

**PACIFIC NORTHWEST AGRICULTURAL  
SAFETY AND HEALTH (PNASH) CENTER**

NIOSH/CDC Cooperative Agreement #5 U54 OH007544

# FINAL REPORT 2011-2016

October 2017



*Research for  
Healthy Workers,  
Strong Communities &  
Productive Agriculture*

<http://deohs.washington.edu/pnash>

# OUR MISSION

The Pacific Northwest Agricultural Safety and Health Center conducts research and promotes best health and safety practices for Northwest producers and workers in farming, fishing and forestry. Affiliated with the UW School of Public Health, PNASH integrates expertise from multiple disciplines, institutions and community partners. Areas of emphasis include new production technologies and the needs of under-served and vulnerable populations.

NIOSH/CDC Cooperative Agreement #5 U54 OH007544

**21**  
YEARS IN  
OPERATION

**\$7.8**  
million funding  
over 2011-2016

**23**  
CORE FACULTY  
AND STAFF

  
**DEGREES CONFERRED:**  
**12 MASTERS**  
**4 DOCTORAL**

**53**  
STUDENTS

**20 PROJECTS**  
+ 14 additional awards/projects



## INTERNAL ADVISORY COMMITTEE

**Richard Fenske, PhD, MPH**  
Director

**Michael Yost, PhD**  
Associate Director

**Marcy Harrington, MPA**  
Center Manager

**Victoria Breckwich Vásquez, DrPH, MPH**  
Director of Comm. Engagement & Education

**Catherine Karr, MD, PhD**  
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**Christopher Simpson, PhD**  
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PACIFIC NORTHWEST AGRICULTURAL  
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DEPARTMENT OF ENVIRONMENTAL & OCCUPATIONAL HEALTH SCIENCES  
UNIVERSITY of WASHINGTON · SCHOOL OF PUBLIC HEALTH



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## **ACKNOWLEDGMENTS**

This work was only accomplished through active collaborations with state agencies, industry leaders, worker communities, and health care providers. Thank you for your partnership and honest advice. We cannot name most of these contributors, due to research participation confidentiality, but the work here presented for PNASH's 2011-2016 cycle, is the result of cooperation of over 1,000 organizations and individuals throughout the Pacific Northwest.

Moreover, we are proud of our faculty, staff and students who have contributed to a growing body of expertise and impact in agricultural safety and health. The PNASH Center celebrated its 20<sup>th</sup> anniversary in 2016. Throughout the past 20 years, we have built an organizational foundation and made substantive impacts on areas with a high burden of injury and disease for producers, workers and their families.

This report represents the great and continuing effort of PNASH people and partners in conducting research 'for healthy workers, strong communities and productive agriculture.'

# EXECUTIVE SUMMARY



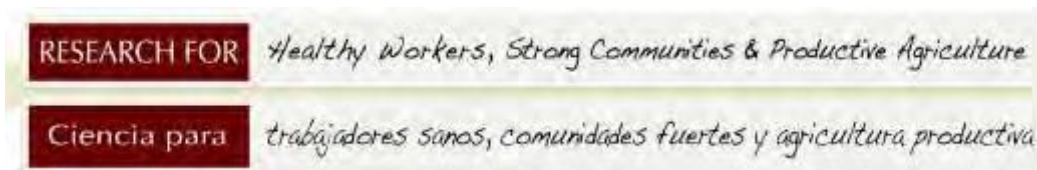


## I. EXECUTIVE SUMMARY

The [Pacific Northwest Agricultural Safety and Health](#) (PNASH) Center is dedicated to the prevention of illness and injury among agricultural producers, workers and their families. One of ten regional centers, PNASH serves Alaska, Idaho, Oregon and Washington, integrating expertise from multiple disciplines, institutions and community partners. The Center is focused on safe and sustainable agricultural workplaces and communities with an emphasis on injury and illness prevention, especially among hired laborers, migrant/seasonal workers, and children. Our approach includes:

- Working in partnership with employers, workers, agencies and other research and service organizations.
- Conducting innovative research and intervention programs that focus on problem solving.
- Taking solutions to the workplace through training, outreach, and participatory research.

PNASH's 2011-2016 funding cycle marks our 20<sup>th</sup> anniversary and a research portfolio only possible through a strong foundation of partnerships and trust among the agricultural industries and communities we work with. At the beginning of this cycle, our Center personnel formed a tagline to reflect our mission and values:



This executive summary highlights some key outcomes and findings from our 2011-2016 projects and programs, yet we invite you to dig deeper. Each project spans a large body of work with current and pending scholarly publications, educational products, or internal technical reports. These may contribute to your work, so please contact us with any questions or interests in collaborating. Most important to our mission is ensuring that these results impact practice in the field.

### PNASH ORGANIZATIONAL ACCOMPLISHMENTS

The research accomplishments presented here reflect the organizational success of PNASH and that of our teams of faculty, staff and students. A core of 12 fulltime staff worked closely with over 30 faculty, 53 students and 8 regional institutional subawards to Washington State University, Oregon Health Sciences University, Oregon State University and the University of Alaska. Over 14 communities were engaged throughout the Northwest, and, due to the importance of the Yakima Valley to regional agriculture, PNASH maintains a field office and staff based in Yakima, WA.

This cycle saw tremendous growth for PNASH and the scope of our work, with more projects selected for funding through NIOSH's Agricultural, Forestry and Fishing program, several new large projects awarded by NIH to Dr. Catherine Karr and many small projects supported through state awards. Overall, **PNASH had 34 projects in the 2011-2016 cycle**. This success in grant funding was only possible due to the foundational funding of the NIOSH Agricultural Center award, multidisciplinary collaboration, stakeholder support, and organizational and personnel capacity of the PNASH Center.

## ENGAGEMENT OF REGIONAL STAKEHOLDERS AND PARTNERS

A priority of the PNASH Center in this last funding cycle has been our engagement with stakeholders in the region. We have built upon previous stakeholder engagement activities, identified gaps, and worked systematically to address the challenges presented to us by stakeholders.

**Employers and Producers.** Engagement with employers and producers in health and safety problem-solving is a strength of our Center and has proven to be an effective strategy for creating safer workplaces.

We have had direct collaboration with agricultural producers and with equipment manufacturers in the ergonomic evaluation of mobile platforms in orchards (Johnson project). In addition, we formed a technical advisory group that included employers and WSU extension faculty to ensure that our research was directly relevant to the needs of the producer community. We also have strong cooperation with the industry-sponsored WA Tree Fruit Research Commission and with WSU in our studies of new technologies to minimize pesticide drift (Fenske project). In the dissemination of our *Practical Solutions for Pesticide Safety* manual (Galvin project), we included farm managers in our Expert Working Group, and producers provided access to their workplaces for worksite walk-through evaluations. Similarly, employers gave us access to worksites for our heat-related illness studies (Spector project). In forestry, Dr. John Garland has worked effectively with contract logging firms to implement new safety training (P&E Core; Outreach Program). Finally, many of our feasibility studies were selected to branch our work throughout the region and address fishing and forestry industry and workforce needs (see Feasibility Projects section).



**Northwest Worker Communities.** Working directly with these community groups ensures that our research, intervention and education activities address the health and safety concerns of workers (see Outreach Program for further details).

[El Proyecto Bienestar](#) (the Well Being Project) is a long-standing community based participatory research project and partnership between the UW PNASH Center, Northwest Communities Education Center/Radio Cadena, Heritage University, and the Yakima Valley Farm Workers Clinic. In 2014 *El Proyecto Bienestar* (EPB) was reinvigorated with the introduction of a new community advisory board (CAB). Issues of concern have included sexual harassment prevention, childhood asthma, nitrates in groundwater, and a rural anencephaly cluster. This CAB has been an essential partner in our work, and has been the inspiration for new work in the areas of childhood asthma (Karr project; P&E Core) and workplace sexual harassment (Breckwich Vásquez project; Outreach Program). A second major community engagement activity involves the forestry sector. We have developed a new project with the community-based Northwest Forest Worker Center.



**Regional Stakeholder Activities.** In addition to the direct stakeholder engagement activities conducted through our projects, PNASH collaborates with a variety of regional working groups, serving as subject matter experts and objective partners to new initiatives and ongoing collaborations.

Regular collaborations included the WA State Governor's Ag Safety Day, the Western Forum for Migrant and Community Health, the WA Agricultural Leadership Safety and Skills Program, and the WA DOSH Agricultural Committee. A major 2014-15 activity of Dr. Breckwich Vásquez, PNASH Outreach Director, was an appointment to the WA Farm Work Group, a formal mediation process established by the WA State legislature to discuss and resolve labor-management issues in agriculture. Finally, PNASH leadership took two tours to Oregon to engage a diverse range of stakeholders, including OR OSHA, SAIF (the major insurer of agriculture in the state),



the Oregon Law Center, the Sea Grant program, and the U.S. Coast Guard, as well as meeting with researchers and educators at Oregon State University and Oregon Health and Science University. PNASH faculty are called upon by state legislators in Washington and Oregon for their expertise regarding worker and community safety and health concerns.

## EDUCATION

### ***Worker Education and Training***

Dr. Breckwich Vásquez, PNASH Outreach Director, joined PNASH leadership in 2012 and launched several new educational activities. A new PNASH collaboration began with the WA Department of Agriculture's Innovative Farmworker Education Program, with Dr. Breckwich Vásquez joining the state hands-on training program. She also joined as a core partner in [El Proyecto Bienestar](#) leading to important new Sexual Harassment prevention education and awareness efforts in WA agriculture (See Feasibility: Sexual Harassment Prevention).

Mr. Pablo Palmáñez, PNASH Agricultural Workplace Specialist, contributed regularly as a presenter in Spanish language safety and health sessions. He also led an outreach and training program for Latino managers and workers in the tree fruit industry. Visits were customized to the grower's need and included training on heat-related illness and pesticide safety. A total of 120 farmworkers were trained and 23 farms were visited, with 10 being new farms to PNASH's network (Outreach Program).



Ms. Marcy Harrington expanded on PNASH's previous ladder injury and heat illness education work and produced two new educational videos (Spanish with English subtitles): Workers' Ladder Injury Stories and Heat Illness. The program topics are in-demand and timely. [View videos on the US Ag Center YouTube Channel.](#)

Dr. John Garland, reached over 200 Northwest forestry workers annually with safety educational seminars and consultation. He collaborated on the development and dissemination of the OR OSHA Hazards Alert, [Chain Shot in Logging Hazard](#). In addition, he developed a unique resource for Latino forestry workers in the form of a Spanish/English glossary, [Glossary of Forestry Services](#), to facilitate communication and understanding of forest management practices. He is a Co-Investigator and a technical advisor to multiple NIOSH-funded logging and forestry projects and is a member of the NIOSH NORA council.

### ***Professional Education***

PNASH was the primary contributor to a 2015 two-day continuing education course sponsored by the NIOSH-funded UW Education and Research Center. The course, *Current Topics and Best Practices in Occupational and Environmental Medicine in Agricultural Communities*, included presentations on pesticide drift, agricultural ergonomics, heat exposure, and the diagnosis of work-related injury and illness. This conference led to the online course developed through the PNASH project, *Feasibility: Agricultural Medicine eLearning Series for Mid-Level Health Care Providers*.

### ***Graduate and Undergraduate Students***

During the 2011-2016 cycle, we provided training opportunities to 53 students – 13 PhD students, 4 medical student interns, 11 masters students, and 25 undergraduate interns. Among these 53 students, 16 graduate degrees were conferred during the 2011-2016 cycle. (See Additional Accomplishments section for a full list of students and their projects).

## RESEARCH, INTERVENTION AND EDUCATION PROJECTS

PNASH investigators have conducted a wide range of projects, supported by multiple funding sources. In this section we highlight the 7 primary projects that were supported by the NIOSH 2011-16 PNASH Center award.

In addition, significant contributions have been made through 12 PNASH-funded feasibility projects (see Feasibility Projects) and 14 projects funded through other grant awards (see Additional Accomplishments).



[View](#) 2016 Video feature on student, Jane Pouzou.

### **Farmworker OP Exposure through Protein Adducts**

**PI: Christopher Simpson**

This project developed an assay to improve understanding of worker exposures to a wide range of organophosphate (OP) pesticides and advanced the method for potential use in field and clinic settings, providing rapid feedback to workers, clinicians, and physicians. We developed an assay based on the measurement of OP-adducts to butyryl cholinesterase (BChE) using immunomagnetic beads (IMB) and mass spectrometry. The assay provides accurate determination of the percentage modification of the active site of BChE and can detect down to 2% of BChE modified with pesticide, thereby eliminating the need for collection of a baseline pre-exposure blood sample from each worker. The assay has since been expanded to measure pesticide adducts to two other proteins, acylpeptide hydrolase and carboxylesterase. We demonstrated the effectiveness of the IMB purification in whole blood, plasma and dried blood spots. However, work remains to optimize the method for clinical use.

### **Using IPM to Reduce Pyrethroid Pesticide Exposures in Dairy Workers**

**PI: Michael Yost**

This project partners with WSU to reduce pyrethroid pesticide use in dairy operations by introducing Integrated Pest Management (IPM) practices. Four dairies collaborated in an intervention trial, introducing a feed-through product for the control of fly larvae in manure in place of standard, pesticide-based procedures. The intervention reduced fly populations, pesticide use, and worker exposure potential. We also found that manure management is a key element of a dairy IPM fly control program. The results made such an impression on three dairies that a decision was made to add feedthrough products to their existing IPM fly control programs. Results have been shared state-wide through our collaboration with WSU and the WA Dairy Federation.



### **Study of Risk Factors for Heat-Related Illness in Agricultural Workers**

**PI: June Spector**

This two-year pilot found that 1) farmworkers subscribe to varying degrees to the belief that cooling treatments should be avoided after heat exposure; 2) the desire to lose weight may be reflected in behaviors that promote increased sweating; 3) highly caffeinated energy drinks are preferred to increase work efficiency and maintain alertness; and 4) the location of drinking water at work (e.g., next to restrooms) and whether water is clean are important considerations for worker consumption of drinking water. Dr. Spector received a NIOSH KO1 award based on this work and will extend these studies with an intervention project awarded in our 2016-2021 cycle, *A Multi-level Approach to Heat-Related Illness Prevention in Agricultural Workers*.

## **Reducing Agricultural Worker Risks through New and Emerging Technologies**

**PI: Richard Fenske**

This project focused on new pest control practices, development of new drift assessment methods, and evaluation of pesticide spraying technologies. Jane Pouzou (PhD student) focused on product substitution and comparative risk analysis. Results support EPA's cancellation of azinphos-methyl from the perspective of acute occupational health impacts, but also indicate that acetamiprid exposures may be higher than anticipated. It was demonstrated that the currently available and most frequently-used pesticide compounds for apple orchards are in general safer for pesticide applicators following label instructions than alternatives of 10 years ago, when organophosphate use was more prevalent. However, the field study supported the finding that workers can exceed current risk estimates, even under normal work conditions.

Eddie Kasner (PhD student) developed a novel method of tracking drift, using micro-nutrients (metals) sprayed in orchards. Additional methods developed were real-time particle monitoring and water sensitive paper. Our field trials found that, compared to traditional application technology, new tower sprayers can reduce downwind worker exposure to drift by up to 35%. The trial also found that with normal wind conditions, drift was occurring at distances approximately 1.7 times greater than the Application Exclusion Zone for orchard airblast applications, as defined by the recently revised EPA Worker Protection Standard.

## **Ergonomic Evaluation of Emerging Technologies in the Tree Fruit Industry**

**PI: Peter Johnson**

Tree fruit production activities – such as pruning and structural cutting, green fruit thinning, and harvesting – require high-intensity physical labor. Traditionally, these activities are performed from the ground and on ladders. A rigorous field study during the 2014 harvest assessed three treatment groups: harvesting from the ground, ladder, and harvest-assisted mobile platforms. A new method to measure repetitive arm motion was developed and validated by comparison to video observation. Overall, workers using the harvest-assist mobile platform had reduced physical work demands and lower ergonomic stressors (back and shoulder inclination as well as repetitive motion of arms) than those picking from ladders. This project also demonstrated the benefits of the platform technology for efficient harvesting.

## **Pilot: Assessing Agricultural Safety and Health among Hmong Farmers**

**PI: Butch DeCastro**

Hmong refugees are increasingly being resettled throughout the U.S., and are frequently engaging in small, family-owned farm operations. This pilot project was important in taking a preliminary, foundational step towards fully investigating agricultural work hazards among refugees operating small-scale farms. We assessed safety and health issues using novel participatory approaches: the participatory rural appraisal process as well as integrated Photovoice and farm worksite observational exposure assessments. Additionally, we successfully established a working relationship with the Hmong community in the Skagit Valley. Findings suggest Hmong-operated small-scale farming involves a variety of distinct occupational hazards that would benefit from interventions tailored to context and culture.



#### **Prev 4: Impact of Workplace Stress on Health in Farmworker Families** **PIs: Kent Anger and Diane Rohlman**

This 2-year project produced and piloted a training and wellness program for agricultural workers. Farmworkers face stressors on the job that may affect their performance and safety at work, relationships at home, and physical and mental health. These workers report high levels of stress from job mobility, language barriers, job security, financial concerns, and long workdays. This pilot study was designed to identify indicators of stress and to evaluate the effectiveness of a Total Worker Health® (TWH) intervention that addresses typical causes of

stress for agricultural workers. Participating workers in the pilot showed several positive changes to measures of occupational stress, safety, health and well-being, health care, lifestyle, and social support. The resulting TWH toolkit, “BeSuper! Agriculture” is available (January 1, 2018) for agricultural employers for use with supervisors/work teams (English and Spanish). The training program and tracking methods for supervisors and workers were found to be effective and well liked by the pilot participants. “Be Super!” can help employees become exceptional supervisors, foster healthy teams, and create a culture of safety and wellbeing.

#### **Edu 1: Pesticide Safety in Tree Fruit: Translating Research, Overcoming Barriers** **PIs: Nadine Lehrer and Kit Galvin**

This education and research project aimed to overcome key education barriers to pesticide safety and to disseminate pesticide safety solutions. Our tree fruit industry and regional educators provide exceptional training opportunities throughout Washington, yet they recognize that language and cultural barriers remain for Hispanic pesticide applicators and their supervisors. By translating research into an accessible and relatable form, orchard owners, managers, pesticide handlers, and educators will be better equipped to protect workers and their families from potential pesticide exposure and illness.

Throughout this project we worked with an active advisory board and engaged workers, managers and human resources professionals. Our *Practical Solutions for Pesticide Safety* guide has reached orchards across Washington State and pesticide educators around the nation. Since 2012, over 2,000 copies have been requested and its solutions have been presented to over 5,000 growers throughout the Northwest. A "Practical Solutions Pesticide Safety Kit" was developed for use by pesticide safety educators and orchard safety trainers, and includes materials to be used in a hands-on training. We are now working to distribute pesticide label health and safety information in English and Spanish through a mobile app – PNASH has piloted the app and demonstrated proof-of-concept to public and private investors. A lasting legacy will be our collaboration of university, agency, and industry representatives. This group is now pursuing the development of an “Agricultural Supervisor Development Program” to promote healthier workplaces and address the training gap in pesticide education for workers in the tree fruit industry.





# CENTER OVERVIEW



PNASH featured in video produced by American Public Health Association



## II. CENTER OVERVIEW

The [Pacific Northwest Agricultural Safety and Health](#) (PNASH) Center is dedicated to the prevention of illness and injury among agricultural producers, workers and their families. One of ten regional centers, PNASH serves Alaska, Idaho, Oregon and Washington, integrating expertise from multiple disciplines, institutions and community partners. The Center is focused on safe and sustainable agricultural workplaces and communities with an emphasis on injury and illness prevention, especially among hired laborers, migrant/seasonal workers, and children. Our approach includes:



- Working in partnership with employers, workers, agencies and other research and service organizations.
- Conducting innovative research and intervention programs that focus on problem solving.
- Taking solutions to the workplace through training, outreach, and participatory research.

PNASH research priorities and project selections are based on the burden and need of our Northwest communities, the seriousness of the hazard, the number of people affected, and the probability that research will lead to health improvements.

We are housed in the UW Department of Environmental and Occupational Health Sciences, School of Public Health and have formal affiliations with multiple UW programs as well as with Washington State University (WSU), and Oregon State University, among others. Our faculty, staff, and students bring expertise to our agricultural industries in the areas of medicine, nursing, industrial hygiene, epidemiology, engineering, and education.

### RELEVANCE

Jobs in the agricultural industries, which include farming, fishing and forestry, consistently rank among the most dangerous. The fatality rate for workers in the farming sector is six times higher than the all-industry average, while the fatality rate for workers in the commercial fishing and logging sector is 32 times the all-industry average. In



**32x**

Fishing workers are 32 times more likely to



**32x**

Forestry workers are 32 times more likely



**6x**

Agriculture workers are 6 times more likely to

addition to injuries and fatalities, agricultural workers are also at high-risk for illnesses such as lung diseases, hearing loss, heat-related illnesses, skin diseases and certain cancers associated with chemical use and prolonged sun exposure. Farming is a unique workplace in that families frequently live on-site. Each year 14,000 children are injured and 100 children are killed on US farms.

**\$7.6 BILLION**

The economic burden of agricultural injuries to the U.S. in a single year is assessed at \$7.6 billion in medical and lost-productivity costs.<sup>1</sup>

### NEW AND FUTURE DIRECTIONS

The PNASH Center has begun a new 5-year cycle, 2016 to 2021. New directions this cycle include injury surveillance, dairy safety and health, and an enhanced Outreach Core to increase engagement of stakeholders and to move our research results into practice.

<sup>1</sup> This is an inflation adjusted estimate of the 1992 estimates of \$4.57 billion that appeared in Leigh, J., McCurdy, S., & Schenker, M. (2001). Costs of Occupational Injuries in Agriculture. *Public Health Report*, 116(3), 235-248

# ADMINISTRATIVE & PLANNING CORE



PNASH's second home is the Yakima Valley – the 'fruitbowl' of Washington State. For 18 years PNASH has had Yakima-based offices and dedicated professional staff.

### III. ADMINISTRATIVE AND PLANNING CORE

The Administrative and Planning Core provides an infrastructure for the Center and assists with the implementation of individual project and program objectives. Core programs ensure that activities are well coordinated and integrated within the Center, are of high scientific quality, meet their objectives, and work in coordination with community and industry partners to move results into practice.

Administrative and Planning Core specific aims:

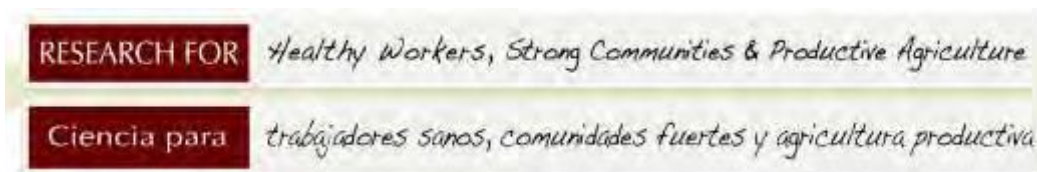
- A. **Management, Operations, Facilities and Communications.** Grant and fiscal management, protocol assurance, record-keeping and reporting in compliance with institutional, state and sponsor requirements, facilitation of strategic planning, provision of appropriate and adequate organization, resources, internal communications and facilities for the conduct and integration of research, education, translation and intervention/prevention activities.
- B. **Internal and External Advisory Committees**
  - Internal Advisory Committee.** A multidisciplinary team of current PNASH leadership, the Internal Advisory Committee (IAC) meets monthly guiding Center activities and priorities.
  - Scientific Advisory Committee.** Four national experts provide the Center with scientific review and direction on future work.
  - Stakeholder Advisories.** Provide guidance on the relevance of activities to the region and to industry sectors; identify emerging and important issues; collaborate in the dissemination and transfer of research results.
- C. **Data and Statistical Service.** Consultation from Dr. Paul Sampson, Professor of Statistics, and Ms. Kit Galvin, PNASH Senior Scientist. Both Dr. Sampson and Ms. Galvin consulted with project teams throughout this cycle of work. Dr. Sampson provided consultative service to investigators in data analysis and biostatistics - starting from the point of study or survey design and continuing through final analysis. Ms. Galvin developed internal protocols to ensure consistency in data management and quality across the center.
- D. **NIOSH and NIOSH Agricultural Center Collaboration.** PNASH was an active partner in NIOSH and NIOSH Ag Center initiatives. Current collaborations include the NIOSH Coordinating Committee, academic symposia, WEST/ON, Alaska Field Station, NORA committees, and Agricultural Centers Evaluation Program.
- E. **Pilot/Feasibility Project Program and Emerging Issues Fund.**  
(See report section Pilot/Feasibility Program).
- F. **Outreach Program.** (See report section Outreach Program).
- G. **Evaluation Program.** (See report section Evaluation Program).

**PNASH PEOPLE:** PNASH faculty, staff and students are extraordinary contributors, working in small teams that embrace the challenge of original research and field-based science. Each has enriched the experience of our work, especially through their facilitation of our direct engagement with producers and workers.

PNASH places high value on student education and actively integrates student learning into our projects. In the 2011-2016 cycle, we engaged 13 PhD students, 4 medical student interns, 11 masters students, and 25 undergraduate interns. Among these 53 students, 16 graduate degrees were conferred during the 2011-2016 cycle. (See Additional Accomplishments section for a full list of students and their projects).



At the beginning of this cycle, our Center personnel formed a tagline to reflect our mission and values:



#### PNASH INTERNAL ADVISORY COMMITTEE

A multidisciplinary team of current PNASH leadership, the Internal Advisory Committee (IAC) meets monthly, providing oversight and advice to the Principal Investigator and project investigators in making scientific and administrative decisions.

Richard Fenske, PhD, MPH	Director	rfenske@uw.edu
Michael Yost, PhD	Associate Director	airion@uw.edu
Marcy Harrington, MPA	Center Manager	marcyw@uw.edu
Victoria Breckwich Vásquez, DrPH ,MPH	Director of Comm. Engagement & Education	vbreck@uw.edu
Catherine Karr, MD, PhD	Internal Advisory Committee	ckarr@uw.edu
Christopher Simpson, PhD	Internal Advisory Committee	simpson1@uw.edu

#### PNASH SCIENTIFIC ADVISORY COMMITTEE

The annual meeting of scientific advisors – as the membership of the Scientific Advisory Committee - provides the Center and projects with guidance on effectiveness, direction of future work, project methods and result interpretation as well as relevance of activities to regional and national policies and initiatives.

Doug Brock, PhD	Associate Professor, UW Family Medicine and MEDEX Program
Jennifer Lincoln, PhD, CSP	Director, NIOSH Center for Maritime Safety and Health Studies
Howard Kipen, MD, MPH	Chair and Professor, Environmental & Occupational Medicine, Rutgers University
Linda McCauley, RN, PhD, FAAN, FAAOHN	Dean and Professor, Nell Hodgson Woodruff School of Nursing, Emory Univer.

The 2011-2016 cycle was rich with awards and recognitions to PNASH faculty, staff and students. Notable achievements for our leadership include:

- In 2014 [Dr. Mike Yost](#), PNASH Associate Director, was selected as chair of the UW Department of Environmental and Occupational Health Sciences (DEOHS).
- [Dr. Jennifer Lincoln](#), Director of the NIOSH Alaska Pacific Office and a PNASH scientific advisor, was appointed in 2014 as Affiliate Faculty at the UW DEOHS. PNASH nominated Dr. Lincoln for the appointment and will help her develop student learning opportunities in commercial fishing safety.
- PNASH's Director of Community Engagement and Education, [Dr. Vicky Breckwich Vásquez](#), was named assistant professor in the School of Nursing & Health at UW Bothell.
- In 2016, [Dr. Catherine Karr](#) won one of only 102 Presidential Early Career Awards given by the White House. Dr. Karr was nominated for her community-engaged approach to studying environmental contaminants and the impact on children's health – especially on asthma. Winning the award is an honor for Dr. Karr, for PNASH and for our [El Proyecto Bienestar](#) community partnership. It reinforces the value of research built with strong community partners.

*"I feel like working with communities to respond to their priority concerns should be an important part of our national research portfolio. But it requires a commitment to taking the time to develop and maintain collaborative relationships. Having a national award recognizes that this type of research is terrific and hopefully will encourage others."*  
- Dr. Catherine Karr

## NEW PROJECT GRANTS AND AWARDS

Each year, thanks to the nucleus of research expertise and support formed by the Center, our faculty and staff researchers successfully procure additional project grants to help advance the goals and priorities of the PNASH Center. Over 2011-2016, the following projects addressing PNASH's mission were awarded. See Additional Accomplishments section for summative reports on each project.

### Next-Generation Air Pollution Research (EPA Star Grant 2016-2019)

**PI: Catherine Karr.** This innovative project develops low-cost air pollution sensors to help Native American and Latino communities in the Yakima Valley reduce their exposure to wood smoke. Researchers will use next-generation air particle sensors that are portable and battery powered and then work with local students to both understand and help reduce the community's exposure to wood smoke.

### Home Air in Agriculture Pediatric Intervention Trial (NIEHS R01 2014-2019)

**PI: Catherine Karr.** The goal of the HAPI project, made possible through [El Proyecto Bienestar](#), is to reduce exposure to inflammatory agents and allergens in the homes of Latino children residing in an area of intense dairy and crop-based industrial agricultural production. Such environments pose significant environmental justice-related issues, which are particularly detrimental for vulnerable subpopulations (Latino farm worker children). Community based participatory activities identified pediatric asthma as a priority health concern for the community.

### Measuring Worker Exposure to UV Radiation in the Cannabis Industry, and Efficacy of Protective Clothing (WA State SHIP Grant 2015-2017)

**PI: Chris Simpson.** The cannabis industry is rapidly expanding in Washington – yet with limited safety and health information for workers. This project assessed the intensity of UV exposure and associated health risks experienced by workers in the cannabis industry through employing new wearable UV sensors and through evaluating UV protective garment's effectiveness.



**Prevention of Occupational Exposures to Pesticide Drift (WA Medical Aid and Accident 2015-2017)**

**PI: Richard Fenske.** This feasibility study characterized the risk of occupational drift exposure, expanded epidemiological surveillance, and tested novel drift exposure measurements. Study findings will improve state partner data collection techniques, enhance exposure prevention training, and contribute to understanding and preventing drift exposure—a major reason for pesticide-related illnesses among Washington agricultural workers. *This pilot study informs the new 2016-2021 research project: Prevention of Occupational Exposure to Pesticide Drift.*

**Heat Exposure, Injury Risk, and Productivity in Agricultural Workers (NIOSH K01 2014-2017)**

**PI: June Spector.** This project examined the association between heat exposure and traumatic injury risk in agricultural workers and examined the feasibility of using a biomarker of heat acclimation to detect workers at risk. Study results will improve estimates of future productivity losses and health effects related to climate change and will lead to improved engagement with employers on heat-related illness prevention efforts. *This study informs the new 2016-2021 research project: A Multi-Level Approach to Heat-Related Illness Prevention in Agricultural Workers.*

**Safety and Health of Latino Immigrant Forestry Services Workers (NIOSH U01 2014-2017)**

**PI: Arnold de Castro.** Occupational injury and illness rates among forestry service workers are 2 to 3 times the rates of the average US worker, and fatality rates are 9 times as high. We developed case studies based on in-depth, qualitative interviews with 25 forest workers in southern Oregon about serious on-the-job injuries/illnesses experienced in the previous year and about their attempts to improve working conditions.

**Forestry Glossary of Terms (Oregon OSHA 2015-2016)**

**PI: John Garland, OSU and Affiliate Professor.** This project developed an educational tool for forestry services workers and employers (Spanish/English). Graphical reference cards provide translated terminology for forest service activities and explain the underlying forest management goals and practice.

**Heat Alert System Aimed at Heat-related Illness Prevention and Productivity Optimization in Washington Agricultural Workers (WA Medical Aid and Accident Fund 2014-2015)**

**PI: June Spector.** This project was a collaboration with Washington State University's (WSU) AgWeatherNet weather station network program to assess the feasibility and acceptability of a heat awareness system for growers, coupled with recommendations for how to reduce this risk. *This study informed the new 2016-2021 research project: A Multi-Level Approach to Heat-Related Illness Prevention in Agricultural Workers.*

**Health and Safety of Women Agricultural Workers (MAAF 20013-2014)**

**PIs: Catherine Karr, Victoria Breckwich Vásquez & Elizabeth Torres, UW and Radio Cadena.** The *El Proyecto Bienestar* partnership addressed a community priority and a newly recognized issue in the field of occupational health: sexual harassment. The hidden nature of this issue profoundly affects women's ability to work safely. Our partnership, along with a community advisory board and focus groups of farmworker women, assessed the interrelationship between sexual harassment and worker health, and developed audience-tested prevention strategies.

**Feasibility: Notification of Pesticide Applications to Minimize Workplace Exposures (WA Medical Aid and Accident Fund, 2013-2014)**

**PI: Richard Fenske.** The project evaluated the feasibility and effectiveness of a notification system, allowing farm neighbors to alter work patterns so that workers and families would not be in orchards at the time of pesticide applications.

**Motivational Videos for Farmworker Ladder Safety and Heat Illness Prevention (NIOSH Supl, and WA Medical Aid and Accident Fund, 2012-2014)**

**PIs: Richard Fenske and Marcy Harrington.** This project has expanded the use of two PNASH-produced Spanish radio programs into educational videos for farmworker training. The program topics, which focus on the prevention of ladder injuries and heat-related illness, are in-demand and timely.

<http://www.youtube.com/user/USagCenters>

**Washington Leaders for Conversations about Climate (UW School of Public Health 2012-2014)**

**PIs: Richard Fenske and Victoria Breckwich Vásquez.** This project used a student / local champion and community-based participatory research model to launch conversations in rural parts of Washington State on the complex topic of climate change. Five undergraduate students, all from underrepresented minority and migrant farmworker families, conducted community needs assessments, identified a community leader and developed a volunteer base to join them on this project. Public community education forums were held in three Hispanic farmworker communities.

**Development and Validation of Laboratory & Field Methods for Occupational Exposure to the Insecticide Acetamidprid in Washington State Orchards (WA Medical Aid and Accident 2012-2013)**

**PIs: Gretchen Onstad and Richard Fenske.** This project developed analytical and field methods for exposure assessment to acetamidprid, a nicotinyl insecticide used for codling moth control in apple orchards.

**Development of a Surveillance Strategy to Guide Injury Prevention Efforts in the Washington Commercial Fishing Industry. (WA Medical Aid and Accident Fund 2011-2013)**

**PI: June Spector.** This pilot engaged WA commercial fishing stakeholders, including safety professionals, US Coast Guard, and insurers, in characterizing nonfatal fishing injuries and assessing data sources to develop a sustainable surveillance strategy to prevent injuries in WA fishermen. ***This study informed the new 2016-2021 research project: Safety Surveillance for Pacific Northwest Fisheries.***

**Improving PPE Effectiveness in Agricultural Applications. (WA Medical Aid and Accident Fund 2013)**

**PI: Mike Yost and Kit Galvin.** This project addressed three safety concerns of WA airblast applicators: data-driven respirator cartridge change-out schedule; field efficacy of gloves used by pesticide handlers; and a PPE hat that can be used with regular PPE suits and jackets.

**ConneX UW Extension Course: ENVH490 Introduction to Children's Environmental Health & Disparities Research (Yakima Valley Farmworkers Clinic/HRSA 2011-2012)**

**PI: Catherine Karr.** We offered a summer environmental education course in Yakima, WA, with university credit for ConneX program students, a program for local, disadvantaged, students with an interest in health careers. A field research component included student-led community surveys relevant to the priorities of *El Proyecto Bienestar*.



## ADDITIONAL ACCOMPLISHMENTS

**SENSOR Workshop, Seattle, WA.** On March 2-3, 2016 PNASH hosted the annual NIOSH SENSOR Workshop. The **Sentinel Event Notification System for Occupational Risk (SENSOR)** is a NIOSH funded program that builds and maintains occupational illness and injury surveillance capacity within state health departments. This meeting convened these state programs to improve their practice and review results. In addition, the meeting focused on Northwest-specific needs and research. PNASH contributed with event coordination and the following sessions: SENSOR Case Coding Exercise; Practical Solutions for Pesticide Safety; Overview of NIOSH Ag Centers; Pesticide Drift Reduction Strategies; and Pyrethrins/Pyrethroids and IPM in Dairies.

**Washington Farm Work Group.** In 2014, Dr. Vicky Breckwich Vásquez, PNASH Outreach Director, was appointed to a new initiative, the **Washington Farm Work Group (WFWG)**, which was formed under the WA Employment Security Commission by the state legislature to find mutual points of interest in agriculture and administrative solutions to agricultural issues. WFWG called upon PNASH's expertise on sexual harassment of women in agriculture as well as on pesticide drift. See WFWG report, [2015 Farm Work Group Report](#).

**Washington State Latino/Hispanic Assessment Report.** This 2014 report spotlighted Latino health issues, with contributions written by representatives from across the region. PNASH's Catherine Karr developed the feature, *Latino Children and Environmental Health Hazards*, and Victoria Breckwich Vásquez contributed, *Environmental Health Risks of Latinos in Washington State* and *Occupational Health Risks of Latinos in Washington State*. See pages 82-89 of the [Washington State Latino/Hispanic Assessment Report](#).

**NIOSH's National Occupational Research Agenda (NORA) for Agriculture, Forestry and Fishing.** PNASH served as site-host for the NIOSH NORA Ag, Forestry and Fishing (AgFF) Sector Council Meeting August 6-7, 2014. NORA is a multi-stakeholder partnership program to stimulate innovative research and improved workplace practices. In 2005, DEOHS and PNASH assisted NIOSH in launching the NORA AgFF effort by coordinating a Town Hall forum in Seattle to gather stakeholder testimony on safety and health research priorities for agriculture and other high-risk occupations. The current AgFF agenda and council have guided research and research-to-practice efforts throughout the past decade. In April 2016, a new decade's agenda for NORA AgFF will be launched. See more on [AFF NORA](#).

**Oregon Partner Meeting.** PNASH convened our Oregon investigators and partners on February 10-11, 2015, in Portland, Oregon. Twenty-six participants reviewed our progress and discussed needs for occupational safety and health research in farming, fishing, and forestry in Oregon. Specific discussion topics included Total Worker Health®, sexual harassment, and the Mexican-Indigenous workforce in Oregon. In addition, a visit was made to *Pineros y Campesinos Unidos del Noroeste (PCUN)* (Northwest Treeplanters and Farmworkers United) to learn about its community initiatives and research priorities.

**Agricultural Center Evaluators, Coordinators and Outreach (ECO) Group.** PNASH continued a close collaboration across all NIOSH AFF Regional Centers through Director's meetings and the Agricultural Center Evaluation, Communication, and Outreach (ECO) group. The ECO group's goals are to share resources and knowledge, collaborate on Center-wide communications and evaluation efforts, and enhance intra-extramural dialogue with the NIOSH Ag Centers and NIOSH program offices. Ms. Harrington at PNASH facilitated the overall ECO group from 2014-2016, a group of 60 members that span all NIOSH Ag Centers. Meetings take place every other month with working groups focused on Evaluation, Legislative Education, the YouTube Channel, Awareness Events, and the National Ag Safety Database.

### Other/Annual Activities

- **2012 & 2014. PNASH Research Review, Scientific Advisory Committee and NIOSH Site Visit**
- **2013, 2014, 2016 NIOSH Centers Meetings & State of the Science Meeting**
- **2011-2016. Ag Center Directors Meeting**
- **2011-2016. WestON Meeting, Denver, CO**

## EVALUATION PROGRAM

PNASH's evaluation program moves beyond traditional program monitoring, using a developmental approach to assist project teams in improving efficacy and outcomes. Our goal is to ensure that our efforts are relevant, feasible, and sustainable; that they reflect the best science and practice; and that they demonstrate efforts consistent with the ultimate goal of reducing injuries and illness.

PNASH methods include stakeholder and data-based needs assessments, innovative surveys, interviews, participatory research methods, advisories, and external reviewers. This complexity requires close collaboration with stakeholders and review by our scientific advisors. PNASH's approach for highly engaged communities and partners is reflective of the CDC Program Evaluation Framework (1999) principle to involve stakeholders throughout all stages of a program.

Annually, PNASH internally assesses progress and impacts. We use the logic model approach (Kellogg 2004) and have adapted this framework in project and program evaluation plans (see Appendix for each project's Logic Model). The logic model includes five components:

**INPUTS** - resources, contributions, partners/advisors

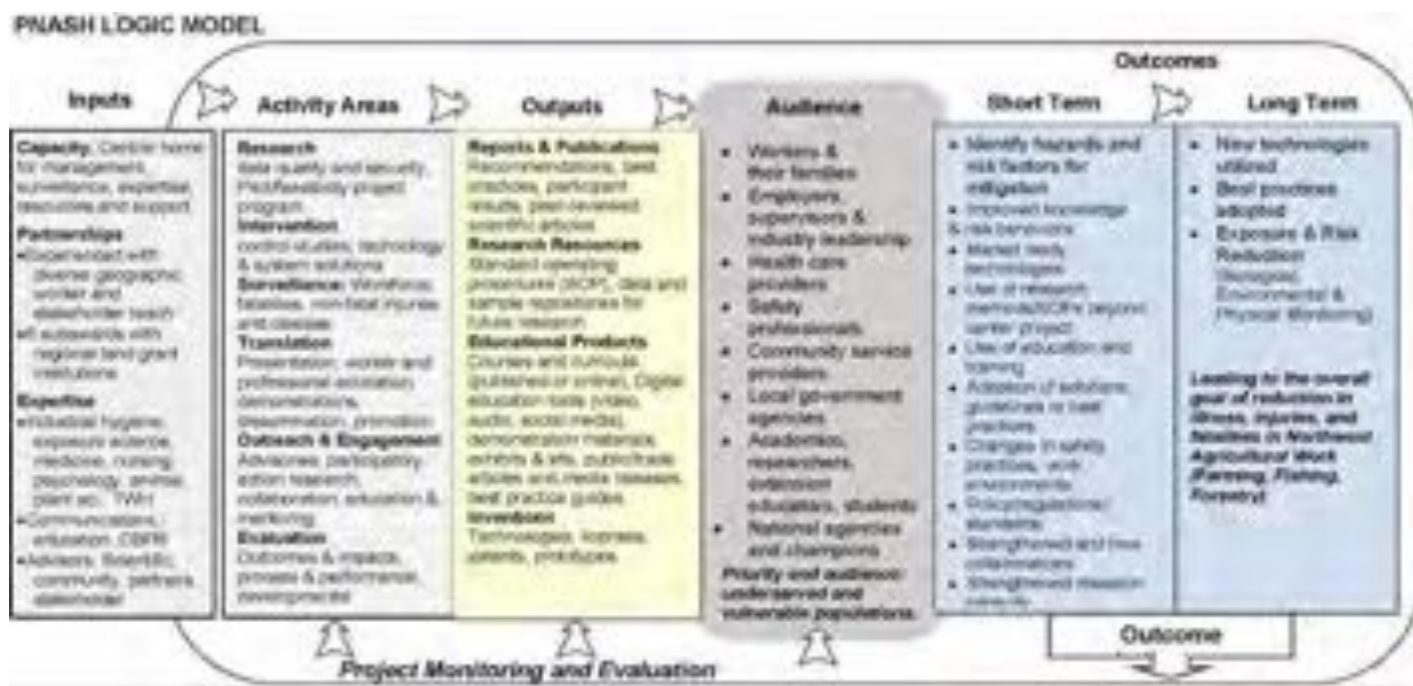
**ACTIVITIES** - major efforts

**OUTPUTS** - events and products that reach people who participate in the program

**AUDIENCE** - defining the target audience for research to practice (translational activities)

**OUTCOMES** - intermediate and long term results or changes for individuals, groups, communities, organizations, or systems that are part of the program (e.g., reduction in exposure, injury, illness; adoption of interventions, knowledge gained, change in risk taking behaviors)

This helps move beyond merely tracking short-term outputs (e.g., number of workshops held) towards framing and answering complex, outcomes-based questions, such as "Was the intervention adopted and used and, if so, how extensively?" Studying the logic model allows us to make decisions regarding the most appropriate allocation of resources for the success of activities in attaining key outcomes at programmatic and scientific levels.





## Project Outcome Evaluation

In conjunction with the logic model, PNASH project teams used an outcome metrics table to outline a specific approach for outcome and impact evaluation. These outcomes and metrics are developed for each project and are revisited annually and during the mid-term developmental consultation.

### EXAMPLE PROJECT OUTCOME METRICS

OUTCOME	INDICATORS	DATA SOURCE & TOOL	ACCOMPLISHMENTS	MILESTONE DATE
1. Evidence of relationship between AgWeatherNet wind data and drift event probability	At least 60% of drift events linked to wind ramping events of some kind	GIS model and case-crossover study preliminary results	<i>Progress assessed at milestone date or annually.</i>	Yr 1 Q2
2. New methods for characterizing drift event weather conditions and validating weather measurements	Development of one new standard operating procedure (SOP) and methods  Use of new methods	Protocols entered into project database  Publication peer-review Publication citations	<i>Progress assessed at milestone date or annually.</i>	Yr 2 Q4
3. Increased knowledge about drift prevention strategies	Pre-post assessment indicates improved awareness of drift strategies after presentation	PNASH TurningPoint Audience Response System survey data of participants at annual Ag Safety Day	<i>Progress assessed at milestone date or annually.</i>	Yr 2 Q4
4. Incorporation of study findings into spray best management practices training course	Education integrated into trainer education programs  Drift alerts integrated into AgWeatherNet Program	New PNASH modules appear in WSDA and WSU Spray Drift Best Management Practices Course	<i>Progress assessed at milestone date or annually.</i>	Yr 5 Q1
5. Frequency and magnitude of drift events decreases	Incidence of WA drift cases decreases over time from 2016 to 2021	As shown in each year's WA DOH Annual Pesticide Data Reports	<i>Progress assessed at milestone date or annually.</i>	Yr 5 Q4

For each PROJECT OUTCOME, a metric (INDICATOR) has been defined, which serves as a performance measure. The measurement method and data source is described for each performance indicator under DATA SOURCE & TOOL. The external conditions necessary (if the outcomes are to contribute to achieving the goal) is described under ASSUMPTIONS/ENVIRONMENT. Key MILESTONE DATES are identified in the developmental evaluation sessions. In these sessions, we specifically assess impact opportunities, which are areas where a target audience for a health or safety intervention shows interest and acceptance in the intervention. Identifying these areas and determining appropriate intermediate impact metrics is a step toward an action plan to move an intervention into practice.

## OUTCOMES

Independent Review of the NIOSH Agriculture, Forestry and Fishing Program (AFF). PNASH prepared and presented statements of impact/accomplishments of PNASH work from 2007-2011 and its contribution to the NIOSH AFF Program. The independent review found the NIOSH AgFF program's extramural programs to be highly relevant and a proven contributor to improvements in agricultural workplace safety.



**Program Monitoring Database, “Harvest,”** built on previous NIOSH and Ag Center evaluation tools, allows tracking and analysis of PNASH project outcomes and impacts. Unique to this database is the integration of impact stories, stakeholder anecdotes/quotes, PHS Progress Report fields, and a customizable evaluation matrix to track project-specific indicators of success, such as those reported in this final report. The system employs a relational database with a web-hosted platform for any-time, any-where data entry and reference. **Harvest** was introduced to NIOSH/Ag Centers in November 2014. Currently, two Agricultural Centers, the Nation Children’s Center, and the UC Davis Center have adopted and developed the database for their use.



PNASH’s Harvest database - adopted by other NIOSH Centers

**Stakeholder Interviews.** In 2012 and 2015, stakeholder needs and climate assessments were conducted by PNASH leadership with 54 key stakeholders and partners around the Northwest. These periodic assessments inform the IAC and project teams, working to ensure our progress is relevant, timely and to the general satisfaction of our key stakeholder partners.

**Developmental Evaluation.** Dr. Brock and Ms. Harrington conducted mid-cycle developmental evaluation consultations with project teams, evaluating: successes; unanticipated challenges; plans for navigating challenges; current and future project impacts; and, how stakeholders can become more positively engaged. The Developmental Evaluation approach is described by Michael Patton – an expert in program evaluation – as “The evaluator is part of a team whose members collaborate to conceptualize, design and test new approaches in a long-term, on-going process of continuous improvement, adaptation and intentional change.”

**Agricultural Center Evaluators, Coordinators and Outreach (ECO) Group.** PNASH evaluators were founding members of the ECO group. From 2014-2016, Ms. Harrington facilitated the NIOSH Agricultural Center ECO group to develop national and center-specific guidance and informational materials, emphasizing program outcomes and impact. National educational materials and templates for centers were disseminated and used in annual stakeholder and legislative education activities.

## OUTREACH AND EDUCATION PROGRAM



The Outreach and Education Program provides the Center's foundation for building relationships and sharing information with our agricultural communities. This small program had an infusion of supplemental funding in FYs 2014 and 2015, enabling PNASH to improve its response to regional needs for training and educational products. Through our combined education programs, in the 2011-2016 cycle we directly reached 15,000 individuals throughout the Northwest and across the country. Additionally, 31 collaborators and partners, representing more than two dozen different businesses and organizations, were actively engaged through our projects and programs.

## NEW PRODUCTS & RESOURCES DEVELOPED

### **EPA Pesticide Safety Video: Pesticide Safety for Agricultural Workers: Pesticide Safety (Module**

**6) Pesticide Safety for Agricultural Workers** is a free 21-minute educational video compliant with the criteria set by GlobalGAP, the EPA's revised Worker Protection Standard, and reviewed by the WA State Department's of Agriculture and Labor and Industries.

In addition to being made available to all growers in the produce industry, the Washington State Tree Fruit Association (WSTFA) will incorporate this video into their GRAS2P (Growers Response to Agriculture, Safe and Sustainable Practices) educational program. [View video on the US Ag Center's YouTube Channel.](#)



### **Agricultural Medicine in the Northwest - On Demand eLearning Course**

(See *Feasibility: Agricultural Medicine eLearning Series for Mid-Level Health Care Providers*)

#### **Introduction: Advancing Occupational and Environmental Health Practice in the Northwest.**

This course contributes to a foundation in occupational and environmental medicine (OEM) for providers, is designed to improve their ability to recognize, diagnose, treat, and prevent work-related injuries and illnesses, and to provide best available patient education. CDC accredited CME is available to those who complete this course. [View course flyer.](#) [To register, click here.](#)

**Special Topics Lecture Series.** A series of 1-hour online lectures on pertinent and emerging topics of interest to those who provide health care to agricultural communities. The program brings together expert instructional and research faculty, covering topics such as pesticide exposures, asthma, heat-related illnesses, and musculoskeletal disorders. CDC accredited CME is available to those who complete this course. [View course flyer.](#) [To register, click here.](#)



### **PNASH Video by APHA TV**

The PNASH Center was featured by the American Public Health Association (APHA) in a new venture to raise the visibility of the important work of public health professionals. This video provides information on new and ongoing initiatives that improve public health. PNASH was showcased for our work on behalf of agricultural workers and communities. [View PNASH's video.](#)

**Videos for Farmworker Ladder Safety and Heat Illness Prevention.** This project has expanded on PNASH's previous ladder injury and heat illness education work, producing two new educational videos (Spanish with English subtitles): "Workers' Ladder Injury Stories" and "Heat Illness". The ladder video integrates real worker injury stories to motivate workers and local experts to review best practices. The Heat Illness video uses a novela format with local actors and nurse narrator that offers details on recognizing signs and symptoms and emergency response. [View videos on the US Ag Center YouTube Channel.](#)



### Glossary of Forestry Services Terms

This resource for Latino forestry workers and their supervisors is in Spanish and English. The glossary facilitates communication and understanding of forest management practices terms and the management objectives behind them. See OR-OSHA's website for the [Glossary of Forestry Services Terms](#).

**Northwest Forest Worker Safety Review.** The Northwest Forest Worker Safety Review is an annual newsletter created to promote a healthy and safe Northwest forestry industry. News of research, developments, and coming events are compiled annually by the PNASH Center and shared with a Northwest network of more than 400 people. [http://depts.washington.edu/pnash/forest\\_safety](http://depts.washington.edu/pnash/forest_safety)

**New PNASH Website.** The re-development of the PNASH website enabled mobile device user access, which was key for agricultural community users, who use hand-held devices more regularly than personal computers. In addition to a content management system (CMS) upgrade, new features were added to improve the search function across PNASH research projects. UW branding standards were adopted. Each year, our website is accessed by over 7000 unique visitors. See <http://deohs.washington.edu/pnash>

### New webpage and material resources developed in 2011-2016:

- **Pesticides and Health Webpage**, including the course for health care providers, *Understanding Pediatric Outcomes from Pesticides and Nitrates*. [http://deohs.washington.edu/pnash/pesticides\\_health](http://deohs.washington.edu/pnash/pesticides_health)
- **Heat Illness Prevention**, [http://deohs.washington.edu/pnash/heat\\_illness](http://deohs.washington.edu/pnash/heat_illness)
- **Northwest Forest Worker Safety**, [http://depts.washington.edu/pnash/forest\\_safety](http://depts.washington.edu/pnash/forest_safety)
- **Sexual Harassment Prevention**, [http://depts.washington.edu/pnash/sexual\\_harassment](http://depts.washington.edu/pnash/sexual_harassment)
- **Orchard Injuries**, [http://depts.washington.edu/pnash/orchard\\_injuries](http://depts.washington.edu/pnash/orchard_injuries)

### EDUCATION & TRAINING ACTIVITIES

**Ag Safety Day, 2011-2016.** PNASH co-sponsors Washington State's annual Governor's Industrial Safety and Health Conference for the agricultural industry. PNASH serves on the planning committee advisory board, along with 10 other organizations and the lead agency, the Washington Department of Labor and Industries. The conference, with programs in English and Spanish, was designed for employers, supervisors, workers, and safety and health professionals. Each year it has grown and now reaches more than 500 people and is hosted in two locations. PNASH staff serve as session proctors and exhibitors, with demonstrations such as pesticide exposure simulation with Fluorescent Tracers. PNASH activities have included: 2016 *Pesticide Drift Management* (Eng/Sp), 2015 co-sponsorship of pre-conference course, *Introduction to Machinery and Machine Safeguarding*; 2014 co-sponsorship of *Ammonia Safety*; 2013 *Cultural Humility* (Eng/Sp) and *Tips and Tools for Training & Confined Space* (Eng/Sp); and 2012 *Practical Solutions for Pesticide Safety* (Eng/Sp).

**Western Forum for Migrant and Community Health, 2011-2016.** Each year, PNASH serves on the planning committee for the Northwest Regional Primary Care Associations' Western Forum for Migrant and Community Health. When the Forum is in the Northwest, PNASH sponsors the poster research reception. The Forum is an annual meeting of health professionals and community health workers who serve underserved, diverse populations throughout the Western states. PNASH hosted workshops, such as: *Pasos Saludables and Sí Sé Bosque* – two projects finding solutions to farm and forest worker health and safety issues through participatory action methods; *Health and Safety of Women Agricultural Workers in Yakima Valley: Key Prevention Messages*; *Next Steps in a Community-Campus Partnership Project on Sexual Harassment*, and; *Climate Change Loteria Game*, a session on a student-led education project.

**UW Health Sciences Common Book Series – Seth Holmes' *Fresh Fruit, Broken Bodies*, 2014-2015**

The book *Fresh Fruit, Broken Bodies* by Seth Holmes was selected as the 2014-2015 Common Book for the UW Health Sciences Common Book Series. This effectively exposed all UW Health Sciences students to the issue of agricultural worker safety and showcased the PNASH Center's work in this field. The Common Book Series fostered inter-professional dialogue with a goal of creating true collaborations between health professionals. *Fresh Fruit, Broken Bodies* documents challenges in accessing affordable, humane, and quality health care, housing, and jobs. PNASH partnered in the program, offering educational forums for students and the public. The series included panel presentations, student discussion forums and articles throughout the year, and a panel forum, *Pesticide Issues in Agricultural Occupational and Environmental Health*, which was hosted in Seattle on April 12, 2015. See [article on PNASH](#) developed in conjunction with this event.

**Current Topics and Best Practices in Occupational and Environmental Medicine in Agricultural Communities, 2015.** Held in Yakima, WA, on February 27-28, 2015, this was a new event in partnership with the [Northwest Center for Occupational Safety and Health](#). The session was geared toward health care providers and public health professionals in rural and agricultural areas, and provided current occupational and environmental health expertise on issues relevant to the Yakima Valley, such as an anencephaly cluster, pesticide drift, chronic back pain and ergonomics. See [program](#). This course led to the online course listed above, **Agricultural Medicine in the Northwest - On Demand eLearning Course**.

**Washington Tree Fruit Industry Outreach and Training, 2014-2015.**

Pablo Palmández, PNASH's agricultural workplace specialist, led an outreach and training program to Latino managers and workers in the tree fruit industry. Visits were customized to the grower's need and often included training on heat-related illness and pesticide safety. A total of 120 farmworkers were trained and 23 farms visited, with 10 being new farms to PNASH's network.



**Pesticide Applicator Recertification Training with Washington State Department of Agriculture, 2013-2014.**

PNASH's outreach director, Dr. Breckwich-Vásquez, trained with the Washington State Department of Agriculture (WSDA) to provide hands-on training to Spanish-speaking pesticide handlers and agricultural workers throughout Washington state as part of the Farmworker Education Program. PNASH participated in six trainings and trained 310 workers on respirators, PPE, decontamination, and mixing and loading.

**ENVH490 Introduction to Children's Environmental Health & Disparities Research, 2012.** PNASH led a four-week instructional course and a two-week field research experience in the Yakima Valley. PNASH responsibilities and activities covered all aspects of instruction development, student tuition and academic credits, guest speakers, and field research experience. Since 2003, PNASH has led a summer environmental education course in Yakima, WA, with university credit for ConneX program students. ConneX is an education



outreach program at the Yakima Valley Farm Workers Clinic (YVFWC) that encourages young people from disadvantaged backgrounds in the Yakima Valley to enter health professions. In 2012, 13 ConneX students completed the ENH490 course. A public seminar was offered with guest speakers on nine topics (see products). In the field research component of the course, students administered and analyzed 540 community surveys, assessing the Yakima communities' health and safety knowledge and concerns about home and neighborhoods, accessing information, meals and playtime, and environmental health.

**Seminar Series Sponsored, 2012.** In conjunction with the ENH490 course, guest speaker seminars were delivered in an open forum and advertised for participation by community students, partners, and stakeholders. Seminar subjects included community-based participatory research – theory & practice; environmental justice; environmental health issues in the Yakima valley; drinking water and environmental health ; lab water analysis - nitrate contamination of well water in the lower Yakima valley; exposure science; occupational health issues of young workers; children's environmental health; and water quality, fish consumption and health.

## COMMUNITY ENGAGEMENT & NEEDS ASSESSMENT

**El Proyecto Bienestar (or, Well Being Project)** is a long-standing community based participatory research project and partnership between the UW PNASH Center, Northwest Communities Education Center/Radio Cadena, Heritage University, and the Yakima Valley Farm Workers Clinic. In FY2014 *El Proyecto Bienestar* (EPB) was reinvigorated with the introduction of a new community advisory board (CAB). Topics included sexual harassment prevention, AFARE asthma project findings and presentations, nitrates in groundwater, anencephaly, and new grant development. From 2003-2012, PNASH led the summer environmental education course in Yakima, WA. An important new direction launched by EPB responds to the Yakima community priority of workplace abuse: **Health & Safety of Women Ag Workers – Sexual Harassment**. The hidden nature of this issue profoundly impacts women's ability to work safely. Our partnership, along with a community advisory board and a focus group of farmworker women, assessed the interrelationship between sexual harassment and worker health and developed audience-tested prevention strategies. (*See Feasibility: Sexual Harassment Prevention Training Video*).

*"I have enjoyed being a part of research with PNASH and feel our joint work has resulted in positive impacts in the community. There are exciting opportunities to continue working together, especially given the enormous need that exists."*  
- PNASH Community Partner

**Stakeholder Needs Assessment.** Dr. Breckwich Vásquez collaborated with Center leadership and advisors to conduct a stakeholder needs assessment. Through personal, semi-structured interviews with 39 key partners and stakeholders, Dr. Breckwich Vásquez learned about our external engagement impacts and challenges, and she shared this information with PNASH staff at a series of internal workshops. In response, PNASH has moved forward with an action plan to enhance Center communication strategies.

**Northwest Forestry Sector Outreach.** In the last cycle, PNASH pursued the development of partnerships and assessed needs for forestry and logging safety. Partner meetings laid the groundwork for a new NIOSH funding opportunity, with forestry industries safety as a top priority. Topics of regional interest included resources for Latino immigrant forest service workers and training for contract loggers. Meetings took place with 1) Portland State Univ, Oregon Law Center, *Pineros y Campesinos Unidos Noroeste* (PCUN), Portland, OR; 2) OR OSHA Logging Code Committee, Salem, OR (and field tour); 3) Representatives from OR-OSHA, Association of Oregon



Loggers and multiple logging and forest service contract companies; 4) Northwest Forest Worker Center, Promotoras de Salud, Ashland; and Lomakatsi Restoration Project (and field tour), Ashland, OR.

The **Washington State Logger Safety Initiative** was launched in FY2014. In FY2013, PNASH's Dr. John Garland advised the Initiative Taskforce on education strategies. PNASH will continue this work to assist as needed on education and evaluation efforts to understand our logging workforce, risk factors, and approaches needed to reduce injuries and fatalities within this workforce.



Dr. Garland, PNASH logging education lead and DEOHS Affiliate Professor, has continued to work in close collaboration with Pacific Northwest contract loggers and state agencies responsible for logging and forestry sector safety. Dr. Garland serves as advisor to the Associated Oregon Loggers and Oregon OSHA Code Committee. He regularly presents research findings from his paper, *The Limiting Factor in North American Forest Operations: A Skilled Workforce*, at forums such as the Council on Forest Engineering meetings, the International Forest Engineering Conference, and the Oregon Logging Conference. In 2013, he consulted for the release of a

**Hazard Alert: Chain Shot in Logging Hazard.** He and Ms. Harrington are members of the NIOSH NORA Forest Sector Council, a group that has addressed national priorities and emerged hazards.

**Northwest Fishing Sector Outreach.** Previous to this cycle, PNASH had limited direct work in commercial fishing, instead serving as a general resource and assisting the NIOSH Alaska Regional Office with its initiatives. This cycle, we strategically employed our pilot/feasibility project program and the use of state funds to explore new partnerships and to develop capacity within PNASH to contribute to commercial fishing safety research. In 2011-2016, four small projects addressed needs in: nonfatal injury surveillance, total worker health®, and Filipino fish processors. (See *Feasibility Project Program* section)



#### **ADDITIONAL OUTREACH & EDUCATION ACCOMPLISHMENTS**

- PNASH Mass Communications: monthly E-Newsletter, website, Facebook, YouTube
- Northwest media outlet outreach – radio, trade journals, dailies
- Monthly meetings of Community Advisory Board - *El Proyecto Bienestar*, Yakima County
- Washington State Department of Agriculture Stakeholder Advisory Committee participation
- Oregon Law Center Indigenous Workers project advisor
- Regional promotion of National Farm Safety & Health Week
- Washington State Department of Agriculture Stakeholder Advisory Committee Participation
- Oregon Law Center Indigenous Workers Project Advisor
- October 2012. Linking science with communities to address environmental and occupational health concerns. Society for Advancement of Hispanics/Chicanos and Native Americans in Science. Seattle, WA
- June 24-25, 2015. Future of Occupational Health Speaker Series and Symposium

**In addition, there were multiple presentations at stakeholder and training events for farmworker and pesticide handler education as well as clinician continuing education.**

# CORE PROJECTS

PNASH's Core Projects are competitively selected by NIOSH/CDC through a peer-reviewed process. We propose research that:

- Addresses hazards that are the most serious, affect the greatest number of workers, and where that research will make a difference.
- Meets the needs of Northwest employers, workers, and service providers.





## **FARMWORKER OP EXPOSURE THROUGH PROTEIN ADDUCTS YEARS 2011-2016 (UW ROYALTY RESEARCH FUND 2012)**

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### **See Appendices for project:**

Terms & Abbreviations; Logic Model; and, Enrollment Report

### **RELEVANCE**

Organophosphorus pesticides (OPs) have widespread commercial application in the U.S. and worldwide. Although organophosphorus pesticides (OPs) continue to be used in agriculture, there is considerable concern regarding the adverse health effects of these compounds on agricultural workers as well as the general population. OPs cause illness through inhibition of cholinesterase (ChE), a critical enzyme in the nervous system. High exposures can have adverse effects including dizziness, headaches, fatigue, nausea, vomiting, diarrhea, muscle twitching, and blurred vision and in severe cases can lead to seizures, respiratory depression, and respiratory failure (Reigart and Roberts 1999). In Washington State, ChE activity is measured in farmworkers who are expected to have high exposures to OPs. When depression in ChE activity is observed, remedial actions are undertaken to reduce exposures and protect worker health. However, the ChE activity assay lacks sensitivity and specificity, which results in a substantial number of false-positive and false-negative measurements.

Our previous work developed an assay that provides greater sensitivity and specificity as compared to traditional cholinesterase activity monitoring – eliminating the need for collection of a baseline pre-exposure blood sample from each worker. This project expands this assay to improve the understanding of worker exposures to a wide range of OP pesticides and further developed it for potential use in field and clinic settings, providing rapid feedback to workers, clinicians, and physicians.

### **OUTCOMES**

- PNASH researchers expanded their previously developed OP-adduct assay to include other protein targets in addition to ChE: acylpeptide hydrolase (APH) and carboxylesterase (CE). These additional enzymes are more sensitive than butyryl cholinesterase (BChE) to certain OP pesticides, increasing the breadth of OP pesticide exposures that can be monitored.

- We made progress towards an immunomagnetic bead (IMB) based purification and LC-MS/MS assay to include other protein targets in addition to BChE (i.e. acylpeptide hydrolase (APH) and carboxylesterase (CE)). Antibodies were obtained for purification of these protein targets. We demonstrated the effectiveness of the IMB purification in whole blood, plasma and dried blood spots. However, work remains to optimize the method.
- The method was improved to decrease the amount of blood required such that a dried blood spot (DBS) can be analyzed. This could allow monitoring using a simple finger-stick rather than a blood draw to provide a rapid and complete understanding of worker exposures to a wide range of OP pesticides. We have demonstrated that we can recover and identify BChE and APH from DBS. Our focus on defining the sensitivity and reproducibility of measurement of chlorpyrifos adducts to BChE and APH in DBS. Experiments to define the sensitivity and reproducibility of measuring chlorpyrifos adducts to BChE and APH in DBS are not yet completed.

## PARTNERS & ADVISORIES

Central Washington Occupational Medicine Clinic and the Healthy Worker Clinic cooperated in allowing us to recruit workers who participated in WA's cholinesterase monitoring program. Collaborators at the National Institute for Biotechnology & Genetic Engineering, Dr. Bhalli, Dr. Khan, and Dr. Khalid collected samples from workers in Pakistan. PNASH researchers also recruited additional farmworkers from an orchard near Quincy, WA.

## RESEARCH

**Aim 1: Develop a sensitive mass spectrometric (MS)-based assay that can provide an accurate determination of the percentage modification of the active site serine residues of plasma butyrylcholinesterase (BChE) and red blood cell (RBC) acylpeptide hydrolase (APH), eliminating the need for a determination of baseline enzymatic activity values for workers prior to the spraying season**

In PNASH's previous cycle (2006-2011) we developed an assay that provides accurate determination of the percentage modification of the active site of plasma butyrylcholinesterase (BChE) and can detect down to 2% of BChE modified with pesticide, thereby eliminating the need for collection of a baseline pre-exposure blood sample from each worker. In the 2011-2016 cycle, the assay has since been expanded to measure pesticide adducts to two other enzymes, acylpeptide hydrolase (APH) and carboxylesterase (CE). These enzymes are more sensitive than BChE to certain pesticides, increasing the breadth of pesticide exposures that we can monitor.

We generated immunoprecipitation and mass spectrometric methods for APH and CE using red blood cells or white blood cells, respectively. This sensitive assay for quantification of OP-protein adducts uses immunomagnetic bead purification followed by analysis using mass spectrometry (IMB-MS). The assay provides an accurate determination of the percentage modification of the active site serine residues of plasma (BChE) and can detect down to 2% of total BChE modified with OP. We have applied this assay to archived plasma samples obtained from pesticide exposed farmworkers in Washington State and Pakistan. We expanded the suite of OP-modified proteins analyzed by this approach to include APH and CE. To this end we have raised antibodies against APH and CE, which will be used for immunoaffinity capture and purification of these biomarkers. We have also synthesized <sup>15</sup>N-isotopically labeled APH which will be used as an internal standard for quantification of native and modified APH in the mass spectrometry assays.



**Aim 2: Generate antibodies specific to native and OP-modified BChE to be used in assays to detect OP exposure**

To accomplish this, we synthesized three organophosphorylated peptide analogs representing the diethoxyphosphorylated-, monoethoxyphosphorylated- and dihydroxyphosphorylated(phospho)-O-serine peptides and conjugated them to immunogenic proteins. These haptens were then used to generate monoclonal antibodies. |



**Aim 3: We shall adapt the IMB-MS assays for OP modified BChE and APH developed in Aim 1 for application to dried blood spots (DBS).**

We have demonstrated the effectiveness of the IMB purification and can recover and identify BChE and APH from DBS. Experiments to define the sensitivity and reproducibility of measuring chlorpyrifos adducts to BChE and APH in DBS are not yet completed.

A field sampling campaign of thirteen WA orchard workers was conducted to improve our method for field use, by further decreasing the amount of blood required such that a dried blood spot can be analyzed. This could allow monitoring using a simple finger-stick rather than a blood draw to provide a rapid and complete understanding of worker exposures to a wide range of OP pesticides. This study was unique from prior pesticide exposure studies in this project in that we collected a time series of samples from individual workers. Samples were collected from workers prior to handling chlorpyrifos, at the start of spraying, when finished spraying for the season, and one month after finishing. Finger stick blood spots were collected along with venipuncture samples enabling us to directly compare the less invasive finger stick and the traditional blood draw method.

**Aim 4: Utilize the IMB/HPLC-tandem-MS and immunoassays to measure OP exposures in blood samples obtained from occupationally exposed farmworkers**

The IMB/HPLC-tandem-MS assay for OP-adducted BChE was used in 125 blood samples from farmworkers in Washington State. We targeted adducts from either chlorpyrifos or azinphos-methyl. We were able to detect the aged adduct of chlorpyrifos (mono-ethyl phosphoserine) on BChE in about 30% of the samples analyzed. The method showed a sensitivity of 2% in detecting chlorpyrifos adducts on BChE. No adducts from azinphos-methyl exposures were detected. We then measured OP exposure in spot-samples collected from pesticide-exposed workers in Pakistan.



Washington State Pesticide Handlers Loading Pesticides for Spraying

The OP assay was also applied in a longitudinal study of a cohort of 13 pesticide handlers in Washington State, where samples were collected before, during and after use of the pesticide chlorpyrifos.

The OP-BChE adducts were undetectable in samples collected prior to the spray season, or on the first day of spraying pesticides; whereas 54% of subjects had detectable OP-BChE adducts in samples collected on the last day of the spray season and one month following the last spray event. In contrast, no consistent temporal changes in BChE activity were apparent. OP exposures were relatively low in this cohort – only one of the 52 samples analyzed had adduct levels greater than 20%, and no samples exhibited BChE depression greater than 20%. These data reinforce our prior observations that the adduct assay is a more sensitive measure of exposure to OP pesticides that inhibit BChE, compared to measurements of BChE activity.

**ADDITIONAL AWARDS AND ACCOMPLISHMENTS**

University of Washington Royalty Research Fund. Additional pilot funding was awarded to evaluate the association between OP exposure (measured by questionnaire, as BChE depression and as BChE adducts) and alpha-synuclein ( $\alpha$ -syn) – a biomarker for Parkinson's disease. Although the sample size was relatively small, preliminary findings indicate that OP exposure per se was not associated with changes in  $\alpha$ -syn. However there was a suggestion that a genetic polymorphism associated with low physiological levels of paraoxonase 1 – a gene involved in detoxification of OP pesticides - was associated with higher risk for OP poisoning.

As part of the current project, we have developed a biosample repository containing ~350 blood samples obtained from pesticide exposed workers in Washington State, and in Pakistan. These populations represent a range in levels of



pesticide exposure and can be used by PNASH researchers, and other colleagues, to evaluate the performance of field deployable assays of OP exposure.

## **FUTURE WORK**

Work continues to optimize the on-bead digestion and LC-MS/MS analysis steps for the IMB-based assays, in both venipuncture and DBS samples. When this optimization is complete the optimized assays will be applied to samples in our biorepository to evaluate assay performance.

## **OUTPUTS**

Ruitta, A: [2012] Occupational Determinants of Chlorpyrifos Adducts to Plasma Cholinesterase in Chlorpyrifos Exposed Agricultural Workers in Washington State. MS Thesis, University of Washington.

Marsillach J, Costa LG, Furlong CE: [2013] Protein Adducts as Biomarkers of Exposure to Organophosphorus Compounds. *Toxicology* 307: 46-54. [PMC3747771](#)

Marsillach J, Hsieh EJ, Richter RJ, Maccoss MJ, Furlong CE: [2013] Proteomic Analysis of Adducted Butyrylcholinesterase for Biomonitoring Organophosphorus Exposures. *Chem Biol Interact* 203: 85-90.

Krenz JE, Hofmann JN, Smith T, Cunningham RN, Fenske RA, Simpson CD, Keifer MC: [2014] Determinants of Butyrylcholinesterase Inhibition Among Agricultural Pesticide Handlers in Washington State, 2006-2011. *Annals Occupational Hygiene* 1-16.

Nielsen SS, Checkoway H, Zhang J, Hofmann JN, Keifer MC, Paulsen M, Farin FM, Cook TJ, Simpson CD: [2015] Blood  $\alpha$ -Synuclein in Agricultural Pesticide Handlers in Central Washington State. *Environmental Research* 136: 75-81. [PMC4548290](#)

Searles Nielsen S, Hu SC, Checkoway H, Negrete M, Palmández P, Bordianu T, Racette BA, Simpson CD: [2017] Parkinsonism Signs and Symptoms in Agricultural Pesticide Handlers in Washington State. *Journal of Agromedicine* 22(3):215-221.

## **ACRONYMS AND TERMINOLOGY**

**2-PAM** - 2-pyridine aldoxime methyl chloride

**ACh** - acetylcholine

**AChE** - acetylcholinesterase

**APH** - acylpeptide hydrolase

**BChE** - butyrylcholinesterase

**CE** - carboxylesterase

**ChE** - cholinesterase

**DBS** - dried blood spots

**IMB** - immunomagnetic bead

**LC-MS/MS** - liquid chromatography coupled to tandem mass spectrometry

**MS** - mass spectrometry

**NTE** - neuropathy target esterase

**OP** - organophosphorus

**RBC** - red blood cell



## USING IPM TO REDUCE PYRETHROID PESTICIDE EXPOSURES IN DAIRY WORKERS YEARS 2011-2016

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### See Appendices for project:

Terms & Abbreviations; Logic Model; and, Enrollment Report

### RELEVANCE

Pyrethroid pesticides are widely used in agriculture and are applied on livestock, including dairy cows, in the form of sprays, pour-ons, dips, and tags to control flies and other insects. They are also applied to the premises around animal housing and manure storage areas. Fly control is essential to reducing cow agitation that impacts milk production and risk of worker injuries. There are many motivations to minimize pesticide use, such as potential worker exposure and costs for the purchase, use, storage, and disposal of these chemicals, as well personal protective equipment for applicators. Since 2001, pyrethroid-related illnesses documented by the Washington State Department of Health have quadrupled, suggesting that exposures to pyrethroid insecticides have been increasing both at home and in the workplace. In addition, the industry faces the future challenge of insect resistance to pyrethroids.

This project evaluated the potential for reducing pesticide use in dairy operations by introducing a new intervention for fly control, a larvicide in cow and calf feed, into a dairy's existing Integrated Pest Management (IPM) fly control program.

*At one dairy, pyrethroid use on adult cows was reduced from every three weeks in previous years to once at the end of the four-month fly season.*

### PARTNERS & ADVISORIES

Dairy recruitment was conducted through contacts established with the Washington State Dairy Federation (WSDF) and Washington State University (WSU) Extension, as well as, large animal veterinarians and nutritionists. The Washington State Department of Health provided in-kind support in assessing exposures in a volunteer sample of workers by conducting the laboratory analysis for pyrethroid metabolites in urine.

## OUTCOMES

- Results from the survey of WA dairy operators showed that the use of pyrethroid insecticides for fly control was common throughout the state and that new non-chemical options were gaining acceptance. Results were shared with WSDF members through a [summary fact sheet](#) and with agricultural extension specialists with a Journal of Extension publication.
- This project successfully introduced a new IPM fly control method, larvicide feedthrough products, into four dairies' fly control programs and demonstrated that it reduced fly populations, pesticide use, and worker exposure potential. Results at three dairies impressed the operator such that the decision was made to add feedthrough products to their existing IPM fly control program.
- The study also found that the consistent daily use of feedthrough products, along with ventilation and frequent bedding changes in calf-housing, a prime fly breeding area, resulted in a substantial reduction in fly populations.
- Researchers recommended rotating pour-on pesticide products with different active ingredients across application dates to reduce the opportunity for flies to develop resistance to one specific insecticide.
- The study also identified likely pesticide exposure locations for workers and measured the persistence of pesticide residues on surfaces post application, indicating the exposure potential after application.
- Dairy and individual participant results and custom pesticide safety education were provided to six dairies. A summary fact was created to share results of the feedthrough study with the WSDF and the dairy industry.
- This project's engagement with dairy stakeholders, contributed to the newly awarded project, *Injury and Illness Prevention in the Pacific Northwest for the Dairy Industry*. Dairy stakeholders included private and state veterinarians, nutritionists, producers, and additional WSU Agricultural Extension Specialists.

## RESEARCH

### **Aim 1: Estimate the prevalence of pesticide use and alternatives for pest management by surveying WA state dairies.**

We developed the Dairy Pesticide Practices Survey along with our collaborators to understand current pest prevalence and pest management practices. Surveys were addressed and mailed from the Washington State Dairy Federation (WSDF) office. Two follow-up reminders were issued, one as a postcard mailed to each recipient and a second via WSDF's weekly e-newsletter. The survey asked producers about frequency of treatment for flies and external parasites, motivations for treatment, use of pyrethroid insecticides, use of formulations, use of non-chemical methods of fly management, costs of pest management, and information sources for pest control options. A total of 79 surveys were returned with 77 considered suitable for inclusion in data analysis; the response rate was approximately 19 percent. Results showed that use of pyrethroid and pyrethrin insecticides was common throughout the state and that non-chemical options were becoming more accepted. Results were provided to the WSDF and other operations through our WSU Extension partnership in a [summary fact sheet](#) and published in the Journal of Extension. Researchers used results from this survey to engage dairies and to identify potential IPM intervention strategies.

### **Aim 2: Work with cooperating dairy farms to assess the effectiveness and operating costs of current pest management strategies by evaluating treatment practices and pest pressure.**

Recruitment was conducted through contacts established through WSDF members and cooperating farmers working with Washington State University (WSU) Veterinary extension. After establishing a network of collaborating farms, we began to conduct a baseline assessment of the effectiveness and operating costs of their pest management strategies. We then engaged participants to develop an IPM intervention aimed at reducing pesticide use.

**Aim 3: Work in conjunction with WSU and with trade groups and individual owners to introduce existing intervention strategies that improve pest management and improve handling methods**

During the Summers of 2013 and 2014, PNASH researchers conducted IPM intervention trials to identify the best candidates for the intervention evaluation study. Based on these pilot results and farmer input, the first two options were unsuitable. A calf-bedding treatment method that inhibits larvae development, did demonstrate a positive correlation between calf-hutch bedding with lower pH and lower fly larvae counts. (Calf-bedding is a prime breeding location for some flies.)

However, this intervention required more worker time to implement, making consistent compliance more difficult for the dairy. The second proposed IPM strategy - predatory wasps - were already in use at some participating dairies, so it could not be used as a new method.

A larvicide additive to feed (feedthrough) was selected for the intervention evaluation study. In Summer 2015, four dairies participated. The intervention used a larvicide, diflubenzuron, to prevent the development of fly larvae in manure. The larvicide was added to the adult cow feed and milk for calves for daily use during the peak fly season (June – September). The participating dairies had both young calves and adult cows.

At one operation (three dairy locations), the operator observed that the use of the larvicide administered in the calves' milk showed a marked reduction in fly populations in a large calf-hutch area compared to high fly populations in previous years. At the same dairy, the feedthrough product in the IPM program extended the time between permethrin applications on adult dairy cows (from once every 30 days to once every 40 days). The operator reported he plans to continue using the larvicide feedthrough product as an addition to his IPM fly control program.

At another dairy, this study showed that in a small calf barn, the consistent daily use of larvicide in milk and ensuring clean bedding (which includes the removal of manure and urine), dramatically reduced the high fly populations. In previous years, this operator used pyrethroid pour-on products for adult cows once every three weeks. In comparison, during the feedthrough interventions study, only one application was needed and it was at the very end of the fly season. The operator also observed fewer flies around the adult cows compared to previous years.

**Aim 4: Assess potential pyrethroid exposures in a volunteer sample of workers by measuring metabolites in urine (in-kind contribution by WA-DOH)**

Biomonitoring of dairy workers identified urinary metabolites of the specific pyrethroid pesticides used at the dairy. The metabolite levels in the study population were not different from most Latino/as in Washington State. This comparison data was from the concurrent parent study, Washington Environmental Biomonitoring Survey (WEBS) 2010 – 2011, conducted by the Washington State Department of Health (DOH). The WEBS study also was unable to determine the pyrethroid metabolite levels attributable to occupational exposure for the occupational group (structural pesticide control applicators.) The pyrethroid metabolite levels found in this study's participants were lower than those found in a comparison group of participants in other studies; none of the participants in our study or in the comparison group showed any signs of illness due to pesticide exposures.

To further investigate potential dairy worker exposure to permethrins, two studies were conducted. One found that gates and railings (metal) closest to the pour-on application sites had the highest levels of surface contamination post application. The other, a controlled permethrin decay study situated in the dairy environment found the half-life to be 7 days, which is similar to previous studies of permethrin on cow hair. As these pesticides persist, recommendations included wearing single-use nitrile gloves and handling of clothing to prevent continued exposure for contaminated clothing and work-to-home exposures.



2016 Video: Lessening the Risks to Dairy Farm Workers – feature on student, Sara Mar.

## **Aim 5: Evaluate the effectiveness of the intervention strategies and work with WSU and farmers to develop educational documents for wide dissemination to promote adoption of reduced risk pest management**

The results of the study demonstrated that the IPM strategy implemented at participating dairies was an effective addition to the IPM fly control program. We found that feedthrough products integrated into dairies' existing IPM fly control program reduced fly populations and, therefore, reduced the need for and the use of pyrethroid pesticides. This outcome then implies a reduced potential for worker exposure.

The feedthrough products contain the larvicide, diflubenzuron, and kill the fly larva in the manure before the adult flies can emerge, irritate the cows, and reproduce. Key to the success of this IPM method is consistent use of larvicide feed-through with both calves and adult cows throughout the fly season and continuation of other IPM methods, including adequate ventilation and frequent manure removal. Calf hutches benefited from the feed-through, as ventilation and manure/bedding removal is more limited for calves than for adult cows. Pour-on products, including those with active ingredients other than permethrin, need to be rotated across application dates to reduce the opportunity for the flies to develop resistance to one specific insecticide. The success of the feed-through addition indicates that IPM programs at other dairies could benefit from the use of feedthrough products.

General study results on worker pyrethroid exposure and prevention measures have been reported back to industry cooperators, including the following results: 1) Pyrethroid insecticides can be a potential exposure risk for dairy workers. They deposit and persist on metal surfaces such as chute railings and gates, and they may be present on cows and other surfaces; 2) All dairy workers need to be aware of the potential for exposure. Single-use disposable nitrile gloves around cows and barns would better protect hands from direct contact with the residues; 3) Standard hygiene practices would also contribute to minimizing these and other exposures at the dairies; 4) Additional beneficial protective practices include wearing clean work clothes each day, storing and washing dirty work clothes separately from the family laundry, and storing boots worn at work either at the dairy or outside of the home away from family shoes.

As part of an MS Thesis, a UW student contributed to the development of methods to return individual participant urine sampling results in-person to the dairy workers participating in the study. In addition, participants received materials that integrated visual communications to explain exposure and metabolite results. Materials were written in English and Spanish and were customized for each individual participant.

### **FUTURE WORK**

We continue our outreach and education to dairy farm stakeholders throughout the state through PNASH's Outreach and Education Core and through Dr. Yost's newly awarded project, *Injury and Illness Prevention in the Pacific Northwest for the Dairy Industry*. Ongoing outreach includes publication of research outcomes in journals and industry publications.

### **OUTPUTS**

Ferguson HJ, Galvin K, Vásquez V, Yost M, O'Neal S: [2015] Survey of Pest Management Practices on Washington Dairy Farms. *Journal of Extension* 53(2).

Grinnell, D: [2015] Overcoming Literacy and Language Barriers to Improve Safety Knowledge of Washington State Dairy Farm Workers. MS Thesis. University of Washington.

Fact Sheet – [A Survey of Pest Management Practices on Washington State Dairy Farms](#).

Fact Sheet – [Feed-through Insecticide to Reduce Pyrethroid Use in Dairy Operations](#).

Other scientific publications are in preparation. Final technical reports are on file at PNASH.

### **Standard Operating Procedures (SOPs):**

IPM to Reduce Pesticide Exposures in Dairy Workers - Biomonitoring of Pyrethroid Pesticide Exposure Procedures

IPM to Reduce Pesticide Exposures in Dairy Workers - Pyrethroid Pesticide Decay Procedures

IPM to Reduce Pesticide Exposures in Dairy Workers - Surface Wipe Sampling Procedures



## ACRONYMS AND TERMINOLOGY

**Calf Hutch** - a type of calf housing commonly used at modern dairy farms.

**IPM (Integrated Pest Management)** - is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment (*definition obtained from the University of California Statewide Integrated Pest Management Program*).

**Larvicide Feedthrough** - animal/livestock feed to which larvicide (a form of insecticide) is added. The larvicide-added feed passes through the animal's intestinal tract, the larvicide inhibits the development of fly larvae in the manure, thereby preventing the development into adult flies and acting as a method of fly control.

**Metabolite** - a product that remains after a drug is broken down (metabolized) by the body. More generally, it is any substance produced during metabolism (digestion or other bodily chemical processes) (*definition from U.S. National Library of Medicine*).

**Permethrin** - a pyrethroid pesticide commonly used to control flies in dairies.

**Pyrethroids/Pyrethrins** - are insecticides included in over 3,500 registered products, many of which are used widely in and around households, including on pets and in treated clothing, in mosquito control, and in agriculture. Symptoms experienced from pyrethroid-related illnesses include headache, nausea, vomiting, epigastric pain, weakness, lethargy, fatigue, dizziness, sweating, muscle pain, and/or other dermal, eye and respiratory irritant symptoms (*information obtained and summarized from the U.S. Environmental Protection Agency and the California Department of Public Health*).

**WA-DOH** - Washington State Department of Health

**WEBS** - Washington Environmental Biomonitoring Survey

**WSDF** - Washington State Dairy Federation



## PILOT: STUDY OF RISK FACTORS FOR HEAT-RELATED ILLNESS IN AGRICULTURAL WORKERS YEARS 2011-2013

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### See Appendices for project:

Terms & Abbreviations; Logic Model; and, Enrollment Report

### RELEVANCE

Heat exposure has been identified as an important cause of non-fatal illness and death in agricultural workers. From 2003 to 2008, the U.S. AFF sector experienced the highest mean heat fatality rate, with the majority of these fatalities occurring in relatively young workers in the crop production and support subsectors. Few studies have focused on heat-related illness (HRI) in hired crop workers, who are largely seasonal, foreign-born, and Spanish-speaking. Likewise, there is limited research on how cultural beliefs and practices related to hydration and HRI may affect the prevention and treatment of HRI in these workers.

This study characterizes the burden of HRI in Washington State agriculture, potential risk factors for HRI, and methods for quantifying the physiological effects of heat exposure in agricultural workers.

### OUTCOMES

- Participants subscribed with varying degrees to the belief that cooling treatments should be avoided after heat exposure, with some believing that cooling should be avoided after heat exposure, and others encouraging the use of cooling treatments.
- Behaviors shared by the farmworkers that could increase HRI risk included wearing excess clothing to promote sweating (for weight loss), preference of highly caffeinated energy drinks over water, and the suspicion of unclean water when drinking water was located next to restrooms. Although the farmworkers in our study were able to describe HRI risk factors, reported practices were not necessarily consistent with reported knowledge.
- Significant risk factors for HRI symptoms found in the field survey of 97 agricultural workers included: ***younger age (and less work experience), piece rate pay, and longer distance to the toilet.***
- CorTemp™ sensors, along with heart rate and actigraphy, were successfully utilized to measure the heat strain and energy expenditure of agricultural workers – a method that can now be used in future research.

- This study generated baseline data and set the stage for future study of the association between potential HRI risk factors and heat effects as well as the development of interventions to reduce HRI. In the new cycle from 2016-2021, Dr. Spector began a new project entitled, *A Multi-level Approach to Heat-Related Illness Prevention in Agricultural Workers*.

## PARTNERS & ADVISORIES

Participants were recruited through a large WA state tree fruit grower that previously worked with PNASH. A formal data sharing agreement was established with the WA State Department of Labor & Industries' Safety & Health Assessment & Research for Prevention (SHARP) program.

## RESEARCH

### Aim 1: Investigate cultural beliefs and practices related to hydration and HRI in adult outdoor crop workers

During the Spring/Summer of 2012, three semi-structured focus group interviews were conducted with 35 Latino/a agricultural workers in the Yakima Valley, WA area using participatory rural appraisal (PRA) techniques, such as body mapping. Transcripts from the PRA workshops were analyzed using qualitative methods.

There were several beliefs and attitudes about hydration. Participants subscribed to varying degrees to the belief that cooling treatments should be avoided after heat exposure, with some believing that cooling should be avoided after heat exposure, and others encouraging the use of cooling treatments.

Behaviors shared by the farmworkers that could increase HRI risk included wearing excess clothing to promote sweating (for weight loss), preference of highly caffeinated energy drinks over water, and the suspicion of unclean water when drinking water was located next to restrooms. Although the farmworkers in our study were able to describe HRI risk factors, reported practices were not necessarily consistent with reported knowledge. All findings were published and incorporated into HRI educational materials. The resulting materials were disseminated regionally to workers and employers through PNASH's Outreach and Education Core.

### Aim 2: Identify potential HRI risk factors in adult outdoor crop workers

An interactive multimedia (audio, visual) survey instrument aimed at characterizing potential HRI risk factors was developed in English and Spanish. The survey incorporated information about potential HRI risk factors from the PRA workshops. A formal data sharing agreement was established with the Washington State Department of Labor & Industries to share workers' compensation claims data and Division of Occupational Safety & Health (DOSH) workplace inspection data relevant to HRI. This claims data were used to characterize the burden of HRI in Washington agriculture. In addition, these data identified potential risk factors for HRI which were incorporated into the survey instrument.

In the summer of 2013, 97 crop workers in Washington State participated in a cross-sectional survey. The majority (91%) of participants were born in Mexico, and nearly all identified as Latino/a. The mean age was 41 years, 53% of participants were male, and over half of participants reported only possessing a primary school education. 59% and 11% of participants reported being able to read very well in Spanish and to read very well in English, respectively. The majority of participants reported working with tree fruit, and common tasks included harvesting and thinning green fruit.



*"A traditional remedy for heat stress in my community is to drink strong coffee with lime. Now I know, it makes it worse because of the caffeine."  
-HRI workshop participant*

Workers used an audio computer-assisted self-interview instrument that has undergone reliability and validity evaluation. The survey included Spanish and English narrations of questions and photographs and illustrations, which were designed to be vivid and realistic. Potential HRI risk factors related to demographics, training, work, hydration, clothing, health, and environmental domains were included in the survey. Mixed-effects logistic regression was used to identify risk factors for self-reported symptoms associated with heat strain and HRI (dizziness/light-headedness or heavy sweating) experienced at work in hot conditions.

Significant risk factors for HRI symptoms identified in the survey results – based on self-reported symptoms – included: decreased age (and less work experience), piece rate pay, and longer distance to the toilet. In addition, those with HRI symptoms were: more likely to report being female, to have not received HRI training during the past year, and to feeling that they were not allowed to take extra breaks, rest or drink water. Those with HRI symptoms were more likely to report working harder, drinking more caffeine, drinking fluids less frequently, and having good or fair (versus excellent or very good) general health. Although previous studies have reported associations between piece rate pay and increased injury risk, this is the first study to report an association between piece rate (versus hourly pay) and HRI in crop workers.

There was no significant association found through this survey between environmental conditions and the risk of HRI, but this was not surprising considering the contribution of other common factors such as internal heat generation (exertion).

### **Aim 3: Measure heat exposure and physiological responses (heat strain) in the fields in a sample of adult outdoor crop workers**

During July-August 2013, we evaluated physiological effects of heat stress (heat strain) in a convenience sample of 18 tree fruit workers from one WA orchard for one shift using ingestible temperature sensor “pills” (CorTemp™; HQ Inc, Palmetto, FL) to measure core body temperature. CorTemp™ sensor systems consist of small FDA registered and cleared (510K, No. 880639) ingestible thermometers that wirelessly transmit core temperature to an external data logger. Core temperature and heart rate can be combined to assess physiological strain when working in the heat.

Protocols for assessing heat strain in agricultural workers have been developed by the PI’s research team. The CorTemp™ sensors, along with heart rate and actigraphy, were successfully utilized to measure heat strain and energy expenditure.



### **FUTURE WORK**

This pilot project was a foundation for a systematic series projects to address heat-related illness in agricultural workers. The following projects were conducted in the Years 2014-2017 and a new project was awarded under PNASH’s 2016-2021 cycle of funding.

#### **A Multi-level Approach to Heat-Related Illness Prevention in Agricultural Workers (NIOSH 2016-2021)**

Dr. Spector and her team build on previous heat-related illness (HRI) studies to develop and evaluate a multi-level approach to address HRI for farmworkers in the tree fruit industry. The project will assess whether an intervention package, including a supervisor and worker training toolkit that addresses individual, workplace, and community factors, as well as a heat alert system for farm supervisors, reduces the risk of adverse heat health effects. To accomplish study aims, a technical advisory board and an Expert Working Group (EWG) that includes workers and farm managers will guide the development, testing, and dissemination of the intervention.

#### **Ag Weather Net: Heat Awareness System (UW Department of Environ. and Occupational Health Sciences, 2014-2015)**

Dr. Spector and her team collaborated with Washington State University’s (WSU’s) AgWeatherNet weather station network program to assess the feasibility and acceptability of a “heat awareness system” for farm supervisors (i.e. an alert system that notifies growers when weather conditions present HRI risk, coupled with recommendations for how to reduce this risk). AgWeatherNet provides access to weather data from WSU’s automated weather station network of over 160 weather stations and a range of decision aids currently geared toward crop protection. This work forms the

foundation for the HRI prevention intervention proposed in the new project described above, *A Multi-level Approach to Heat-Related Illness Prevention in Agricultural Workers*.

### Heat Exposure, Injury Risk, and Productivity in Agricultural Workers (NIOSH 2014-2017)

Dr. Spector was awarded a K01 grant (new investigator award) to examine the association between heat exposure and traumatic injury risk in agricultural workers, with the ultimate goal of developing injury prevention solutions. The research also aimed to understand the relationship between heat stress and productivity, and the feasibility of using a biomarker of heat acclimation to detect workers at risk for heat-related illness (HRI) and injury. These associations and potential mechanisms have been suggested in previous studies, but not explored in agriculture. In a field study, harvest workers were evaluated in the field for associations between heat stress, psychomotor performance and productivity. In addition, the field studies tested the feasibility of using urinary 8-hydroxy-2'-deoxyguanosine (8-OHdG) as a biomarker of heat acclimation. In an epidemiologic study, the researchers drew on established climate models and WA workers' compensation data. Researchers reviewed 12,200 workers' compensation injury claims between 2000 and 2012 in relation to maximum daily humidex exposures. The paper released (see citation below) shows an increased risk for

*“Our findings underscore the importance of working together with workers and growers to identify and evaluate practical strategies that address the increased risk of injury that outdoor agricultural workers face in the heat.”*

*- June Spector, Principal Investigator*

traumatic injuries in ag workers during hot conditions, particularly with certain work-intensive harvesting activities in July. The connection between heat and injury was not surprising. With heat exposure, dehydration, and fatigue, a person can become less stable on their feet and have more difficulty concentrating. The study team took these lessons into the field to determine the specific mechanisms and risk factors for injury. In addition, the team engaged with employers to estimate future productivity losses and health effects, and to identify potential heat-related illness prevention interventions.

### OUTPUTS

- Spector JT, Krenz J, Calkins M, Ryan D, Carmona J, Pan M, Zemke A, Sampson PD: [2018] Associations Between Heat Exposure, Vigilance, and Balance Performance in Summer Tree Fruit Harvesters. *Applied Ergonomics* 67:1-8. Online version published ahead of print <https://authors.elsevier.com/a/1Vjs0RfpMqVb>. doi: 10.1016
- Quiller G, Krenz J, Ebi K, Hess JJ, Fenske RA, Sampson PD, Pan M, Spector JT: [2017] Heat exposure and productivity in orchards: Implications for Climate Change Research. *Arch Environ Occup Health* 31:1-4. PMID: 28139172. PMCID: PMC5562533.
- Spector JT, Bonauto DK, Sheppard L, Busch-Isaksen T, Calkins M, Adams D, Lieblich M, Fenske R: [2016] A Case-Crossover Study of Heat Exposure and Injury Risk in Outdoor Agricultural Workers. *PLOS ONE*. PMID: 27716794. PMCID: PMC5055365.
- Spector JT, Krenz J, Blank KN: [2015] Risk Factors for Heat-Related Illness in Washington Crop Workers. *Journal of Argomedicine* 20(3): 349-59. PMID: 26237726. PMCID: PMC5562231
- Spector JT, Sheffield PE: [2014] Re-evaluating Occupational Heat Stress in a Changing Climate. *Annals Occupational Hygiene* 58 (8): 936-42. PMCID: PMC4481564
- Spector JT, Krenz J, Rauser E, Bonauto DK: [2014] Heat-Related Illness in Washington State Agriculture and Forestry Sectors. *American Journal Industrial Medicine* 57(8): 881-95. PMID: 24953344. PMCID: PMC5562230
- Lam M, Krenz J, Palmández P, Negrete M, Perla M, Murphy-Robinson H. and Spector JT: [2013] Identification of Barriers to Prevention and Treatment of Heat-Related Illness in Latino Farmworkers Using Activity-Oriented, Participatory Rural Appraisal Focus Group Methods. *BMC Public Health* 13:1004. PMID: 24156496. PMCID: PMC4015616
- Spector JT: [2017] Heat Exposure, Injury Risk, and Productivity in Agricultural Workers, Oral Presentation. NIOSH State of the Science Conference, Denver, CO.



## Research Tools and Standard Operating Procedures (SOP):

Survey: Interactive Multimedia Survey: Characterizing HRI Risk Factors for Agricultural Workers (English and Spanish)

SOP: CorTemp™ Sensors Heat Strain Assessment in Agricultural Workers

Software: Spector J & Lieblich M. (2016). R package to estimate wet bulb globe temperature from datasets of standard meteorological measurements using models developed by Liljegren et al. Version 1.0. Available at:

<https://github.com/mdljts/wbgt>

Training: Preventing Heat-related Illness (HRI). **Agricultural Medicine in the Northwest: Special Topics Lecture Series.** CDC accredited CME is available to those who complete this course. To view the course flyer, [click here](#). [To proceed to complimentary registration, click here](#).

Trade articles:

[Avoiding heat-related illness - Study finds workers paid piece rate tend to work harder and take fewer breaks, increasing the risk of heat-related illness symptoms](#). Good Fruit Grower Dec 28, 2015.

[Hot Weather can Increase Risk of Agricultural Worker Injuries](#) University of Washington News Release, 2016.

## ACRONYMS AND TERMINOLOGY

**Actigraphy** - a non-invasive method of monitoring human rest and human activity cycles AFF - Agriculture, Fishing, and Forestry

**HRI (Heat-Related Illness)** - exposure to abnormal or prolonged amounts of heat and humidity without relief or adequate fluid intake that can cause various types of illness, including heat stroke, heat exhaustion, heat cramps, sunburn and heat rash.

**Piece Rate Pay** - payment that is usually a price paid per unit of work.



## **REDUCING AGRICULTURAL WORKER RISKS THROUGH NEW AND EMERGING TECHNOLOGIES YEARS 2011-2016**

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### **See Appendices for project:**

Terms & Abbreviations; Logic Model; and, Enrollment Report

### **RELEVANCE**

Washington State has approximately 168,000 acres of apples and produces roughly half of the U.S. apple crop. With this intense level of production, the potential spray drift of pesticides from orchard airblast applications is a health concern for workers, neighboring farmers, and residents. Tree fruit production has made advances in pest management yet has continued to depend on traditional airblast sprayer technology and the use of high volumes of toxic pesticides due to pest pressures. Personal protective equipment (PPE) is the most commonly used form of protection among pesticide handlers in tree fruit. However, previous PNASH research has found that the use of PPE is often insufficient for protecting workers.

The purpose of this project is to analyze the effectiveness of new pest control practices, including pesticide product substitutions, and application technologies to reduce: 1) the risk of pesticide handler exposure to pesticide products, and 2) worker exposure to pesticide drift.

### **OUTCOMES**

- Our field study of dermal and inhalation exposure for pesticide handlers indicated that skin is the primary route of exposure, supporting previous studies. The body areas with the highest skin exposures were the upper legs, thought to occur during the mixing of pesticides before the application.
- It was demonstrated that the currently available and most frequently-used pesticide compounds for apple orchards are, in general, safer for pesticide applicators (when following label instructions) than alternatives of 10 years ago, when organophosphate use was more prevalent. However, in many cases pesticide handlers exceed the level of concern set by a benchmark dose. The field study supported the finding that workers can exceed the risk estimates, even under normal work conditions.

- A comparative risk analysis of nine different alternatives to the organophosphorus insecticide, azinphosmethyl, confirms the scientific basis for phase-out of azinphosmethyl due to associated acute occupational health impacts. Results also indicated that acetamiprid exposures may be higher than anticipated for pesticide handlers who wear protective clothing according to label instructions.
- Novel methods were developed to measure pesticide drift, including the use of micronutrient tracers (zinc, molybdenum, and copper), real-time particle monitoring, and water sensitive paper.
- Our trials of three airblast sprayers showed that drift was occurring at distances approximately 1.7 times greater than the Application Exclusion Zone for orchard airblast applications, as defined by the recently revised EPA Worker Protection Standard. Compared to traditional application technology, new tower sprayers can reduce downwind worker exposure to drift by up to 35%.
- Study results were given to participating pesticide handlers, managers and crop consultants as well as recommendations on how to minimize dermal exposure.
- Dr. Kasner completed a review of a farm-to-farm pesticide notification systems worldwide. This review is of interest to Washington stakeholders exploring the feasibility of a notification system in Washington State.
- Dr. Edward Kasner, PhD student working on Aim 2 of the project, recently completed his doctoral degree and will continue as a Senior Fellow (postdoc) to continue research-to-practices aims.
- Dr. Jane Pouzou, PhD student working on Aim 1 of this project, received recognition for her work through a competitive training grant award from the NIEHS Environmental Pathology/Toxicology Program. She also received the Russell L. Castner Endowed Student Research Fund Award and was named Outstanding PhD Student in the Department of Environmental and Occupational Health Sciences.

## PARTNERS & ADVISORIES

This study was made possible through collaboration with the Washington State Department of Health, Washington State University (WSU), and the Washington Tree Fruit Research Commission. WSU collaborators included Regional Extension Specialist Gwen Hoheisel who served on Edward Kasner's Doctoral Supervisory Committee and AgWeatherNet staff who shared meteorological data related to drift events.

## RESEARCH

**Aim 1: Evaluate interventions designed to reduce agricultural worker exposure and risk during pesticide applications in tree fruit, and**

**Sub-Aim: Measure dermal and inhalation exposures of pesticide handlers using conventional and new pesticide products during airblast applications.**

This aim of the project is the evaluation of a pesticide product substitution intervention. PhD student Jane Pouzou conducted a comparative risk analysis of nine different alternatives to the organophosphorus insecticide, azinphos-methyl (AZM), which was recently phased out for tree fruit pest control. Exposure data used by EPA and other regulatory agencies were obtained from two industry task groups, and toxicity studies were obtained from EPA. These data were combined with PNASH-generated exposure data to estimate total exposure and risk of acute neurotoxicity for each pesticide. Results of this analysis supported the phase-out of AZM due to associated acute occupational health impacts, but results also indicated that acetamiprid exposures may be higher than anticipated in handlers who wear protective clothing according to label instructions.



[View](#) 2016 Video feature on student, Jane Pouzou.

In 2012 PNASH researchers conducted a field study of dermal and inhalation exposure for twelve pesticide handlers applying AZM and ten handlers applying acetamiprid in eastern Washington. Three methods were used to measure skin exposure: 1) rinsing residues from hands, 2) wiping residues from the face, and 3) collecting insecticides deposited on patches (thick absorbent paper) that were attached to the outermost layer of protective clothing worn by each handler. The dominant exposure route for the insecticides in this study was through the skin. This is thought to occur while mixing pesticides before the application, which may be prevented by wearing a protective apron. The body area with the highest level of skin exposure was the upper legs. Recommendations made to the managers and pesticide handlers included wearing additional PPE rather than the minimum amount required by the label, wearing an apron while mixing pesticides and decontaminating PPE immediately after using with soap and water.

AZM Samples were analyzed in the laboratory for AZM and AZM-oxon, the latter of which has been identified as being present in the environment along with AZM. If present, AZM-oxon is important to include in the risk-risk analysis comparison with acetamiprid because it is considered to be more toxic than AZM. Analysis methods for acetamiprid, the alternative pest control product to AZM were used in the risk analysis.

Dr. Jane Pouzou then conducted the Comparative Risk and Pesticide Decision Making Survey, a mixed-media survey and phone interview with 68 licensed crop consultants in Washington State, to understand the drivers of pesticide selection and how to better characterize new pest control compounds and principles. The survey demonstrated that decisions were largely based on the user's understanding of effectiveness and cost. Participants responded positively to the study and have received the results for their own review.

*"I enjoyed working with you, let me know if I can ever be of help again."*

*- WA Crop Consultant  
Participant*

To understand orchard managers' decision making on their pesticide product selection and use, a final Multi-Criteria Decision Analysis (MCDA) was conducted. The analysis integrated information from: 1) EPA data and toxicity studies, 2) PNASH-generated exposure data, and 3) the crop consultant survey. This study demonstrated that MCDA can provide a useful framework for alternatives assessment and that qualitative and quantitative data can be easily and systematically combined based on efficacy, pollinator toxicity, costs, and other pesticide selection criteria. While predictions of pesticide preference did not perfectly match pesticide use records, useful information on tradeoffs between acute and subchronic health impacts among ten different pesticides was gained. The widespread adoption of probabilistic methods in regulation will enhance knowledge and precision regarding the hazards of workers and other exposed populations.

The currently available and most frequently-used pesticide compounds for apple orchards are, in general, safer for pesticide applicators (when following label instructions) than alternatives of 10 years ago, when organophosphate use was more prevalent. However, in many cases pesticide handlers exceed the level of concern set by a benchmark dose. The field study supported the finding that workers can exceed the risk estimates, even under normal work conditions.



Field test measuring pesticide drift with three sprayers: axial fan airblast (AFA), directed air tower (DAT), and a multi-headed fan tower (MFT). The field study was

**Aim 2: Evaluate new engineering controls to reduce agricultural worker exposure due to pesticide drift during pest control applications in tree fruit orchards.**

The second aim of this project focused on the evaluation of new pesticide application technologies (sprayers) for drift reduction. We collaborated with Washington State University in field-testing that began in 2014. Under the direction of PhD Candidate, Edward Kasner, novel methods for measuring tracers of pesticide spray drift were developed and used in three orchard-based field studies in July 2015, June 2016, and September 2016.

We evaluated three pesticide sprayers based on their drift reduction potential, as measured by tracers in the field. We compared three

conducted at a research orchard that allowed for a randomized block study design to minimize environmental differences that could arise between trials. Meteorological conditions, including wind, temperature, and humidity, were measured by a permanent weather station west of the orchard and a temporary station to the northeast.

Drift potential was evaluated using an innovative method of putting different micronutrient tracers (zinc, molybdenum, and copper) in each sprayer tank. Downwind from the orchard, a series of field targets composed of filter paper, polyethylene plastic line, and polyester line were placed horizontally and vertically to collect aerosol particles to measure downwind deposition. Air sampling pumps connected to IOM inhalable dust samplers were placed on the back tractors and at various places downwind. On a spray day, the same one-acre orchard block was sprayed with each application technology and only one kind of micronutrient per technology.

Micronutrient tracer use and spray order were randomized across spray days. Each sprayer was outfitted with a global positioning system (GPS) to record time and location data. Vertically suspended samples of continuous polyester pile with wireless cotton core (12 mm diameter, 2 m length) were collected at 3 different heights and 15 different locations downwind of the spray site. Samples were analyzed for micronutrient tracer mass using inductively coupled mass spectrometry (ICP-MS) and then normalized by tank concentration to show the total volume of tank equivalents intercepted from the drift plumes. Finally, we built a mixed-effects model to describe the relationship between potential worker exposure as an outcome variable (drift volume) and the following variables: sprayer type, location, downwind distance, height, and wind speed.

We found evidence to suggest that: 1) drift was occurring at distances approximately 1.7 times greater than the application exclusion zone (AEZ) for orchard airblast applications, and, 2) tower sprayers can reduce downwind worker exposure to drift. The comparative evaluation found that the MFT sprayer produced less measurable drift than the AFA and DAT sprayers. Compared to the AFA sprayer, the tower sprayers (MFT and DAT) decreased drift by up to 35% through shorter nozzle-to-tree canopy distances that allowed for more targeted application. The results of this study highlight the importance of differentiating by not only downwind distance but also sprayer type, sampling height, and orchard canopy architecture for Drift Reduction Technology (DRT) testing and AEZ radius setting.



Three application technologies (sprayers) evaluated

### **Aim 3: Develop recommendations for optimal pest control methods to minimize handler exposure and pesticide drift.**

Results from this study were compiled into recommendations for PPE use while handling acetamiprid and engineering controls for minimizing pesticide drift. These recommendations will be further developed during fiscal year 2017-2018 as part of the research-to-translation work of a PNASH postdoc and the PNASH Center Outreach and Education Core. Some key messages for pesticide handlers were: 1) gloves should be worn at all times while handling acetamiprid, and 2) properly calibrated tower sprayers can reduce drift potential.

### **ADDITIONAL AWARDS AND ACCOMPLISHMENTS**

In 2016, Magali Blanco, an MS student, received funding from the Graduate Opportunities and Minority Achievement Program to conduct a companion methods development study. She also received the Russell L. Castner Endowed Student Research Fund Award and was named Outstanding MS Student in the Department of Environmental and Occupational Health Sciences. Ms. Blanco used real-time particle monitoring and time series data to better characterize drift variability during a spray event. Ms. Blanco graduated in Spring 2017 and will be continuing her research on pesticide drift as a PhD student in Fall 2017.



Christine Delgado Perez, an undergraduate student, supported this research by analyzing water sensitive paper samples that were used to capture aerosol droplets during the 2016 spray trials. After two years of working with this team, she graduated and will be pursuing a career in public health and medicine.

### **Notification of Pesticide Applications to Minimize Workplace Exposures: A Feasibility Study**

In May 2014, the Washington Department of Health (WA DOH) alerted state agencies and growers to a spike in pesticide spray drift illness cases among tree fruit orchard workers. Over a two-month period, approximately 60 individuals were exposed to pesticides in 15 drift events, which is equal to the number of cases that the agency normally sees over the course of an entire year. In response, WA DOH renewed its call for improved communication between farms, sprayers, and crew members. The goal of this project was to evaluate the feasibility of a notification system that would allow supervisors to ensure workers are not located in areas where pesticide drift could likely occur. Detailed interviews with agriculture supervisors demonstrated that most orchard supervisory personnel are willing to participate in an orchard-to-orchard notification system that harnesses the capabilities of mobile technology. According to preferences elicited from industry leaders and managers, an optimal spray notification system maintains privacy, notifies several parties quickly and efficiently, is flexible and mobile-friendly, and is less expensive than other notification options. Next steps to explore the feasibility of a notification system include engaging more stakeholders such as pesticide applicators, farm owners and managers, farmworker groups, research and education communities, and state regulatory agencies. A successful design would require input from all stakeholders, be easy to use on a mobile device, and have ongoing quality assurance.

### **Prevention of Occupational Exposures to Pesticide Drift (WA State Medical Aid and Accident Fund 2015 – 2017)**

An additional award was granted through the Washington State MAAF to begin collaboration with the WA DOH to link historical weather and land use data to 252 reported drift events (690 cases) between 2000 and 2015. This study characterized the risk of occupational drift exposure, expanded epidemiological surveillance, and tested novel drift exposure measurements. This study marks the first time that occupational health drift incident data was paired with historical weather and land use data over a large period of years. Study findings impacted state partner data collection techniques, enhanced exposure prevention training, and contributed to understanding and preventing drift exposure—a major reason for pesticide-related illnesses among Washington agricultural workers.

## **FUTURE WORK**

Results and recommendations for the tree fruit industry and pesticide handlers will be further developed during the 2017-2018 year as part of the research-to-translation work of a PNASH postdoc and the PNASH Center Outreach and Education Core. We will continue close collaboration with Washington State University (WSU) and the Washington Tree Fruit Research Commission to ensure the integration of WSU orchard sprayer calibration techniques into our field studies and dissemination of these findings to Washington growers.

## **OUTPUTS**

Kasner EJ, Fenske RA, Galvin K, Yost MG, Palmández P: [2016] Review of Agricultural Spray Notification Systems. 2016 Technical Report.

Pouzou JG: [2016] The Use of Multi-Criteria Decision Analysis in Performing Alternatives Assessment and Comparative Risk Analysis: The Case Study of Codling Moth Pesticides. PhD Thesis, University of Washington.

Blanco M: [2017] Real-Time Particle Monitoring of Pesticide Drift from Two Different Orchard Sprayer. MS Thesis, University of Washington.

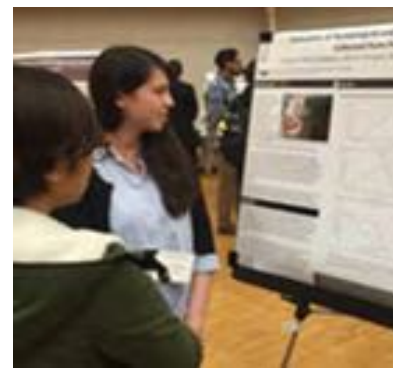
Kasner EJ: [2017] On Preventing Farmworker Exposure to Pesticide Drift in Washington Orchards. PhD Thesis, University of Washington.

### Standard Operating Procedures (SOPS):

Laboratory and field methods for occupational exposure to the insecticide acetamiprid in Washington State orchards. Field methods for measuring downwind drift with micronutrient tracers.

**Survey:** Crop Consultants on Pesticide Preferences, Attitudes, and Beliefs (online)

**Video:** Reducing Agricultural Worker Risks through New and Emerging Technology – feature on student, Jane Pouzou. [https://www.youtube.com/watch?v=eKIs2ghP\\_dl](https://www.youtube.com/watch?v=eKIs2ghP_dl).



Christine Perez Delgado, student research assistant poster

### Selected Presentations:

- Pouzou, JG: [2014]. Comparative Risk and Probabilistic Exposure Estimates of Insecticide Use in Tree Fruit Production, Poster Presentation. International Society of Exposure Science, Cincinnati, Ohio.
- Kasner, EJ: [2014]. Notification of Pesticide Applications to Minimize Workplace Exposures: a Feasibility Study, Poster Presentation. International Society of Exposure Science, Cincinnati, Ohio.
- Pouzou, JG: [2014] Development of Laboratory and Personal Sampling Methods for the Evaluation of Dermal and Inhalation Exposures of Pesticide Handlers Applying Acetamiprid, Poster Presentation. Occupational, Environmental and Public Health Conference, Blaine, WA.
- Kasner, EJ: [2014] Using Data to Protect Workers and Others from Pesticide Drift: Exposure Assessment, Poster Presentation. Washington State Environmental Health Association Annual Educational Conference, Grand, WA.
- Pouzou, JG: [2015] Comparative Occupational Exposure Assessment of Two Pest Control Alternatives in Tree Fruit Orchards, Poster Presentation. Occupational, Environmental and Public Health Conference, Blaine, WA.
- Kasner, EJ: [2015] Evaluation of New Technologies to Reduce Drift and Pesticide-Related Illness among Tree Fruit Orchard Workers: October 2014 Pilot Study Design and Findings, Poster Presentation. International Society of Exposure Science, Henderson, NV.
- Kasner, EJ: [2016] Disrupting the Pesticide Drift Exposure Pathway: Evaluation of New Technologies to Reduce the Risk of Pesticide-related Illness among Tree Fruit Orchard Workers, Poster Presentation. Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides Annual Winter Workshop, Seattle, WA.
- Fenske, RA: [2016]. Evaluation of New Technologies to Minimize Worker Exposure to Pesticide Drift in Orchards, Oral Presentation. International Society of Agricultural Safety and Health, Lexington, KY.

**Multiple presentations to local advisories and organizations including the WA State Legislature, UW Latino Center for Health Strategic Forum, Friends of Farms and Forests Advisory Meeting and the Washington Tree Fruit Association.**

### ACRONYMS AND TERMINOLOGY

(Definitions obtained and summarized from the U.S. Environmental Protection Agency.)

**Application Exclusion Zone (AEZ):** the area surrounding the application equipment that must be free of all persons other than appropriately trained and equipped handlers during pesticide application.

**Organophosphorus Pesticide (OP):** organophosphates are a class of insecticides used in agriculture, homes, gardens and veterinary practices that can cause deleterious health effects.

**Pesticide Drift:** is the movement of pesticide dust or droplets through the air at the time of application or soon after, to any site other than the area intended. Pesticide droplets are produced by spray nozzles used in application equipment for spraying pesticides on crops, forests, turf and home gardens.

**Worker Protection Standard (WPS) of the U.S. EPA:** Federal regulations and standards intended to inform workers and handlers about pesticide safety, provide protections from potential exposure to pesticides, and mitigate exposures that do occur.



## **ERGONOMIC EVALUATION OF EMERGING TECHNOLOGIES IN THE TREE FRUIT INDUSTRY YEARS 2012-2016**

**Peter Johnson, PhD, MS**

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### **See Appendices for project:**

Terms & Abbreviations; Logic Model; and, Enrollment Report

### **RELEVANCE**

Tree fruit production activities – such as pruning and structural cutting, green fruit thinning, and harvesting – require high-intensity physical labor. Traditionally, these activities are performed from the ground and on ladders. Now, new innovations are being introduced, such as apple collection systems (vacuums and conveyors) and ladder replacements (harvest assisted mobile technology). These new technologies are designed to increase productivity and reduce injury risk for workers (e.g. ladder falls). However, new practices also have the potential to introduce new ergonomic and safety hazards.

This field study conducted ergonomic evaluations of harvesting that compared the use of ladders with the use of harvest-assist mobile technology (a platform). In collaboration with an innovative manufacturer and with growers, our field study comparatively evaluated these methods for ergonomic stressors, including kinematic (arm movements) and physiological (muscle fatigue and muscle activity).

### **OUTCOMES**

- Overall, workers using the harvest-assist mobile platform had lower ergonomic stressors than those picking from ladders. This project also demonstrated the benefits of the platform for efficient harvesting.
- The use of harvest-assist mobile platforms reduced physical work demands on workers (back and shoulder inclination as well as repetitive motion of arms) when compared to orchard ladder use.
- Resulting best practice recommendations for orchard managers include: 1) rotate workers between the ground and platform to distribute the impact on the musculo-skeletal system over to different body areas, 2) adjust platform height and vertical area for harvesting to minimize time workers spend picking with arms higher-than-shoulder and to maximize time they are in an upright posture, and 3) provide adequate and appropriately spaced breaks during the workday.

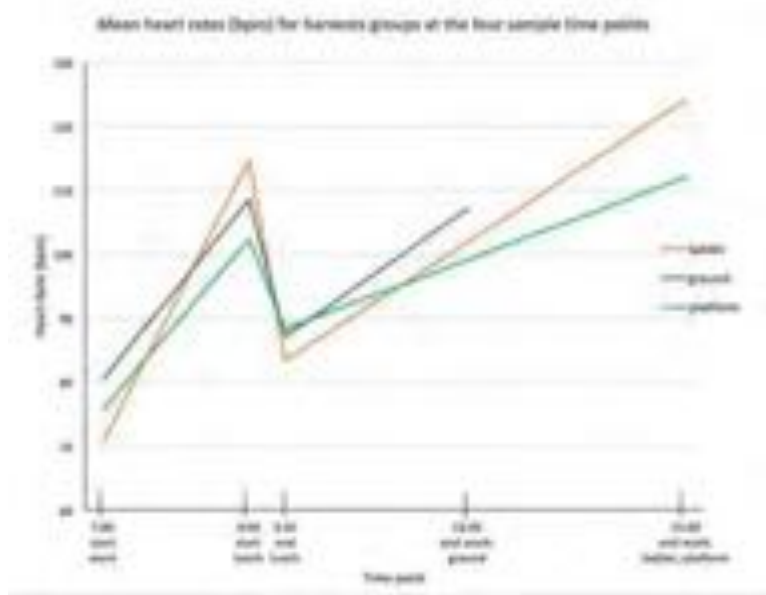
- Study results were provided to the project Technical Advisory Group (which included participating employers and manufacturers) and at the annual meeting of the Washington Tree Fruit Association.
- Our partnership with the agricultural equipment manufacturing company, *Automated Ag Systems*, during the first year of production of the *Bandit Xpress* (a self-propelled harvest assist platform) enabled us to consult and inform safety aspects of the design. At the World Ag Expo 2014 in Tulare, California, PNASH presented the hazard assessment along with the *Bandit Xpress* by *Automated Ag Systems*. At the Expo, the equipment was named one of the 2014 Top-10 New Product Winners.

## PARTNERSHIPS AND ADVISORIES

This project was advised through a Technical Advisory Committee comprised of industry stakeholders, including producers, orchard managers, extension specialists, equipment manufacturers, and ergonomists. The committee provided input and recommendations for this study, such as adding analysis of economic factors and additional ergonomic assessments. New collaborations were established with a large apple producer for field studies and with *Automated Ag Systems*.

## RESEARCH

This field study compared ergonomic risk factors for workers harvesting apples from: 1) a tripod orchard ladder, 2) the ground, and 3) standing on an harvest-assist mobile platform. Traditionally, apples are picked and then placed into a bag suspended from the shoulders and workers use a tripod ladder to reach apples. However, modern orchards now have fruiting walls (trellised apple trees) that can accommodate semi-automated technologies, such as the harvest-assist mobile technology. Workers ride on these elevated mobile platforms, harvesting fruit from the upper portion of the canopy into small apple bags and then emptying the bags directly into a bin on the platform. Apples in the middle and lower in the canopy are picked from the ground level and ladders are not used. Harvesting with the platform can increase productivity and potentially reduce the hazards and musculoskeletal risk factors associated with climbing and carrying a ladder.



**Aim 1: With current traditional pruning, thinning, and harvesting methods, identify safety hazards and measure and characterize the physical demands along with measures of productivity. The intention is to establish baseline metrics for the traditional tasks to enable comparisons to tasks performed with the existing and emerging assistive tools and technologies collected in Aim 2, and**

**Aim 2: With existing and emerging assistive pruning, thinning, and harvesting technologies, identify safety hazards, as well as measure and characterize the physical demands along with measures of productivity, and compare to traditional tasks collected in Aim 1**

In 2014, we conducted an ergonomic field study by comparing apple harvesting using *Bandit Xpress* harvest-assist mobile platform to harvesting using the conventional orchard ladder. A study group was established through a new partnership with a large apple producer that adopted the new technology and whose workers had at least three months harvesting experience. A rigorous field study assessed three treatment groups, which included harvesting from: 1) ground, 2) ladder, and 3) harvest-assisted mobile platforms.

Throughout the study, field conditions were held consistent among the three study groups, including the same orchard architectures and age, fruit variety, picking instructions, and pay method. These conditions allowed us to complete a

*“I appreciate you are worried about our safety at work and are doing something about it.”*  
- Project Participant

comprehensive comparison of ladders and platforms by comparing objective and subjective assessments of physical demands as well as productivity.

Twenty-four workers participated in the study. All the participants were Latino males who spoke Spanish as their primary language. Eight participants were in each of the three study groups: ground, ladder, and platform. Workers were paid piece rate by the number of bins they filled each day. Platform and ground crews shared bins, so the total number of bins filled per crew each day was divided by the

number of crew members (4), to obtain the number of bins per person per day. Ladder harvesters picked into individual bins and were paid by the number of bins they each filled in a day.

### **Whole body exertion and body area fatigue**

Time-of-day was the primary factor for increases in whole body exertion and body area fatigue, with significant increases in both the monitored and self-reported measures at the end of the workday. Ladder harvesters had the greatest increase in heart rate over the work periods and the greatest decrease in heart rate over lunch (figure x). There was not a significant difference in heart rate among the three harvest methods. Moving the major break (lunch) from 2 hours after starting work to mid-day would create work periods of equal duration, which may help reduce the exertion and fatigue levels experienced by the end of the day. In comparison to the other groups, ladder workers overall worked at the highest exercise levels; therefore, using a harvest-assist mobile platform could reduce harvester fatigue levels.

### **Lower back and shoulder posture and fatigue**

Harvesting from the platform provided workers with a more comfortable upright posture than picking from the ground or ladders. Harvesting from the platform also reduced the right arm extension compared to the right arm extension among workers in the ladder and ground groups. Ladder workers in this study used their non-dominant arm more frequently than the workers in the other two groups. When using platforms for harvesting, it is important to rotate workers between the ground and platform to distribute the impact on the musculoskeletal system over to different body areas.



### **Comparison of objective and subjective measures**

An aspect of this study was to determine if the subjective measures, such as the Borg RPE and Borg CR10, could be used in place of the objective measures for whole body exertion (heart rate) and shoulder fatigue (arm inclination), respectively. The objective measures used in this study required instrumentation with one heart rate monitor and three inclinometers per participant, a relatively costly and time-intensive approach. In this study, the correlations between objective and subjective measures were weak and did not provide sufficient evidence to support substituting the objective measures with the subjective rating scales. The subjective scores still provide important information on a worker's experience of whole body and body area fatigue.

### **Economic factor: Bin fill rate**

Our study's economic assessment of productivity was based on bin filling rates, but did not include other factors such as fruit quality. On harvest-assist platforms, either a two or three-person crew would have bin-filling rates greater than either the ground or ladder methods.

### **Aim 3: In collaboration with our Technical Advisory Group, develop and evaluate modifications to traditional, existing, and emerging assistive technologies to minimize musculoskeletal discomfort and injury**

A Technical Advisory Group (TAG) was established that included, ergonomists, agricultural engineers, extension faculty,



physical therapists, representatives from industry (including employees with a farmworker history), and equipment manufacturers. They provided recommendations including industry relevant methods for measuring productivity and additional tools for collecting information on the worker-related musculoskeletal health factors.

As a result of TAG input, we added muscle activity measures and the standardized Nordic Questionnaire. We improved the current Borg CR10 scale for perceived fatigue by addressing more body parts, such as foot/ankle. In addition, a new method to measure repetitive arm motion was developed and validated by comparing to video observation.

#### **Aim 4: Translate and communicate the study findings (Research to Practice) to the tree fruit industry**

Results were provided to the project TAG, which includes key influencers on technology adoption (such as WSU Extension, tree fruit industry representatives and WA State Department of Labor and Industries ergonomists). Likewise, results were shared with participating employers and manufacturers and at the annual meetings of the Washington Tree Fruit Association in years 2015 and 2016.

Key study results and messages for the tree fruit industry are that overall workers using the harvest-assist platform had lower ergonomic stressors than those working from ladders or picking from the ground.

#### **Best practice safety and health recommendations related to harvesting:**

1. Ensure that ground workers do not work in front of the harvest-assist platform.
2. Rotate workers between the ground and platform when using harvest assist mobile technology. By providing different work positions and movement, impact on the musculoskeletal system is more evenly distributed among different body areas.
3. Adjust platform height and vertical area for harvesting to minimize the amount of time workers pick with arms higher-than-shoulder and to maximize the amount of time they are in an upright posture.
4. Provide adequate and appropriately spaced breaks during the workday.
5. Determine the number of pickers on the platform crew based on the density of fruit available for harvesting.
6. Provide safe steps for climbing on and off platforms to prevent climbing on tires and other moving parts.

#### **FUTURE WORK**

A "Best Ergonomic Practices for Tree Fruit Harvesting" pamphlet (Spanish and English), created in collaboration with the WA State Department of Labor and Industries, is in development and will be disseminated through PNASH's Outreach and Education Core over our 2016-2021 program cycle.

#### **OUTPUTS**

Thamsuwan, O: [2016] Objective Methods for Characterizing Physical Exposures Which May Contribute to Work-related Musculoskeletal Disorders in Agricultural Workers. PhD Thesis, University of Washington.

Thamsuwan O, et al.: [2016] Different EMG Normalization Methods and Implications for Field-Based Data Acquisition of Muscle Activity, Conference Paper. PREMUS Conference: Prevention of Work-Related Musculoskeletal Disorders, Toronto, Canada.

Thamsuwan O, et al.: [2015] Characterizing Repetitive Upper Arm Motions in Apple Harvesting, Poster Presentation. Conference: 19th Triennial Congress of the International Ergonomics Association, Melbourne, Australia.

Thamsuwan O, et al.: [2015] Comparison of Exposure to Repetitive Upper Arm Motions and Non-neutral Upper Arm Postures between Apple



Harvesting with Ladders and Mobile Platforms, Poster Presentation. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, Los Angeles, California.

Thamsuwan O, et al.: [2014] A Method for Characterizing Repetitive Upper Arm Motions in Apple Harvesting and a Comparison of Exposures to Repetitiveness Between Ladders And Mobile Platforms, Poster Presentation. The 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives, Omaha, Nebraska.

Galvin K, et al.: [2014] Ergonomic Comparison of Apple Picking from Ladders, Harvest-Assist Mobile Platforms, and the Ground, Oral Presentation. The 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives

Galvin K, et al.: [2014] Ergonomic Comparison of Apple Pickers using Ladders and a Harvest Assist Mobile Platform, Oral presentation. Occupational and Environmental Health Conference, Blaine, WA.

Presentations were also given at Washington Tree Fruit Association Annual Meeting in years 2015 and 2016.

#### **Survey Instruments and Protocols Standards:**

Effort Surveys (Spanish): Borg RPE, OMNI RPE, Borg CR10

Effort Surveys (English): Borg RPE, OMNI RPE, Borg CR10

Nordic Questionnaire Modified (Spanish)

Nordic Questionnaire Modified (English)

Accelerometers: Start and Stop Work Signal Protocol

#### **ACRONYMS AND TERMINOLOGY**

**Conveyor (apple collection system)** - *(The following description is paraphrased from [GrowingProduce.com](http://GrowingProduce.com)):* Pickers, both on the platform and on the ground, place the fruit on fingered conveyor belts that carry it to a rotating bin filler. By combining pickers on the platforms and on the ground, harvest can be done in a single pass through the row. Eliminating the need for ladders and buckets, the conveyor is thought to reduce picker fatigue.

**Ergonomic Job Hazard Analysis** - a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment (*definition from U.S. Department of Labor, Occupational Safety and Health Administration*).

**Harvest Assisted Mobile Technology (Platform)** - platforms upon which pickers stand, which serve as a replacement for ladders.

**Piece Rate Pay** - payment that is usually a price paid per unit of work (e.g. dollar amount per apple picked, per bin filled etc.). **Tripod Orchard Ladder** - a portable, self-supporting ladder used in orchards and landscape maintenance, for tasks such as pruning and fruit harvesting. It is designed with a flared base and a tripod pole that provides support on soft, uneven ground (*definition from U.S. Department of Labor, Occupational Safety and Health Administration*).

**Vacuum (apple collection system)** - *(The following description is paraphrased from [GrowingProduce.com](http://GrowingProduce.com))* The unit is comprised of two parts – the self-propelled platform and the vacuum harvesting unit. A crew of four pickers man the hydraulic platform picking fruit from trees up to 13-14 feet. Pickers place each apple into a receptacle attached to a foam-lined vacuum tube, which whisks the fruit away at 12 feet per second. Eliminating the need for ladders and buckets, the vacuum is thought to reduce picker fatigue.



## **PILOT: IMPACT OF A TOTAL WORKER HEALTH® INTERVENTION ON WORKPLACE STRESS IN FARMWORKERS YEARS 2014-2016**

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**See Appendices for project:** Terms & Abbreviations; Enrollment Report, and Invention Report

### **RELEVANCE**

This project addresses workplace stress – a need seen in our previous surveys of farmworker families. Living and working conditions are unique in agriculture. Farmworkers face stressors on the job that may affect their performance and safety at work, relationships at home, and physical and mental health. Agricultural workers report high levels of stress from job mobility, language barriers, job security, financial concerns, and long workdays. Due to the seasonal nature of agriculture, workers often experience periods of unemployment or job insecurity followed by periods of intense and physically demanding work with long hours.

With community and industry input, this project has produced and piloted a training and wellness program for agricultural workers. This pilot study was designed to identify indicators of stress and to evaluate the effectiveness of a Total Worker Health® (TWH) intervention that addresses typical causes of stress for agricultural workers.

### **OUTCOMES**

- The resulting TWH toolkit, “BeSuper! agriculture” is available (January 1, 2018) for agricultural employers for use with supervisors/work teams (English and Spanish). The training program and tracking methods for supervisors and workers were found to be effective and well-liked by the pilot participants. “Be Super!” can help employees become exceptional supervisors, foster healthy teams, and create a culture of safety and wellbeing.
- In the vineyard pilot study, the “BeSuper!” TWH intervention led to several positive changes to measures of occupational stress, safety, health and well-being, health care, lifestyle, and social support. Biomonitoring results revealed decreases in BMI and body fat. There were improvements in lifestyle measures including fewer sugary drinks and fast food meals. Likewise, there were positive changes in consumption of fruits and vegetables, using techniques to reduce food cravings, frequency of drinking sugary drinks, eating low calorie meals, drinking 5-7 glasses of water per day, and the use of stress-reducing techniques. There were significant

increases in (hard and moderate) physical exercise. In addition, waking during the middle of the night declined significantly. Social support improved. Family diet and exercise encouragement both increased significantly and exercise sabotage by others such as co-workers declined significantly.

- This pilot study demonstrated the potential to conduct strong and impactful TWH interventions for agricultural workplaces.

## **PARTNERS & ADVISORIES**

The pilot was conducted with cooperation of a wine grape grower and has now been expanded to additional growers. The program will be sustained into the future through the OHSU Oregon Healthy Workforce Center and close partnerships with ¡Salud!, Tuality Health Care and LIVE, Inc. LIVE Inc. is a wine grape grower certification program with the motto *Science-based standards for sustainable winegrowers*. Their membership includes 317 NW winegrowers.

## **RESEARCH**

### **Aim 1: Identify workplace stressors and lifestyle factors associated with stress in farmworkers**

This project grows out of a previous PNASH project by Dr. Rohlman. She sought to characterize occupational and lifestyle stressors in farmworker couples and to examine the impact of seasonal work demand and gender on health outcomes.

In Dr. Rohlman's study, Hispanic agricultural workers (n=17) participated in structured interviews to identify psychosocial and occupational stressors unique to their lifestyle (unpublished study). Findings from these interviews and a literature review examining psychosocial and workplace stressors in agricultural workers were used to develop a questionnaire to assess stressors in agricultural workers. The following items were included in the questionnaire to identify and characterize work-related stressors: work history, job strain (Karasek, 1998), work-family stress (Netemeyer, 1996), supervisor support (Hammer, 2009), and safety outcomes (Griffin and Neal, 2000; Hemingway and Smith, 1999). In addition, items addressing lifestyle factors associated with stress were evaluated, including sleep (Buysse, 1989), diet and nutrition (Thompson, 2002), acculturation (Hovey and Magaña, 2000), and psychological factors (Boiko, 2005; Kessler, 2002; Mroczek and Kolarz, 1998). Several of these questionnaires have been adapted for use with Spanish-speaking agricultural workers; other standardized questionnaires were reviewed and pilot-tested during the interviews to determine the appropriateness for this population. An important theme that emerged throughout the interviews was the additional stressors faced by couples in which both parents worked.

Spanish-speaking interviewers administered the questionnaire to 32 couples (n=64) in May (low work demand) and September (high work demand) of 2012. Couples were eligible to participate if both partners were ≥18 years old, the male partner was currently working in agriculture, and there was at least one child ≤12 years old in the home. One couple did not complete all the data collection instruments and was excluded from the analysis.

This population did not report significant differences in stress between low and high work demand times. However, women reported more work-family conflict and less supervisor support. Women experienced more conflict between work and family and received less support at work. This group reported low depressive symptomology and moderate levels of stress; a subset reported elevated levels.

A review of the research, consultation with a vineyard manager and workers, and validation by our project advisory group led to a list of topics that could be addressed to reduce worker stressors and improve health in agriculture:

- Stress and the Ulysses Syndrome (stress symptoms commonly associated with migration)
- Relaxation Techniques
- Health Care and Insurance
- Public Assistance Programs
- Nutrition, Sugar, Calories
- Cardiovascular Exercise, Strength Training, Flexibility
- Sleep

- Farm safety (Pesticides, Heat stress, UV radiation, Ergonomics, Respiratory hazards)
- Time management
- Finances
- Taxes
- Interpersonal Communication

**Aim 2: Develop [and evaluate] a Total Worker Health® intervention to reduce workplace stress in the farmworker community via the workplace**

Training on effective supervision and work-life balance developed in the Oregon Healthy Workforce Center (OHWC) was adapted for farm managers and supervisors. In 2016-2017, this Total Worker Health® (TWH) intervention for agricultural workers was piloted with a large grower with the goal of reducing workplace and individual stress. This was accomplished through small-group educational presentations that addressed issues related lifestyle, well-being, supervisor training and effective supervision.



Computer-based training and *HabiTrak* app

The training program includes:

- 1)** Computer-based training for supervisors on team building, on work-life balance for employees and on how to reinforce employee behaviors. This training was combined with the *HabiTrak* iPhone app to practice and track the frequency of employee interactions and to reinforce behaviors supporting safety, health and personal well-being in employees.
- 2)** A team-based education program addressing lifestyle behaviors, well-being and safety that also includes take-home activities to practice the lifestyle behaviors. The TWH intervention used 'Get Healthier' lifestyle topic cards and Well-being topic cards to facilitate discussion with supervisors and employees in small groups. In addition, there were optional take-home activity sheets that further reinforced each topic. Volunteers in the work crew took turns leading the crew in presenting and carrying out the Lifestyle Card activities (in small group gatherings). The employees received one wellness card to read and use as a take-home activity each week (activities were to be completed outside work or at home). The take-home activities along with a pedometer were provided to each person to support the activities
- 3)** Evaluation measures included pre- and post-intervention: surveys, knowledge tests, and bio-measures. Also collected were frequency of contacts via the app and fidelity checks of the scripted training and take-home activities.

This program was assessed by a pilot study with fourteen participants, 7 from a vineyard (A) and 7 from a farm with both hops and grape production (B). The vineyard (A) completed all aspects of the project, while the hops farm (B) completed everything except the post-intervention survey and the scripted well-being training. Among both groups (n = 14), their mean age was 42; 64% were Hispanic, 21% had attended college, 64% were married and the same 64% had children living at home. The sample included 29% who had 0-5 years of experience in agriculture, 64% who had 11-20 years of experience and 7% who had more than 30 years experience in agriculture. They worked about 9 hours/per day and 45 hours/week.





Dr. Anger describing program to farm managers.

The supervisors at Farm A (n=2) were Hispanic and just under half the supervisors at Farm B (n=7) were Hispanic. All participants at Farm B had supervisory functions (n=7). Overall the sample of supervisors had a mean age of 41.

Supervisors showed a significant increase in knowledge on the post-training test ( $p=0.0006$ ), effect size ( $d$ ) = 0.89. Supervisors rated the training excellent (3.6 on a 4-point scale). The supervisors' self-reports indicated that they did increase interactions with employees, a goal of the training and *HabiTrak* self-monitoring. Reaction measures to the self-monitoring were very positive.

At the piloted vineyard, the intervention led to several positive changes to measures of occupational stress, safety, health and well-being, health care, lifestyle, and social support that were statistically significant; the biomonitoring effects had small to medium effect sizes ( $d$ ) but the other changes had large effect sizes ( $d$ ).

Biomonitoring results revealed decreases in BMI and body fat. There were improvements in lifestyle measures including consuming fewer sugary drinks and fast food meals. Likewise, there were increases in eating fruits and vegetables, using techniques to reduce food cravings, increased eating of low calorie meals, drinking 5-7 glasses of water per day, and the use of stress-reducing techniques. There were significant increases in (hard and moderate) physical exercise. In addition, waking during the middle of the night declined significantly. Social support improved – family diet and exercise encouragement both increased significantly, and other exercise sabotage declined significantly.

Many measures showed no change, and for this small group there were no notable indicators of high stress. However, there was an indication of stress due to immigration, which has been termed the Ulysses Syndrome. The USDA household food security survey response of 0.3 indicated that the families were not going hungry. Only one person recognized that their company's workers' compensation insurance would pay for an illness or injury sustained at work, but 36% indicated they had had an injury, perhaps minor, while at work.

## FUTURE WORK

We continue our research and education to farm stakeholders through ongoing work through the NIOSH-funded Oregon Health Workforce Center. We are now expanding the pilot to additional growers. The program will be sustained into the future through the OHSU Total Worker Health Center and close partnerships with ¡Salud!, Tuality Health Care and LIVE, Inc. LIVE is a new partnership to the project - a wine grape grower certification program with the motto ***Science-based standards for sustainable winegrowers***. Their membership includes 317 winegrowers in the Northwest.

## OUTPUTS

TePoel M, Rohlman D, Shaw M: [2017] The Impact of Work Demand and Gender on Occupational and Psychosocial Stress in Hispanic Farmworkers. *Journal of Agricultural Safety and Health*, 23(2), 109-123.

### Presentations:

Shaw M, Huszar S, Rohlman D: [2012] Occupational Stress in Latino Agricultural Workers, Oral Presentation. Oregon Public Health Association, Corvallis, Oregon.

Rohlman D, Shaw M, Huszar S: [2013] Workplace Demands and Stress in Hispanic Farmworkers, Poster Presentation. Midwest Rural Agricultural Safety and Health Conference, Ames, Iowa.

Rohlman D, Shaw M, Huszar S, Khan K: [2013] Characterizing Stress in Hispanic Agricultural Workers, Poster Presentation. Work, Stress, and Health 2013: Protecting and Promoting Total Worker Health®, Los Angeles, California.

TePoel M, Shaw M, Huszar S, Rohlman D: [2014] Correlates of Mental Health in Seasonal Farmworkers, Oral Presentation. The 13<sup>th</sup> Annual Midwest Rural Agricultural Safety and Health Conference, Ankeny, Iowa.

Rohlman D, Shaw M, TePoel M, Huszar S: [2014] Occupational and Environmental Stress in Latino Agricultural Worker, Oral Presentation. The 7<sup>th</sup> International Symposium to Advance Total Worker Health®, Bethesda, Maryland.

Live, Inc. workshop; Stoller Family Estate; Dayton, OR - August 4, 2016.

Scientific publications are in preparation. Final technical reports are on file at PNASH. Data from the surveys and the training will be available in repositories for use by others and toolkits in English and Spanish will be made available through the Oregon Institute of Occupational Health Sciences at Oregon Health & Science University.

### **Research tool (App):**

*HabiTrak* iPhone app Total Worker Health® for Farmworker Supervisors (English and Spanish)

### **Training tools:**

Agricultural Worker Stress Questionnaire

Toolkit: BeSuper/agriculture! – Computer-based supervisor skills training, paper-based tracking (practice) and scripted wellness/well-being cards with take-home activities to practice the information learned from the cards (materials in *English* and *Spanish*) will be available at the Oregon Institute of Occupational Health Sciences at Oregon Health & Science University. User guides (English only) will accompany the toolkit so that this TWH intervention can be obtained and applied in new settings. Editing software is available to adapt the computer-based training and the original scripted training can be obtained to adapt it to other contexts. Some of the information in the scripted well-being cards is specific to Oregon, but all other information is relevant across industries (although the examples are specific to agriculture).

**Get Healthier Cards** - Scripted peer-led team discussions on health and wellness topics plus take-home activities to practice what is learned from the cards, both in *English* and *Spanish*:

- Get healthier (making goals, pedometer)
- Sleep
- Calories (calories in foods, portion sizes, RMR calculations)
- Liquids & calories (low calorie/sugar options, low-high comparisons)
- Basic nutrition (reading labels, food groups: healthy vs. unhealthy)
- Snacks (healthier options)
- Sugar (natural vs. added, limit added)
- Exercise (benefits, starting out)
- Strength (weekly needs, group strength routine)
- Flexibility (benefits, injury)
- Stress (body-mind, management)
- Moving forward (overview, future health goals)

**Wellbeing Cards** - Scripted peer-led team discussions on well-being topics plus take-home activities to practice what is learned from the cards, both in *English* and *Spanish*:

- |                                   |  |
|-----------------------------------|--|
| ○ Adjusting to a new culture      | ○ Heat stress, UV radiation, & respiratory hazards |
| ○ Stress                          | ○ Ergonomics                                       |
| ○ Stress and the Ulysses Syndrome | ○ Time management                                  |
| ○ Relaxation techniques           | ○ Finances   |
| ○ Public Assistance Programs      | ○ Interpersonal Communication I                    |
| ○ Health Care and Insurance       | ○ Interpersonal Communication II                   |
| ○ Taxes                           | ○ Other Resources for you and your family          |
| ○ Pesticide                       |  |



## **PILOT: ASSESSING SAFETY AND HEALTH AMONG HMONG FARMERS YEARS 2011-2013**

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### **See Appendices for project:**

Terms & Abbreviations; Logic Model; and, Enrollment Report

### **RELEVANCE**

The Hmong are an ethnic group originally from the mountainous regions of southern China and Southeast Asia, who have practiced subsistence agriculture for centuries. According to the U.S. Census, in 2010, nearly 260,000 Hmong refugees were in the U.S., making them one of the largest refugee ethnic groups in the nation. Regionally, a large Hmong farming community resides in western Washington State. Many of these refugees engage in small-scale, family-owned farming. Although Hmong refugees may be skilled in agriculture in their countries of origin, farming in the U.S. poses an unfamiliar environment and practices, which may increase their risk for exposure to agricultural-related hazards, and for resultant injury and illness.

This two-year pilot project assessed work-related safety and health issues among Hmong farmers, using novel, participatory methods to gain insight into the unique challenges this understudied and underserved group encounters.

### **OUTCOMES**

- Novel participatory approaches were developed through collaboration with a Washington State Hmong farmworker community to conduct safety and health assessments. Strategies included Participatory Rural Appraisal (PRA), Photovoice, and an observational worksite exposure assessment.
- Findings suggest Hmong-operated small-scale farming involves a variety of distinct occupational hazards that would benefit from interventions tailored to context and culture.
- Common hazards observed were biomechanical (e.g., awkward postures, bending with the back, repetitive hand motions, lifting >50 pounds, manual task performance in lieu of powered equipment), use of sharp tools without adequate guarding mechanisms, and inadequate personal protective equipment.
- Conventional exposure assessment methods revealed similar hazards and safety risks to those identified through participator methods with Hmong farmers themselves (i.e., musculoskeletal disorders, injuries related to using heavy machinery, heat and cold stress, respiratory exposures (i.e., dust), and activities related to pest management.

- Project participants were offered farm safety education and individualized posters displaying stories about themselves that they could display as part of their farmers' market stand.
- Initial efforts to engage Hmong farmers in agricultural safety and health were successful, providing a foundation to address needs of this regional stakeholder group with whom PNASH had not previously worked with.

## PARTNERS AND ADVISORIES

The Hmong Outreach Educator with the Washington State University Small Farms Team Project served as the primary liaison to the Hmong community. A community advisory board (CAB) was assembled and comprised of community and agricultural leaders in the region, some of whom had connections or previously worked with Hmong groups. The CAB assisted in engaging and establishing an entrée with Hmong farmers, advising project procedures and activities, and disseminating project findings.

## RESEARCH

### **Aim 1: Determine the feasibility of using participatory assessment methods (PRA and Photovoice) in comparison to conventional worksite observational exposure assessments to characterize safety and health issues encountered by a sample of Hmong refugee farmers**

We began our study by establishing a working relationship with the Hmong community in western Washington State. Before recruiting participants, a CAB of community members, agricultural industry professionals, researchers, and advocates with prior ties or experiences working with Hmong refugee farmers was assembled. This CAB provided advice on culturally appropriate and acceptable ways to interact with the Hmong community in the context of research and also provided feedback on approaches to share findings with the community.

With the help of the Hmong community liaison, a sample of Hmong men and women farmers were recruited to participate in the assessment over the course of a full growing season. Qualitative data was obtained through discussion groups structured with PRA methods in which workers performed hazard assessment exercises to evaluate information about their own work experiences and their local conditions. Given cultural differences and limited English proficiency, participatory assessment approaches were viewed as more effective than conventional research methods. Participatory approaches encourage study participants to provide data they view as meaningful and have their perspective more prominently represented and valued.

A “start-of-growing-season” PRA workshop was designed to gain insight into the types of farming activities and tasks, when these tasks are performed throughout the calendar year, the associated safety and health hazards and exposures, and the work practices used to mitigate risk of injury or illness. For example, using pictorial cards in a matrix-style grid, participants matched commonly grown vegetable and flower crops to specific farming tasks. Another activity involved participants completing a matrix-style calendar to identify a schedule of farming activities and specific hazards. The session concluded with participant storytelling about work-related injury or illness experiences and about ways farmers try to protect themselves.

The PRA assessment was complemented by Photovoice methodology that consisted of participants themselves taking photographs to capture illustrative examples of farm safety and health hazards. At the conclusion of the “start-of-growing-season” workshop, participants were given digital cameras. They were asked to photograph scenes throughout the growing season that depicted representations of farm work safety and health hazards. They were trained on Photovoice methods, including the purpose of taking photographs, basic photography techniques, and camera operation and protection. Additionally, participants were instructed on ethical considerations (e.g., asking permission before photographing individuals and avoiding photographing faces, incriminating circumstances, minors, or identifiable



Icon-based exercise to identify farm work activities and safety and health concerns  
(de Castro, 2014)



addresses/residences, automobile license plates, or locales). We also conducted conventional observational exposure measurements of participants' farms using an assessment tool that measured location, activities, hazards, pesticides, and equipment.

## **Aim 2: Identify priority agricultural safety and health hazards experienced by Hmong refugee farmers**

There are very few standardized tools available to assess safety and health hazards in agricultural operations. Additionally, there are a number of groups of agricultural workers, including Hmong refugees and other racial/ethnic immigrants, for which little is documented about safety and health conditions they experience. This study developed an observation-based methodology for systematically evaluating occupational health and safety hazards in agriculture. Our project pilot-tested this on multiple small-scale Hmong farming operations. Each observation assessed the range of safety and health hazards (e.g., musculoskeletal hazards, dust and pollen, noise, and mechanical hazards), as well as on factors such as type of work area, presence of personal protective equipment, and weather conditions. Thirty-six observations were collected on nine farms. The most common hazards observed were bending at the back and lifting <50 pounds. Use of sharp tools without adequate guarding mechanisms, awkward postures, repetitive hand motions, and lifting >50 pounds were also common. The farming activities observed involved almost no power equipment, and no pesticide or chemical handling was observed. The use of personal protective equipment was uncommon.

The results of this assessment coincided with the perceived safety and health hazards obtained through the PRA and Photovoice approaches. The principal safety and health hazards identified by this project included musculoskeletal disorders, injuries related to using heavy machinery (e.g., rototillers, tractors), heat and cold stress, respiratory exposures, and activities associated with pest management). A common health complaint among both older and younger participants was acute and chronic back pain, which they readily associated with the physical demands of farm work tasks.



Participants most often talked about farm work tasks that put them at risk for musculoskeletal problems. They identified tasks that generally required difficult, awkward postures and positioning, such as bending for long periods, pulling crops out by hand, using tools such as knives to harvest vegetables and flowers, and washing crops. Of most concern was weeding because of the associated stooping and bending, as well as transporting crops to farmers' markets, which required heavy lifting. For example, one participant mentioned that he typically transports 5-gallon buckets filled with water and cut flowers to farmers' markets, with each bucket weighing approximately 30 pounds. Compounding this, participants remarked that, after being already fatigued from a long day of working in the fields,

they have to prepare vegetables and flowers for loading during nighttime hours and rise very early the next morning to deliver and set up stands at farmers' markets.

Additional concerns raised by participants touched on socioeconomic and cultural concerns. Participants characterized these concerns within their overall day-to-day lives as farmers. For example, only being able to lease (and not own) land plots that are marginal in quality, unaffordable equipment, and inadequate income selling at farmers' markets all contribute to persistent lower socioeconomic status in participants' views. In turn, these circumstances perpetuate the challenge of improving their quality of life. Moreover, being relative newcomers to the U.S., participants were sometimes unable to adequately communicate with English speakers when conducting farm-related business, negatively impacting their farms and incomes.

As an assessment method, employing both the PRA format and Photovoice activities were conducive to directly obtaining participant perspective about what they viewed as safety and health priorities. These approaches complemented with the traditional method of the worksite walk-through inspection, which collectively offered a unique



approach that triangulated data sources to gain rich, multi-dimensional perspectives of agricultural safety and health issues.

**Aim 3: Describe ‘best practices’ used by Hmong refugee farmers which reduce exposure to agricultural hazards, which may be transferred and applied to other refugee groups in small farm operations**

In 2014, we published an article outlining observational exposure assessments that complemented this study. We also created a *Facilitator’s Participatory Rural Appraisal Guide for Occupational Health Professionals* to describe the “best practices” that may be transferred and applied to other refugee groups engaging in small operations. Our research was presented at the American Public Health Association Annual Meeting and the Research Translation with Vulnerable Populations Conference.

**FUTURE WORK**

The increasing diversity of the U.S. workforce compels occupational health professionals to pay more attention to underserved, minority groups who may be at disproportionately higher risks for injury and illness – especially if they are employed in non-traditional, small enterprise workplaces. More research is needed that investigates occupational safety and health concerns among refugee worker populations, in particular. Such research must consider how cultural factors contribute to or influence work-related health and well-being. Interventions tailored to small-scale, family-operated enterprises are needed, including education, training, and practical, low-cost hazard control measures.

**OUTPUTS**

Neitzel, R, Krenz, J, de Castro, AB: [2014] Safety and health hazard observations in Hmong farming operations. *Journal of Agromedicine* 19(2) 130-49.

de Castro, AB, Krenz, J, Neitzel, RL: [2014] Assessing Hmong Farmers Safety and Health. *Workplace Health Safety* 62(5): 178-85.

Facilitator’s Participatory Rural Appraisal Guide for Occupational Health Professionals

**Presentations:**

Krenz J, Cha B, de Castro AB: [2012] Assessing Agricultural Safety and Health Among Hmong Farmers in Washington State, Poster Presentation. American Public Health Association Annual Meeting, San Francisco, California.

Krenz J, de Castro A, Spector J: [2012] Using Participatory Rural Appraisal in Agricultural Safety and Health Research, Poster Presentation. Workshop on Research Translation with Vulnerable Worker Populations Conference, Fort Collins, Colorado.

**ACRONYMS AND TERMINOLOGY**

**Hmong** - persons of Hmong descent predominantly from China or Southeast Asia (most notably Thailand, Vietnam and Laos). Many Lao Hmong war refugees resettled in the US following the North Vietnamese invasion of Laos and the Laotian Civil War during the Vietnam War.

**Participatory Rural Appraisal (PRA) Process** - a set of participatory and largely visual techniques for assessing group and community resources, identifying and prioritizing problems and appraising strategies for solving them. It is a research/planning methodology in which a local community (with or without the assistance of outsiders) studies an issue that concerns the population, prioritizes problems, evaluates options for solving the problem(s) (*definition from KS Toolkit*).

**Personal Protective Equipment (PPE)** - is equipment worn to minimize exposure to hazards that cause workplace injuries and illnesses (*definition from U.S. Occupational Safety and Health Administration*).

**Photovoice** - a process by which community members capture and record their life experiences and community through photography and stories. Photovoice includes group discussion about the photographs and what they mean. Photographs and stories are presented to the community in order to raise awareness (*definition from Community-Campus Partnerships for Health, University of Washington*).



## EDU 1: PESTICIDE SAFETY IN TREE FRUIT: TRANSLATING RESEARCH, OVERCOMING BARRIERS YEARS 2011-2016

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### See Appendices for project:

Terms & Abbreviations; Logic Model; and, Enrollment Report

### RELEVANCE

Washington State's tree fruit industry employs about 187,000 permanent and seasonal workers, most of whom are Hispanic and 70% of whom are year-round state residents. Our tree fruit industry and regional educators provide exceptional training opportunities throughout Washington, yet they recognize that barriers remain for Hispanic pesticide applicators and their supervisors. These barriers often stem from language and cultural differences between the workers, managers, and safety educators.

This education and research project aimed to overcome key education barriers to pesticide safety and to disseminate pesticide safety solutions. By translating research into an accessible and relatable form, orchard owners, managers, pesticide handlers, and educators, will be better equipped to protect workers and their families from potential pesticide exposure and illness.

### OUTCOMES

- Distribution and adoption of the [Practical Solutions for Pesticide Safety](#) (English and Spanish) guide in orchards across Washington State and by pesticide educators around the nation. Since 2012, over 2,000 copies have been requested and its solutions have been presented to over 5,000 growers throughout the Northwest.
- A collaboration of university, agency, and private industry representatives are currently pursuing the development of an "Agricultural Supervisor Development Program" to promote healthier workplaces and address the training gap in pesticide education for workers in the tree fruit industry.
- Development and pilot of the Pesticide Label Safety App. The App provides easy access to English and Spanish pesticide health and safety information, which is currently only available in English on the label of the pesticide container. PNASH has demonstrated proof-of-concept. With the support of the University of Washington technology transfer office, we are launching a financially self-sustaining version of the App covering all pesticides used in WA tree fruit. This App is a foundation for providing translated labels for other agricultural commodities.

- Our WA growers' survey identified several new pesticide educational needs and revealed that some of PNASH's (and Partners') key training messages are being shared on farms, including heat-related illness (HRI) prevention messages, the role of proper PPE in regards to heat-related illness, and cleaning personal protective equipment (PPE) to prevent dermal exposure and residue transfer. Survey results also confirms the need for Spanish language materials and training for the Worker Protection Standard (WPS), pesticide label health and safety information, Integrated Pest Management (IPM), and supervisor training.

## PARTNERSHIPS AND ADVISORIES

Aim 2 of this project worked in collaboration with a stakeholder working group that included industry, workers, and state pesticide education leadership. Aim 3 of the study was conducted in partnership with the Washington State University Tree Fruit Research Extension Center (WSU TFREC). The WSU Social and Economic Research Survey Center (WSU ERSC) managed the survey distribution and data collection for Aim 4.

## RESEARCH

### **Aim 1: Disseminate risk factors, practical pesticide safety solutions, and pesticide safety barrier research results to the agricultural community by using interactive methods such as an audience response system for large meetings.**

This aim, led by Ms. Galvin, began by distributing a previously developed PNASH educational tool, [\*Practical Solutions for Pesticide Safety\*](#). This manual was widely disseminated among the industry personnel, including among pesticide handlers, crew foreman, supervisors, managers, orchard owners, industry representatives, pesticide safety educators, and agriculture safety professionals. In addition, research results were translated for different target audiences and

disseminated in presentations, recertification classes, trade journal articles, newsletters, and websites. Presentations used audience participation and evaluation methods, such as the Turning Point audience response system or 'clickers'. Manuals were also disseminated on-request and during interactions with staff at conference exhibits and through sign-ups during presentations. The guide is now being used in educational programs across the region. Since 2012, over 2,000 copies have been requested and its solutions have been presented to over 5,000 growers throughout the Northwest.

In addition, other organizations have initiated their own Practical Solutions training programs. "It's pure gold!" declared a loss control manager at a major Northwest worker's compensation company. The company reached over 1000 growers, managers, and pesticide handlers who have attended either an English or Spanish session. The company printed the guide at their own cost and provided copies to each participant. The *Good Fruit Grower* published the article, "New pesticide safety guide released: Guide includes practical solutions to aid in pesticide handling safety." This is a widely-read trade journal for orchardists and viticulturists, and its readership is both national and international. This promotion, continues to draw interest within the tree fruit industry and with other commodity groups.

A "Practical Solutions Pesticide Safety Kit" (Spanish and English) was developed for use by pesticide safety educators and orchard safety trainers. The kit includes materials for four practical solutions to be used in a hands-on training led by pesticide safety educators. The package for each solution contains a large poster featuring a photograph and/or illustration of the solution and the two associate key safety messages, a hands-on example of the solution, and curriculum for the educator.



Practical Solutions for Pesticide Safety (SPAN/ENG)

**Aim 2: Develop strategies for overcoming barriers to pesticide safety in orchards through stakeholder engagement, using qualitative statistical social science approaches for small samples to categorize stakeholder viewpoints on barriers, and convening a facilitated stakeholder working group to achieve consensus on plans for overcoming these barriers.**

The major aim to identify and address barriers in pesticide safety education, was led by Dr. Lehrer and the project's Stakeholder Working Group (SWG). Pesticide safety in tree fruit orchards is a contested issue, with some stakeholders feeling that pesticides are handled safely while others worry that current practices pose severe health and safety risks for farmworkers.

Dr. Lehrer used [Q methodology](#) to examine the diversity of views around pesticide safety, exposure, and human health concerns in Washington State's tree fruit industry. Q methodology is designed to draw out the differences and similarities among stakeholder views. In Q methodology, the researcher's focus is on the subjective viewpoints of the participants, which in turn reveals commonalities in beliefs among the group of participants. Q-methodology, as used here, was designed to rigorously and systematically identify stakeholder perspectives in a way that would be transparent to participants, and that could be used by a multi-stakeholder working group to negotiate around pesticide safety risks and potential opportunities for risk mitigation and safety education.

*"We've done an injustice a little bit to these supervisors because we've not invested in their skills and knowledge... I'm like, 'Let's catch 'em up!' And when you have good supervisors you have less turn over because people want to work for that good supervisor."*  
- Human Resource Manager Participant

Forty-nine individuals participated, of which 41 (those who completed the entire Q sort) were included in the data set. Participants were given a blank sorting grid and 45 laminated cards, each printed with one Q statement. These statements were developed from 18 interviews and focus groups held in Spanish and English in 2012. Q-sort participants were instructed to place each card in a space on the grid, according to how similar or different each one was from their personal viewpoint, with the left-most column labeled "least like my view" (-5) and the right-most column "most like my view" (+5), with "neutral" (0) as the central column.

Results found three different worldviews (or factors) regarding pesticide safety in Washington State tree fruit orchards. The first worldview, nicknamed the "skeptic," was held by individuals who were concerned about the environmental and human health impacts of pesticide use, and felt that current regulations were not sufficient to protect people from pesticide exposure. The second worldview, nicknamed the "acceptor," agreed that there was an inherent risk in using

*"I had to check myself because I have a definite bias. I was trying to put the boot on the other foot"*

*"Placing statements on the grid was harder and required me to re-think why I had placed some in certain categories."*

- Q-sort Participants

pesticides, but felt strongly that these risks were known, small, well-controlled and managed. The third worldview, nicknamed the "incrementalist," focused primarily on opportunities to make human capital and technology improvements in the workplace. Like the skeptic, the incrementalist worried about human health impacts of pesticides and exposure to risk but agreed with the acceptor that solutions lay more strongly in improved communications than in any regulatory or structural changes. Despite the differences in worldviews found in the Q study, there were also many commonalities among the three viewpoints identified.

Individuals who had participated in the Q study were invited to participate in an ongoing working group process, to identify and pursue a mutually acceptable improvement for pesticide safety concerns. We invited people from the three different worldview clusters to a series of five Stakeholder Working Group meetings held between 2014 and 2016. The Stakeholder Working Group felt that to improve workplace safety and health, the underlying solution was to improve

supervisors' skills, specifically through management and supervisor training. The SWG decided information was needed on current orchard hiring and training procedures. Thus, in Years 4 and 5, interviews were conducted with 21 human resources managers at tree fruit companies, 90 surveys completed were completed by tree fruit supervisors, and questions were included in the survey of tree fruit owners/managers about supervisory training needs in the industry (Aim 4).

Data from all three of these sources was brought back to the SWG in Year 5, and the group decided to move forward on pursuing a supervisory skills training certificate program. The group has continued to meet through 2017 and is working with a regional community college and tree fruit industry association to develop and pilot a certificate program curriculum and to secure additional funding to continue these efforts beyond 2018. This project can be considered a success in that, as hoped, the Q study served as a tool for the SWG to identify and pursue an improvement to orchard health and safety (supervisory skills training) that is ongoing and that should have a life beyond this project as part of the tree fruit industry. A SWG member shared "I do want to mention an experience from last week... During an orchard stop we were discussing orchard managers and supervisors. How do you recruit, how do you train, where can people get the training etc. I mentioned this project and 3... from [the] WA group turned right around and said - tell us more. Where can we sign up, when will the course be ready... after the tour a few others came up and asked for details. There is pent up demand!"

### **Aim 3: Pilot a new approach to overcoming language and access barriers by providing Spanish translations of the English-only pesticide label health and safety information for pest management which allow growers and managers to access and share it with their Hispanic handlers and managers**

To improve accessibility for pesticide label health and safety information in Spanish for the Tree Fruit industry, a mobile app was developed and piloted. Spanish is the first language for most the orchard managers and pesticide handlers. Frequently, in our project engagement we heard, "We need labels in Spanish" or "The English is hard to understand." To meet this unaddressed need, we developed the bi-lingual mobile app, **Pesticide label Health and Safety Information**. The App includes 90 pesticides labels commonly used in tree fruit with information on: the product, first aid, health hazards, personal protective equipment, and container storage and disposal. As a pilot, the app was limited in scope. It focused on seven major pests of apples and pears, drawing on WSU's 2016 Tree Fruit Crop Protection guide and labels database. The pilot test was a resounding success, demonstrating the urgent need for label information in Spanish, and



Pesticide label App in (SPAN/ENG)

that the app is the appropriate delivery media. Managers and pesticide handlers have not been getting the critical accurate information they need from the labels, though the current law requires them to use the labels on the pesticide container. Ten orchard managers participated in the test (primary language, English = 2 and Spanish = 8). Nine of ten already used smart phones and reported that the Spanish helped them understand the label, and that they found the app easy or very easy to use. When asked if they preferred the app or the paper label, 9 of 10 choose the App and one had no preference. Most participants were willing to pay for the app, 7 said they would spend between five and ten dollars for the bilingual label app with just the product and health and safety information or a full label. Industry partner interviews and our pilot have demonstrated proof-of-concept and we will continue our work to introduce this service into to practice.

Based on the success of the pilot study, we received support from the University of Washington technology transfer group, CoMotion, for developing the information technology (IT) to provide software as a service from the UW under their Social Impact model. The goal is for the App be a self-sustaining software as a service program provided from within the UW school of Public Health and PNASH, first for the tree fruit industry and then expanding to other labor-intensive crops and other states.



#### **Aim 4: In year 5, evaluate the impact of the research results dissemination and of overcoming barriers to pesticide safety activities by conducting a widespread survey of the agricultural community**

This project supported a complimentary activity, a state-wide [survey](#) of growers, *Emerging Issues and Concerns in Tree Fruit* (English and Spanish). This survey was a collaboration of WSU's Tree Fruit Research and Extension Center and PNASH to understand current trends in a wide range of topics important to the industry, including: emerging pests, IPM programs, lime sulfur drift, supervisory training, the revised EPA Worker Protection Standard, and heat-related illness as it pertains to PPE use.

PNASH contracted with the WSU Social and Economic Research Survey Center to manage the survey distribution and data collection. A mixed mode method (paper and online) was used to increase the response rate. The pool of potential participants (1179) received 5 mailings, which either contained a letter with instructions on how to fill out the survey online or a similar letter with the paper versions in Spanish and English and a pre-paid return envelope.

The survey response rate was 28%, with 310 individuals submitting either partial or complete surveys. The survey's results demonstrated that several of the solutions and key messages developed by PNASH and partners were being shared on farms, including using key heat-related illness (HRI) prevention messages and cleaning personal protective equipment (PPE) to prevent dermal exposure and residue transfer.

Heat-related illness is an emerging area of occupational health research and of particular concern to Pesticide Handlers due to PPE use in hot temperatures. Our survey in Washington showed wide use (>95%) of three key measures for reducing heat exposure: providing drinking water (99%), start work earlier in the morning (99%), and shorter work days (96%). More education is needed for providing shade (87%), for providing HRI training (82%) and for recommending light weight/colored clothing (71%). The survey showed that future HRI campaigns for growers and managers will need to emphasize extra rest breaks and acclimatization. Fifty-nine percent of respondents reported using rest breaks and 56% reported using acclimatization schedules for HRI prevention. Survey respondents identified that lighter disposable PPE is now more widely used to prevent HRI for pesticide handlers. This message has reached many growers, as results showed 60% reporting a change away from the heavy reusable rain suits. The four top reasons for PPE changes were:

*"We've never had something similar in Spanish. Spanish is the handler's language. Our boss never explained to us the labels and we have to consult the labels by ourselves. (Now) It takes me two to three minutes to consult information I need using the app."  
- Pesticide Handler piloting the app*

because of changes in pesticide label directions (93%), to minimize heat exposure (87%), to follow the handler's preference (75 %), and to maintain facilities area for decontamination (73%).

Results also confirmed our understanding of the need for Spanish language materials and training for both the Worker Protection Standard (WPS) and pesticide label health and safety information. Issues facing the industry included WPS communication challenges, not knowing Spanish, communicating label PPE and respirator requirements in Spanish, and workers not understanding or trusting labels. These results support PNASH's ongoing project to develop a sustainable program for providing

accurate translation of pesticide label health and safety information using a smart phone app.

The survey also revealed opportunities for additional education in IPM programs and supervisor training. Overall, these results show progress made and areas for further work specifically related to minimizing worker exposure to pesticides and heat for the WA Tree fruit industry, as well as access to safety information in Spanish. The input provided by growers' will help guide future directions for education and outreach in the industry.

#### **FUTURE WORK**

The work of Aim 2 will continue in collaboration with the projects' SWG and the development of a supervisor certificate for pesticide safety. Aim 3's development of the Pesticide Label Safety App, led by Ms. Galvin, is being pursued through the University of Washington CoMotion (technology transfer) program, with the goal to be self-sustaining through user

(grower) purchases. Pesticide education activities – and follow-through on the education needs identified in the survey – will continue through PNASH’s 2016-2021 program cycle under the Outreach and Education Core, and under Ms. Galvin’s new *Phase II* project, Practical Solutions for Pesticide Safety.

## OUTPUTS

Galvin K, Krenz J, Harrington M, Palmández P, Fenske RA: [2016] Practical Solutions for Pesticide Safety: A Farm and Research Team Participatory Model. *Journal of Agromedicine* 21(1):113-22. doi: 10.1080/1059924X.2015.1107519. PubMed PMID: 26488540.

Survey: Emerging Issues in the Washington State Tree Fruit Industry (SP/ENG). Report at [http://deohs.washington.edu/pnash/sites/deohs.washington.edu.pnash/files/documents/PestEd16\\_GrowerSurvey\\_Ver7Final\\_13April17.pdf](http://deohs.washington.edu/pnash/sites/deohs.washington.edu.pnash/files/documents/PestEd16_GrowerSurvey_Ver7Final_13April17.pdf)

Practical Solutions for Pesticide Safety – Guide and Pesticide Educator Kit (English and Spanish), [http://depts.washington.edu/pnash/practical\\_solutions](http://depts.washington.edu/pnash/practical_solutions).

Trade Article: [New Pesticide Safety Guide Released](#), Good Fruit Grower March 2012.

App - beta version: Pesticide Label Safety and Health Information (SP/ENG)

Other manuscripts have been submitted for publication. Industry Presentations & Exhibits: 10 trade and community conferences and 5 educational sessions.

## ACRONYMS AND TERMINOLOGY

**HRI (Heat-Related Illness)** - Exposure to abnormal or prolonged amounts of heat and humidity without relief or adequate fluid intake can cause various types of heat-related illness, including heat stroke, heat exhaustion, heat cramps, sunburn and heat rash.

**IPM (Integrated Pest Management)** - is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment (*definition obtained from the University of California Statewide Integrated Pest Management Program*).

**Pesticide Drift** - is the movement of pesticide dust or droplets through the air at the time of application or soon after, to any site other than the area intended. Pesticide droplets are produced by spray nozzles used in application equipment for spraying pesticides on crops, forests, turf and home gardens. Some other pesticides are formulated as very fine dry particles (commonly referred to as dust formulations) (*definition from U.S. Environmental Protection Agency*).

**PPE/Personal Protective Equipment** - is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses (*definition from U.S. Department of Labor, Occupational Safety and Health Administration*).

**Worker Protection Standard (WPS) of the U.S. EPA** - Federal regulations and standards intended to inform workers and handlers about pesticide safety, provide protections from potential exposure to pesticides, and mitigate exposures that do occur (*definition obtained from the U.S. Environmental Protection Agency*).

# FEASIBILITY PROJECT PROGRAM

The PNASH Center administered a Feasibility Project Program. The goal of the program is to stimulate new and expanded research, intervention, and education/translation activities in the area of occupational safety and health in Northwest farming, forestry, and fishing.

Previously funded pilot projects have allowed the Center to address emerging issues, bring in new investigators, and address needs/industries not included in other projects. Over the Center's 20 years, it has funded 42 pilot or feasibility projects, including 12 in the 2006-2011 cycle.



# FEASIBILITY 1: REDUCING OCCUPATIONAL HEALTH AND SAFETY RISKS AMONG YOUNG WORKERS IN AGRICULTURE THROUGH CLINICIAN ENGAGEMENT YEARS 2011-2013

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## RELEVANCE

Agricultural workplace fatality rates among youth under age 18 are extremely high, accounting for approximately 42% of workers killed during 1992-2000, and 10% of workers killed from 1998-2007. Although ag work is one of the most dangerous jobs for adolescents, little research has characterized the work experience and health risks for Latino youth working in agriculture. This small project introduced a rapid clinical assessment (RCAT) tool developed by the Migrant Clinicians Network to migrant health care providers in the Yakima Valley Farm Workers Clinic.

## PARTNERS & ADVISORIES

This project was made possible through the support of the Yakima Valley Farm Worker Clinic (YVFWC), Migrant Clinicians Network (MCN), WA State Department of Labor and Industries, Heritage University and El Proyecto Bienestar.

## OUTCOMES

The Migrant Clinician Network received health care provider audience testing results to inform the development of the Rapid Clinical Assessment Tool (RCAT). The RCAT was introduced in the Yakima Valley Farm Workers Clinic (YVFWC), a farmworker clinic system serving 139,369 patients in Central Washington State.

A survey was successfully conducted through PNASH and YVFWC's community-based project, El Proyecto Bienestar, contributing to research and setting Yakima community research and education priorities.

This study highlights the need for workplace health and safety guidance for youth employed in agriculture. The results support Internet-based outreach and the use of the RCAT to aid occupational health discussions in clinical settings.

## RESEARCH

The RCAT tool is a newly developed instrument that provides information on occupational hazards encountered by working youth in farmworker communities. To address the needs specific for the Yakima Valley, we adapted material created by MCN and integrated specific data and regulatory information from the Washington Department of Labor and Industries. There were challenges in conducting research within a busy clinical setting. However, the involvement of the clinic staff in shaping the tools for this project was successful, with 10 clinician participants (nurse, physicians, nurse practitioners, and physician assistants) testing RCAT in 10 patient visits during routine clinical practice. The project was able to "field test" the MCN Rapid Clinical Assessment Tool with the intended audience for the first time. We provided feedback to MCN with recommendations to improve and develop the rapid clinical assessment tool for further use.

In addition, the project yielded novel data on the work hazard experience of young workers in agriculture. This data was integrated into a survey of young Latino-American farmworkers, 14 to 18 years old, regarding their agricultural work experience. One hundred forty youth with farm-work experience completed the survey; 6% reported a previous work-related injury or illness and 53% reported receiving some workplace health and safety training. Correct identification of legally restricted duties for youth varied but were generally low, indicating the need for workplace health and safety guidance for youth employed in agriculture. Participants identified working alone past 8pm (57%), driving a forklift (56%), doing roofing work (39%), working in freezers (34%), and driving a delivery vehicle (30%). The Internet was identified as the most likely and reliable place youth would go to find information on workplace health and safety. Few participants (15%) reported clinician-initiated conversations on occupational health; however, a high proportion of participants responded positively to questions regarding the usefulness of the RCAT for this purpose.

## OUTPUTS

Perla ME, Iman E, Campos L, Perkins A, Liebman AK, Miller ME, Beaudet NJ, Karr CJ: [2015] Agricultural Occupational Health and Safety Perspectives Among Latino-American Youth. *Jour. Agromedicine* 20(2):167-77. PMID: 25906275  
Karr, C: [2012] Children's Environmental Health in Agricultural Settings. *J Argomedicine* 17(2):127-39. PMID: 22490026  
Rapid Clinical Assessment Tool for Adolescent Farmworker Injury and Exposure: [www.migrantclinician.org/toolsource](http://www.migrantclinician.org/toolsource)

## **FEASIBILITY 2: DEVELOPMENT OF A WORK STRESS SURVEY FOR FARMWORKERS YEARS 2011-2012**

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### **RELEVANCE**

Many factors affect the health of agricultural workers, including job demands, workplace hazards, and limited access to medical care. Although recent reports indicate that farm-related injuries and fatalities are declining, there has been an increase in stress-related behavioral health problems including suicide, depression, and substance abuse. There is evidence that immigrant farmworkers, a rapidly growing U.S. agricultural labor force, are bearing an undue share of these problems that could contribute to an increased risk for adverse health effects. The goal of this pilot was to develop methods to assess workplace stress for agricultural workers and to identify the key stressors faced by agricultural families.

### **PARTNERS & ADVISORIES**

The partners at Portland State University's Department of Psychology, Oregon Health & Science University CROET, and Columbia Gorge Fruit Growers helped to make this study possible.

### **OUTCOMES**

This study makes several contributions to our understanding of the role occupational stress has on the health and safety of agricultural workers and their families. Through health assessments and interviews, this project has developed a set of tools to evaluate factors related to occupational stress among Latino/a agricultural workers.

This feasibility project informed the methods for a 3-year PNASH study entitled Impact of Workplace Stress on Health in Farmworker Families, which was based out of the NIOSH Total Worker Health® Center at Oregon Health Sciences. Based on community and industry input, this project adapted training and wellness programs to pilot a new Total Worker Health® (TWH) intervention to reduce stress for Latino agricultural workers. (See project report, Pilot: Kent Anger).

### **RESEARCH**

Our first aim was to develop a tool to assess workplace stress specific for Latino agricultural families. We conducted a review of the literature, initiated conversations with researchers, and conducted interviews with agricultural workers to develop an Agricultural Worker Stress Questionnaire. The survey consists of items addressing workplace and lifestyle factors (e.g., Job Strain/Satisfaction, Supervisor Support, Work-Family Conflict, Psychological Well-being, Sleep/Diet, Social Support, Child Care). One important factor that was identified was additional stressors faced by couples when both parents were working. Based on this finding, we modified the validation study to include both men working in agriculture and their wives. Next, we evaluated stress in agricultural workers at periods of high work-demand and low work-demand times. The association between self-reported stress (measured by the questionnaire) and a biological marker of stress (hair cortisol) was examined.

The results of the study show that both men and women reported experiencing depressive symptoms. Compared to low work-demand periods, during high work-demand periods, including during harvest times, both men and women reported increased stress and an increase in unhealthy habits, such as consuming more fast food and drinks with added sugar. Over all seasons, women reported lower support and control over their job, compared with men. Women, compared with men, also reported more stress that was associated with conflicts between work and home. These conflicts, among both men and women, increased during high work-demand times relative to low work-demand periods.

### **OUTPUTS**

The Agricultural Worker Stress Questionnaire

Rohlman D, Shaw M, Huszar S, Khan K: [2013] Characterizing Stress in Hispanic Agricultural Workers, Poster Presentation. Work, Stress, and Health 2013: Protecting and Promoting Total Worker Health®, Los Angeles, California.

Rohlman D, Shaw M, TePoel M, Huszar S: [2014] Occupational and Environmental Stress in Latino Agricultural Worker, Oral Presentation. The 7th International Symposium to Advance Total Worker Health®, Bethesda, Maryland.

TePoel, M, Rohlman, D, & Shaw, M: [2017] The Impact of Work Demand and Gender on Occupational and Psychosocial Stress in Hispanic farmworkers. Journal of Agricultural Safety and Health 23(2), 109-123.



## **FEASIBILITY 3: RISK FACTORS FOR HEAT-RELATED ILLNESS AMONG OR FARMWORKERS YEARS 2012-2013**

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### **RELEVANCE**

Farmworkers are particularly at risk for heat-related illness (HRI) given their tasks involve heavy exertion in an outdoor setting. However, at the time of this pilot, previous research had not focused on agricultural workers. There are approximately 90,000 migrant and seasonal farmworkers in Oregon and the identification of risk factors for HRI that are specific to the agricultural setting is essential to the development of educational and management prevention solutions. The specific aim of the proposed study is to identify personal, medical, cultural, environmental, and work-related risk factors for HRI among Latino farmworkers in Oregon.

### **OUTCOMES**

This project helped establish Dr. Bethel as a subject matter expert within OR and beyond on heat-related illness among farmworkers. As such, Dr. Bethel now serves as an advisor to Oregon-OSHA regarding a proposed outdoor heat rule. This pilot project provided novel data on the risk factors for HRI present in the agricultural setting. It also provided data on the nature and prevalence of HRI prevention measures employed in the agricultural setting.

### **PARTNERS & ADVISORIES**

The study was conducted in collaboration with Dr. June Spector's HRI Project in Washington State (See project report, Pilot: June Spector).

### **RESEARCH**

This one-year pilot was conducted by Oregon State University (OSU) in collaboration with the UW PNASH Heat-Related Illness (HRI) project in Washington State to characterize HRI in farmworkers. A computer-based survey instrument developed at PNASH was administered to a farmworker community in Oregon. In addition, OSU researchers and students conducted personal interviews with 100 Latino migrant or seasonal workers engaging in outdoor crop production. To obtain information on background symptoms of HRI experienced by farmworkers, the survey and interview included questions on work history, current work activities, water consumption and breaks, payment type (piece-rate or hourly), resources provided by employers, behaviors while working in hot conditions, certain health conditions, and demographics.

The responses indicate that nearly 30% of participants reported experiencing two or more HRI symptoms during the previous week. There was a low level of knowledge regarding the dangers of working in high-heat conditions and a low level of concern about heat-related illness. Participant responses indicated there was a moderate comfort level with taking breaks. Nearly 75% of respondents drank water at least once an hour; 65% of respondents consumed soda while working; and 40% of respondents worked at a site in which no cooling measures were provided (e.g. shade, trees, rest stations). The results suggest that hydration and cooling measures need to be emphasized to workers and growers as a way to decrease heat-related illness.

### **OUTPUTS**

Bethel, JW, Spector, JT, Krenz, J: [2017] Hydration and Cooling Practices Among Farmworkers in Oregon and Washington. *Journal Argomedicine* 22(3): 222-228.

Bethel JW, Harger R: [2014] Heat-related illness among Oregon farmworkers. *Int Jour Environ Res Public Health* 5;11(9):9273-85. PMID: PMC4199019

Bethel, J: [2016] Hydration and Cooling Practices among Farmworkers at Risk for Heat-Related Illness in Oregon and Washington, Oral Presentation. Oregon Public Health Association Annual Meeting, Corvallis, Oregon.

Bethel, J: [2016] Variability in Hydration and Cooling Practices among Farmworkers at Risk for Heat-Related Illness in Washington and Oregon, Poster Presentation. American Public Health Association Annual Meeting, Denver, Colorado.

## FEASIBILITY 4: PARKINSONISM AMONG WA AGRICULTURAL PESTICIDE HANDLERS YEARS 2012-2014

**Susan Searles Nielsen, PhD**  
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### RELEVANCE

Previous human and animal studies suggest that some pesticides, including those typically applied by agricultural pesticide handlers, may increase the risk of parkinsonism (PS). Epidemiological studies suggest a 49% increased risk of PS in individuals who have had chronic occupational exposure to pesticides. However, evidence of a direct association between occupational exposure to pesticides and PS is still inconclusive, and most human studies have solely looked at Parkinson's disease, the most common cause of PS. The study assessed the feasibility of conducting neurological exams on active pesticide handlers to determine the prevalence of PS signs and symptoms and to identify any association between chronic occupational organophosphorus (OP) pesticide exposure and PS signs and symptoms.

### OUTCOMES

This pilot project confirmed the feasibility of examining active pesticide handlers for neurological effects while also generating important new knowledge on PS etiology and pathology. In addition, the project findings suggest the importance of employing additional neurological assessments that may provide more sensitive measures of potential neurological health effects resulting from pesticide exposure.

### PARTNERS & ADVISORIES

The Healthy Worker and the Central Washington Occupational Medicine clinics in the Yakima Valley assisted in the recruitment of participants who were currently enrolled in the Washington State Cholinesterase Monitoring Program.

### RESEARCH

In the 2014 spray season, we examined 38 actively working pesticide handlers ages 35-65 participating in the State of Washington's Cholinesterase Monitoring Program in the Yakima Valley. A neurologist who specializes in movement disorders utilized the Unified Parkinson's Disease Rating Scale motor subscore 3 (UPDRS3) and daily activities subscore 2 (UPDRS2). In addition, participants self-reported work and medical histories. The most common symptoms and signs were, respectively, excess saliva and action tremor. The UPDRS3 and UPDRS2 were unrelated to the number of years applying pesticides. Our study provided minimal evidence that this class of pesticides contribute to PS and no evidence that PS is as prevalent in this group of workers as it is in selected other occupational groups (i.e. welders, manganese miners). Future studies of this sort should focus on older or retired workers in whom symptoms of parkinsonism are expected to be more prevalent. Furthermore, the utilization of other neurological assessments may provide more objective and sensitive measures of potential neurological health effects of pesticides.

### OUTPUTS

Nielsen SS, Hu SC, Checkoway H, Negrete M, Palmández P, Bordianu T, Racette BA, Simpson CD: [2017] Parkinsonism Signs and Symptoms in Agricultural Pesticide Handlers in Washington State. *Journal Agromedicine* 22(3):215-221. doi: 10.1080/1059924X.2017.1317684. PMID: 28418778. PMCID: PMC5533575

Nielsen SS, Checkoway H, Zhang J, Hofmann JN, Keifer MC, Paulsen M, Farin FM, Cook TJ, Simpson CD: [2015] Blood  $\alpha$ -Synuclein in Agricultural Pesticide Handlers in Central Washington State. *Environmental Research* 136: 75-81. PMCID: PMC4548290



Screen shot from the recruitment video played at medical clinics

## FEASIBILITY 5: TRANSMISSION OF MICROORGANISMS IN DAIRY FARMS YEARS 2013-2015

**Peter Rabinowitz, MD, MPH**

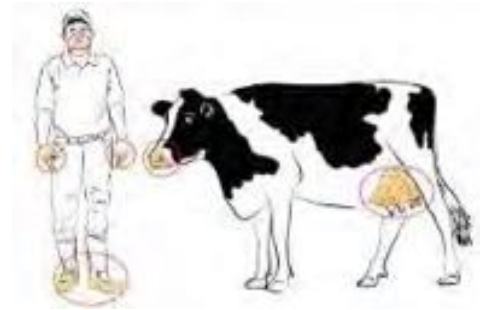
Associate Professor

Department of Environmental and Occupational Health Sciences

University of Washington

### RELEVANCE

Dairy farming involves close contact between workers and animals as well as shared environmental exposures on the farm. These conditions may provide a mechanism for microbes to move between humans, animals, and the environment within the dairy farm setting; this process is known as zoonosis. There is evidence that such microbial transmission can lead to infection in both workers and cows when zoonotic pathogens are exchanged. In contrast, some evidence suggests that microbial exposures on farms may have beneficial aspects to human health. To explore the degree of microbial sharing taking place on dairy farms, we performed a survey of Staphylococcal species in a sample of dairy workers, cows, and their shared dairy farm environments in a “One Health” model. This small project assessed microbial transmission between humans, animals, and environments in dairy farms, as well as occupational exposures and risks to dairy workers.



Bacteria transfer between cows-humans-cows

### OUTCOMES

Developed methods for simultaneously assessing the health of humans, of animals, and of the environment within animal agriculture settings using an interdisciplinary human health (including industrial hygiene) and veterinary health field team approach. Wide dissemination of the project results and the educational brochure (in English and Spanish) by our Dairy industry partners (see Outputs) throughout Washington State, including at agricultural safety and health events reaching producers, workers and health care providers. The brochure was pretested with both English and Spanish-speaking dairy workers in Washington State prior to its publication and dissemination. This project has led to a new 5-year NIOSH-funded study at PNASH, entitled “Healthy Dairy Worker Study,” (Rabinowitz).

### PARTNERS & ADVISORIES

Collaboration with local dairies was made possible through partnerships with the Washington Dairy Federation, the Dairy Products Commission and the WSU Dairy Agricultural Extension Service.

### RESEARCH

Microbial samples were collected from workers, cows and the surrounding environments in five dairy farms in Washington State, including at conventional and organic operations at both large- and small-scale. In addition, workers completed an exposure and risk factor survey adapted from previous occupational health surveys for animal workers. The microbial analysis found both a high prevalence and a high diversity of Staphylococcus species in humans, cows, and dairy environments. The overlap of Staphylococcal species between people and cows suggests human-animal microbial transmission, including for species that could cause mastitis. The evaluation of worker practices through the survey demonstrate significant variability in behavior regarding hand-washing, use of PPE, and exposure to raw milk.



These findings suggest that microbial sharing of organisms between workers and cows is occurring at dairies, despite current infection control measures such as training on the use of PPE that may reduce such sharing. Since sharing may vary between farms, future research must be conducted to determine best practices to optimally manage microbial exposures to both humans and animals in dairies, including determining what tasks lead to the highest exposure. Potential interventions to be studied in the future could include sick leave policies, access to handwashing facilities, onsite laundry, washing hands after glove removal, monitoring humans and cows for evidence of infection, and exercising caution with raw milk consumption.

### OUTPUTS

Research findings have been presented regionally, including Washington State University, UW/UBC Occupational and Environmental Health Conference and the Western Forum for Migrant and Community Health.

Fowler D: [2016] Occupational Zoonotic Exposures of Dairy Workers, Oral Presentation. American Public Health Association Annual Meeting and Expo, Denver Colorado.

## FEASIBILITY 6: UNDERSTANDING THE RELATIONSHIP BETWEEN WORKING CONDITIONS, OCCUPATIONAL INJURIES, AND CHRONIC DISEASE AMONG SEASONAL FILIPINO FISH PROCESSING WORKERS IN DUTCH HARBOR, AK YEARS 2013-2014

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### RELEVANCE

In the Dutch Harbor community of Alaska, 90% of the jobs are in commercial fishing. Of the over 4,000 residents, Filipinos represent 28% of the community. This study explored the influence of the unique Alaskan environmental conditions on occupational health and safety risks, work performance and the health behaviors of Filipino workers. The purpose of this study was to explore the health behaviors and conditions of Filipino fish processing workers and how unique environmental conditions influence occupational health and safety risks in the Alaskan fishing setting.

### OUTCOMES

The information gathered in the project forms the basis of future studies and interventions with migrant workers and immigrants in commercial fishing and fish processing communities. Accordingly, this project helps to inform active and future projects at the NIOSH Alaska Station.

This project helped establish Dr. Garcia's interest in occupational safety and health among Filipino migrant workers; he continues to seek collaborative research opportunities with occupational safety and health experts, such as with Dr. Butch de Castro of the University of Washington.

Results and recommendations of the study were shared with the occupational safety and health team of the company where the data was collected.

### PARTNERS & ADVISORIES

Through this study, relationships were formed with leaders in two major fishing industries, community-based organizations and in the Filipino community of Dutch Harbor/Unalaska.

### RESEARCH

Thirty in-depth interviews were conducted among Filipinos working in fish processing in two of the largest fishing industries stationed in the Dutch Harbor area. Almost all of the interviews were conducted in Filipino (Tagalog). The average length of each interview was about 45 minutes. Respondents indicated that cold weather interferes with the workers' job performance, increasing their risk for injury and illness. Concurrently, respondents characterized the commonly experienced loneliness and boredom that is attributed to the community's isolation and rurality. It was reported that this leads to more high-risk behaviors. Other non-environmental factors affecting worker health include concerns with roommates and supervisors as well as culture-specific practices. Findings suggest the importance of job rotation to avoid long exposures to cold temperatures, the value of having designated individuals tasked with informing workers about company and community resources that promote healthy lifestyles, and the possible utility of a joint worker-management safety committee.

### OUTPUTS

Garcia GM, de Castro B: [2017] Working Conditions, Occupational Injuries, and Health Among Filipino Fish Processing Workers in Dutch Harbor, Alaska. *Workplace Health* 65(5):219-226. PMID: 27729501  
Garcia GM: [2015] Understanding the Relationship Between Working Conditions, Occupational Injuries, and Chronic Disease Among Seasonal Filipino Fish Processing Workers in Dutch Harbor, AK. Manuscript.  
Garcia GM: [2015] Understanding the Effects of Working in the Fishing Industry in the Subarctic Region Among Filipinos. Abstract.

*"Thank you for coming here to talk to us. I hope that the stories we've shared can help improve our working conditions."  
- Project Participant*



## FEASIBILITY 7: GRAS2P FOOD SAFETY VIDEO YEARS 2013-2016

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### RELEVANCE

There are few training resources available to assist growers and farmworkers in meeting new food safety and pesticide safety requirements. There is a need for a video that addresses the major federal requirements on these topics, that can be used to supplement existing training and that can educate, inform and engage the viewer in a culturally sensitive way. This project developed a new, EPA and Washington State approved, training resource for the tree fruit industry addressing food and worker pesticide safety.

### OUTCOMES

The video, Pesticide Safety for Agricultural Workers: Pesticide Safety (Module 6), is the first educational product approved to meet the 2016 revised EPA Worker Protection Standard. The Washington State Tree Fruit Association (WSTFA) incorporated this video (English and Spanish) into their GRAS2P (Growers Response to Agriculture, Safe and Sustainable Practices) educational program.

### PARTNERS & ADVISORIES

These videos were guided by fieldworker/grower training through the Washington State Tree Fruit Association and reviewed by US EPA and the Washington State Department of Agriculture and Labor and Industries.

### PROJECT

Pesticide Safety for Agricultural Workers is a free 21-minute educational video compliant with the criteria set by GlobalGAP, the EPA's revised Worker Protection Standard, and reviewed by the WA State Departments of Agriculture and Labor and Industries. In addition to being made available to all growers in the produce industry, the Washington State Tree Fruit Association (WSTFA) will incorporate this video into their GRAS2P (Growers Response to Agriculture, Safe and Sustainable Practices) educational program.

This educational project integrated the current non-governmental food safety criteria of GlobalGAP and the governmental pesticide safety standards (Worker Protection Standard or WPS) of the EPA into a bilingual (Spanish/English), culturally sensitive, training video for farmworkers in the domestic produce industry. This project has been funded through local partners in the agricultural industry, the WSTFA, PNASH, and the EPA. The pesticide safety component that was sponsored by PNASH, is available at no cost through the EPA and the Pesticide Educational Resources Collaborative.

### OUTPUTS

Video: Pesticide Safety for Agricultural Workers: Pesticide Safety (Module 6):  
[www.youtube.com/channel/UCto11hDpAjpUG5IzWeXPIBg](http://www.youtube.com/channel/UCto11hDpAjpUG5IzWeXPIBg)

Video: Fieldworker Orientation and Food Safety (all 6 modules available for purchase): [www.farmworkertraining.com](http://www.farmworkertraining.com)



*"This video is a great tool for agricultural producers, which will help them train their employees in various aspects related to worker and food safety"*  
- Ofelio Borges, WSDA



## FEASIBILITY 8: PILOT: TOTAL WORKER HEALTH IN SALMON FISHERMEN FROM CORDOVA, AK YEARS 2014-2015

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Division of General Internal Medicine

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### RELEVANCE

Commercial fishing is the most hazardous occupation in the U.S. with workers experiencing both acute and chronic health risks. While fishing fatality data is an area of active research, information on chronic health conditions that affect fishermen is limited. This one-year study assessed chronic health conditions and habits among the gillnet fleet based out of Cordova, AK.

### OUTCOMES

Study participants who had physical exams in Cordova received their individual results, recommendations for follow up, and a summary of the study findings by letter. The leaders of the Cordova District Fishermen United and the Cordova community were presented information to share on prevention to help reduce occupational hearing loss and upper extremity disorders.

The study brought together a group of partners who had not worked together before, including the Cordova Public Health Center, Cordova District Fishermen United, Alaska Sea Grant program, NIOSH-Alaska office, a research nurse living in Cordova, and the University of Washington.

Dr. Cherry and Ms. Baker, Director, Cordova Extension of Alaska Sea Grant Office, are currently collaborating with our national investigators in drafting a research proposal related to fishing vessel exposure and health outcomes.

The study provided novel data on the chronic health conditions and habits of Alaskan fishermen that serves to inform future studies in the field. By focusing the study on chronic – rather than acute health risks – the results provide valuable contributions to the currently limited body of knowledge on the subject.

### PARTNERS & ADVISORIES

The University of Alaska Sea Grant program and NIOSH – Alaska office were essential to the successful design and conduct of the study. The Cordova District Fishermen United (CDFU), Cordova Public Health Center, the National Fisherman journal, and the NW Pacific Fishing Expo in Seattle were important partners for supporting various aspects of the study.

### RESEARCH

A pre-season survey was mailed to licensed gillnetters to collect basic demographics and health habits during the off-season. These questions targeted sleep habits, fatigue, dental care, mental health, physical fitness, use of alcohol and tobacco, noise exposure, medical history, work history, and work practices. A follow-up survey was completed by 45 of the initial respondents to assess how health priorities changed during the fishing season. Nine participants wore Fit Bit devices to monitor sleep and activity before and during the fishing season. The study team traveled to Cordova in July to meet with local stakeholders and to perform physical exams on a subset of twenty Cordova participants; included in the physical exams were fitness, vision and hearing tests. An in-depth health history interview with a focus on occupational injury and health-risk behaviors was also conducted with the twenty Cordova participants. About half of survey participants reported hearing loss, and nearly all the exam participants had noise-induced hearing loss on audiogram. About half of participants reported some type of upper extremity disorder affecting the shoulder, elbow, wrist, or hand. The cardiovascular fitness level on exam was quite variable, ranging from poor to excellent. All reported challenges with fatigue while fishing, and some reported experiencing poor sleep during the off-season as well. We hope that awareness of these results will lead to: more consistent use of hearing protection while fishing; greater attention to prevention of upper extremity disorders through utilizing proper ergonomics; and development of best practices to manage fatigue before and during the fishing season.

### OUTPUTS

Results of the study highlighted in Alaska's Fisherman's Journal: North Pacific Focus. [https://www.nationalfisherman.com/wp-content/uploads/2012/09/NPF\\_Fall15.pdf](https://www.nationalfisherman.com/wp-content/uploads/2012/09/NPF_Fall15.pdf)

Manuscript submitted to Journal of Agromedicine in August 2017.



## FEASIBILITY 9: PILOT: NON-FATAL INJURIES AMONG COMMERCIAL FISHING WORKERS IN ALASKA, WASHINGTON, AND OREGON YEARS 2014-2016

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Samantha Case, MPH and Devin Lucas, PhD  
(NIOSH, Western States Division) with Laura  
Syron, MPH (Oregon State University)

### RELEVANCE

Commercial fishing is the most hazardous occupation in the United States, as measured by fatality data. In a review of commercial fishery fatality data in NIOSH's Commercial Fishing Incident Database (CFID) during 2000-2009, 504 commercial fishing deaths occurred in the U.S. The Bureau of Labor Statistics' (BLS) Survey of Occupational Injuries and Illnesses (SOII) contains nonfatal injury and illness data, but does not include data on self-employed fishermen, who comprise a substantial part of the workforce. This study reviewed US Coast Guard (USCG) investigations of all reported nonfatal, traumatic injuries to workers onboard commercial fishing and fish processing vessels operating in Alaska during 2010-2014, and in Washington, Oregon, and California during 2002-2014.

### OUTCOMES

This study demonstrated the feasibility of utilizing CFID and epidemiologic analytical methods for continued nonfatal injury surveillance in the commercial fishing industry to assess hazards and evaluate safety programs or initiatives.

An analytical database was developed to assist injury prevention researchers and commercial fishing stakeholders in identifying specific needs and prevention strategies. A new NIOSH-funded PNAS H project was awarded to develop this tool, led by Dr. Laurel Kincl at Oregon State University in a 5-year grant, entitled Safety Surveillance for Pacific Northwest Fisheries.

### PARTNERS & ADVISORIES

In collaboration with the NIOSH Western States Division, we conducted commercial fishing safety research using U.S. Coast Guard investigative reports and expanded NIOSH's Commercial Fishing Incident Database to include nonfatal injury data.

### RESEARCH

Researchers abstracted and coded relevant information and entered data into CFID. A descriptive analysis identified patterns and characteristics of the nonfatal injuries, associated work tasks, and worker information. During the three-year period 2012-2014, Alaskan crewmembers reported more nonfatal injuries (286) than West Coast crewmembers during the twelve-year period 2002-2014 (208 injuries). In AK, the majority of injuries were reported in three fleets: Bering Sea/Aleutian Islands (BSAI) Pacific Cod and Other Ground Fish Freezer Trawl (26%); BSAI Pollock Factory Trawl (17%); and BSAI Pacific Cod Freezer Longline (16%). In Alaska, nearly half of all injuries were to the upper extremities, including many open wounds and fractures. Over half of the injuries reported in Alaska were due to contact with objects/equipment. On the West Coast, the Pacific Whiting fleet (30%) and Dungeness crab fleet (23%) accounted for over half of the injuries. Similarly, the upper extremities were the most commonly injured body part, with amputations and fractures occurring most frequently. Contact with objects/equipment was responsible for over half of the injuries, with vessels (29%) and fishing gear (26%) being the most common sources of injury. The research team successfully reviewed reports of injuries in the Alaska and West Coast commercial fishing industry and developed an analytical database. Specific fleets in each region could be engaged to identify prevention strategies targeting specific injuries and work tasks to mitigate risk of injury.

### OUTPUTS

Syron LN, Lucas DL, Bovbjerg VE, Bethel JK, Kincl LD: [2016] Utility of a Work Process Classification System for Characterizing Non-fatal Injuries in the Alaskan Commercial Fishing Industry. *Int Journ. Circumpol Health* 75. PMID: 4717151.

Case S, Bovbjerg V, Lucas D, Syron L, Kincl L: [2015] Reported Traumatic Injuries Among West Coast Dungeness Crab Fishermen, 2002-2014. *Int Marit Health* 66(4):2017-10. PMC 4704689.

Press Release: <http://oregonstate.edu/ua/ncs/archives/2016/jan/injuries-among-dungeness-crab-fishermen-examined-new-osu-study>

## FEASIBILITY 10: AG MEDICINE ELEARNING SERIES FOR MID-LEVEL HEALTH CARE PROVIDERS YEARS 2015-2016

**Nancy Simcox, MS**

Director of Continuing Education Programs Department of Env. and  
Occupational Health Sciences

University of Washington

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### RELEVANCE

The roles and numbers of mid-level providers (MLPs), such as physician assistants and nurse practitioners, are increasing in rural areas that have large populations of agricultural workers. This project produced an eLearning series that focuses on unique Occupational and Environmental Medicine agricultural issues in the northwest is required to increase competency among MLPs to recognize, diagnose, treat, prevent and provide patient education pertaining to agriculture-related occupational injuries and illnesses in the region.

### OUTCOMES

An online continuing education program was developed that focuses on the regional issues facing ag workers and integrates research results and best practices from medical and public health professionals.

As of May 2017, 28 students have registered in the course.

This program will be sustained through the Department of Environmental and Occupational Health Sciences, Continuing Education Program, providing a trusted continuing education channel to NW providers to share new research results and increase knowledge of agricultural medicine.

### PARTNERS & ADVISORIES

Collaborators providing expertise for content development and program promotion include: The University of Washington, MEDEX Northwest, WA State Centers for Occupational Health and Education, Migrant Clinician's Network, and PNASH.

### PROJECT

This project brings together new regional partners and a program with an expert line-up of instructional and research faculty, covering basics such as workers' compensation resources and administering effective occupational and environmental health histories. More specific topics include pesticide exposures, asthma, heat-related illnesses, and lower lumbar spine injuries in agriculture. This program is being offered in a multi-media e-learning format to respond to the needs of busy clinicians.

Module 1, the Introduction to Agricultural Medicine: Advancing Occupational and Environmental Health Practice in the Northwest, was launched in January 2017, with the lecture series following in February 2017. The Ag Medicine Courses are currently offered for free through the Department of Environmental and Occupational Health Sciences, Continuing Education Program. In the future, the series will move forward as topics are developed.

### OUTPUTS

Module 1: Introduction to Ag Medicine: Advancing Occupational and Environmental Health Practice in the Northwest.

Other Lecture Series Learning Modules:

Recognition, Management & Prevention of Pesticide Exposure: Occupational Perspective Matthew Keifer, MD, MPH

Recognition, Management & Prevention of Pesticide Exposure: Pediatric Perspective. Catherine Karr, MD, PhD, MS

Preventing Heat-related Illness. June Spector, MD, MPH

Respiratory Disease Associated with Hops Dust. David Bonauto, MD, MPH

Recognition, Diagnosis and Treatment of Lumbar Spine Injuries. Gregory Carter, MD, MS

*"We can use this during the students' didactic year before they go off to their clinical rotations. It is particularly important for our students as we try to place 100% of them in rural or underserved areas where farm workers are a high percent of the population."*

*-Linda M. Dale, D.H.Ed.,  
PA-C, Program Director, PA  
Program at Heritage University*

**Mike Yost**, PhD, MS  
Chair and Professor  
Department of Env. and Occupational Health Sciences  
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Washington State worker's compensation claims data indicate that dairy workers in the state have a higher rate of injury with an average of 2.61 claims per 100 full time equivalents (FTEs) compared to the state average injury rate for all industries of 1.51 per 100 FTEs. Industry-specific risks include acute injuries from animal assaults, slips and falls on wet surfaces and chronic injuries from repetitive stress. A thorough study of injuries to workers in the Washington dairy industry and other similar industries have not been previously conducted.

## OUTCOMES

## PARTNERS & ADVISORIES

## RESEARCH

Injury Type	2018 (%)	2019 (%)
Struck	18.2%	17.2%
Fall from elevations	27%	10.8%
Struck by/against	19.9%	18.2%
Fall same level	12.5%	16.2%
Wrench of the back	8.7%	15.2%
Vehicle	2.4%	12.5%

Source: WA Workers' Compensation Claims Data  
 Notes: WAFLU does not collect information about workers' compensation claims by industry.

## OUTPUTS

PACIFIC NORTHWEST AGRICULTURAL SAFETY AND HEALTH CENTER | Final Report, 2011-2016



## FEASIBILITY 12: SEXUAL HARASSMENT PREVENTION YEARS 2015-2016

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### RELEVANCE

Workplace sexual harassment (WSH) in agriculture is a growing concern that threatens the livelihoods 420,000 women farmworkers nationwide. Published literature suggests that 50% of all U.S. women will experience WSH at some point, and rates may be higher among women working in male-dominated environments. Sexually harassed women experience higher rates of healthcare utilization, chronic pain, depression, and work withdrawal compared to non-harassed women - even for up to ten years after the WSH incident(s).

### OUTCOMES

A comprehensive awareness campaign that incorporated the research findings was developed by the project researchers in collaboration with farmworker women in Washington State. Over 1,000 wallet cards were shared with farmworker women to understand how to report WSH in Washington. In 2017 the wallet cards were adapted by a partner agency for distribution throughout the State of Oregon.

Dr. Breckwich has worked to increase the recognition of sexual harassment in agricultural settings as a public health issue, and has positioned the issue as one to be addressed through multi-stakeholder partnerships among growers, workers and justice advocates. Engagement has taken place throughout the State of Washington and around the nation through an active 12-member advisory group, community events, six presentations and three webinars.



Dr. Breckwich Vasquez at student forum introducing the Sexual Harassment project.

The campaign and video curriculum production effort continues through contributions from both the non-profit and for-profit sectors. A companion research project, Cultural and Communication Perspectives from the Agricultural Sector about Sexual Harassment Prevention and Training (Breckwich Vásquez, P.I.), is underway, with results that will be integrated into the video and curriculum.

### PROJECT

The overall objective of this project, conducted through PNASH's community-based partnership, El Proyecto Bienestar, was to examine and address sexual harassment as an occupational health hazard in the Washington agricultural workforce. This project was proposed in response to concern voiced by farmworker health and social service providers, as well as in response to increased media and legal action regarding sexual harassment in the agricultural workplace.

Our earlier work through a Washington State grant aimed to understand Latina farmworkers' perceptions of workplace sexual harassment, related factors and consequences, and potential points of intervention. Three main themes showed that women farmworkers: (1) frequently experienced both quid pro quo and hostile work environment forms of sexual harassment; (2) faced employment and health consequences due to the harassment; and (3) felt that both individual- and industry-level changes could prevent the harassment.

This pilot then produced a sexual harassment prevention training video script and curriculum designed for agricultural growers and workers. Methods for developing the video script began with preliminary qualitative analysis of our concurrent study results, storyboarding and iterative development with advisors. The 12-member advisory group were selected from various backgrounds based on their involvement in local issues, contacts, expertise in sexual harassment, service to the migrant farmworker community and knowledge of the agricultural community (including industry).

The continuing development of this educational resource for the agricultural workforce is vital for preventing worker exposure to sexual harassment. Through additional donations, we expect to begin filming in Fall 2017 and to finalize the video (Spanish) in Spring 2018. Future steps include audience testing of the educational curriculum and video and post-intervention assessment of the outcomes among the more than 800 agricultural workers, managers and owners in Washington.



## **PARTNERS & ADVISORIES**

This project comes with strong commitments from key leaders at the WA State Human Rights Commission, Equal Employment Opportunity Commission, Northwest Justice Project, WA Growers League, Equitable Food Initiative, Inc, and WA State Department of Agriculture, all of whom served as advisors as part of the SH Project Advisory Committee 2014-2015 (PAC) and most of whom are on the current SH Video Advisory Committee 2015-2017 (VAC).

## **OUTPUTS**

Kim NJ, Vásquez VB, Torres E, Nicola RM, Karr C: [2016] Breaking the Silence: Sexual Harassment of Mexican Women Farmworkers. *Journal Argomedicine* 21(2): 154-62. PMID: 26797165

### **Presentations:**

Vásquez VB, Early J: [2016] Preventing Workplace Sexual Violence in Agriculture: Understanding the Issue and Utilizing Educational Tools, Oral Presentation. Society for Public Health Education's Annual Meeting. Charlotte, North Carolina.

Vásquez VB: [2016] Sexual Harassment: A Worker Health & Safety Issue. Presentation for the WA State Commission on Hispanic Affairs. Yakima, Washington.

Vásquez VB: [2016] Sexual Harassment Among Farmworker Women: Showcasing a Worksite Prevention Video, Panel session. International Women's Day: Policing Women and Gender Justice." Northwest Film Forum. Seattle, WA.

Vásquez VB: [2015] Preventing Workplace Sexual Harassment in the Agricultural Industry: Understanding the Issue and Highlights of a Prevention Campaign in Yakima Valley. Sea Mar Community Health Centers 10th Annual Latino Health Forum. Seattle, WA. October 13.

### **Webinars:**

Vásquez VB, Garay R: [2016] Los Determinantes de Salud y la Violencia Sexual: Prevenir la Violencia Sexual con Herramientas para la Educación de Salud y Capacitación. Webinar presentation for Migrant Clinician's Network Community Health Work Training Series. June 29. Online.

Vásquez V, Soto J: [2016] Sexual Harassment in Agriculture: Definitions, the Role of Prevention, and Guidelines for Growers. Webinar for WAFLA's Grower Membership Training Series. June 20. Online.

2016 Webinar for WAFLA's Grower Membership Training Series

### **Others:**

Video script: Sexual Harassment in Agriculture: A Workplace Prevention Training. August 28, 2016

Video trailer: Sexual Harassment in Ag, <https://vimeo.com/179345478/60047830f7>

Media: [http://deohs.washington.edu/pnash/sexual\\_harassment](http://deohs.washington.edu/pnash/sexual_harassment), FB page: [www.facebook.com/harassmentinagriculture](http://www.facebook.com/harassmentinagriculture)

News: UW Bothell, Bandanas Connect Students with Farmworkers, <http://www.uwb.edu/news/may-2016/bandana>

# ADDITIONAL ACCOMPLISHMENTS

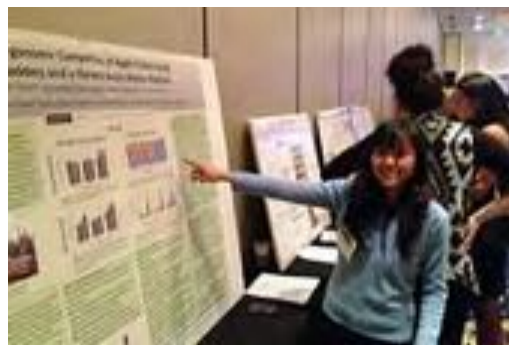


## V. ADDITIONAL ACCOMPLISHMENTS

### PNASH STUDENTS 2011-2016

Student education and mentorship in agricultural safety and health is a primary goal for our PNASH programs and projects. Often these students contribute substantially to a project, offering unique expertise and a passion for our mission and community-engaged approach. Student awards and supporting programs at the University of Washington have had a significant impact in augmenting PNASH student research, including the NIOSH Education and Research Center,

[Achievement Rewards for College Scientists \(ARCS\)](#), [Graduate Opportunity and Minority Access Program \(Go-Map\)](#), [Environmental Health Research Experience Program \(EHREP\)](#), and the [College Assistance Migrant Program \(CAMP\)](#).



NAME	PRINCIPAL INVESTIGATOR	PROJECT	TIME PERIOD	UNIV.	EDUCATION
Magali Blanco	Richard Fenske	Real-Time Particle Monitoring of Pesticide Drift from Two Different Orchard Sprayers	2017-present, 2015-2017	UW	PhD Student, MS Graduate, Exposure Science
Miriam Calkins	June Spector	Heat Exposure, Injury Risk, and Productivity in Ag Workers	2014-present	UW	PhD Student, Exposure Science
Samantha Case	Laurel Kincl	Non-Fatal Injuries among Commercial Fishing Workers	2014-present	OSU	PhD Student, Exposure Science
Maggie Hughes	Peter Johnson	Ergonomic Eval. of Emerging Technologies in Tree Fruit	2013-present	UW	PhD Student
Ornwipa Thamsuwan	Peter Johnson	Ergonomic Eval. of Emerging Technologies in Tree Fruit	2012-2016	UW	PhD Graduate, MS Graduate, Industrial Engineering (specialty in Ergonomics)
Carly Miller	Debra Cherry	Total Worker Health in Salmon Fishermen from Cordova, AK; Intern at NIOSH in Alaska	2013-present	UW	PhD Student, Epidemiology
Sheldwin Yazzie	Richard Fenske	Aggravating Factors of Asthma in a Rural Environment	2012-2013	UW	PhD Student, Epidemiology
Emilio Nieto	Peter Rabinowitz	Transmission of Microorganisms in Dairy Farms	2014 Summer	UW	PhD Student, Summer
Eddie Kasner	Richard Fenske	Reducing Agricultural Worker Risks through New and Emerging Technologies	2012-2017	UW	PhD Graduate, Exposure Science
Jane Pouzou	Richard Fenske	Reducing Agricultural Worker Risks through New and Emerging Technologies	2012-2016	UW	PhD Graduate, Exposure Science
Christine Loftus	Richard Fenske	Aggravating Factors of Asthma in a Rural Environment	2010-2014	UW	PhD Graduate, Epidemiology
Jenna Armstrong	Richard Fenske	Passive and Active Air Sampling for Residential Exposures to Airborne Pesticides & Ox Analogs	2009-2012	UW	PhD Graduate, Exposure Science
Nicole Davis	Victoria Breckwich Vásquez	Sexual Harassment Prevention in Agriculture	2013-2015	UW	Medical Student, Intern

Nicole Kim	Victoria Breckwich Vásquez	Sexual Harassment Prevention in Agriculture	2013-2014	UW	Medical Student, Intern
Sarah DeYoung	Richard Fenske	Aggravating Factors of Asthma in a Rural Environment	2012 Summer	UW	Medical Student, Intern
Michelle Lam	June Spector	Heat-Related Illness Prevention	2012 Summer	UW	Medical Student, Intern
Laura Syron	Laurel Kincl	Nonfatal Injuries among Commercial Fishing Workers	2014-present	OSU	MPH Graduate
Kim Doughty	Butch de Castro	<i>Peligros en el Bosque</i> : Health and Safety Training Fotonovelas	2015-2017	UW	MPH Graduate
Dawn Ryan	June Spector	Heat exposure, injury risk, and productivity in agricultural workers	2015-2017	UW	PhD Student, Exposure Science MPH Graduate
Kali Turner	June Spector	Occupational Injuries of Agricultural Workers in Washington State	2015-2017	UW	MPH Graduate
Elizabeth Ambriz	Victoria Breckwich Vásquez	Sexual Harassment Prevention in Agriculture	2013-2015	UW	MPH Graduate
Katherine Gregersen	Richard Fenske	Ergonomic Eval. of Emerging Technologies in Tree Fruit	2014-2015	UW	MPH Graduate
Margaret Willis	Richard Fenske	Exploring Clinician Training and Curriculum Development on Pesticides and Child Health	2014-2015	UW	MPH Graduate
Kristina Blank	June Spector	Heat-Related Illness in WA State Agricultural Workers	2013-2014	UW	MPH Graduate
Dan Grinnell	Michael Yost	Using IPM to Reduce Pyrethroid Exposure in Dairy Workers	2013-2015	UW	MS Graduate
Aaron Ruita	Michael Yost	Occup. Determinants of Serum ChE Depression in Chlorpyrifos Exposed Ag Workers in WA	2010-2012	UW	MS Graduate
Grant Quiller	June Spector	Heat stress, heat strain, and productivity in Washington State tree fruit harvesters	2014-2016	UW	MS Graduate
Anna Contreras	Richard Fenske	Pesticide Safety in Tree Fruit: Translating Research, Overcoming Barriers	2015-2016	UW	Undergraduate Intern
Ruben Reyes	Victoria Breckwich Vásquez	Sexual Harassment Prevention in Agriculture	2015-present	UW	Undergraduate Intern
John Yang	Catherine Karr	Home Air in Agriculture Pediatric Intervention Trial	2014-present	UW	Undergraduate Intern
Bianca Irimia	Peter Rabinowitz	Transmission of Microorganisms in Dairy Farm	2014-2015	UW	Undergraduate Intern
Sara Mar	Michael Yost	Using IPM to Reduce Pyrethroid Exposure in Dairy Workers	2015 Summer	UW	Undergraduate Intern
Jessica Martinez	Michael Yost	Using IPM to Reduce Pyrethroid Exposure in Dairy Workers	2015 Summer	UW	Undergraduate Intern
Anais Munoz	Victoria Breckwich Vásquez	Sexual Harassment Prevention	2014-2015	UW	Undergraduate Intern
Theresa Bordianu	Richard Fenske	Administrative and Planning Core; Farmworker OP Exposure through Protein Adducts	2013-2014	UW	Undergraduate Intern
Jose Carmona	Michael Yost	Administrative and Planning Core; Changing the Climate Conversation; Pyrethroid Exposure in Dairy; Heat-related Illness Prevention	2012-2014	UW	Undergraduate Intern
Brenda Solis	Michael Yost	Using IPM to Reduce Pyrethroid Exposure in Dairy Workers	2014 Summer	UW	Undergraduate Intern
Nohely Diaz	June Spector	Changing the Climate Conversation	2012-2013	UW	Undergraduate Intern

Anisia Dugala	Jeffrey Bethel	Heat-Related Illness among Oregon Farmworkers	2012-2013	OSU	Undergraduate Intern
Gabriela Escuita	Jeffrey Bethel	Heat-Related Illness among Oregon Farmworkers	2012-2013	OSU	Undergraduate Intern
Hanna Frankel	June Spector	Surveillance Strategy to Guide Injury Prevention Efforts in WA Commercial Fishing	2012-2013	UW	Undergraduate Intern
Anna Fretheim	June Spector	Administrative and Planning Core	2011-2013	UW	Undergraduate Intern
Renee Harger	Jeffrey Bethel	Heat-Related Illness among Oregon Farmworkers	2012-2013	OSU	Undergraduate Intern
Brenda Nuñez	Richard Fenske	Changing the Climate Conversation	2012-2013	UW	Undergraduate Intern
Hollie Roberts	Jeffrey Bethel	Heat-Related Illness among Oregon Farmworkers	2012-2013	OSU	Undergraduate Intern
Sarra Tekola	Richard Fenske	Changing the Climate Conversation	2012-2013	UW	Undergraduate Intern
Carmen Ruby Torres	Richard Fenske	Changing the Climate Conversation	2012-2013	UW	Undergraduate Intern
Briana Martinez	Richard Fenske	ConneX course community survey assistant	2012 Summer	UW	Undergraduate Intern
Blanca Mejia	Richard Fenske	ConneX course teaching assistant	2012 Summer	UW	Undergraduate Intern
Gabino Abarca	June Spector	Heat-Related Illness Prevention	2016-present	UW	Undergraduate Intern
Christine Perez Delgado	Richard Fenske	Reducing Ag Worker Risks through New and Emerging Technologies	2015-present	UW	Undergraduate Intern
Briana Martinez	Richard Fenske	Administrative and Planning Core	Summer 2012	UW	Undergraduate Intern



## ADDITIONAL GRANT-FUNDED PROJECTS

The nucleus of research expertise and support – formed by the PNASH Center – assists our strategic planning and procurement of grant support for additional projects that advance the goals and priorities of the PNASH Center. For the 2011-2016 cycle, here are our additional project accomplishments.

### **The New NIOSH Cooperative Agreement 2016-2021 at the PNASH Center**

This cycle includes 6 projects and an enhanced Outreach Core to support engagement and education as we partner with worker, industry, health care, government, academic, and community groups. The six new projects are categorized as Research, Prevention/Intervention, Surveillance, or Translation.

**Prevention of Occupational Exposure to Pesticide Drift** (Fenske, P.I.) This project aims to understand the mechanisms of pesticide drift exposure among agricultural workers and prevent such exposures in the future. We will link data from the WA Department of Health and Washington State University (WSU) AgWeatherNet to determine the probability of drift events due to environmental conditions during spraying, develop a predictive model, and conduct field studies to validate our model. Study findings will be used to provide new user-friendly tools and trainings to predict drift event-prone weather conditions.

**The Healthy Dairy Worker Study** (Rabinowitz, P.I.) This partnership study with WSU will enroll new workers in the dairy industry and evaluate microbiome changes over time. We will characterize worker exposures to microbes and allergens and evaluate whether these exposures impart immune benefits (the ‘hygiene hypothesis’), and/or increase risk of disease, including infection and airway inflammation. This study will help identify priorities for preventive interventions and healthy host adaptation to the dairy environment.

**A Multi-level Approach to Heat Related Illness Prevention in Agricultural Workers** (Spector, P.I.) Building on our previous heat-related illness (HRI) studies, we will develop and evaluate a multi-level approach to address HRI for farmworkers in the tree fruit industry. The project will assess a proposed work-based intervention program as well as whether off-hour environmental conditions contribute to risk for HRI during work. To accomplish study aims, an Expert Working Group (EWG), which includes workers, farm managers, and other stakeholders, will guide the development, testing, and dissemination of the intervention.

**Injury and Illness Prevention in the Pacific Northwest for the Dairy Industry** (Yost, P.I.) Dairy workers in Washington State have an injury claim rate 72% higher than the average injury claim rate among all workers in WA State. The hazards of animal assaults, slips, trips and falls are exacerbated by a growing hired workforce that has little previous experience in this industry. This project is designed to deliver and evaluate worker safety training, and it will include newly hired workers recruited for the Healthy Dairy Worker Study. The project, conducted in partnership with WSU, is guided by the ongoing participation of a Technical Advisory Group of agricultural and safety representatives and an Expert Working Group of on-the-ground dairy managers and workers involved in day-to-day activities of milk production and animal handling.

**Safety Surveillance for Pacific Northwest Fisheries** (Kincl, P.I., Oregon State University) While good progress has been made in the surveillance and prevention of fatalities, there is little evidence on the causes of severe but non-fatal injuries. This OSU research team will assess vessel disaster and casualty data collected by NIOSH and the USCG. The project will include additional sources of vessel and fishermen casualty and safety data from insurance claims, and will also conduct primary data collection. The combination of these data will form the foundation for ongoing, scalable, practical surveillance systems for hazard assessment and for evaluation of programs for interventions in the commercial fishing industry.

**Practical Solutions for Pesticide Safety** (Galvin, P.I.) This project will identify and evaluate solutions that farm managers, forest service managers, and pesticide handlers can implement to minimize pesticide exposures. The new resources will be applicable to the revised EPA Worker Protection Standard and recent food safety requirements. We will engage workers and managers in walk-through evaluations and field testing to identify key safety issues and novel solutions. This project will deliver the solutions through expanded hands-on pesticide training modules and the use of online media to ensure broad access.

## **NIH ECHO Cooperative Agreement - Environmental influences on Child Health Outcomes (NIEHS 2016-2023)**

**PI: Catherine Karr, University of Washington**

PNASH's Dr. Karr has recently been awarded more than \$4.7 million by the National Institutes of Health to investigate how the environment influences neurodevelopment and asthma risk in children. This is a seven-year multi-site study of more than 3,000 ethnically diverse pregnant mothers and their newborns. The cohorts are in communities across the United States, including in Seattle, Yakima, San Francisco, Memphis, Minneapolis and Rochester. Karr said. "Our study contributes specialty expertise characterizing air pollution and phthalate exposures as well as social factors such as stress, and examines their influence on child asthma, allergies and neurodevelopment."

## **Next-Generation Air Pollution Research (EPA Star Grant 2016-2019)**

**PI: Catherine Karr, University of Washington**

Dr. Karr received a \$750,000 grant from the U.S. Environmental Protection Agency to develop low-cost air pollution sensors to help Native American and Latino communities in the Yakima Valley reduce their exposure to wood smoke. Researchers will use next-generation air particle sensors that are portable and battery powered. Researchers will then work with local students over the next three years to both understand and help reduce the community's exposure to wood smoke. Forest fires and residential fires are likely contributors to wood smoke pollution in rural Washington. "We will work with the community, including with Heritage University, the Yakama Nation and area high schools, putting new low cost air pollution sensors to work to understand areas of concern and opportunities to improve local air quality," said lead investigator Catherine Karr, Professor of Pediatrics and Environmental and Occupational Health Sciences. The project builds on longstanding research-to-action partnerships between the University of Washington Pacific Northwest Center for Agricultural Safety and Health (PNASH) and the Yakima Valley community.

## **Home Air in Agriculture Pediatric Intervention Trial (NIEHS R01 2014-2019)**

**PI: Catherine Karr, University of Washington**



The primary goal of the HAPI project, made possible through [\*El Proyecto Bienestar\*](#), is to reduce exposure to inflammatory agents and allergens in the homes of asthmatic Latino children residing in an area of intense dairy and crop based industrial agricultural production. Community-based participatory activities in the Yakima Valley of Washington State have identified pediatric asthma as a priority health concern for the community. This study addresses three highly underdeveloped components of asthma and environment research: the health of children with asthma living in communities with industrial-scale agricultural operations, asthma in a particularly vulnerable subpopulation (Latino farmworker children), and evidence-based intervention strategies in these populations.



Children with poorly controlled asthma aged six through twelve years, recruited through the Yakima Valley Farmworker Clinic, are randomized to the clinic's usual asthma educational program or an enhanced program which includes two portable high efficiencies particulate air (HEPA/NH3) cleaners located in the child's sleeping area and living room. Children in the usual program group will receive HEPA/NH3 units after their study year. This study seeks to characterize key indoor pollutant exposures for 75 children with asthma who reside within 400 meters of crop production or dairy

operations. The program opened for recruitment in the summer of 2015 and has approximately 57 families who are either currently enrolled or have completed their study year.

## **OUTPUTS**

News article: Yakima Herald, M. *Asthma study hopes to improve disease management among Valley children.*

## **Heat Exposure, Injury Risk, and Productivity in Agricultural Workers (NIOSH K01 2014 - 2017)**

**PI: June Spector, University of Washington**

This new investigator award, to Dr. June Spector, examines the association between heat exposure and traumatic injury risk in agricultural workers, with the ultimate goal of developing injury prevention solutions. The study will first draw on established climate models and WA workers' compensation data. Then, harvest workers will be evaluated in the field for associations between heat stress, psychomotor performance and productivity. In addition, the field studies will test the feasibility of using urinary 8-hydroxy-2'-deoxyguanosine (8-OHdG) as a biomarker of heat acclimation.

Researchers reviewed 12,200 workers' compensation injury claims between 2000 and 2012 in relation to maximum daily humidex exposures. The paper released (see citation below) shows an increased risk for traumatic injuries in ag workers during hot conditions, particularly while participating in certain work-intensive harvesting activities in July. The connection between heat and injury was not surprising. Due to heat exposure, dehydration, and fatigue, a person can become less stable on their feet and have more difficulty concentrating.

The study team will now take these lessons into the field to determine the specific mechanisms and risk factors for injury. The team will engage with employers to estimate future heat illness-related productivity losses and health effects and will develop heat related illness prevention interventions.

### **OUTPUTS**

Spector JH, Bonauto DK, Sheppard L, Busch-Isaksen T, Calkins M, Adams D, Liebllich M, Fenske R: [2016] A Case-Crossover Study of Heat Exposure and Injury Risk in Outdoor Agricultural Workers. PLOS ONE  
<http://dx.doi.org/10.1371/journal.pone.0164498>

Trade article: *Avoiding heat-related illness - Study finds workers paid piece rate tend to work harder and take fewer breaks, increasing the risk of heat-related illness symptoms.* Good Fruit Grower Dec 28, 2015.  
<http://www.goodfruit.com/avoiding-heat-related-illness>

Press release: *Hot Weather can Increase Risk of Agricultural Worker Injuries* <http://deohs.washington.edu/news/more-washington-agricultural-workers-injured-hot-weather>

## **Safety and Health of Latino Immigrant Forestry Services Workers (NIOSH 2014 – 2017)**

**PI: Arnold de Castro, University of Washington**

Forestry services workers are largely young immigrants from Latin America and are at high-risk for work-related injury and illness. While performing work essential for U.S. forest management, these workers encounter injury and illness rates 2-3 times higher and fatality rates 9 times higher compared to the general U.S. workforce. To address this occupational health disparity, an academic-community based organizational partnership between University of Washington's Pacific Northwest Agriculture Safety & Health Center, Northwest Forest Worker Center (NFWC) and the University of California Berkeley's Labor Occupational Health Program created a safety and health training and advocacy initiative called **Sí Sé: Salud y Seguridad en el Trabajo (Yes, I Know: Health and Safety on the Job)**. Using a participatory model and mixed-methods study design, this project characterizes working conditions, injury and illness experiences, safety mitigation efforts, employer retaliation, and recovery/return-to-work times among this workforce. Data collection involved worksite observations, employer and worker surveys, and in-depth case study interviews. Findings were then used to develop educational materials, including first-person digital stories to be used by NFWC's promotoras de salud (lay health educators) in worker training and advocacy programs. Additionally, employer and supervisor training needs were addressed by producing and evaluating bilingual "Safety Talk" training materials to be used at forest worksites. The overarching goal of this project is to facilitate empowerment-building among a community of underserved, highly vulnerable workers and forestry services contractors, to seek workplace and employment improvements.

## Measuring Worker Exposure to UV Radiation in the Cannabis Industry, and Efficacy of Protective Clothing (WA State SHIP Grant 2015-2017)

PI: Chris Simpson, University of Washington

The cannabis industry is rapidly expanding in Washington and there is limited quantitative information about potential health and safety hazards for workers. To characterize the intensity of UV exposure and associated health risks experienced by workers in the cannabis industry, this project measures levels of UV radiation and associated worker exposures in five cannabis growing facilities that utilize a variety of lighting technologies and process workflows. The project will test new, inexpensive wearable UV sensors that employers can use to determine their workers' exposures to UV radiation. In addition, researchers will assess UV protective garment effectiveness for reducing worker exposure to UV radiation.

## Prevention of Occupational Exposures to Pesticide Drift (WA State Medical Aid and Accident Fund 2015 – 2017)

PI: Richard Fenske, University of Washington

We worked with the Washington State Department of Health to link historical weather and land use data to 283 reported drift events (762 cases) between 2000 and 2015. This work characterizes the risk of occupational drift exposure, expands epidemiological surveillance, and tests novel drift exposure measurements. This study marks the first time that occupational health drift incident data will be paired with historical weather and land use data over a large period of years. Study findings will impact state partner data collection techniques, enhance exposure prevention training, and contribute to understanding and preventing drift exposure—a major reason for pesticide-related illnesses among Washington agricultural workers.

## Health and Safety of Women Agricultural Workers (MAAF 20013-2014)

PIs: Catherine Karr, Victoria Breckwich Vásquez and Elizabeth Torres, University of Washington and Radio Cadena

*El Proyecto Bienestar* (EPB) partnership has addressed an important new community priority and a newly recognized issue in the field of occupational health: Sexual Harassment. The hidden nature of this issue profoundly impacts womens' ability to work safely. Because of the urgent nature of the issue, PNASH and Radio Cadena launched a one-year prevention campaign in eastern Washington with the primary goal to increase public awareness of the problem and to provide information on workers' rights as well as training resources for workers and employers. Our partnership, along with a community advisory board, and focus groups of farmworker women, assessed the interrelationship between sexual harassment and worker health and developed audience-tested prevention strategies. Over the summer of 2014, community and industry education and outreach included: the development and distribution of 18,000 resource cards, broadcasting a 4-minute radionovela with a call-in show at Radio Cadena, delivery of a popular education play for male farmworker allies in partnership with the WA Department of Agriculture, and script development for a future workplace training video.

This small 2-year project took one-step toward more comprehensive efforts to address sexual harassment. The PNASH-funded project, ***Feasibility: Sexual Harassment Prevention***, is developing a training video and curriculum for the agricultural industry. Dr. Vásquez is now also working with regional and national partners to develop, *Research Young, New Agricultural Workers* (REYNA) with the goals to: reduce sexual violence in agriculture and improve knowledge and resources, 2) strengthen the educational pipeline for young women in agriculture of low socio-economic status. The number of Latina women and girls entering agriculture (as migrant and seasonal workers) is increasing in Washington and throughout the nation. The problem is timely, urgent and in need of a sustained response.

### OUTPUTS

WA Sexual Harassment Resource Cards (Spanish)

Radio novella and call-in show (Spanish)



Worker Wallet Card

## **Washington Leaders for Conversations about Climate (UW School of Public Health 2012-2014)**

**PIs: Richard Fenske and Victoria Breckwich Vásquez, University of Washington**

This project used a student/local champion and community-based participatory research model to launch conversations in rural parts of Washington State on the complex topic of climate change. The goal of these inter-generational teams was to develop a local understanding of the science and issues that included impacts specific to their communities. Five undergraduate students, from underrepresented minority and migrant farmworker families, worked as a team and within their own home communities – which were four distinct rural counties in Washington State. The students learned about climate change research, conducted community needs assessments, identified a community leader and developed a volunteer base to join them on this project. Public community education forums were held in three Hispanic farmworker communities and one mixed rural/urban community.

There were 87 total participants engaged by these forums, and 54 of the adults completed a pre- and post-intervention evaluation, which queried their knowledge, attitudes and behavioral intentions concerning climate change. Among all the participants, most had a high school education or less (83%), were born in Mexico (85%), spoke Spanish at home (79%), and identified themselves as Latino/Hispanic (88%), and as Catholic (77%).

Overall, the results indicate that participants in these forums learned some basic information about climate change, that the forum affected their attitudes regarding climate change, and that most were ready to take action on climate change

### **OUTPUTS**

Climate Change Lotería (Spanish and English)

### **Notification of Pesticide Applications to Minimize Workplace Exposures: A Feasibility Study (WA Medical Aid and Accident Fund, 2012-2014)**

**PI: Richard Fenske, University of Washington**

Farmworker exposure to agricultural pesticide drift is a high priority concern for public health. In May 2014, the Washington Department of Health (WA DOH) alerted state agencies and growers of a spike in pesticide spray drift illness cases among orchard workers. Over a two-month period, approximately 60 individuals were exposed to pesticides in 15 drift events, which is equal to the number of cases that the agency normally sees over the course of an entire year. A recent [CDC/NIOSH report](#) documented one of these drift events. In response, there have been calls for improved communication among farms, applicators, and workers.



Pesticide Spraying in Eastern WA

We conducted a systematic review of pesticide spray notification systems throughout the world, with the goal of addressing the needs of Washington State orchards. Telephone interviews, emails, and program websites were used to review residential and commercial notification systems used in New Zealand, the United Kingdom, China, Canada, and the United States (see attached report). Direct notification methods such as sign posting, telephone calls, and personal visits have been used for a long time in the agricultural industry. Recent advancements in mobile communications technologies, precision agriculture, and farm data analytics have made remote notification methods more user-friendly. Assuming that costs, work burdens, and legal liabilities are minimized, a remote farm-to-farm spray notification system appears to be a promising means by which to prevent farmworker exposure to pesticide drift. Future work is needed by a coalition of partners (farm owners and managers, farmworker groups, research and education communities, and state agencies) to engage stakeholders and determine how to best develop agricultural workplace spray notification systems.

**Report:** [EJ Kasner, RA Fenske, K Galvin, MG Yost, P Palmández. Review of Agricultural Spray Notification Systems. Technical Report 2016-1. Pacific Northwest Agricultural Safety and Health Center, Department of Environmental and Occupational Health Sciences, University of Washington, July 2016.](#)



## Development of a Surveillance Strategy to Guide Injury Prevention Efforts in the Washington Commercial Fishing Industry (WA Medical Aid and Accident Fund, 2013-2015)

PI: June Spector, University of Washington

PNASH investigators addressed a pressing information need – surveillance of non-

NIOSH, PNASH conducted an exploratory project to build new agreements with a variety of data sources (insurers, clinics, hospitals) and to develop a system to characterize nonfatal injuries and intervention opportunities. Two data sources offered the UW researchers enough information to analyze: the US Coast Guard's (USCG) database (termed MISLE) and the database of a Seattle-based insurance claims adjuster. They were able to use these sources to describe non-fatal injury data for Washington-based commercial fishers.

In this exploratory review, analysts found:

- The most common injuries occur to workers **on deck**.
- **Wrists and hands** were the most common anatomical sites of injury in both data sources.
- Wrist and hand injuries frequently appear to be **due to crush injuries**, particularly during cargo handling operations, particularly when moving cases of frozen fish.

These findings suggest that hand-crush protection may prevent significant numbers of injuries, but specifics about the activities leading to injury were not available. "We hope our results will motivate stakeholders in commercial fishing to organize a central database for non-fatal injury collection" – June Spector, PI.

## Aggravating Factors of Asthma in a Rural Environment (AFARE) (NIEHS 2009-2014)

PI: Catherine Karr, University of Washington

This community based project characterized ambient triggers of asthma in the rural setting by following 50 (children and adults) asthmatic community participants, mapping their exacerbations and comparing these with known agricultural exposures. Ambient sampling with an innovative and adaptable sampler confirmed the nature of the exposures. A multifaceted evaluation assessed the process, outcomes and impact of the program on the partnership, the participants, the clinical providers, and the community. This project was conducted through [El Proyecto Bienestar](#).

In 2016, Dr. Karr won one of only 102 Presidential Early Career Awards given by the White House. Dr. Karr was nominated because of this project and her ongoing community-engaged approach to studying environmental contaminants and the impact on children's health – especially asthma. Winning the award is an honor that reinforces the value of this kind of research built with strong community partners. "I feel like working with communities to respond to their priority concerns should be an important part of our national research portfolio. But it requires a commitment to taking the time to develop and maintain collaborative relationships. Having a national award recognize this type of research is terrific and hopefully will encourage others," Karr said.

Results are being shared back to the Yakima community, industry stakeholders, clinicians and the scientific community.

## OUTPUTS

Armstrong, JL, Fitzpatrick, CF, Loftus, CT, Yost, MG, Tchong-French, M, Karr, CJ: [2013] Development of a unique multi-contaminant air sampling device for a childhood asthma cohort in an agricultural environment. Environ Sci Process Impacts 15(9): 1760-7. PMCID: PMC4751038.

Loftus, C, Yost, M, Sampson, P, Arias, G, Torres, E., Vásquez, VB, Bhatti, P, Karr, C: [2015] Regional PM2.5 and Asthma Morbidity in an Agricultural Community: A panel study. Environ Res 136: 505-12. PMCID: PMC4425279.

Loftus, C, Yost, M, Sampson, P, Torres, E, Arias, G, Breckwich Vásquez, V, Hartin, K, Armstrong, J, Tchong-French, M, Vedal, S, Bhatti, P, Karr, C: [2015] Ambient ammonia exposures in an agricultural community and pediatric asthma morbidity. Epidemiology 26(6): 794-801. PMCID: PMC4587379.

Hand Wrist Activity Classifications	
Classific	
Handling gear on deck	13.3
Processing catch	12.4
Handling frozen fish (general)	41
Working in engine room	5.3
Unclassified	19.5
Other	8.8

### **ConneX Program and UW Summer Extension Course (HRSA/Yakima Valley Farm Workers Clinic 2011-2013)**

PNASH led a summer environmental education course in Yakima, WA with university credit for ConneX program students. ConneX is an education outreach program at the Yakima Valley Farm Workers Clinic with the aim to create a competitive pool of young people from disadvantaged backgrounds to enter health professions. PNASH faculty, partners and graduate students led the curricula and organized a field survey and sampling activity. The community surveys from 2004 through 2010 helped our partnership to understand the environmental and occupational health concerns, and to evaluate the effectiveness of our educational interventions.

## OTHER RELATED PNASH PUBLICATIONS

Listed below are PNASH publications that fall outside of the direct project activities and reports for 2011-2016. These are often publications based on previously funded projects or related work.

- Butler-Dawson J, Galvin K, Thorne PS, Rohlman DS: [2016] Organophosphorus Pesticide Exposure and Neurobehavioral Performance in Latino Children Living in An Orchard Community. *Neurotoxicology* 53:165-72. PMID: 26820522.
- Fowler H, Adams D, Bonauto D, Rabinowitz P: [2016] Work-related Injuries to Animal Care Workers, Washington 2007-2011. *Am J Ind Med.* 59(3):236-44. PMC4872621.
- Gibbs JL, Yost MG, Negrete M, Fenske RA: [2016] Passive Sampling for Indoor and Outdoor Exposures to Chlorpyrifos, Azinphos-Methyl, and Oxygen Analogs in a Rural Agricultural Community. *Environ Health Perspect.*
- Krenz JE, Hofmann JN, Smith TR, Cunningham RN, Fenske RA, Simpson CD: [2015] Determinants of Butyrylcholinesterase Inhibition Among Agricultural Pesticide Handlers in Washington State: An Update. *Ann Occup Hyg.* 59(1): 25-40.
- Spector JT, Krenz J, Blank KN: [2015] Risk Factors for Heat-Related Illness in Washington Crop Workers. *J Agromedicine* 20(3):349-359. PMID: 26237726.
- Wilmsen C, Bush D, Barton-Antonio D: [2015] Working in the Shadows: Safety and Health in Forestry Services in Southern Oregon. *Journal of Forestry* 113(3): 315-324(10).
- Armstrong JL, Fenske RA, Yost MG, Tchong-French M, Yu J: [2014] Comparison of Polyurethane Foam and XAD-2 Sampling Matrices to Measure Airborne Organophosphorus Pesticides and Their Oxygen Analogs in An Agricultural Community. *Chemosphere* 92(2): 451-457.
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