeholders and partners who have played a crucial role in dissemination activities. NEC stakeholders / partners represent industries in all three sectors (agriculture, forestry and fishing) and include: local trainers (in ME, NH, MA, MD, DE and PA), extension educators (UVM Extension, Cornell Extension, Penn State Extension, University of ME Cooperative Extension), Sea Grant programs, (MIT and University of RI), insurance companies (Agri-services Agency, Farm Family, Nationwide, the commercial fishing's Point Club), Future Farmers of America, advocacy groups (Farm Bureau, Northeast Dairy Producers Association [NEDPA], MA and ME Lobstermen Associations, Empire State Forest Products Association), manufacturer collaborations (BareCo, Femco, John Deere, Northeastern supply) and migrant farmworker clinics. These collaborations facilitate the dissemination of OSH materials and technologies in worker communities, such as the circulation of fliers on PTO shields or information on ROPS programs frequently provided by Farm Family, Agri-services Agency and Nationwide agents. Partners also participate in train-the-trainer courses or utilize training curriculum for their customers.

Outputs and Outcomes. Table 2, provides an overall summary of the various Outputs and Outcomes for years 2010 to 1015. By leveraging resources from partners and state agencies to expand the type and number of services that could be provided to AFF workers, the NEC was able to offer training for farmworkers in both English and Spanish, covering a number of prevention issues such as, confined space, animal handling, skid-steer operation, PTO safety and pesticide safety.

Table 2: Number of Outreach Services provided by NEC from 2011 to present

	Total	Agriculture	Forestry	Fishing
Worksite Inspections	267	267	-	-
Trainings-English	312	249	66	7
Trainings-Spanish	136	136	-	-
First Aid / CPR Training	227	227	-	-
Outreach Events	334	334	-	-
Youth Training	232	232	-	-
Skin Cancer screening	310	278	31	1
Hearing Screening	7	7	-	-
Respiratory Fit-testing	44	44	-	-
N2G Events	15	14	1	-
Articles	25	19	-	6
Website hits	92,714	92,571	52	91
Social Media-Facebook, Wikipedia, NIOSH Ag Centers YouTube Channel	117	96	20	1

In addition to this overview of Outreach activities over the past five years, the following section provides a more detailed description of several community outreach events and collaborations that have been provided to AFF communities over the past five years:

Farm Disaster Assistance Collaboration. In September of 2012, Tropical Storms Irene and Lee struck the Central NY region, causing severe flooding and leaving a wide swath of damage in rural upstate communities. Many farms were severely impacted by flooding damage, losing crops, animals and farm structures. A number of farms could not receive emergency assistance, as roads were either washed away or under water. To assist these farms, the NEC immediately began working with the NY Farm Bureau, Cornell's Farm Net and the NYS Dept. of Health to provide a variety of urgently needed services and materials. These services were provided free of charge and included: financial and mental health counseling, assistance with identifying aid or various non-farm services, personal protective equipment, farm safety audits to identify hazards created by flooding conditions, tetanus shots and drinking water / well testing.

Virginia Tech / NEC Collaboration – Developing an Online Networking Site for Commercial Fishing Safety Researchers. In the spring of 2013, NEC researchers organized a research retreat for Northeast commercial fishing safety researchers in Baltimore, MD to discuss commercial fishing safety priorities (which were presented by Jennifer Lincoln, Director of the NIOSH Commercial Fishing Safety Office), as well as solutions and existing gaps in fishing safety research. At the retreat, researchers from prominent Northeastern universities (Harvard, Drexel, Hopkins) and NOAA discussed their interest in ongoing opportunities for collaboration and discussion of regional commercial fishing safety issues. In collaboration with a commercial fishing safety researcher from Virginia Tech, an online collaboration site called FISHSAFE was developed, which allowed participants to post information, resources and other documents, as well as commercial fishing safety alerts and event notifications.

Cooperative Extension / NEC Collaboration-Developing a Farm Disaster Preparedness Curriculum. In 2014, NYCAMH partnered with Cooperative Extension Agent Jim Ochterski to develop a disaster-training curriculum for trainers to conduct workshops with NY farms on disaster-preparedness. The curriculum discusses proactive steps that can be taken to reduce storm damage and ways to cope with power outages, maintenance of farm operations, prevention of fires or structural collapse of farm buildings, ways to monitor livestock biosecurity and safety tips for transporting farm equipment on public roadways. A training course that utilizes this curriculum was offered in the fall of 2015 to local farmers.

NEC / Harvard Total Worker Health / Fishing Partnership Support Services Collaboration – Creating a Commercial Fishing Total Worker Health Program. In October of 2015, researchers from NEC, Harvard, and Fishing Partnership organized a systems mobilization workshop to leverage the resources and interest from 60 coastal community organizations in the development of a worker health program that is tailored to the needs of commercial fishermen in MA and ME. Data from Fishing Partnership indicates commercial fishermen have elevated rates of diabetes, smoking, HIV, Hepatitis-C, PTSD and depression, as compared to the general population, but lack easy access to healthcare resources. Utilizing the skills, experience and resources of the coastal organizations attending (i.e. healthcare, substance abuse, government groups, fishermen, advocacy groups), attendees outlined a strategy for implementing a tailored health program in 2-3 years.

RESEARCH CORE:

Research Core Program Description and Associated Activities: The two primary Center Research Core projects included 1) a proposal to improve and expand injury surveillance in the Northeast using data from passive and existing surveillance systems and 2) a proposal to address current gaps in NIOSH commercial fishing injury surveillance data relative to the lobster fishing fleet in the Northeast. These research activities were identified as a vitally important step to characterizing injury trends, identifying intervention priorities and informing/evaluating Center efforts. These projects were also of critical importance nationally, given the elimination of NIOSH intramural surveillance programs, such as NAWHS and gaps in intramural surveillance, such as the Northeast lobster fleet which largely fishes inshore and as such are less likely to be monitored by the USCG. Additionally, existing workplace injury reporting systems are incomplete for agricultural, given the fact that farms with less than eleven employees are exempt from OSHA. Both projects were considerably productive over the five year cycle and an overview of each projects' objectives, activities, outputs and outcomes are provided below:

The New Surveillance Strategy for Farming and Forestry Injury Project. In order to ensure the comprehensive collection of farming and forestry injury data, surveillance researchers have been comparing and contrasting data from multiple passive and existing injury surveillance sources in six Northeastern States (NY, VT, NH, ME, NJ, and MD). Data sources include the following:

1) EMS Pre Hospital Care (PCR) reports
2) Death Certificate registries
3) Electronic Newspaper surveillance
4) Electronic hospital inpatient and emergency department data

The goal of the project has been to see the extent to which various data sources successfully capture farm and forestry injury data. Using data agreements that have been coordinated with various state entities, project staff use free-text and location codes from PCRs, along with ICD-9-CM external cause of injury codes (E-codes) from hospital data, to identify and track farm and logging work-related injuries. Data from these passive surveillance sources in ME and NH have been coded over the past few years using the Occupational Injury and Illness Classification System (OIICS). Project staff use a combination of free text review and ICD-9 and ICD-10 codes to determine if injuries occurred at agricultural or forestry worksites. Over the past five years, 1,593 agricultural and logging injury events were identified in ME and NH. Project researchers have also discovered that multiple data sources are necessary to capture injury data, as none of these data systems captures most work-related injuries in the agricultural and forestry industries. In other Northeastern states the process of securing injury data is still underway, with the

recent acquisition of datasets from CT. Project researchers have also succeeded in improving definitions and descriptions of events, algorithms for keyword searches, event trends, episode of care summaries and payor information.

Surveillance Research Results. Data from the most complete NEC surveillance datasets in ME and NH, demonstrate that the average age of individuals injured on farms is 42 for agriculture, while in logging the average age of injured workers is 45. Forty-three percent of individuals injured on farms are women, while in logging, the majority of injury victims were male. The primary injury sources on farms were machinery and animals (which account for most farm-related injuries among females). Mapping of agricultural injuries indicates that many occur in southern New Hampshire and south central Maine. Injury rates in both industries tended to increase in the summer months. The primary sources of injury in the logging sector were identified as trees, heavy equipment, and chainsaws.

Outputs and Outcomes. Over the course of the five year funding cycle, surveillance researchers have gathered injury data from multiple data sets in ME, NH, NY, CT, NJ (death data), MD (HCUP) and NJ (HCUP). Data from ME and NH has been case-matched between EMS and hospital data. Researchers are also completing sensitivity, specificity and positive predictive assessments of the farm location check-box and the identification of common cases between various data sources.

Musculoskeletal Disorder Rates in Northeast Lobster Fishermen. This NEC fishing research project sought to bridge a gap in national commercial fishing surveillance efforts by tracking the morbidity and mortality among lobster fishermen, an important group in the Northeast fishing industry. Data from the project would be a vital component of expanding the excellent surveillance data that is provided by the NIOSH Center for Maritime Health and Safety Studies. This NIOSH intramural office uses data from the USCG and NOAA, however, the lobster fishery is unique as it primarily state regulated. As a result, estimates of total occupational exposures in lobster fisheries have not traditionally been available as they are in other fisheries sectors.

In order to calculate work exposure, researchers gathered data that would allow them to develop specific estimates of work hours for lobster fishers. Injury data was also collected in quarterly surveys that incorporated questions from the Nordic questionnaire. These survey questions were included to permit researchers to measure musculoskeletal injury prevalence rates. Researchers were also able to pinpoint specific body segments that commonly sustain repetitive use injuries. Survey data was collected over the phone on a quarterly basis for several years from a cohort of 274 lobster boat captains. In addition to surveys, project researchers conducted in-person interviews on an annual basis with captains and crew members participating in the quarterly surveys (n=271 captains and 124 stemmen). Interviews focused on capturing information on physical pain that could point to non-acute injuries and factors contributing to injuries.

Lobster Fishing Surveillance Results. Analysis of project industry data indicates that although lobster fishermen have a relatively low fatality rate, as compared to other fishing sectors, they have an increased risk of injuries to wrists, hand, shoulder and back. Fatality rates were derived for the lobster fishing fleet and were estimated to be 24.8/100,000 FTE. The incidence rate for injuries was estimated to be 51.0 per 100 FTE. Forty-three percent of low-back injuries affected fishermen's ability to work, while only two subjects who reported back pain actually received treatment. For subjects reporting wrist or hand injuries, 38% indicated the injury impacted their ability to work. Most of the fishermen reporting hand or wrist injuries received treatment.

Outputs and Outcomes. Project outputs include estimates of lobster fishing FTEs for both ME and MA, injury trends for lobster fishermen in both states and information on factors contributing to lobster fishing injuries. Overall injuries to wrists and hands, usually involving cuts were identified as potential priorities for intervention, as well as lower back pain. Two peer-reviewed manuscripts have been published: one on the FTE and acute injury data collected in the first half of the study and one on the chronic musculoskeletal pain. A third manuscript is currently in preparation on the FTE and acute injury data for the entire four years of the study. The mid-point study results were disseminated to the cohort participants, and to the public at the Maine Fisherman's Forum in 2015 and 2016, the Massachusetts Lobstermen's Annual Meeting in 2017, Preventing Musculoskeletal Disorders Conference, 2016, and the Massachusetts Intercampus Marine Science Symposium, 2016.

Additional outcomes of the research include spin-off research, such as biomechanical evaluation of lobster equipment redesign. One intervention idea to reduce exposure to hand/wrist pain was the subject of a feasibility study. A biomechanical evaluation of a foot operated lobster banding tool was conducted and data were collected on the changes in muscle activity and posture angles corresponding to use of these tools. Results indicated that there were no statistical differences between the usage of the foot-activated tool and the traditional tool and lobstermen were much slower with the foot-operated tool. Qualitative data indicated that the lobstermen preferred the traditional tool.

PREVENTION/ INTERVENTION CORE: Projects that were featured in the NEC prevention and intervention core focused on the development or improvement of hazard control technology for two of the primary sources of injury and death in the Northeast, i.e. tractor overturns and PTO driveline entanglements. Although, rollover protective structures have been typically identified as a solution to the prevention of tractor overturn injuries and fatalities, researchers from Pennsylvania State University sought to develop a cheaper and easier solution that would alert the tractor operator before the overturn occurs, thus preventing damage to the tractor, as well. For the PTO project, intervention development project staff focused efforts on identifying the barriers and motivators for utilizing PTO driveline shields, which are commercially available but rarely utilized. As with NEC research projects, the NEC's prevention/prevention projects had the potential to not only address the most frequent cause of morbidity and mortality in the Northeast, but also nationally, as these events account for a disproportionate number of farm-related injury events nationally. While the tractor stability project focused primarily on technology development, the PTO project sought to increase farmer's interest in utilizing existing, effective technology.

Farm Tractor Stability Systems. As discussed in myriad publications focusing on injury and fatality trends in the agricultural industry, the leading cause of work-related death on farms is tractor overturns. ROPS or rollover protective structures are commercially available and can protect the tractor operator in the event of an overturn, however, many tractors do not have them and installing them retroactively can be costly and time-consuming. As a result, NEC researchers from Pennsylvania State University proposed to develop new hazard control technology that concentrates on early warning systems that can alert the farmer and prevent rollovers from happening.

In an important component of developing rollover early warning systems for tractor operators, is investigating what type of early warning system is most reliable. To examine this question, project researchers looked at the human factors and engineering issues that would need to be resolved to develop this type of technology. To explore these issues, project researchers built a farm tractor simulator with a 6-axis motion base, a 360 degree visual display, and an 8000 series John Deere tractor cab. The simulator was also enhanced to provide a seventh axis of motion, to more realistically and accurately capture rollover scenarios. Using this tractor cab simulator, 20 subjects were asked to reproduce various tilt angles in order to access tilt angle perception. In addition to this work, subjects were videotaped driving tractors on their farms in order to assess their primary areas of focus, such as in back of the tractor, to the side, in front or high or low. Using this information, project researchers were able to identify the most appropriate location for installing early warning systems. Tests were also conducted to evaluate the effectiveness of various alert cues. These tests led to the development of a sensor that uses a low-cost inertial measurement unit that can estimate the roll and pitch angles of the cabin, and represent these on a bubble display. Additional cues such as a buzzer or steering wheel vibration were tested in combination with the bubble display.

Tractor Stability Intervention Development Results. Tractor simulator and field research data indicate that subjects typically under-produced the extent of the roll angle by 8% (with a standard deviation of 4º-5 º). There was no statistically significant correlation between pitch angles and the subject's estimates of roll angles or experienced and inexperienced drivers.

<u>Outputs and Outcomes.</u> Study outputs include an increased understanding of roll and pitch perception, an increased understanding of tractor operator human factors and the development of hazard control technology that provides an early alert system that has the potential to prevent side and rear overturns. Presentations have also been presented at IEEE and ASABE, and paper on the project has been published in JASH. Other products include open source software, a tractor driving simulator,

a $100 tilt detector and a partnership with Volvo research and development. Outcomes, original equipment manufacturer buy-in will lead to equipment translation, cost-savings and a drop in injuries and fatalities.

Social Marketing of Machinery Safety Shields. Driveline entanglement events are primary source of injury and fatality on U.S. farms and, in particular, the Northeast. Injury data from two Northeastern states, NY and PA demonstrate machinery entanglement fatalities are among the top three sources of farm-related fatality. As with other farm hazards, protective technology exists, however many farmers have not proactively utilized this technology which increases the potential for worker injury and death when working around these dangerous devices. The primary goal of this project was to encourage farmers to replace missing or broken Power-take off (PTO) shielding on PTO drivelines, thus reducing the potential for worker death or injury.

Since the prevention/intervention challenge involved the need to address motivational barriers vs. knowledge barriers, project researchers chose to use social marketing as the interventional framework. This approach worked well to increase farmers' interest in installing ROPS in NY. Project activities included, a telephone survey to establish current rates of PTO shielding behavior, interviews to identify farmers' barriers and motivators to installing shields, discussions with PTO driveline manufacturers to address design issues, focus groups to develop tailored promotional messages and the launch of a social marketing campaign highly informed by project research.

Machinery Safety Shield Intervention Results. Data from the PTO driveline phone survey, conducted in year one, indicated that 90.2% of PTO drivelines in New York are adequately shielded. This data was presented to the project advisory board, largely made up of farmers and equipment dealers. The advisory board was very skeptical about the accuracy of these results and urged us to confirm the proportion of adequately shielded PTO drivelines using on-farm audits. Over the course of several months, 211 on-farm audits were completed and 1,470 implements were examined. The audits confirmed the advisory board suspicion that phone surveys were inaccurate, finding only 57% of PTO drivelines were adequately shielded. Farmer interviews identified a number of barriers to PTO driveline shielding, most of which included concerns with PTO driveline shield design. As stated by farmers, driveline shields are difficult to find and install. They often break and make driveline maintenance difficult and as a result, the shields are removed. These issues were reviewed with driveline shield manufacturers and one company, in particular, was very eager to address these design flaws. These PTO shields were then trialed on NY farms with very favorable results. Interview data also led to the development of a variety of tailored driveline shielding promotional messages that highlighted the emotional impact and logistical difficulty of farming without limbs.

Despite the success in the intervention development phase, the final evaluation of the social marketing campaign was disappointing. PTO driveline shielding sales were not significantly increased in intervention counties. One of the key explanations identified, was that farmers have a long-standing, negative history with PTO shields based on past interactions with these devices. As a result, researchers recommend using persuasion techniques to enhance PTO driveline social marketing campaigns.

Outputs and Outcomes. Primary project outputs and outcomes include the establishment of a professional PTO shielding advisory board; assessment of the accuracy of telephone surveys vs. on-farm audits for determining shielding rates; pictures of nearly 1500 driveline shields in situ on NY farms; characterization of key barriers and motivators to PTO driveline shielding, the development of a user-friendly PTO driveline shield developed by industry partners and which has been field-tested to ensure farmer approval; social marketing messages that have been tailored to highlight farmers key shielding motivators and tested via focus group discussions.

EDUCATION/TRANSLATION CORE: Both of the NEC projects featured in the Education/Translation Core over the 2010-2015 were focused on translating evidence-based research or practices into various AFF populations. One project, was a continuation of a previous Center grant that concentrated on developing engineering specifications that would reduce worker exposures to hazardous fumes typically found in manure storage facilities. These specifications were translated into an ASABE

standard, however, project researchers recognized the need to develop an educational program that would facilitate the custom design of ventilation systems that reduce worker exposures to toxic gases in confined-space manure storage pits. As a result, in the 2010-2015 cycle, project staff proposed to develop a web-based, computer simulation program that would help designers develop improved and customized ventilation systems. The goal of the second NEC education/Translation Core project has been to work with fishermen in the Northeast fleet to identify hazard reduction practices currently being used by Northeast fishermen, with a particular focus on practices that reduce exposures to winch entanglements and to share disseminate these practices to others in the Northeast fishing fleet. Both projects address prominent sources of fatality and injury in the fishing and farming community. To be specific, improper manure gas ventilation typically involves multiple deaths when these events occur, as rescuers often rush in to help the initial victim, becoming overwhelmed with toxic gases themselves. For deck winch entanglements, comparisons by region indicate the highest number of entanglement deaths occurred in the Northeast from 2000-2009.

On-Line Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk. The prominent aims of this proposal involved developing and testing an online, web-based computer simulation program that would allow developers to design customized ventilation systems that would fit a range of manure storage configurations. After alpha and beta-testing, the computer simulation program, project engineers would then disseminate the simulation program widely in training courses that would be developed for engineers and agricultural facilities planners. To encourage this dissemination opportunity, researchers also sought to revise the International engineering standard, ANSI/ASABE S607, Ventilating Manure Storages to Reduce Entry Risk, to specify the inclusion of the on-line, web-based design tool.

In the initial phase of project research, engineering staff selected SolidWorks as the framework for the online, web-based computer simulation model. Following the development of the online platform, the program was validated by comparing SolidWork confined space simulation evacuation and oxygen replenishment times with PHOENICS. Pre-processing packages and output interpretation were also developed, tested and improved. Preliminary versions were than alpha and beta-tested with engineers and agricultural facilities planners. Following the launch of the online computer simulation model, researchers developed a curriculum to familiarize planners with the online tool. Trainings were offered primarily as webinars or key venues, with participants earning CEUs to increase participation interest. The tool was also widely marketed in trade journals, mailings and key websites. Evaluation of key performance indicators was ongoing.

Online Manure Ventilation Tool Translation Results. Several versions of the tool were launched over the five year time period, with each building on assessment and feedback from previous iterations of the tool. The current version included modules for stand alone, solid-covered tanks, slotted-covered tanks beneath tunnel ventilated barns, slotted-covered tanks beneath naturally ventilated barns, and slotted-covered tanks beneath cross ventilated barns. Many additional improvements in the online tool were incorporated following initial tests, such as improved presentation of animated cut-plot animations; the addition of multiple pump-out annexes with pit fans attached and a feature that allows for variation in the direction of ipit fan ventilation aire into the tank in both the vertical and horizontal planes. The development of a six session, five hour workshop was completed with multiple presentation formats, such as a live workshop, webinar, or an independent on-line tutorial. The session includes a combination of lecture sessions and participant interactive sessions. Researchers also examined zones of unacceptable contaminant gas concentrations in ventilated barns above a slotted-covered manure tank to identify a manure pit ventilation rate that effectively removes contaminant gases from the tank.

<u>Outputs and Outcomes.</u> Project outputs and outcomes include the revision and renewal of engineering standard, ANSI/ASABE S607 for another 5 years; an on-line tool for design professionals, planners, and regulators to evaluate the effectiveness of manure pit ventilation systems in removing contaminant gases and replenishing oxygen in manure tanks and thereby reduce entry risk https:www.ventdesign.agsafety.psu.edu; a user's manual resource that provides guidance to both new and experienced on-line tool users; a teaching curriculum that can be offered in multiple formats to facilitate broader introduction and adoption of the on-line tool by designers, planners, and regulators; a seven session online tool workshop presented live at the ASABE International Meeting in New Orleans, Louisiana in July, 2015. The workshop was recorded, closed captioned, and

uploaded onto you-tube; publication of "Online Design Aid for Evaluating Effectiveness of Manure Pit Ventilation Systems to Reduce Entry Risk", in Frontiers in Public Health in May, 2016; a one-hour webinar, which is a condensed version of the workshop titled "*Online Tool for Designing Manure Pit Ventilation Systems to Reduce Entry Risk*" was presented nationally to the Natural Resource Conservation Service (NRCS) on May 24, 2016; a news release and article that was picked up and appeared in *Popular Mechanics* magazine.

Northeast Fisheries Winch Safety Improvement Project. The objectives of this Education/Translation Core study were to identify safety practices that had been organically developed by fishing boat captains so they could be disseminated to the other fishers and to develop hazard control technology that reduces the occurrence of winch entanglements in the Northeast fleet. To accomplish these objectives, project researchers conducted an initial survey with Northeast fishermen to describe common winch configurations and safety practices in the Northeast fishing industry. Forty-five captains completed surveys, primarily in the ports of Gloucester and New Bedford in Massachusetts, and Point Judith in Rhode Island (ranked #22, #1 and #20 respectively among US ports for value of landings in 2015). Working with a local fabricator, project staff developed schematics of hydraulic level winders and an emergency crashbar and conducted focus groups with fishermen to get their feedback on the designs. Data from focus groups were used to select the most popular design (the emergency crash bar) and these were installed and tested successfully on Northeast vessels.

Winch Safety Translation Results. Results from the initial survey indicated 100% of participating captains had deck winches on their boats that were hydraulically powered. Roughly 90% of survey respondents reported having a PTO (shut–off switch) on board, however, 39% of these respondents also reported that shut-off switches were more than one arm's length away from the winch operator, prohibiting timely winch shut-down in the event of an entanglement. Results from the survey also demonstrated that the hazardous manual technique for level winding of net cables on the drum winch, found on 39% of the boats, is only used on boats with main-deck winch placement. Since the overwhelming majority of captains do not employ hydraulic level winders on their vessels, the hydraulic level wind option was eliminated as an entanglement solution.

Focus group feedback offered further clarification of the most feasible entanglement prevention options on Northeast vessels. According to participants, hydraulic level winders could offer workload efficiencies, however they felt the cost-benefit ratio would not be favorable. Participants see the emergency crashbar could provide a cost effective solution to entanglements and would be easy to retrofit on boats with various deck configurations. Rhode Island Engine design was then contracted to develop and install a full-scale prototype of the crashbar device, essentially known as an active pressure sensitive winch guard, on the fishing trawler, F/V Lightening Bay, homeported in Point Judith, Rhode Island. The sea trial of this installation, led to the development of a video about the crashbar which is available at https://vimeo.com/154893452.

The sea trial of the Active Pressure Sensitive Winch Guard worked successfully, stopping the drum winch rotation when activated by a push or slam in milliseconds. The reset and counterbalance valve designed into the device by the fabricator also worked as intended and permitted slow reversal of the winch to facilitate the extrication process. In March and April of 2016 the project team showcased the video of the APS Winch Guard shut-off device at the Fishermen's Forum on Rockport, Maine, March 4, 5, 2016 and at the Commercial Marine Expo in New Bedford, MA on April 27, and 28. The APS Winch Guard was also described in detail and illustrated in the March 2016 issue of National Fisherman in the section titled Boats & Gear: Trawl Technology.

Outputs and Outcomes. An Active Pressure Sensitive Winch Guard has been designed, fabricated and successfully tested in a sea trial on the F/V Lightening Bay in Point Judith, RI; an information video has been developed https://vimeo.com/154893452 and is featured on the project website. Video displays and discussion of APS Winch Guard at Fishermen's Forum (ME) March 2016 and Commercial Marine Expo (MA) April 2016; Promotion of the winch guard device in 2017 Skipper's Logbook published by Navigator magazine.

EVALUATION CORE:

Description of Evaluation Core. BEST used a variety of evaluation techniques including logic models, timelines, social network analysis, cost analysis, and data visualization to conduct our evaluations and present findings to stakeholders. Maintaining clear logic models for the NEC and individual R01 projects and tracking the progress of all Center projects (outputs, impacts, and progress relative to project timelines) was a quarterly activity. We conducted quarterly evaluations of the six scientific projects conducted in association with Harvard, UMASS Lowell and Penn State. The evaluation team regularly reviews the definition of outputs, outcomes and R2P with investigators. Each quarterly data collection included questions related to each project's contact with NEC and gathered through direct contact with project investigators. All projects reported significant contact with NEC administration and the evaluation team in each quarter. In addition, the evaluation team participated in the AFF Center wide ECO Group collaboration. We have actively collaborated with the ECO group to promote greater understanding of and increased emphasis on outputs, outcomes and R2P including cost analysis.

Listing of outputs and outcomes associated with the NEC Evaluation Core in 2011 – 2015:

1) Constructed logic models for all the NEC Scientific Projects in order to monitor and document the short, intermediate and five year outcomes of the NEC and its projects.

2) Monitored progress towards stated outcomes for each scientific project using its logic model and adherence to project timeline, direct observation, surveys and case studies. Project PIs were emailed survey questions and were asked to respond within two weeks. One investigator commented that "the quarterly reports have encouraged periodic evaluation of progress and rethinking of methods for achieving what we set out to do". Quarterly reports also included publication advice and suggestions as to where to publish AFF results.

3) Structured evaluation methods for all NEC Outreach efforts and programs. End user evaluation results of the training program "Game of Logging" (GOL) have been used to improve the training for the coming year. The Local Emphasis Program (LEP) evaluation on Dairy Farms is in process (see Outreach). Data collection and analysis are underway. A publication is planned. Participating farmers will receive results of this study. Several scientific projects gather data from target audiences and will use it to tailor interventions (See Progress Report).

4) Identified barriers to tackling AFF in NE that include lack of data, lack of funding, funding uncertainty, problems demonstrating effectiveness and impact in one 5 year cycle, building collaborations over short time frames, conflict between research and industry culture, norms and realities, challenges accommodating to target community culture (subject access and retention), limitations in low income population, lack of understanding of risk, too many hazards, too few agents of change, high turnover, need for interdisciplinary teams, pros and cons of government regulations, need for cost benefit analysis, and determining the cost of implementing safety changes.

5) Provided updates to scientific project PIs, the NEC administration and the Scientific Advisory Panel on all evaluation results and providing relevant recommendations for keeping projects and efforts on track.

6) Conducted economic analyses planning, such as the cost-analysis of the impact of the NY OSHA Local Emphasis Program. This analysis led to a publication that appeared in AJIM titled "Impact of Preparing for OSHA Local Emphasis Program Inspections of New York Dairy Farms: Case Studies and Financial Cost Analysis". (Gadomski AM, Vargha M, Tallman N, Scribani MB, Kelsey TW. Am J Ind Med. 2016 Mar;59(3):245-55. doi: 10.1002/ajim.22546. Epub 2015 Nov 25. PMID:26603133.) We found that "Overall, the impact of OSHA inspections was positive, leading to improved safety management and physical changes on the farm and worker trainings, although the farmers' perspectives about OSHA inspection were mixed. The cost of compliance was low relative to estimated overall production costs...". On May 13, 2015, BEST also organized a workshop that featured a hands-on presentation on cost-effectiveness analysis/cost-benefit analysis by Tim Kelsey, Professor of Agricultural Economics, Pennsylvania State University.

7) Contributed substantially to a collaborative AFF center-wide infographic highlighting impacts of the centers for distribution to stakeholders, including state and national legislators.

8) Contributed substantially to the first extramural AFF center NIOSH-published Program Performance One-Pager (PPOP) for the NEC.

9) Evaluated the NEC's annual meetings of scientific and feasibility project investigators. In 2014, the NEC annual meeting was held on September 24-25, in Saratoga Springs, NY. Researchers from each of the six funded scientific projects and six of the feasibility projects were in attendance. Attendees presented their projects at a poster session on the evening of 9/24/14, and as brief oral presentations on 9/25/14. Poster presentations are a helpful adjunct to annual meetings as they promote discussion and networking among the investigators. The oral presentation format was limited to five slides which served to summarize project activities, publications, outputs, outcomes and next steps for translating AFF research into practice (R2P). The R2P topic stimulated considerable discussion after each presentation and was very helpful for exploring R2P challenges.

10) Measured collaboration and relationships between and among center staff/administration and extramural partners via social network analysis (SNA). Our use of SNA is innovative. We have disseminated our method in several venues. This longitudinal analysis, conducted annually, has demonstrated substantial cross-sector development of the NEC network as well as enhanced productivity with respect to publications. This analytic approach was presented by Melissa Scribani, MPH, at the national meeting of the American Evaluation Association in October 2016.Our SNA identifies weak areas for intervention, opportunities for trans-disciplinary collaboration. Changes in the network from year to year were quantified through comparative visual analysis of the annual sociograms, the number of roster additions/deletions, and a comparison of the proportion of trans-disciplinary connections. Analysis of specific types of contact (e.g., co-publication) was conducted as a means to assess productivity of the NEC. Expansion of the roster included several advisors from the commercial fishing community. Sociograms depicting "any contact" expanded to become more integrated. An increase in the size of several nodes was observed, most notably among the fishing sector contacts, indicating a higher level of degree centrality for those nodes. This would suggest that contacts in the fishing sector are becoming more integrated within the network and are forming additional relationships over time. The network moved towards the desired "wheel" or "circle" shape.

Table 3: NEC Social Network Analysis – Summary 2012-2016

	2012	2013	2014	2015	2016
Roster members	58	61	72	77	74
Survey response rate (%)	81.0	88.5	93.1	85.7	87.8
Total ties (any contact)	795	840	1039	1194	945
Extramural ties	129	191	243	388	287
% of total ties extramural	16.2	22.7	23.4	32.5	30.4
Co-publication ties			70	84	121

11) Developed and applied a risk/cost/impact/innovation rubric to profile NEC scientific projects and demonstrate their salience (see Table 4).

12) Reached out to NEC project investigators to track and encourage the reporting of success stories (see Table 5). For example, the surveillance project has found that relying on one data source (hospital discharge data) to accurately measure the magnitude of farm injuries is limited. They recommend an alternative approach that involves the use of various public health data sources, as well as medical record data, trauma and emergency medical services (pre-hospital) data, and survey

data. This multi-faced approach is more likely to capture a broad spectrum of injuries, from minor to severely traumatic. This is a creative solution to the elimination of many federal agricultural injury surveillance programs.

13) Participated in the ECO Awareness group in doing regional promotions for National Farm Safety & Health Week in September 2015. NEC staff continued as members of the YouTube Channel workgroup and the Ag Awareness Group workgroup.

14) Collaborated with the ECO groups from other AFF Centers on databases, research and evaluation methods and evaluation outputs. We have provided several suggestions on how to structure future AFF variables related to evaluation. These include the following with specific examples from NEC projects including Table 2 *Risk/Cost/Impact/Innovation Rubric*.

Outputs:
Publications – peer reviewed
Reports
Media/press releases/public service announcements
Workshops sponsored
Conferences held
Professional presentations/posters
Educational material developed (webinars, trainings etc.)
Licenses
Patents
Copyrights
Professionals trained
Funds leveraged (grants or projects attached or supported by the center)

Intermediate Outcomes Definitions and Examples:
Definition – Evidence of reduction of risk factors in the workplace e.g. ROPS preventing overturn fatalities
Policies and Regulations
Standards
International Engineering Standard (ANSI/ASABE S607), "Ventilating Manure Storages to Reduce Entry Risks"
Best Practices and Guidelines
Research Methods and Procedures: ROPS Retrofit Program: a social marketing approach, along with a retrofit hotline and rebate, to encourage farmers in New York to install ROPS on their tractors.
Pilot and Market Ready Technology: Ergonomic hip belt designed to reduce pain and strain among orchard workers
Education and Trainings
Increased Productivity: NEC tested a long, 2-handled blueberry rake design and showed it increased productivity
Demonstrated Risk Reduction (Biological and Physical Monitoring): ROPS installation to prevent tractor roll over injury and fatality

End Outcomes Definitions and Examples:
Definition- Evidence of reduction in workplace exposure, illness or injuries
Exposure Reduction
Reduction in Illness, Injuries, and Fatalities

Table 4: *Risk/Cost/Impact/Innovation Rubric* was developed by the evaluation core, to focus on intermediate outcomes.

	RISK	COST	IMPACT	INNOVATION
On-line Tool	Exposure to hydrogen sulfide*, CO_2, ammonia, explosive gases, and decreased O_2 *(d/t increased	Multiple fatalities in one incident because rescuer succumbs. Prior software was expensive. Tool allows user to avoid site	Prior work published in 6 papers. ANSI/ABAE standard now moving online for manure pit ventilation. Website	Hazard mitigation via pit ventilation. Allows end-user to access software at no cost. User friendly and adapted to work for just

	use of gypsum). Risk posed to farmer as well as rescuer.	license fee. Cost associated with maintaining website.	launched 9/23/14.	about any configuration. Could be adapted to fishing holds.
Lobstermen	Lobster line entanglement. Repetitive use injury of hand/wrist (carpal tunnel), back, shoulder and knee.	Wrist/hand, shoulder, back and knee MS injury are being documented.	Lobstermen are state licensed and not included in federal data.	Lobstermen not studied before. Work exposure was measured. Validated Nordic MS Qu used to measure injury.
Shields	Machinery entanglements d/t unshielded PTO can lead to amputations, and fatality - One of the top three causes of death on a farm	Amputations and fatality lead to lost farms and productivity. BareCo can offer shield at lower price.	Increase # of shielded PTO and decrease risk of injury. Pre and post shield installation photos. Several papers published, one on the reliability of shield-use self-reporting.	Use social marketing to encourage PTO shield use. Partner with local dealerships to provide information and make improved shields more widely available. Partner with shield manufacturers to address concerns raised by farmers about PTO shields.
Winch	Amputations, entanglements and fatality. Vessel instability or sinking. Large turnover of crew, large variety of boat designs. Winch location affects vessel stability.	Majority of boats do not have shut-off within arm's length. Paddle bar on top of winch drum to shut it off costs about $2K. Cost analysis would be helpful.	Develop prototype for emergency stop that would reduce winch entanglement.	Multi-component prevention strategy (education, outreach, multiple shut off options, paddle bar) needed.
Surveillance	Data needed to assess risk and injury trends. E coding of external cause of injury or location codes or free text captures risk and injury data.	Using existing data is less costly than repeated surveys and can identify trends over time.	NIOSH interest. Outpatient data in ME added 17 cases to injury identification technique. Trending underway using existing data.	PCR data used for injury surveillance. No changes required of data for process. Use for other types of injury: NH included. Translating this model for NIOSH State based OCC Health Surveillance.
Tractor Stability	300,000 tractors in use. 100 deaths/year. 3x shorter life for each hour of tractor use. Rear and side overturn.	$2.5 million estimate per death. $100 per tractor tilt detector. OEM buy in will lead to large cost savings. Industry investment (Volvo) made in 2014.	Driver alerting system for side overturn. Rear overturn prevention by mechanical intervention.	Tractor driving simulator – tilt cab. Use of existing eye and face tracking technology on tractors.

Table 5: NEC Success Stories and Impact

Shields	The NEC identified a new type of PTO guard and has been working with manufacturers to broaden distribution to farmers in the NE. In addition, the research team has developed several message concepts that have been tested with local farmers. The research group has been able to identify the barriers and motivators to PTO shield use, as well as the [lack of] differences in shielding behaviors between commodity and demographic groups. The research team is preparing to submit a grant to strengthen and enhance this study.
Surveillance	New Hampshire plans to use NEC surveillance methods for piloting ways to ID occupational injury in their PCR data. Data summaries are being developed for different states that can be distributed to workers, stakeholders and other researchers. In this way, data can drive AFF safety and health efforts to priority occupational health and safety issues.
Tractor Stability	Photo and video of tractor driving simulator –tilt cab was developed.
On-line Tool	Agricultural engineers, manure facilities planners, ag safety specialists, and safety regulators now have simple and cost effective access to an on-line simulation tool that helps them assess the effectiveness of manure pit ventilation strategies to remove toxic and asphyxiating gases from confined space manure storages prior to entry. The on-line tool also allows users to evaluate the impact of manure pit ventilation upon air quality in the animal housing space above slotted floor covered manure pits during pit ventilation.

Section 2: Project Summaries

FARM TRACTOR STABILITY SYSTEMS TO IMPROVE OPERATOR AND MECHANICAL PERFOMANCE

Project Personnel: Dennis Murphy (PI), Sean Brennan, Phil Garvey, Jennifer Klena, Nicolas Ochoa-Lleras, HJ Sommer, III

Abstract. Developing devices for stability monitoring and rollover alerts is a promising possibility to prevent overturn events, which pose a severe risk to tractor operators. However, performing relevant tests with operators in the field is dangerous and impractical. As an alternative, this work identifies the challenges of simulating a tractor-driving environment in a laboratory and details the solutions put in place to develop a tractor-driving simulator at Penn State University. The simulator includes an instrumented tractor cab mounted on a custom motion base, a 2.43 m tall, 360° high-definition screen, a sound system, and a nine-computer network running open-source software that can be used to conduct experiments and simulate driving scenarios relevant to tractor instabilities. Two sets of experiments have been completed to date.

Background. For the past five decades, tractor rollover has consistently been a leading cause of injuries and fatalities in the agricultural sector. Regulations that require the installation of Rollover Protection Structures (ROPS) have been implemented around the world since the 1970's. However, recent statistics show the problem persists. On U.S. farms, it is still the most common cause of occupational fatalities. The National Institute for Occupational Safety and Health data suggests that between 1992 and 2005, 1,412 workers on farms died from tractor overturns. Penn State's database of farm fatalities shows that in 2010-2014, 32 of the 141 recorded farm fatalities included vehicle rollover or overturn incidents. Pessina et al. (2016), found that 56% of rollover fatalities in Italy from 2008 to 2014 occurred when no ROPS was installed, but also 19% of them occurred when a foldable ROPS was installed, but in the folded-down position at the time of the accident. The ineffective use of ROPS devices, even when they installed, has been a rising problem since 2004. Once a tractor begins an overturn it becomes mostly uncontrollable, which is why there must be an important emphasis on rollover prevention. While ROPS may help mitigate the injuries resulting from a rollover incident, driver assistance devices seek to prevent the incident from occurring.

Driving simulators are regularly used in vehicle studies, including vehicle and traffic control testing, driver performance testing, driver training under various circumstances, and in the development of realistic driving games (Hancock and Sheridan, 2011). In contrast to operation of actual vehicles, driving simulators allow high reproducibility of driving scenarios at the expense of realism. Recently, simulators have moved beyond basic driver testing and training, and many simulators are now used for specialized purposes, such as testing hardware interfaces, allowing multiple drivers in the loop, interacting with real vehicles, and even remote tele-operation of vehicles. The automotive sector regularly uses driving simulators for such hardware- in-the-loop (HIL) tests. The advantages of an HIL system include higher fidelity, faster simulation speed than purely virtual systems, and greater comprehensiveness than purely physical systems. The state-of-the-art in driving simulations often uses HIL in combination with human-in-the-loop testing, sometimes called H2iL, in which human operators interact with an HIL workbench. The use of driving simulators for tractor studies is in the very early stages compared to automotive systems.

Aims

1. Develop a robust, 6-degrees-of-freedom tractor simulator for experimental research studies.
2. Evaluate tractor operator visual scan patterns in a naturalistic setting to determine the optimal location to mount the stability display system (tractor operator interface).
3. Compare operators' precision and accuracy in their perceptions of roll and pitch versus actual tractor simulator angles and assess operator thresholds of safe/unsafe angles.

4. Develop and evaluate detectable display systems (tractor/operator interface) to safely and efficiently convey tractor stability information under simulated operating conditions.

Methods. The Mechanical and Agricultural& Biological Engineering departments at Penn State developed a tractor driving simulator, as shown in Figures 2 and 3. It utilizes a parallel robot with six degrees-of-freedom, plus a custom-built mechanism for additional roll motion up to 25°. The system runs on the open source Robotic Operating System (ROS) and uses Blender for its 3-D physics simulation and rendering. A custom-built screen, 8 ft tall and 48 ft in diameter, provides a 360° immersive environment. A 2000-Watt sound system is use to recreate tractor engine noise, and a steering actuator simulates the torques required to steer the tractor.

Figure 2. The tractor driving simulator.

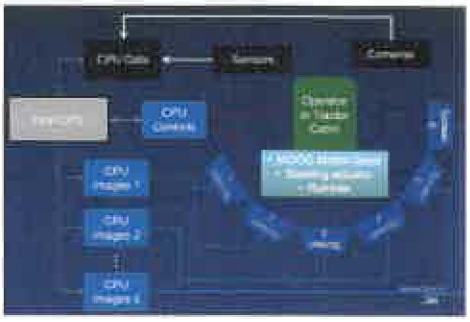


Figure 3. Nine computers work together to produce HD images for the screen., capture sensor data from the driver, and send commands to the actuation systems that produce motion and haptic feedback.

Nine tractor operators, and several farm tractors, including a Case Magnum 260 and a John Deere 9510 Combine Harvester operated by Penn State's Farm Operations' staff were instrumented with two GoPro HERO3+ Black Edition cameras to record tractor operator looking behavior. One camera was mounted in the tractor using GoPro's curved or flat adhesive mounts (with quick release for ease in switching between tractor cabs) and aimed at the operator, while the other was head-mounted on the operator using GoPro's head strap. Tractor operator head, eye, and body movements were recorded while they were engaged in various farming tasks including manure spreading and soybean harvesting. The data allow the researchers to determine when and where the operator was looking while operating the tractor and how much time they spend looking in various locations inside and outside the tractor cab. The head mounted camera will also provide views of the terrain in front of and surrounding the operator. This data was used as input for the experimental studies.

The first experiment was designed to evaluate the operator's ability to memorize and reproduce tilt positions in roll and/or pitch. The subjects sat in the tractor cabin in what they considered a comfortable driving position. They then followed these steps: first, starting from a level position, the platform moves the cabin to a given roll-pitch angle; it remains stationary for five seconds. This tilt angle is the one subjects are asked to remember. Then the platform returns to level. The subject then uses a video game controller to reproduce the exposure angle. When they reach what they believe is the correct roll-pitch position, they press a button to record the corresponding data point. This process was conducted with three practice angles (which were not used in the data analysis), and then for a randomized sequence of 28 set angles for the test.

The second experiment was developed to determine what type of alert interface would be more effective at capturing the operator's attention when a hazardous situation arises. A 3-D virtual environment was developed to simulate the effect of driving a tractor on a sloped field. The subjects were asked to complete two tasks simultaneously, dividing their attention between two competing objectives: monitor the tractor's roll angle and keep an eye on the field and equipment around the tractor. Four alert interfaces were considered. First, a digital bubble-level display that showed the current tractor tilt, plus a time history of the past 5 seconds; this display (shown in Figure 1) was marked with green, yellow and red areas to indicate the level of safety, and was

kept on throughout the whole experiment. Second, an auditory alert that buzzed when a certain safety threshold was passed. Third, a haptic alert that made the steering wheel vibrate when the safety threshold was exceeded. Finally, the fourth interface was a combined system where both haptic and auditory alerts were set off simultaneously.

In the second experiment, subjects sat in the tractor cab, holding the steering wheel as if they were driving. The screen showed a virtual field and the sound system reproduced a tractor engine sound. The tractor started moving through the field at a constant speed of 3 mph, along a succession of hills. Each hill was between 250 m and 300 m long, at a constant slope of 13°; successive hills alternated between positive roll (right side of the cabin tilting downwards) and negative roll. This recreated the effect of driving down a slanted plot of land one way, for 3 to 4 minutes, and then driving back the other way. The total length of the path was 2700 m, and took 35 minutes to complete. While driving on the slope, the cabin would tilt farther, to 17°, three to five times per hill. In order to reduce the predictability of test, the length of the hills and the span between these 17°-roll events were chosen randomly. Additionally, a small-amplitude rocking motion was added to simulate the tractor bouncing on top of the terrain.

The subjects were instructed to keep track of two different tasks during the test. For the stability task, they were to click a right foot-switch whenever the bubble went into the red, or any of the alerts were set off, which happened when the roll angle was above 14.5 °. For the distractor task, they were to click the left-foot switch whenever they saw a black sphere on the screen. Upon pressing the switch, the sphere would disappear. It would reappear at a new location, at random intervals between 6 s and 13 s, across the driver's 360-degree field of view. These two tasks simulate the competing objectives of monitoring the tractor's stability, while also devoting attention to the equipment and surrounding field while conducting field operations.

Findings.

Aims 1 and 2:

The simulator works well and is only of the two in the United States with the capabilities described earlier. Scan patterns were incorporated into the experiments below and were not published separately.

Aim 3:

The single-variable regressions show that the group as a whole overestimated roll by about 8%, while estimating pitch accurately. In both cases, the results had small biases, below 0.8 °. It's important to note that the pitch angles used in the experiment were smaller than the roll angles. If the roll angles are split into small (under 15°) and large groups (15 ° - 24 °) the slopes obtained are 1.05 and 0.91, respectively. For this reason, the differences between roll and pitch accuracy could be explained by the difference in magnitudes, rather than an inherent difference between the ability to reproduce tilt angles in the pitch and roll directions.

The two-variable regressions showed that there is no meaningful contribution of pitch angle towards roll estimation, nor a statistically significant effect of roll angle towards pitch estimation. This would suggest that accuracy of pitch and roll estimates are unrelated for this experiment.

Data showed that the slopes for each group were not meaningfully different from each other.

The results were controlled for fatigue, or learning throughout the experiment: the 28 angles were the same for all subjects, but were presented in a different, random order in each test. There was no significant correlation for the accuracy of the reproduced angles with the order in which they were presented.

Aim 4:

The best interface is the one that produce both the highest number of responses in the shortest time period. The display with no other alert produced faster responses than the haptic and mixed alerts. It also obtained a driver response only 67%

of the time. That means the display was effective, but only when the operator is looking at it. Without having an additional alert to bring the operator's attention to the display, many risky situations might go unnoticed. The cumulative probability distributions show that displayed warnings produce quick responses. Complementing the display with a haptic alert produces the smallest improvement, compared to auditory and mixed alerts. The mixed system performs somewhere between the auditory and haptic alerts, showing that more stimuli does not inherently lead to faster responses.

Conclusions and Impacts. The perceptual errors in roll occurred mostly in large roll situations, above 15°. At those angles, an under-reproduction of 9% showed that test subjects tended to overestimate their roll angle. Perceptual errors of this type would be protective while on the field, since overestimation of the roll angles stimulates more conservative driving. Pitch angles were estimated correctly, on average, but this may have been due to the smaller magnitude of pitch angles in the test. No statistically significant differences were detected between experienced tractor operators and non-operators.

The most effective alert interface as determined by driver reaction speed and effectiveness was the combination of the auditory system used with a visual "bubble" display, when compared to the haptic, mixed, and display-only interfaces. However, the distributions and large variations in the results made testing statistical hypothesis difficult. This performance metric coincided with the subjects' comments—collected after each test—where 11 of them preferred the auditory alert, while only 5 preferred the haptic and 5 the mixed system.

Outputs and Outcomes.

Tractor Driving Simulator

A state-of-the-art farm tractor simulator that utilizes a parallel robot with six degrees-of-freedom, plus a custom-built mechanism for additional roll motion up to 25°. The system runs on the open source Robotic Operating System (ROS) and uses Blender for its 3-D physics simulation and rendering. A custom-built screen, 8 ft. tall and 48 ft. in diameter, provides a 360° immersive environment. A 2000-Watt sound system is use to recreate tractor engine noise, and a steering actuator simulates the torques required to steer the tractor.

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Görücü S, Cavallo E, Murphy D. 2014. Perceptions of tilt angles of an agricultural tractor. J Agromedicine. 2014. 19(1):5-14. doi: 10.1080/1059924X.2013.855690.

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Ochoa-Lleras, N. S Brennan, D. Murphy, P Garvey, HJ Sommer. 2017. Assessing Perceptions and Alerts of Tractor Instability. Presented at CIOSTA2017, Sicily, Italy, June 13-15, 2017.

MUSCULOSKELETAL DISORDER RATES IN NORTHEAST LOBSTERMEN

Project Personnel: Bryan Buchholz (PI), Scott Fulmer

Abstract:The objective of this study was to inform efforts to reduce risk for musculoskeletal disorders among lobstermen in the northeast US by characterizing and quantifying pains and injuries that occur to people while harvesting lobsters commercially. This study aimed to estimate a denominator of exposure to lobstering in full-time equivalents (FTE), to estimate a fatality rate, to calculate incidence rates for acute injuries within the sample population, and to present a profile of the prevalence of pain at the different body locations of the lobstermen. Crews were randomly selected from those licensed to fish in Maine and Massachusetts and followed prospectively to respond to a questionnaire administered quarterly via phone or face-to-face interview with the captain. Data on work exposure were collected and used to assess the Full-Time Equivalent of work hours for the sample. In addition, this survey captured relevant information injuries with rapid onset that occurred on the boat ("acute injuries") during the quarter. At least once during this prospective timeline, the captains and crew completed an in-person interview focused only on chronic or cumulative pain. A total of 395 individuals participated. The annual FTE was 5,876. As expected, the summer months (3rd quarter) had the highest FTE and the winter (1st quarter) the lowest FTE. Fall (4th quarter) and spring (2nd quarter) ranked second and third, respectively. The incidence rates for all injuries (51.0/100 FTE) and injuries requiring treatment (15.4/100 FTE) were much higher than those reported in other studies of fishing that used Coast Guard data. The fatality rate for the data collection period (2012-2015) was 21.3/100,000 FTE. One half of the respondents reported low back pain. Back pain was attributed to or exacerbated by lobstering. Low back pain was prevalent among both captains and stemmen, while stemmen reported more hand/wrist pain than captains. Multiple locations for pain were common in individual participants.

Background:This research project was designed to improve the national surveillance of commercial fishing morbidity and mortality by seeking to understand a regionally important fishing industry, lobstering. Although NIOSH has developed a surveillance program using total occupational exposure data mandated by the National Oceanographic and Atmospheric Administration (NOAA) and collected by the National Marine Fisheries Service, the lobster fishery, is mainly regulated by states, rather than by the federal government. Consequently, the total occupational exposure of the lobster fishery had not been previously available for computing comparable rates. Thus this NEC project fulfilled a need complementary to national surveillance goals for estimating fatality rates by a valid estimate of total occupational exposure of the lobster fishing industry. In addition, the survey was able to estimate non-fatal injury rates and to profile the prevalence of pain in lobstering, an industry unique to the Northeast. By collecting primary data on pain, injury, and total work exposure, an understanding of the industry, useful for informing further research and action into reducing rates, was gained.

Aims:The main objective of this study was to compile the necessary data for the descriptive and analytic epidemiology of occupationally-related mortality and injury associated with lobstering in the Northeast. Information was collected from lobstermen in Maine and Massachusetts to estimate denominators (i.e. exposure to lobstering) and numerators (i.e. the frequency of injury, disability and mortality associated with lobstering) for the total Northeastern workforce and for important subgroups, and to assess variations in these rates among the seasons, geographical regions, or other demographic variables.

Methods:The research took a longitudinal approach. The prospective study quantified work exposure (Full Time Equivalents; FTE) by collecting total occupational exposure from a random sample of lobstermen. The sampling pool was derived from state licensing offices of the two most active states in the industry, Maine and Massachusetts. A computerized random sample of lobster permit holders was generated and from this list, a volunteer sample was recruited. Recruitment utilized a multi-modal approach: mailings, phone calls, and in-person. Sample size was based on expected error less than 10% of the mean exposure estimated from prior studies (GMRI, 2006). Using these prior estimates, and assuming maximal number of weeks worked and length of trip, a sample size of 120 permit holders for each of the two states of Maine and Massachusetts was selected. In order

to allow for 15 percent subject attrition, 138 permit holders from each state was targeted for enrollment. Lobster permit holders who were only licensed to fish beyond the three-mile state territorial limit (a small segment of lobstering known as the "offshore fleet") were excluded. Lobster permit holders holding both inshore and offshore licenses were eligible, but the study only utilized work exposure data within state territorial waters (three-mile limit) for this group. The important characteristic of the inshore fleet for the purpose of the method of analysis was the fact that all their trips would be "day trips", i.e. completed in less than a 24-hour period. Further exclusions included seasonal, student, or recreational licenses, or any restriction that inhibited full participation in the maximum extent of time and equipment usage in the fishery.

Two data collection instruments were used, and administered on separate tracks. The first was administered quarterly only to the captains of the boat. It was designed to capture information specific to the quarter year preceding a given interview. Questions were asked specifically about exposure information: the average duration of a trip, number of days worked per week, crew size, and the number of weeks worked per quarter. These parameters allowed us to estimate the FTE of the lobster-harvesting sector in man-hours and man-days. In addition, this survey captured relevant information on all acute injuries occurring during the quarter. The questionnaire was used to measure the incidence of musculoskeletal injuries and the body segment injured, with indication of severity measured by reports of the utilization of treatment services, and required alteration of routine work. Thus, recorded injuries represented incidence of acute injury only. The categories for type of injury were based on the categories used by the Bureau of Labor Statistics (BLS) for the nature of injury in their nonfatal occupational injury report. Data were collected from the cohort by phone interview following each three-month interval. In the instances where subjects were unavailable for interview following a quarter, data for the missing quarter were collected along with data for the next quarter. The captain was given an incentive of $20 at recruitment and an additional $10 for each quarterly follow-up as compensation for his time. After obtaining verbal informed consent (as approved by the UMass Lowell Institutional Review Board), the captain was offered the option of completing the first quarterly survey, over the phone at the time of recruitment. During this initial phone call, identifying information about the boat and its location were collected to enable an ensuing visit to the boat.

The boat information was used by researchers collecting information on the second track. The second survey instrument contained questions taken from the Nordic Musculoskeletal Questionnaire (NMQ) on pains, disabilities, and related treatment (Kuorinka et al., 1987). The data from this track were collected through face to face interviews of captains and crew members, on an annual basis. In these interviews, researchers sought to quantify aches and pains that may be indicative of non-acute injuries and chronic musculoskeletal disorders. These qualitative descriptions help the researchers to characterize risk and exposure to risk. Our instrument asked five questions, all found on the original NMQ. These questions were on 3-month prevalence of aches, pains, and discomforts; whether or not the pain was caused by work; whether the pain affected normal work routine; did the participant receive treatment for the pain; and did the pain also occur in the past 7 days. We used a 3-month rather than a 12-month exposure period to reduce recall bias or misclassification. We did not ask whether the pain affected non-work activity; whether the pain resulted in a change of jobs; the length of duration of the pain; or whether there was history of pain resulting from an accident. Some health-related demographic questions were also included, such as age, height, weight, and sex.

Findings:A sampling pool of 431 lobstermen was randomly selected from each state's list of license holders. Among both states, 11 lobstermen were found to be deceased, 130 ineligible, and 87 had phone numbers that were incorrect or out of service. Of the remaining subjects from both states, 206 did not respond to an exhaustive number of recruitment calls, and 142 declined to participate. The sample size derived from the sampling pool, after the recruitment protocols were completed, was 286 subjects. In Maine, 146 subjects agreed to participate, and in Massachusetts, 140 subjects agreed to participate. By dividing the number of subjects enrolled by the total number who received recruitment calls (excluding those deceased, ineligible, and could not be contacted because of inaccurate phone numbers), we arrived at an initial participation rate of 46.9% in Maine and 43.3% in Massachusetts.Because of feasibility and cost, the in-person interviews were limited to a cross sectional analysis in the years

2012-2013. Nevertheless, two hundred and seventy-one of the active subjects in the cohort were interviewed face-to-face, as well as an additional 124 stemmen. The demographics of the subjects (N=395) interviewed in person are in Table 6.

The FTEs for each state across the four years are displayed in the Figure 4, and quarterly averages are listed in Table 7. At the mid-point of the longitudinal study, the overall incidence density rate for all reported injuries was 49.7 per 100 FTE, and at completion, 51.0/100FTE (Table 3). We saw that the density for injuries requiring treatment was much lower, consistently about 15/100 FTE. Results support the hypothesis that the lobstering sector has a comparably low fatality rate, with specific body segments (wrist, hand, shoulder and back injuries) being associated with increased risk for injury.

We used the FTEs per license estimated for the years 2012–2013 multiplied times the average number of licenses in 2000–2009 as a denominator for the 14 fatalities in the decade between 2000 and 2009 and found a fatality rate of 24.8/100,000 FTE. There were 10 fatalities in Maine (19.3/100,000 FTE) and 4 in Massachusetts (41.3/100,000 FTE). There were 5 lobstering fatalities in the two states during the four-year data collection period, resulting in a fatality rate of 21.3/100,00 FTE.

The reports of pain or discomfort experienced by lobstermen in the in-person interviews that might be indicative of non-acute or chronic musculoskeletal disorders are displayed as counts and percent prevalence of 395 interviews, in Table 8.

Conclusions:The average annual FTE calculated for lobstermen, 5,876, showed that lobstering is likely the fishery with the most active effort, as measured by FTE, in the United States. The occupational fatality rate was relatively low in comparison to other fisheries. The study was also the first report of non-fatal injuries in the fishery. The estimated rate of acute, non-fatal injuries in the fishery was higher than rates reported in land-based industries via the standard OSHA surveillance system. The lobstering cohort also showed a high prevalence of chronic or cumulative trauma type pain and discomfort. There was some evidence that the profile of injuries was specific to the roles differentiated by the captains and stemmen. The pain profiles indicated work exposure commonly led to pain in the low back, knees, shoulders, and hands/wrists. Although an important number of these pains were treated, fewer altered work, suggesting that working with pain is also a common scenario. In this scenario, it is evident that the reduction of risk to continued exposure to those work-related risks would be an important step in preventing further cumulative effects.

Table 6: – Demographics of the subjects (N=395) interviewed in person

	Maine		Massachusetts		Total		
	Captain	Stemman	Captain	Stemman	Captains	Stemmen	Total
N	137	75	134	49	271	124	395
Gender (%male)	98.5%	89.3%	99.3%	89.8%	98.8%	88.9%	95.9%
	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
Age (yr)	54±13	38±15	56±12	40±14	55±13	39±15	50±15
Experience (yr)	33±13	14±14	28±13	9±8	31±13	12±2	25±16
Height (cm)	180±8	178±8	178±8	178±10	180±8	178±8	178±8
Weight (kg)	94±17	84±17	89±15	84±16	92±16	84±17	89±16

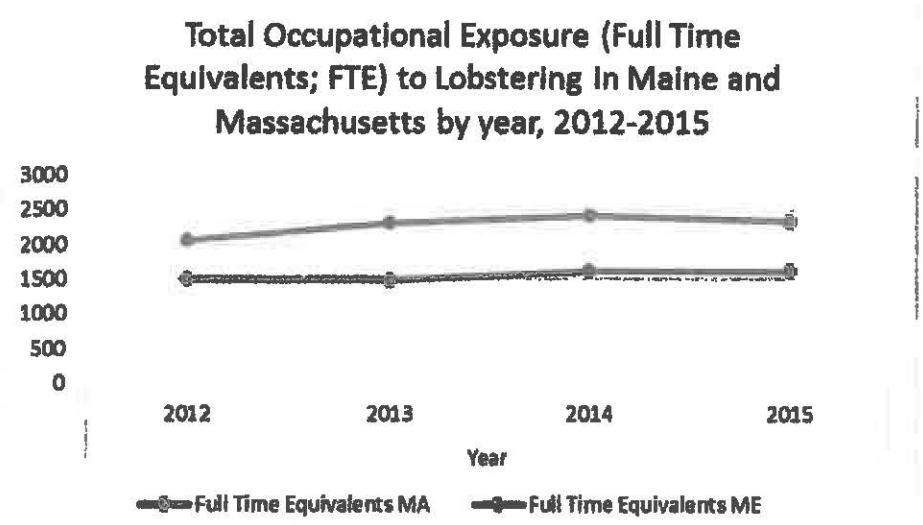

Figure 4- Full-Time Equivalents (FTEs) by State and Year

Table 7 – Quarterly Full-Time Equivalents (FTEs)

Qtr	Maine*			Massachusetts**			Total***		
	4yr ave hours per license	%FTE per license	FTE	4yr ave hours per license	%FTE per license	FTE	4yr ave hours per license	%FTE per license	FTE
1	125	25%	1233	90	18%	211	108	22%	1315
2	477	95%	4697	334	67%	786	407	81%	4963
3	1003	201%	9877	655	131%	1539	833	167%	10168
4	674	135%	6642	476	95%	1119	578	116%	7057
Year	2279	114%	5612	1554	78%	914	1926	96%	5876

* The average number of licenses in Maine over the four-year period was 4,926.
** The average number of licenses in Massachusetts over the four-year period was 1,176.
*** The average number of licenses in total over the four-year period was 6,102.

Table 3 – Injury incidence rates by type

Type of Injury	2 years		4 years			
	All reported		All reported		Injuries receiving treatment	
	N	Rate*	N	Rate*	N	Rate*
Cuts	82	16.4	149	14.8	47	4.7
Sprains	74	14.8	179	17.8	178	17.7
Bruises	40	8	72	7.2	56	5.6
Unidentified pains	43	8.6	95	9.4	94	9.3
Fractures	7	1.4	12	1.2	12	1.2
Burns	2	0.4	4	0.4	3	0.3
Amputations	1	0.2	2	0.2	2	0.2
Total	249	49.7	513	51.0	155	15.4

* Incidence rate = (N/EH)*200,000; EH = Employee Hours; EH = 1,001,023 total hours of lobstering in the sample for two years; EH = 2,011,765.65 total hours of lobstering in the sample for four years

Table 8 – Reports of chronic pain and discomfort

Body segment		Last 3 months		Caused by work		Received treatment		Altered or prevented normal work		Also in last 7 days	
		N	%	N	%	N	%	N	%	N	%
Head/face		5	1.3	1	0.3	1	0.3	0	0.0	2	0.5
Neck		53	13.4	31	7.8	11	2.8	6	1.5	29	7.3
Shoulder	Right	74	18.7	54	13.7	9	2.3	9	2.3	47	11.9
	Left	24	6.1	16	4.1	4	1.0	2	0.5	13	3.3
	Both	53	13.7	43	10.9	8	2.0	7	1.8	36	9.1
Elbow	Right	24	6.1	18	4.6	5	1.3	3	0.8	13	3.3
	Left	18	4.6	14	3.5	3	0.8	2	0.5	12	3.0
	Both	25	6.3	15	3.8	2	0.5	2	0.5	15	3.8
Hand/wrist	Right	34	8.6	26	6.6	7	1.8	4	1.0	20	5.1
	Left	18	4.6	15	3.8	2	0.5	1	0.3	7	1.8
	Both	63	15.9	45	11.4	9	2.3	4	1.0	37	9.4
Back	Upper	39	9.9	31	7.8	7	1.8	2	0.5	23	5.8
	Lower	199	49.9	143	35.9	56	14.2	23	5.8	122	30.9
Legs	Hips/Thighs	43	10.9	36	9.1	10	2.5	6	1.5	31	7.8
	Knee/Shin/Calf	105	26.6	67	17.0	24	6.1	11	2.8	66	16.7
	Ankles/Feet	59	14.9	35	8.9	11	2.8	6	1.5	37	9.4
Number of pain reports in all regions		836		590		169		88		510	
Individuals reporting pain		325	82.3	248	62.8	103	26.1	50	12.7	236	59.7

Outcomes and Outputs:Two peer-reviewed manuscripts have been published: one on the FTE and acute injury data collected in the first half of the study and one on the chronic musculoskeletal pain. A third manuscript is currently in preparation on the FTE and acute injury data for the entire four years of the study. The mid-point study results were disseminated to the cohort participants, and to the public at the Maine Fisherman's Forum in 2015 and 2016, the Massachusetts Lobstermen's Annual Meeting in 2017, Preventing Musculoskeletal Disorders Conference, 2016, and the Massachusetts Intercampus Marine Science Symposium, 2016.

Additional outcomes of the research include spin-off research, such as biomechanical evaluation of lobster equipment redesign. One intervention idea to reduce exposure to hand/wrist pain was the subject of a feasibility study. A biomechanical evaluation of a foot operated lobster banding tool was conducted and data were collected on the changes in muscle activity and posture angles corresponding to use of these tools. Results indicated that there were no statistical differences between the usage of the foot-activated tool and the traditional tool and lobstermen were much slower with the foot-operated tool. Qualitative data indicated that the lobstermen preferred the traditional tool.

Fulmer S. Preliminary Analysis of Injuries and Work Exposure in Commercial Lobstering Presented at the bi-annual UMass-UConn Occupational Health Symposium. Sturbridge, Massachusetts. May, 2013.

Fulmer S. Ergonomic hazards in lobster fishing. Maine Fishermen's Forum. Rockport, Maine. March 2015.

Fulmer S. Taking Action to Prevent Pain and Injury in Lobstering: A presentation to lobstermen identifying where their bodies hurt, what to do about it. Maine Fishermen's Forum. Rockport, Maine. March 2016.

Fulmer S, Buchholz B. Injuries and Work Exposure in Commercial Lobstering. University of Massachusetts Intercampus Marine Science Symposium, University of Massachusetts Dartmouth. Dartmouth, Massachusetts. March, 2016.

Fulmer S, Buchholz B, Jenkins P, Scribani M. Musculoskeletal disorders and total occupational exposure in commercial lobstering. PREMUS2016: 9th International Scientific Conference on the Prevention of Work-Related Musculoskeletal Disorders. Toronto, Ontario, Canada. June, 2016.

Fulmer S. Ergonomic hazards in lobster fishing. Maine Fishermen's Forum. Rockport, Maine. March 2015.

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: 190-199.

Fulmer, S., Buchholz, B., Scribani, M.B., Jenkins, P. Musculoskeletal Disorders in Northeast Lobstermen. Safety and Health at Work. January, 2017.

Cumulative enrollment table: The lobstering industry is predominantly male, non-Hispanic or Latino, and White. We did not collect data on race or ethnicity. We did collect data on gender. There were 17 females and 400 males included in the study, cumulatively.

NEW SURVEILLANCE STRATEGY FOR FARMING AND FORESTRY INJURY

Project Personnel: Paul Jenkins (PI), Erika Scott, Liane Hirabayashi, Nicole Krupa

Abstract. Developing a low-cost surveillance system for occupational injury in agriculture and logging has long been a challenge. These data are needed to prioritize public health interventions in the agriculture and logging industries, and are crucial to evaluating changes in injury rates, as well as the effectiveness of safety interventions. Recently, the transition to electronic data reporting created new opportunities for the development of sustainable, low-cost surveillance systems. Pre-hospital care reports (PCR) and hospital data (emergency department, inpatient, and outpatient) are datasets of particular interest. The system was tested using data from Maine and New Hampshire, and the methodology is being applied to additional states across the Northeast.

Background. While past research[1-8] and surveillance systems[8-10] have informed public health professionals of injury patterns in agriculture and logging, the primary challenge is that these data become dated, and no ongoing systems are able to provide stable estimates of non-fatal injuries over time. A major limitation to establishing a long-term solution is the cost of active surveillance, or administration of surveys. Another problem in in agriculture and forestry is that specific information on causal agents is often lacking. In addition, in 2015 long-term injury surveys in agriculture, such as the National Agricultural Workers Survey (NAWS) were terminated.

Passive system have historically been able to gather broad categories of injury source of type of event (machinery or animal related, for instance). One goal of this research was to assess the granularity of these data, to better understand causal factors of injury. In this process, we hoped to gain an understanding of what level of detail different data sources provide about an injury event. This study was built on the knowledge gained in a study conducted previously in New York State, using paper pre-hospital care reports (PCR). This study proved the merit of the narrative section of the PCR as a valuable tool for injury surveillance. The free text data is a rich source of type of event and source of injury detail.

Specific Aims.

Aim 1: To establish a multi-state (NY, ME, NJ, VT, NH, MD) agricultural injury surveillance system that incorporates: ambulance reports, hospital inpatient discharge records, emergency department records, death certificates, and NEC fatality dataset records; and to assess the role that each data source plays in the system.

Aim 2: To establish baseline fatal and non-fatal agricultural injury rates for the Northeast and individual states, and to identify the leading fatal and non-fatal agricultural injury event types.

Aim 3: To identify high-risk groups within agriculture, as defined by age, gender or ethnicity.

Aim 4: To disseminate surveillance data to state health departments and stimulate the development of agricultural and forestry safety research through the NEC feasibility grant program.

Aim 5: To assess the feasibility of using this surveillance system to identify logging/ forestry injuries.

Methods. Two primary administrative data were selected for inclusion in the surveillance study: pre-hospital care reports (PCR) and hospital data (inpatient, emergency department, and outpatient). Both types of datasets are routinely aggregated by state health departments and may be requested for research use. First, duplicates were removed in each dataset prior to matching by comparing gender, admission date, zip code, and date of birth. Next, one large database was created by match merging the PCR and hospital data on gender, admission date (allow for plus one for hospital records), zip code and date of birth. Agricultural and logging related injuries were identified by two means: existing variables and a free text search (see Figure 5 below).

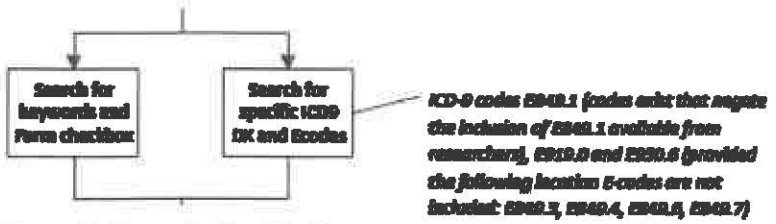

Figure 5. Means to Identify Cases

Secondary data for the study included fatality data gathered from our news clipping service, along with reports from the Census of Fatal Occupational Injury (CFOI) when available. Pre-hospital care reports with narrative free text were obtained from Maine and New Hampshire. Hospitalization data was obtained from Maine, New Hampshire, New York, New Jersey, and Maryland. Data applications are still underway in Vermont. New Jersey PCR data was not able to be obtained due to legal limitations of data sharing outside of the state. New York PCR data no longer contains the narrative free-text, and according go NYSDOH EMS Bureau officials, several years of data are missing due to data entry problems encountered with the data entry contractor.

A "traumatic agricultural or logging injury" was defined as energy transferred to an individual a) from an agricultural or logging source [e.g., tractor, bull, or chainsaw], b) while in an agricultural or logging location, or c) while doing an agricultural or logging activity, which is severe enough to require medical attention. Excluded are injury events that occur on the farm/logging site involving sources NOT associated with farm or logging activity at any time [e.g., skateboard, barbecue grill, etc.]. This was considered appropriate, as injuries requiring medical care are typically more severe than those not requiring medical care, and are frequently work-related. This definition has also been used in other studies.[8,11] Injuries that occur on the farm but do not involve farm activities (e.g., fall from skateboard, burn from barbecue grill, etc.) are not considered to be injury events for the purposes of the surveillance system. This logic applies to non-work injury events on logging sites or woodlots, though these are expected to be uncommon. To assign an injury to the logging industry, not the agricultural industry, required that the narrative of the PCR specifically state that the injured person was 1) A "logger" or 2) Working at a "logging " site or 3) Using heavy logging equipment (feller buncher, skidder, etc.). Because of this particular convention, a large number of tree-related incidents (incidents where the narrative contained words such as chainsaw, tree, log, etc.) were assigned as agricultural and not specifically logging accidents.

Much work was done to understand the relative benefit of the PCR data, and the hospital records. All records were double coded by two experienced coders, using the Occupational Injury and Illness Classification System Version 2. Kappa scores were compared for the two coders, and the relative ability to code these data to the furthest degree of granularity was explored. Finally, these data were assessed for trends in agricultural and logging morbidity.

Results: Researchers determined how often a farm injury event record is present in multiple data sources, and analyzed the effect that merging these records has on the completeness of the record. The dataset resulting from combining the multiple sources included more injury event records overall, and more that can be classified as to injury event source and type, than would have been identified using fewer data sources

Table 9: Kappa Values for Double Coding Agricultural and Logging Injuries Using OIICS

	PCR	Hospital
Nature of Injury		
Division (Level 1)	0.4944	0.3215
Major Grouping (Level 2)	0.5011	0.7634
Detail 3 (Level 3)	0.5246	0.6356
Detail 4 (Level 4)	0.4779	0.5816
Part of Body		
Division (Level 1)	0.7536	0.8933
Major Grouping (Level 2)	0.6310	0.7894
Detail 3 (Level 3)	0.5054	0.5834
Detail 4 (Level 4)	0.4019	0.3936
Source of Injury		
Division (Level 1)	0.8073	0.7418
Major Grouping (Level 2)	0.8244	0.6938
Detail 3 (Level 3)	0.8042	0.6465
Detail 4 (Level 4)	0.7223	0.6234
Type of Event		
Division (Level 1)	0.8405	0.8504
Major Grouping (Level 2)	0.7221	0.6501
Detail 3 (Level 3)	0.6534	0.6318
Detail 4 (Level 4)	0.5550	0.5734

Table 9 illustrates the results from comparing two coders choices for nature of injury, type of event, source of injury, and part of body, using the PCR records and hospital records. Part of body and nature of injury was more consistent in the hospital data; however, type of event and source of injury were better from the PCR reports.
Table 10 illustrates the percentage of classifiable cases using both PCR and hospital data. Overall, pre-hospital data was much better suited to determine the type of event and source of injury than hospital data.

Table 10. Percentage of Classifiable Cases Using OIICS Definition By Level

	PCR (N=1,041) Percent	Hospital (N=570) Percent	Combined (N=1,611) Percent
Nature of Injury			
Level 1 (Division)	95.0	99.8	96.7
Level 2 (Maj. Grouping)	89.5	97.7	92.4
Level 3 (Detailed)	82.1	76.3	80.1
Level 4 (Detailed)	46.4	39.8	44.1
Part of Body			
Level 1 (Division)	100.0	98.8	99.6
Level 2 (Maj. Grouping)	85.2	94.4	88.5
Level 3 (Detailed)	53.4	59.0	55.4
Level 4 (Detailed)	3.4	7.2	4.7
Type of Event			
Level 1 (Division)	95.3	88.8	93.0
Level 2 (Maj. Grouping)	93.7	30.2	71.2
Level 3 (Detailed)	90.0	12.5	62.6
Level 4 (Detailed)	77.1	3.5	51.1
Source of Injury			
Level 1 (Division)	94.8	68.4	85.5
Level 2 (Maj. Grouping)	94.4	65.4	84.2
Level 3 (Detailed)	92.6	9.5	63.2
Level 4 (Detailed)	85.0	1.9	55.6

The two largest categories of agricultural injuries were for machinery (n = 303) and animals (n = 523). Of all animal-related injuries, 87% were caused by horses (n = 454). Machinery-related cases occurred with a greater frequency in Maine (21.8% of all agricultural injuries) than in New Hampshire (16.6%). Alternatively, animal-related injuries occurred with a higher frequency in New Hampshire (47.6%) versus Maine (24.8%). Both findings were statistically significant. Seasonal patterns appear in the agricultural data, with clear peaks in the summer months for each of the three years under surveillance. The same patterns are not apparent in the logging data.

The vast majority of injuries were traumatic in nature (96%) as opposed to acute events, such as heat exhaustion or allergic reactions. Of traumatic injuries, 21% were open wounds, which included cuts, lacerations, and amputations. Amputations most often of fingers made up 2% of all cases. Fractures constituted 10% of the 9.4% of the injury data set, and "soreness, pain, or unspecified injury" constituted nearly one quarter of all cases. Chainsaw (n = 79) and tree-related (n = 175) injuries made up a significant proportion of the injury events that were attributable to both industries (logging work potentially on agricultural land).
We have given aggregate data back to the states, to provide their public health programs with the ability to prioritize safety for agriculture and forestry in their area. We worked with New Hampshire's Occupational Health Surveillance program and Rural Health & Primary Care Section to write an issue brief on farm injury in the state. This project was a finalist for the 2016 Hooley Award from Image Trend, the EMS Software provider for Maine and New Hampshire.

Conclusions. Throughout this grant period, long-standing agricultural injury surveys such as the National Agricultural Workers Survey (NAWS) were terminated, therefore making the creation of a sustainable low cost surveillance system even more important. Describing the burden of injury is an essential piece of the public health model, and is the foundation on which many policy and funding decisions are made. Therefore, investment in a long-term system, well suited to track changes over time is paramount.

Outputs and Outcomes.

Publications

Scott EE, Bell E, Hirabayashi L, Krupa N, Jenkins PL. Data Processing and Case Identification in an Agricultural and Logging Morbidity Surveillance Study: Trends over Time. American Journal of Industrial Medicine. Accepted for Publication, May 2017.

Scott EE, Bell EM, Hirabayashi L, Krupa N, Jenkins P. Trends in Nonfatal Agricultural Injury in Maine and New Hampshire: Results from a Low-Cost Passive Surveillance System. Journal of Agromedicine. January 2017. Volume 22, No. 2. Pages 109-117.

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Scott EE, Krupa NL, Horsman M, Jenkins PL. Estimation of agricultural and logging injury incidence in Maine using electronic administrative data sets. J Agromedicine. 2015;20(2):195-204. doi: 10.1080/1059924X.2015.1009668. PubMed PMID: 25906278.

Presentations

Scott EE. Injury Surveillance in Agriculture and Forestry: Chasing the Ambulance to the Hospital, 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. (lecture)

Scott EE. Establishing a Low-Cost Surveillance System for Agricultural and Logging Injury in the Northeast, July 2016, AgriSafe Network (Webinar)

Scott EE. Injury Surveillance in Agriculture and Logging, April 2015, Columbia Mailman School of Public Health, NYC, NY (lecture)

Scott EE. Occupational Injury Surveillance in Agriculture and Logging, September 2015, University at Albany, Environmental Health Sciences Seminar, Albany, NY (oral presentation)

Scott EE. Comparing Computer Coding of OIICS against a Visual "Gold Standard" for Farming and Forestry Injury, June 2015, CSTE, Boston, MA (oral presentation)

Scott EE. Alternative Sources of Injury Data, May 2015, Northeast Regional Occupational Health Meeting (NEON), Chester, CT (oral presentation)

Scott EE. New Surveillance Strategies for Agricultural and Forestry Injury, April 2015, Columbia Mailman School of Public Health, NYC, NY (lecture)

Developing Surveillance Methodology for Agricultural and Logging Injury in New Hampshire Using Electronic Administrative Data Sets, April 2015, University at Albany School of Public Health Poster Day, Rensselaer, NY (poster)

Scott EE. Establishing a Surveillance System for Traumatic Agricultural and Forestry Injury in the Northeast US, SHARP October 2014, Saskatoon, Saskatchewan (oral presentation)

Scott EE. Usefulness of Electronic Administrative Datasets for Traumatic Injury Surveillance in Agriculture and Forestry, June 2014, CSTE, Nashville TN (oral presentation)

Establishing a Surveillance System for Traumatic Agricultural and Forestry Injury in Maine, April 2014, University at Albany School of Public Health Poster Day, Rensselaer, NY (poster)

Scott EE. New Surveillance Strategy for Farming and Forestry Injury, November 2013, APHA Conference, Boston, MA (oral presentation)

Scott EE. New Surveillance Strategies for Agricultural and Forestry Injury, October 2013, University at Albany, Environmental Health Sciences Seminar, Albany, NY (oral presentation)

Scott EE. Agricultural Injury Surveillance Using Multiple Existing Data Sources, October 2012, APHA American Public Health Association Annual Conference, San Francisco, CA (oral presentation)

Scott EE, Ringelsen MJ. Agricultural Injury Surveillance, June 2012, International Society of Agriculture Safety and Health Burlington, VT (oral presentation)

Scott EE. New York Farm Injury Surveillance, October 2011, NIOSH FACE Annual Meeting, Boston, Massachusetts (oral presentation)

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NORTHEAST FISHERIES WINCH SAFETY IMPROVEMENT PROJECT

Project Personnel: Jack Dennerlein (Initial PI), Ann Backus (Final PI), Carmine DeStefano

Participatory Study Committee

Julie Sorensen, Northeast Center for Occupational Safety and Health CNEC)

Fred Mattera, New England Safety Training Company (NESTCO)

Ted Teske, National Institute for Occupational Safety and Health (NIOSH)

Abstract :The objectives of this study were to improve the safety of winch operations in the Northeast multispecies fishery by interviewing trawler captains to learn about administrative protocols and drum winch configuration and operation, to design one or more mechanical devices to enhance safety, disseminate study results and encourage adoption of safer practices and devices. Fifty-four trawler captains in Gloucester and New Bedford MA, and in Point Judith, RI were surveyed using an instrument developed by the study team and others. Of those surveyed 100% had winches that were hydraulically powered. Of the 89% of survey respondents who reported having a Power Take Off (PTO i.e., shut–off) switch on board, 39% reported that these shut-off switches were more than one arm's length away from the winch operator, thus prohibiting immediate winch shut-down in the event of an accident. While findings showed that 39% of the boats still use the hazardous manual level wind technique, the fishermen in focus groups gave a higher priority to the design and development of a PTO over a mechanical hydraulic level winder.

The sea trial of the resulting *Active Pressure-Sensitive Winch Guard and Stop* was an over-whelming success; the solenoid out-fitted device stopped the winch in less than a second and the counterbalance value controlled the unwinding to permit careful extract of a person or article caught in the winch. A variety of media formats are being used to disseminate the information and encourage adoption.

Background: Winches are necessary equipment on the trawlers in the Northeast multispecies fishery. They are used for hauling back two long cables – generally hundreds of fathoms/thousands of feet long - which are attached to the large fish net that is towed behind the boat. These winches are responsible for a significant number (16%) of the onboard fatal injuries associated with gear entanglement (MMRW, 2010).

Drum winches are especially hazardous to fishermen working nearby because they rotate. The risk of injury is further heightened because the on-off controls for the winch are frequently many steps, even many feet, away from the winch itself. Although most of the commercial fishing fatalities are attributed to flooding, sinking, capsizing, and man overboard, a recent study by the Coast Guard cites "struck by or caught in lines or other equipment" as the next most frequent cause of fatal accidents. During the period of this report, 1992-2007, 20 of the 59 fatalities of this type were due to winch entrapment (Dickey, 2008).

Fatality data gathered as part of a large national study by the NIOSH Alaska Pacific Regional Office personnel showed deck winch entanglements responsible for 12 deaths from 2000-2009 with five of those 12 deaths occurring from New Jersey to Maine, four in the Gulf of Mexico states and Florida, and two in Alaska (Lincoln and Lucas, 2010). US Coast Guard District I (New England and New York) personnel report two gear entanglements (2001, 2003), two shaft entanglements (1999), and three winch entanglements (1995, 2001(2)) (Bassick, 2010).

The Northeast multispecies fishery has the highest fatality rate of all fisheries in the country according to the Morbidity and Mortality Weekly Report of July 16, 2010. In that article, Lincoln and Lucas calculated a rate of 600 deaths per 100,000s FTEs for this fishery (MMRW, 2010). The next highest rate is 425 in the Atlantic scallop fishery (includes Mid-coast and North Atlantic) followed by a fatality rate of 310 in the West Coast Dungeness Crab fishery of Discovery Channel fame. The Northeast multispecies fishery is one of four Northeast fisheries studied by Lincoln and Lucas; together the four accounted for 25% of the

504 deaths in the 2000-2009 period. Non-fatal accidents and near-misses undoubtedly occur however records of these incidents are not routinely kept and data are only available through personal communication.

Aims:

AIM 1: We will address winch safety through the hierarchy of controls: elimination, substitution, engineering, administrative controls and personal protective equipment (NIOSH, 2010). The controls most appropriate in this winch safety context are administrative, including separation, elimination, and engineering.

AIM 1.1: Develop best practices for drum winch operation. Through a participatory process (involving focus groups and surveys) we aim to develop administrative controls that include boat-based policies and practices which keep fishermen at a safe distance from the winch.

AIM 1.2: Develop one or more designs and retrofit kits for emergency shut-off systems for drum winches in the event of an entrapment accident. We will utilize a participatory design process for development of the e-stop, and the target audience is those boats that do not have shut-off capability within an arm's length or have not taken other measures (such as winch positioning and guard rails) to keep fishermen from being entrapped.

AIM 1.3: Develop a remote or automatic hydraulic winder or cable guide that provides level winding of the cable on the spool, separating workers from the high entrapment area in front of the winches. Our exploratory survey revealed that several boats employ a hydraulic pusher, operated from behind the drum and away from the cable intake, to provide level winding of the cable. We will utilize a participatory design process during development of the remote or automatic hydraulic winder to disseminate to boats not-employing this approach.

AIM 2: We will undertake outreach and dissemination activities and engage existing and new networks and collaborations in an effort to encourage adoption of the administrative controls, emergency shut-off designs, and the hydraulic level winder solutions for winches in the Northeast fisheries.

Methods- Inclusion and Exclusion: Carmine (Joe) DeStefano, Program Coordinator, requested public access information from the DOC/NOAA Fisheries Analysis & Program Support that contained contact information for New England Vessels. The request was stated as: *"Fishing with otter trawl gear from 2010 to present" from vessel trip reports (VTR's) and Northeast permit database.* The data base was sent to the study team by the Northeast Marine Fisheries Service Center in Gloucester, MA. We queried this data base using telephone area codes to separate out vessels in the RI area (401), Gloucester MA (978) and New Bedford MA (508). This method yielded 198 vessels for our survey. All other fishing vessels were excluded from the dataset.

Recruitment: From the culled list of 198 names of captains, the goal was to enroll 100 captains in the drum winch study. In total 54 captains were recruited and enrolled.

Survey Development: Through an iterative process, the study team developed survey questions that would be administered to the fishing captains. The survey instrument was critiqued by Fred Mattera, a safety trainer and former multispecies captain from Point Judith, RI and at a meeting of the Participatory Study Committee held in New Bedford in 2012. The original plan, to use a contractor to recruit, enroll, and administer the survey to captains by phone was abandoned after it was clear that captains were not answering the phone calls.

The Harvard School of Public Health IRB P21194 was approved for administration of the survey. Comments from the Participatory Study Committee that met in the fall of 2012 were incorporated into the final version dated 11-28-2012. Survey sections included:

- Vessel Information
- Drum Winch Configurations and Maintenance
- Drum Winch Configurations
- Drum Winch Safety Equipment
- Drum Winch Safety Procedures
- Level Winding Equipment and Operations
- Safety Training and Climate

Approach: Discussions with the Participatory Study Committee resulted in a consensus that boat captains should be approached in person rather than by phone. Joe DeStefano employed a face-to-face "dock talk" approach with captains in Gloucester and New Bedford to establish rapport, then obtained consent and administered the survey. Fred Mattera of Point Judith administered the Point Judith surveys using the same approach. Four captains from Martha's Vineyard also participated. A total of 54 surveys were completed and when allowed, photographs were taken to document winch placement and operation.

Analysis: Survey data were entered into an Excel™ database by an HSPH intern; basic descriptive analyses were undertaken by Ann Backus, Joe DeStefano and by staff at the Northeast Center. A deeper analysis was later undertaken by Eva Madrid Aris and Ann Backus.

Participatory priority-setting: The survey data were shared with focus groups of captains in Gloucester and Point Judith to help the study team determine whether to prioritize designing a level winder or a PTO-style shut-off device. After priority was given to the PTO device, several designs were drawn-up. Consultation with Fred Mattera and a marine fabricator in Point Judith, RI resulted in our choosing Rhode Island Engine as the fabricating company. After presenting schematic diagrams of hydraulic level winders and an emergency "crashbar" to two focus groups of trawler captains in early 2014, NEC researchers hosted two more focus groups, one in Gloucester (Dec. 2014) and one in Point Judith (Nov. 2014) to get additional feedback on these schematics and to test the level of interest in the devices.

Safety education videos: Three on-board educational videos were produced by a professional videographer in collaboration with two captains in Gloucester and one in Point Judith. The third of which was a videographic chronicle of the sea trial of the *Active Pressure-Sensitive Winch Guard and Stop*. Before final release of the videos, the videographer made changes in terminology and labelling based on suggestions made by members of the Participatory Study Committee, December 2015.

Device design and sea trial: A winch guard and shut-off device was designed by Rhode Island Engine and tested in a sea trial on the F/V Lightening Bay on September 25, 2015. Because it is activated by the pressure of a crew member falling against it, the device was named *Active Pressure-Sensitive Winch Guard and Stop*.

Dissemination: Articles in fishing trade publications, videos on the study website, displays at Fishermen's Forums (Maine) and Commercial Marine Expo (Mass), presentations and advertisements in the 2017 and 2018 Skipper's Log Books have been produced.

Selected Findings

Table 11: Captain Experience and Opinion (N=54)

Experience or Opinion	Response
Average vessel experience	18.3 years
Average number of crew members on vessel	3.3 people
Average fishing experience	32.4 years

Administer safety drills? (self-report)	65% Yes
Think *others* inspect safety equipment?	50% Yes
Crew member manually guides wire onto drum? (Figure 2: Drum winch with guide bar.)	35% Yes
Thought a level-winder would improve safety.	76% Yes
Thought a PTO (shut-off) would improve safety.	89% Yes
Would be likely to adopt a level winder.	69% Yes
Would be likely to adopt a PTO (shut-off).	83% Yes

Table 12: Drum Winch Configuration and Operation

Drum Winch Configuration and Operation	**Response**
Split winches (a winch at each side of the deck)	80%
Split winches located on the deck, not upper level	83%
Winches hydraulically powered?	100% Yes
Crew member manually guides wire onto winch?	35% Yes
Do not have hydraulic level winder (Fig. 3)	90%
Have PTO (shut-off) switch on board	89%
PTO (shut-off) is more than 1 arm length from winch operator?	39%

Focus Group Results: In 2014, focus groups were held in Gloucester and New Bedford in two phases of the study. During the first focus group the discussion was to obtain feedback regarding whether to prioritize designing a new hydraulic level winder or a winch stop mechanism. Priority was given to the winch stop mechanism. The second set of focus groups (Nov/Dec 2014) reviewed two winch stop designs.

Sea Trial of Winch Stop Device: On September 25, 2015 researchers undertook a sea trial of the pressure sensitive device developed by Rhode Island Engine and installed on the F/V Lightening Bay. The results of this trial exceeded the expectation of the marine fabricator, the captain and crew of the vessel and the study team. When pressure was applied to the guard/stop device and electrical contact was made that caused the solenoid to shut-down the winch within a second. The marine fabricator had added a counterbalance value to the original design which enabled the operator to run the winch in reverse at a slow speed to allow for removal of the person or article that was caught in the winch. The Trip 3 video listed in outputs chronicles this sea trial.

Dissemination: A variety of outlets have been used for dissemination: fishing industry trade journals, marine trade shows, presentations within NEC and HSPH, presentations to the New England Occupational Safety Surveillance Network, and advertisements purchased in the Skipper's Logbook. In 2016 the study team showcased the sea trial video of the Active Pressure-Sensitive Winch Guard shut-off device at the Fishermen's Forum in Rockport, Maine, March 4, 5, and at the Commercial Marine Expo in New Bedford, MA on April 27, 28. The manuscript was rejected for publication, but is suitable for resubmission to a peer-reviewed journal.

Conclusions: The participatory approach, used throughout the Northeast Fisheries Winch Safety Improvement Project, was extremely valuable; it enabled us to understand the priorities and concerns of the northeast fishermen. Pilot data, collected from fishing captains in the summer of 2010 informed the initial grant submission to NIOSH through the Northeast Center (NEC). During the large study, input from fishermen and others required us to change our approach from a phone survey to face-to-face "dock talks" which resulted in our having a deeper understanding of winch configuration and operations as well as of how economic stress influences safety. The small focus groups of fishermen allowed us to obtain feedback regarding the survey results, set design

priorities, gauge interest, and debate design schematics. The Participatory Study Group consisting of a fisherman, an engineer, NEC staff and the study team were used to vet the survey, approach, and videos.

Winch operation is a serious hazard for deck-hands. Our data show that, whereas 76% of the captains interviewed thought that a hydraulic level winder would improve safety for the deck hands and 69% would be interested in adopting such a device, 89% thought a PTO (shut-off) would improve safety and gave priority to designing such a device. These numbers suggest that the captains view winch entrapment as rather unlikely and were not as interested in paying for a device that might prevent entrapment as adopting and paying for a device that would shut-off the winch should entrapment happen. In terms of outcomes, Aims 1.1, 1.2 and 2 were substantially achieved; Aim 1.2 (hydraulic level winder) was deemed by captains and therefore the study team inexpedient to implement.

Outputs

Backus A, DeStefano C, Madrid E, Sorensen J. Drum winch configurations in northeastern U.S. multispecies groundfish fishery. A cross-sectional study. Manuscript (unpublished).

Articles

Crowley M. Mar. 2016. Winch Excluder. National Fishermen.96(10): 33.

Backus A. Sept. 2012. Avoid Overloading Winches, Hosting, Hauling Rigs. Commercial Fishermen's News. 40(1):28

Backus A. Mar. 2014. Winch safety study identifies emergency shutoffs. *Commercial Fisheries News*. 41(7):37.

Backus A. Jan. 2014. Winch safety study identifies crew hazards. *Commercial Fisheries News*. 41(5):40.

Presentations (selected)

Backus A. Rutgers Safety Tour. US Coast Guard Station, Portland, Maine. June 2016.

Backus A. Northeast Occupational Safety and Health Surveillance Group (state OSH components of departments of public health), May 2012

Backus, A. Harvard ERC Faculty Retreat, August 2012

Backus,A. Harvard ERC External Advisory Board, May 2013, May 2014, May 2015, May 2016

Backus, A., DeStefano C. NEC Dec 2013

Videos

Backus A., DeStefano C. Sept 2015 Video: Winch Safety Project. Trip 3: Sept 25, 2015: F/V Lightning Bay, Photographer Bob Douglas. https://vimeo.com/154893452

Backus A., DeStefano C. August 2015 Video: Winch Safety Project Trip 2: August 6, 2015: F/V Kelsi & Morgan, Photographer Bob Douglas. https://vimeo.com/154889118

Backus A., DeStefano C. May 2015 Video: Winch Safety Project. Trip 1: May 18, 2015: F/V Lady Jane, Photographer Bob Douglas. https://vimeo.com/154883311

Advertisements

Navigator Publishing. 2017 Skipper's Log Book. Winch Guard/Stop quarter page advertisement.

Navigator Publishing. 2018 Skipper's Log Book. Winch Guard/Stopquarter page advertisement.

ON-LINE TOOL FOR DESIGNING VENTILATION SYSTEMS TO REDUCE MANURE PIT ENTRY RISK

Project Personnel: Dennis Murphy (PI), Harvey Manbeck, Virendra Puri, Dan Hofstetter

Abstract: On-farm manure storage pits contain both toxic and asphyxiating gases such as hydrogen sulfide, carbon dioxide, methane and ammonia. Farmers and service personnel occasionally need to enter these pits to conduct repair and maintenance tasks. One intervention to reduce the toxic and asphyxiating gas exposure risk to farm workers when entering manure pits is manure pit ventilation. This report describes an online computational fluid dynamics based design aid for evaluating the effectiveness of manure pit ventilation systems to reduce the concentrations of toxic and asphyxiating gases in the manure pits. This design aid, developed by a team of agricultural engineering and agricultural safety specialists at Pennsylvania State University, represents the culmination of more than a decade of research and technology development effort. This report includes a summary of the research efforts leading to the online design aid development and describes protocols for using the online design aid, including procedures for data input and for accessing design aid results. Design aid results include gas concentration decay and oxygen replenishment curves inside the manure pit and inside the barns above the manure pits, as well as animated motion pictures of individual gas concentration decay and oxygen replenishment in selected horizontal and vertical cut plots in the manure pits and barns. These results allow the user to assess: (1) how long one needs to ventilate the pits to remove toxic and asphyxiating gases from the pit and barn; (2) from which portions of the barn and pit these gases are most and least readily evacuated; and (3) whether or not animals and personnel need to be removed from portions of the barn above the manure pit being ventilated.

Background: On-farm manure storage pits contain both toxic and asphyxiating gases. The primary gases of concern are hydrogen sulfide, ammonia, carbon dioxide and methane. Occasionally, farm workers may enter the manure storage pits for maintenance and repair. Most farms do not have self-contained breathing devices; many do not have toxic and asphyxiating gas detection devices. Consequently, farm workers often enter the manure pits unprotected, lose consciousness and die. Tragically, such incidents often result in multiple deaths as an observing worker tries to assist the one originally overcome by the toxic and asphyxiating gases. Beaver and Field (2007) summarized documented fatalities in livestock manure storage and handling facilities from 1975 to 2004. One result from this analysis of 77 fatalities cases showed an increasing trend in the death rate: 1.6 per year from 1975 through 1984, 2.7 per year from 1985 through 1994, and 3.5 per year from 1995 through 2004. One intervention to reduce the toxic and asphyxiating gas exposure risk to farm workers entering the manure pits is manure pit ventilation. The basic questions then become: (1) How much and for how long must the manure pit be ventilated to reduce entry risk, and (2) Does the manure pit ventilation contaminate portions of the barn above manure pits during pit ventilation?

Aim: The specific aims of the research were to:

1. Develop and field test a user friendly, on-line, web-based computer simulation program for custom designing ventilation systems for a wide range of new or existing on-farm confined-space manure storage configurations, ventilation system details, and initial contaminant gas levels.
2. Develop, deliver, and evaluate a training program to teach engineers and agricultural facilities planners how to use the on-line web-based tool.
3. Review the international engineering standard, ANSI/ASABE S607, Ventilating Manure Storages to Reduce Entry Risk, for possible inclusion of language that incoprporates appropriate CFD engineering analysis.

Methods: A suitable computer aided design program that has computational fluid dynamics (CFD) simulation capability is essential for the user-friendly, on-line design tool development. We selected SolidWorks), one of the premier computer aided design tools, and one of the most widely used in the world by design engineers, for this application. SolidWorks has superb visualization capability. The conceptual model that guided this work was the previously validated and published CFD simulation protocols developed in previous research. Simulated evacuation times and oxygen replenishment times from the design tool were compared to those previously simulated using PHOENICS and reported in several research reports. SolidWorks protocols were modified until

agreement was reached between the ventilation times required to evacuate noxious gases from the manure pit from the SolidWorks simulations and the PHOENICS simulations. The SolidWorks and PHOENICS simulations agreed to within modified ASTM prescribed statistical criteria. This step validated the on-line-tool simulation protocols.

A guided Windows- and web-based pre-processing package was developed to generate the input data required to simulate the ventilation of an on-farm, confined-space manure storage. The input package was sufficiently general to define the geometry and size of the storage, characterize the storage cover, characterize any special features of the storage including partitions or partial partitions or airflow obstructions inside the manure pit, characterize ventilation system details such as fan location and size, air outlet location, and define gas types and initial concentrations, gas emission rates, and initial oxygen levels. A range of typical input selections was provided in each drop down menu, but each also allowed the user to customize the input, if necessary, to properly characterize the manure storage and ventilation system. The pre-processing package then interfaced the selected input data with the SolidWorks computer aided design CFD program. The pre-processing input routine was designed to interface with a Cloud-based Computing platform.

A Windows-based post-processing output interpretation package was developed to generate the output data required to assess the performance of the ventilation system. This routine interprets and presents, in useful formats, the results generated by the CFD analyses from the computer aided design on-line tool. Output data include time to evacuate contaminant gases to below respective TLVs, time to replenish oxygen to 20 % by volume, and the manure storage regions adequately ventilated after several pre-selected ventilated time intervals. The post-processing routine is sufficiently flexible to allow the user to customize the outputs and interpretations desired. The computer aided design on-line output then interfaces with the on-line user's computer and presents the output on-line to the user.

The Windows-based pre-and post-processing packages have been loaded onto a web page maintained by Penn State University Extension. The web page also links either directly to a user's in-house SolidWorks program or to a SolidWorks' Cloud-Based Computing Server. In the Cloud-based Computing format, the user interacts between the server containing SolidWorks' CFD programs using the pre- and post-processing packages. The pre- and post-processing packages were evaluated (alpha-tested) by a set of engineers and agricultural facilities planners familiar with on-farm, confined-space manure storages. The project leaders used these evaluations to refine the pre-and post-processing packages for the purpose of improving user-friendliness and modifying the types of design inputs and outputs required by the typical user. Beta-testing was then conducted using procedures identical to those for the alpha-testing except that the evaluators generated all the inputs for a given confined-space manure storage facility. The beta-testing procedures more closely mimic how a designer uses the on-line tool in the field than did the alpha-testing procedures.

A training program was developed to teach the design engineering and agricultural facilities planning community how to efficiently and effectively use the developed on-line tool. The training program included several training venues such as webinars, on-line web based session(s), and traditional continuing education workshops at professional and trade association meetings. Several web-based training modules are developed and are on the Penn State Extension website.

ASABE Standard S607, Ventilating Manure Storages to Reduce Entry Risk" was reviewed and approved for a second-five-year period prior to an opportunity to update language that incorporates a reference to appropriate CFD engineering analysis. Incorporating this language will occur at the next five-year review in 2020.

Conclusions and Impacts: This project represents an innovative approach that utilizes online software to design manure pit ventilation for human entry into a manure pit that utilizes online software. This software has been turned into an online design aid and represents the culmination of more than a decade-long research and technology development effort at Pennsylvania State University. The online design aid tool results include contaminant gas concentration decay and oxygen replenishments curves inside the manure pit and inside the barns above the manure pits, as well as animated motion pictures of individual gas concentration decay and oxygen replenishment in selected horizontal and vertical cut plots of the manure pits and barns. These

results identify ventilation time requirements, manure pit gas evacuation patterns, and animal and personnel evacuation requirements. The described design aid tool is useful for determining when contaminant gases have been evacuated from the entire manure pit, or portions thereof, to levels suitable for human entry. It is useful for defining the portions of the manure pit that can be entered for planned repair and maintenance or for emergencies even when self-contained breathing equipment is not available to personnel. The online design aid tool is not intended to replace the need to continuously monitor confined-space manure pits for contaminant gases and oxygen level prior to and during an entry event. The online design aid is currently available to users at no cost. In the future, the design aid will be available to users either at no cost or for the cost of computer project simulation run time. This is extremely cost effective, especially for designers, planners, or regulatory personnel that only require manure pit CFD simulations a few times each year.

Outputs and Outcomes:

Webinars

Manbeck HB, DW Hofstetter, DJ Murphy and VM Puri Online Tool for Evaluating Manure Pit Ventilation Systems to Reduce Entry Risk. Webinar presentation to NRCS Personnel. 5/24/16.

Workshops

Murphy DJ, Manbeck HB, Hofstetter DW, and Puri VM. Online Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk. Presented at the 2014 NRCS Engineering Technical Update Workshop, in Pennsylvania Furnace, PA, 6/5/14.

Manbeck HB, DW Hofstetter, DJ Murphy and VM Puri. Enhanced Online CFD Tool Features for Ventilating Manure Pits. A 7 session, 6-hour educational workshop *Online Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk* was conducted as a Continuing Education Session at the ASABE Annual International Meeting, New Orleans, LA. 7/26/15.

Website

Hofstetter DW, HB Manbeck, DJ Murphy, VM Puri. Launched https://ventdesign.agsafety.psu.edu September 23, 2014. The website now contains the 7 session, 6-hour educational workshop *Online Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk* by Dr. Harvey Manbeck to teach users how to use the online tool. Over 40 independent users have registered for an account.

Journal Publications

Murphy, D.J. and H. B. Manbeck. 2014. Confined Space Manure Storage and Facilities Safety Assessment. *Journal of Agricultural Safety and Health*, 20(3):199-210.

Manbeck HB, Hofstetter DW, Murphy DJ and Puri VM. 2016. Online Design Aid for Evaluating Manure Pit Ventilation Systems to Reduce Entry Risk. *Frontiers of Public Health* 4:108. doi: 10.3389/fpubh.2016.00108.

Murphy DJ, HB Manbeck, DW Hofstetter, VM Puri. 2017. Online CAD/CFD-Based Design Tool to Assess Ventilation Strategies to Reduce Confined-Space Entry Risk. 2017. *Chemical Engineering Transactions*, Vol. 58. doi: 10.3303/CET1758001.

Technical Paper Presentations

Hofstetter DW, HB Manbeck, VM Puri, DJ Murphy. Confined Space Ventilation Modeling Using SolidWorks Flow Simulation. Presentation at SolidWorks World 2013 in Orlando, FL, January 21 to 23, 2013.

Hofstetter DW, Manbeck HB, Puri VM, and Murphy DJ. Manure Pit Ventilation Modeling using SolidWorks Flow Simulation. Presented at NABEC 2013, June 16-19, 2013, Altoona, PA. NABEC Poster No. 13-039.

Hofstetter DW, Manbeck HB, Puri VM, and Murphy DJ. CFD Simulation of Manure Pit Ventilation using SolidWorks. Presented at the 2013 ASABE Annual International Meeting, July 21-24, 2013, Kansas City, MO. ASABE Poster No. 1621753.

Hofstetter DW, Manbeck HB, Puri VM, and Murphy DJ. An Online Confined-Space Manure Ventilation Design Tool Using SolidWorks Flow Simulation. Presented at the 2014 ASABE Annual International Meeting, in Montreal, QC Canada, 7/13-16/14. ASABE Paper No. 141913912.

Manbeck HB , DW Hofstetter, DJ Murphy and VM Puri. Online Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk. Presented at the ASAE Conference. New Orleans, LA, 7/26/15.

Hofstetter, DW, DJ Murphy, HB Manbeck, VM Puri. Online Evaluation of Manure Pit Ventilation Systems to Reduce Entry Risk. Presented at Illinois Pork Expo, Springfield, IL, Feb. 16-17, 2016.

Manbeck HB, DW Hofstetter, DJ Murphy and VM Puri. Online Tool for Evaluating Effectiveness of Manure Pit Ventilation to Reduce Entry Risk. Presented at ASABE Conference. Orlando, FL, 7/19/16

Manbeck HB. 2017. Online Ventilation Tool to Reduce Entry Confined-Space Risk. Presented at 2017 Central Pennsylvania Safety Association Professional Development Conference, April 6, 2017.

Murphy DJ, HB Manbeck, DW Hofstetter, VM Puri. 2017. Online CAD/CFD-Based Design Tool to Assess Ventilation Strategies to Reduce Confined-Space Entry Risk. Presented at CIOSTA2017, Sicily, Italy, June 13-15, 2017.

Media Coverage

PennState News . Confined-space manure ventilation design tool to save lives on farms. May 12, 2016. Available at http://http://news.psu.edu/story/410461/2016/05/12/research/confined-space-manure-ventilation-design-tool-save-lives-farms.

Pork News. New tool to monitor manure storage will help save lives. May 24, 2016. Available at http://www.porknetwork.com/news/new-tool-monitor-manure-storage-will-help-save-lives.

Lancaster Farming. May 21, 2016. Manure ventilation design tool to save lives on farms Available at http://www.lancasterfarming.com/farm_life/health_and_safety/manure-ventilation-design-tool-to-save-lives-on-farms/article_9014653b-000c-5c35-869b-fd68322d5851.html.

Flammini D. New ventilation tool available for manure pit designers: Online tool can help create safer environments. June, 2016. Available at http://www.farms.com/ag-industry-news/new-ventilation-tool-available-for-manure-pit-designers-025.aspx.

Radio: KLGR 1490 AM/95.9 FM, Redwood Falls, MN, Host Dustin Hoffman. May 26, 2016. Five minute interview as part of a Farm Report. 10,000 listeners in 2 counties.

Radio: Brownfield Ag News, Host Julie Harker. Five minute interview. Interview distributed to 400 radio station in 10 states.

SOCIAL MARKETING OF MACHINERY SAFETY SHIELDS

Project Personnel: Julie Sorensen (PI), Pam Tinc

Abstract. Agricultural workers face tremendous risks every day. One of the leading causes of injuries on farms is power take-off (PTO) entanglements. Though these injuries are often non-fatal, many result in amputations or otherwise life-long disabilities. PTO shields can be installed to prevent farmers from becoming entangled in the driveline; however, many farmers are resistant to doing so. While many studies have been done to explore this issue, there has been little focus on finding feasible solutions and encouraging the uptake of PTO shields. This study sought to develop a targeted social marketing campaign to increase the use of PTO shields on New York farms. In order to identify an appropriate target population, a telephone survey of over 3,000 NY farmers was conducted to determine shielding practices. Barriers and facilitators to replacing missing or damaged PTO shields were determined via interviews. Using this information, a social marketing campaign was developed with the intent of reducing barriers to

installing PTO shields and increasing the motivators to doing so. Focus groups and surveys with farmers further informed campaign development. The intervention was trialed for a six month period in six NY counties.

Upon completion of the telephone survey, the research team found that the estimated shielding rate (92%) was much higher than anticipated. Therefore, on-farm audits of PTO shields were conducted with 211 farmers, revealing a shielding rate of 57% and little variation between commodities, farm size, or experience. Thirty-eight farmers, farm spouses, and farm children participated in the interviews. Though the social marketing campaign was designed based on farmer input, it failed to demonstrate an increased uptake of PTO shields. Farmers have a long history dealing with PTO drivelines and PTO shields; that history has shown to limit the impacts of social marketing campaigns, and instead highlights the need to innovative persuasion techniques. In further studies, the research team will explore such campaigns in an effort to "boost" the social marketing campaign and increase PTO shielding in NY.

Background. Of the myriad fatal and non-fatal injuries that occur on US farms, machinery entanglements, including power take-off (PTO) entanglements, are among the most common.[1] These injuries can be particularly devastating to the farmer, as many can result in permanent disability. A 2005 study of nearly 700 driveline-related accidents over three decades indicated that 60% of PTO entanglements resulted in non-fatal injuries; two-thirds these involved amputations,[2] resulting in significant medical costs[3] as well as other long-term consequences.

PTO and machinery entanglements can happen on any farm; however, they are most common on small, diversified farms[2] such as those in New York.[4] NEC surveillance data estimates that 11 fatal machinery entanglements occurred between 2008 and 2014; 36.4% of these fatalities are known to have been caused by PTO drivelines.[5]

To prevent entanglements, PTO drivelines can be covered with metal or plastic guards. Such guards allow PTO drivelines to freely rotate while preventing operators from having their hair, clothing, or body caught on the uneven surfaces of the driveline. Unfortunately, many farmers do not replace shields when they are damaged or missing; prior studies have reported missing guards on 20% to 33% of PTO drivelines and damage on up to 20% of shields that are present.[6,7] A damaged shield can be as dangerous as an unguarded driveline.

In the past, the majority of the research on PTO entanglements and shielding has been done to define and characterize the scope of the issue in the US.[2,3,6,8-11] Few studies have described efforts to reduce injuries and fatalities from PTO entanglements outside of educational efforts that demonstrated limited success.[12,13]

Specific Aims. The long-term goal of this proposal was to develop a social marketing intervention model that uses research and industry partnerships to give proven safety devices, such as machinery shields, a sustainable, competitive advantage. This goal was to be achieved through the following specific aims:

1. *Identify a 'target audience' in the NY farm population.*

2. *Identify the target's prominent barriers and motivators to installing shields on rotating shafts.*

3. *Establish a project partnership with shield manufacturers/distributors.*

4. *Develop a machinery shielding, social marketing intervention.*

5. *Evaluate the effects of the social marketing intervention.*

Methods. The initial phase of this research involved identifying a target population within the state of New York. Per the initial research plan, this involved conducting telephone surveys through the National Agricultural Statistics Service (NASS) in NY. During this telephone survey farmers from several commodities (dairy, livestock, fruit, vegetable, and crop) were invited to participate. For each implement the farmer owned, he/she was asked, "is the PTO on *[implement]* shielded?" Shielded was defined for participants as, "having a shield that was not cracked or damaged in any way and properly connected."

In addition to telephone surveys, on-farm PTO shield audits were also conducted. Team members drove throughout NYS and randomly selected dairy and livestock farms to visit. Dairy and livestock farms were selected as they have been shown to be most at risk for PTO entanglements (personal communication with D. Voaklander, CAISP, 2012). At each farm, the team members visually inspected each PTO driveline for shield condition using the FARMHAT tool.[14]

Additionally, photographs of each driveline were taken. All photographs and FARMHAT scores were reviewed by a second reviewer to ensure accuracy. The FARMHAT tool involves scoring farm hazards on a scale of one to five; however, for PTO drivelines, the level two was not clearly defined, and therefore not used. The final ranking was as follows: 1) driveline shield is in place, in good condition, and rotates easily, 3) driveline shield is in place but is bent, cracked, sliced, and/or does not rotate, 4) driveline shield is in place but is bent, cracked, sliced, and/or bearing is missing or damaged, and 5) driveline shield is missing, or the machine never had a driveline shield.

In addition to obtaining data about PTO shielding rates, the research team also conducted interviews to determine the barriers and facilitators that farmers face in regard to replacing damaged or missing PTO shields. Potential participants were contacted via telephone and invited to participate in interviews, which were subsequently conducted at the participant's home. Interviews were audio-taped and transcribed. Open Code software was used to facilitate a Grounded Theory analysis of the data.

Several of the largest shield manufacturers were invited to participate in a study advisory board. The goal of this was to obtain feedback about the project and open a line of communication to allow for manufacturers to obtain feedback about shields from farmers so that improvements could be made.

Using the results of the interviews, several message concepts were identified. These messages were presented to small groups of farmers and farm wives. Participants were selected and invited during county fairs and trade shows where the sessions were held. During these group sessions, participants were asked to discuss the positives and negatives of each message, and also select the most impactful. Sessions were recorded and transcribed. At the conclusion of the sessions, the top messages were selected for inclusion in the social marketing campaign. The selected messages were updated based on suggestions provided during the groups sessions prior to use.

Once prepared, the messages were distributed to farmers in a six-county intervention region. Messages were delivered via popular farm publications, agribusiness partners, mailings and newsletters, and in-person events. After allowing the social marketing intervention to run for a six-month period, a follow-up analysis was conducted. For this analysis, PTO shield sales data was collected to determine the impact of the social marketing campaign on PTO shield uptake.

Results. Telephone surveys conducted by NASS indicated a 90.2% shielding rate for farm implements in NY (response rate = 31.5%). Of these farms, 412 represented dairy or livestock farms, and included a total of 2,632 implements. In subsequent on-farm audits, 211 dairy and livestock farms were visited at random (response rate: 95.9%) and allowed visual inspection of PTO driveline shields. This safety audit demonstrated a shielding rate of 56.7%, which more closely aligned with the literature than the NASS survey estimates. Data from the on-farm audits suggest that both dairy and livestock farmers have similar shielding behaviors. Further, no differences in shielding behavior were seen based on farm size or experience level of the operator.

Interviews were conducted with 11 principle operators (nine male, two female), 13 husband and wife operator teams (26 individuals) and one farm son. From these interviews, three main themes were identified related to barriers to shielding: 1) farmers indicated that they have limited resources (time and money) to be able to prioritize farm safety, 2) farmers have had negative experiences

with shielding, making the risk more appealing, and 3) alternative safety strategies, such as turning off the PTO before getting off the tractor, were favored by the farmers interviewed. Though barriers to PTO shielding were highlighted in the interviews, some motivators were also described. Most often, farmers described PTO shielding as a part of an overall strong safety culture, or as part of a larger goal of protecting family members or workers.

As a result of the advisory board of shield manufacturers and distributers, a new style of PTO shield was identified. This shield addressed many of the barriers that farmers described: it was low cost, easy to install, easy to perform maintenance, and provided a universal fit. Given these qualities, the social marketing intervention was designed to alert farmers to this new shield while also promoting PTO shielding in general.

Twenty-eight male and 13 female farmers participated in a total of ten small group discussions about a variety of proposed social marketing messages. From these discussions, three messages were selected for inclusion in the social marketing campaign:

- "Try out the new, affordable PTO shield. It's easier than farming without limbs."
- "Auction today: It took three generations to build this farm and one broken shield to lose it."
- "Losing your arms in a PTO accident is tough, but the toughest thing is not being able to hug your granddaughter again."

The messages were finalized based on feedback from the groups, and promoted through agricultural publications, partnerships with agribusinesses, and during local trade meetings and events. Unfortunately, a follow-up evaluation of the intervention revealed that few farmers in the intervention region had purchased PTO shields.

Conclusions. Though much was learned about the issues surrounding PTO shield use by NY farmers, further work must be done in order to correct this issue. The improved BareCo PTO shield addressed many of the concerns that farmers shared with the research team; however, one vital barrier could not be addressed by either a new style shield or a social marketing intervention. Farmers' history with PTO shields has made them resistant to trying yet another PTO shield. Though many farmers have tested the improved PTO shield, have reported that it meets their needs, and have improved their own shielding behavior, this is not the norm.

To remedy this, the research team has been awarded a grant focused on encouraging farmers to take the first step toward PTO shielding. The research team will use six principles of influence strategies (liking, authority, social proof, consistency, reciprocity, and scarcity) to boost the impact of the social marketing campaign and encourage farmers to try the new style PTO shield.

Outputs and Outcomes.

Publications

Weil R, Mellors P, Fiske T, and Sorensen JA. 2014. A qualitative analysis of power take-off driveline shields: barriers and motivators to shield use for New York State farmers. *Journal of Agricultural Safety and Health,* 20(1): 51-61. DOI: 10.13031/jash.19.10425

Tinc PJ, Madden E, Park S, Weil R, and Sorensen JA. 2015. Concept identification for a power take-off shielding campaign. *Journal of Agromedicine,* 20: 55-63. DOI: 10.1080/1059924X.2014.976731

Chapel DB, Sorensen JA, Tinc PJ, Fiske T, Wyckoff S, Mellors PW, and Jenkins P. 2015. Validation of self-reported power take-off shielding using on-site farm audits. *Journal of Agricultural Safety and Health,* 21(2): 95-104. DOI: 10.13031/jash.21.10724

Sorensen JA, Tinc PJ, Dalton D, Scott EE, and Jenkins PL. 2017. A comparison of interventional approaches for increasing power take-off shielding on NY farms. *Journal of Agromedicine.* DOI: 10.1080/1059924X.2017.1318726

Presentations

Sorensen JA. 2014. *"It's tough to tie your shoes while you're walking:" A qualitative analysis of power take-off driveline shields: barriers and motivators to shield use for NY farmers.* 7th International Symposium: Safety and Health in Agricultural and Rural Populations. Saskatoon, SK, Canada.

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Additional Materials:

Inclusion of Children (none)

Materials Available for Other Investigators

PTO shielding survey instrument: The instrument used to collect information about shielding behaviors among farmers.

PTO audit form and protocols: The instrument and instructions for evaluating PTO shield use on farms.

PTO barriers and motivators interview guide: The guidance document for conducting qualitative interviews with farmers and farm families.

PTO focus group discussion guide: The guidance document for testing social marketing materials with farmers.

PTO media channels survey: The survey used to determine the most appropriate media channels for reaching our target audience.

PTO social marketing materials: The materials developed as part of the social marketing campaign.

Final Financial Status Report *(FFR) (SF-425)* will be sent separately by Finance Department

Cumulative Inclusion Enrollment Tables (pages 54-60)

Equipment Inventory Report (pages 61-64)

Final Invention Statement and Certification (pages 65-69)

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Farm Tractor Stability Systems to Improve Operator and Mechanical Performance

Comments:

Racial Categories	Ethnic Categories									Total
	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
Asian	1									1
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White	5	37			2					44
More Than One Race										0
Unknown or Not Reported										0
Total	6	37	0	0	2	0	0	0	0	45

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Musculoskeletal Disorder Rates in Northeast Lobstermen

Comments: The lobstering industry is predominantly male, non-Hispanic or Latino, and White. We did not collect data on race or ethnicity. We did collect data on gender.

Racial Categories	Ethnic Categories									Total
	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
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported							17	400		417
Total	0	0	0	0	0	0	17	400	0	417

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: New Surveillance Strategy for Farming and Forestry Injury

Comments: Not needed, secondary data source

Racial Categories	Ethnic Categories									Total
	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
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported										0
Total	0	0	0	0	0	0	0	0	0	0

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Northeast Fisheries Winch Safety Improvement Project

Comments:

Racial Categories	Ethnic Categories									Total
	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
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported									54	54
Total	0	0	0	0	0	0	0	0	54	54

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Online Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk

Comments: Not needed

Racial Categories	Ethnic Categories									Total
	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
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported										0
Total	0	0	0	0	0	0	0	0	0	0

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Social Marketing of Machinery Safety Shields

Comments:

Racial Categories	Ethnic Categories									Total
	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
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported							161	1123	45	1,329
Total	0	0	0	0	0	0	161	1,123	45	1,329

Cumulative Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

Study Title: Evaluation of NYCAMH Dairy Safety Program

Comments:

Racial Categories	Ethnic Categories									Total
	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
Asian										0
Native Hawaiian or Other Pacific Islander										0
Black or African American										0
White										0
More Than One Race										0
Unknown or Not Reported									30	30
Total	0	0	0	0	0	0	0	0	30	30

Form Approved Through 10/31/2018
OMB No. 0925-0002

Department of Health and Human Services

Final Invention Statement and Certification

(For Grant or Award)

DHHS Grant or Award No.
2U54OH007542-11

A. We hereby certify that, to the best of our knowledge and belief, all inventions are listed below which were conceived and/or first actually reduced to practice during the course of work under the above-referenced DHHS grant or award for the period

9/1/2011 *original effective date* through 8/31/2016 *date of termination*.

B. Inventions (Note: If no inventions have been made under the grant or award, insert the word *"NONE"* under

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO DHHS
	None	
(Use continuation sheet if necessary)		

C. Signature — This block *must* be signed by an official authorized to sign on behalf of the Institution.

Title
Director, Bassett Research Institute

Typed Name
Anne Gadomski

Signature A Gadomski

Date 9/28/17

Name and Mailing Address of Institution
Mary Imogene Bassett Hospital
One Atwell Road
Cooperstown, NY 13326

Col

Form Approved Through 10/31/2018
OMB No. 0925-0002

Department of Health and Human Services

Final Invention Statement and Certification

(For Grant or Award)

DHHS Grant or Award No.
2U54OH007542-11

A. We hereby certify that, to the best of our knowledge and belief, all inventions are listed below which were conceived and/or first actually reduced to practice during the course of work under the above-referenced DHHS grant or award for the period

9/1/2011 *original effective date* through 8/31/2016 *date of termination*.

B. Inventions (Note: If no inventions have been made under the grant or award, insert the word *"NONE"* under

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO DHHS
	None	
(Use continuation sheet if necessary)		

C. Signature — This block ***must*** be signed by an official authorized to sign on behalf of the institution.

Title
Director of Sponsored Programs

Typed Name
John W. Hanold

Signature
John W. Hanold

Date
09/28/2017

Name and Mailing Address of Institution
The Pennsylvania State University
110 Technology Center Building
Office of Sponsored Programs
University Park, PA 16082

Form Approved Through 10/31/2018
OMB No. 0925-0002

Department of Health and Human Services

Final Invention Statement and Certification

(For Grant or Award)

DHHS Grant or Award No.
U54 OH007542

A. We hereby certify that, to the best of our knowledge and belief, all inventions are listed below which were conceived and/or first actually reduced to practice during the course of work under the above-referenced DHHS grant or award for the period

9/1/11 *original effective date* through 8/31/16 *date of termination*.

B. Inventions (Note: If no inventions have been made under the grant or award, insert the word *"NONE"* under

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO DHHS
NONE		
(Use continuation sheet if necessary)		

C. Signature — This block *must* be signed by an official authorized to sign on behalf of the institution.

Title
Director, Office of Research Admin.

Typed Name
Susan C. Puryear

Signature
Susan C. Puryear

Date
9/28/17

Name and Mailing Address of Institution
University of Massachusetts Lowell
600 Suffolk Street
Lowell, MA 01854

Form Approved Through 10/31/2018
OMB No. 0925-0002

Department of Health and Human Services

Final Invention Statement and Certification

(For Grant or Award)

DHHS Grant or Award No.
2U54OH007542-11

A. We hereby certify that, to the best of our knowledge and belief, all inventions are listed below which were conceived and/or first actually reduced to practice during the course of work under the above-referenced DHHS grant or award for the period

9/1/2011 *original effective date* through 8/31/2016 *date of termination*.

B. Inventions (Note: If no inventions have been made under the grant or award, insert the word *"NONE"* under

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO DHHS
	None	
(Use continuation sheet if necessary)		

C. Signature — This block ***must*** be signed by an official authorized to sign on behalf of the institution.

Title

Typed Name

Signature | Date

Name and Mailing Address of Institution
Harvard T.H.Chan School of Public Health
Office of Sponsored Programs
Harvard University
Cambridge, MA 02138

HHS 568 (Rev. 06/15)

EQUIPMENT INVENTORY LIST AUTHORIZATION/PURCHASE

Report Date: 9/27/2017
Project Title: The Northeast Center for Agricultural Health
Grantee Name: Mary Imogene Bassett Hospital
Grants Management Officer: Larry Guess
Grant Number: 2U54OH007542-11
Project Period: 9/1/2011 to 8/31/2016
Project Officer: William Robison
Grants Specialist: Mary Pat Shanahan

Please note-there were no purchases during this time period for either New Surveillance Strategy for Farming and Forestry Injury or Social Marketing of Machinery Safety Shields.

Description of Item (i.e., pH Meter)	Mfr.[1] (i.e., Fischer)	Serial Number	Quantity	Condition	Location	Purchase Cost	Date Received
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.

[1]Mfr. (Manufacturer)

Property Administrator & PO Disposition Recommendation and Instructions:

Description of Item (copy from above)	Disposition	Address[1]
Click here to enter text.	Choose an item. Click here to enter text.	Attn: Click here to enter text. Centers for Disease Control & Prevention Peachtree Distribution Center 3719 North Peachtree Road, #100 Chamblee, GA 30341
Click here to enter text.	Choose an item. Click here to enter text.	
Click here to enter text.	Choose an item. Click here to enter text.	
Click here to enter text.	Choose an item. Click here to enter text.	

1The CDC Warehouse is the central receiving point for the delivery of all non-hazardous and non-perishable supplies and equipment, CDC – AM – 2004-03, update 2010

Rev. 4/7/14

EQUIPMENT INVENTORY LIST AUTHORIZATION/PURCHASE

Report Date: 9/27/2017
Project Title: Farm Tractor Stability Systems to Improve Operator and Mechanical Performance-no purchases during this time period
Grantee Name: Mary Imogene Bassett Hospital
Grants Management Officer: Larry Guess

Grant Number: 2U54OH007542-11
Project Period: 9/1/2011 to 8/31/2016
Project Officer: William Robison
Grants Specialist: Mary Pat Shanahan

Description of Item (i.e., pH Meter)	Mfr.[1] (i.e., Fischer)	Serial Number	Quantity	Condition	Location	Purchase Cost	Date Received
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.

[1]Mfr. (Manufacturer)

Property Administrator & PO Disposition Recommendation and Instructions:

Description of Item (copy from above)	Disposition	Address[1]
Click here to enter text.	Choose an item. Click here to enter text.	Attn: Click here to enter text. Centers for Disease Control & Prevention Peachtree Distribution Center 3719 North Peachtree Road, #100 Chamblee, GA 30341
Click here to enter text.	Choose an item. Click here to enter text.	
Click here to enter text.	Choose an item. Click here to enter text.	
Click here to enter text.	Choose an item. Click here to enter text.	

1The CDC Warehouse is the central receiving point for the delivery of all non-hazardous and non-perishable supplies and equipment, CDC – AM – 2004-03, update 2010

Rev. 4/7/14

EQUIPMENT INVENTORY LIST AUTHORIZATION/PURCHASE

Report Date: 9/27/2017
Project Title: Muscuoloskeletal Disorder Rates in Northeast Lobstermen-no purchases during this time period
Grantee Name: Mary Imogene Bassett Hospital
Grants Management Officer: Larry Guess

Grant Number: 2U54OH007542-11
Project Period: 9/1/2011 to 8/31/2016

Project Officer: William Robison
Grants Specialist: Mary Pat Shanahan

Description of Item (i.e., pH Meter)	Mfr.[1] (i.e., Fischer)	Serial Number	Quantity	Condition	Location	Purchase Cost	Date Received
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.

[1]Mfr. (Manufacturer)

Property Administrator & PO Disposition Recommendation and Instructions:

Description of Item (copy from above)	Disposition	Address[1]
Click here to enter text.	Choose an item. Click here to enter text.	Attn: Click here to enter text. Centers for Disease Control & Prevention Peachtree Distribution Center 3719 North Peachtree Road, #100 Chamblee, GA 30341
Click here to enter text.	Choose an item. Click here to enter text.	
Click here to enter text.	Choose an item. Click here to enter text.	
Click here to enter text.	Choose an item. Click here to enter text.	

1The CDC Warehouse is the central receiving point for the delivery of all non-hazardous and non-perishable supplies and equipment, CDC – AM – 2004-03, update 2010

Rev. 4/7/14

EQUIPMENT INVENTORY LIST AUTHORIZATION/PURCHASE

Report Date: 9/27/2017
Project Title: Northeast Fisheries Winch Safety Improvement Project-no purchases during this time period
Grantee Name: Mary Imogene Bassett Hospital
Grants Management Officer: Larry Guess

Grant Number: 2U54OH007542-11
Project Period: 9/1/2011 to 8/31/2016
Project Officer: William Robison
Grants Specialist: Mary Pat Shanahan

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Rev. 4/7/14

EQUIPMENT INVENTORY LIST AUTHORIZATION/PURCHASE

Report Date: 9/27/2017
Project Title: Online Tool for Designing Ventilation Systems to Reduce Manure Pit Entry Risk-no purchases during this time period
Grantee Name: Mary Imogene Bassett Hospital
Grants Management Officer: Larry Guess

Grant Number: 2U54OH007542-11
Project Period: 9/1/2011 to 8/31/2016
Project Officer: William Robison
Grants Specialist: Mary Pat Shanahan

Description of Item (i.e., pH Meter)	Mfr.[1] (i.e., Fischer)	Serial Number	Quantity	Condition	Location	Purchase Cost	Date Received
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Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.	Choose an item.	Click here to enter text.	$Click here to enter text.	Click here to enter a date.
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Rev. 4/7/14