



WASHINGTON STATE
UNIVERSITY

Research, Innovation and the Future of Washington State

Dr. Noel N. Schulz, WSU First Lady

Edmund O. Schweitzer III Chair in Power Apparatus & Systems

School of EE and CS

Voiland College of Engineering and Architecture

Washington State University Pullman

Noel.Schulz@wsu.edu

[@wsu_noel_schulz](#)

The Schulz Family

Andrew
PhD Student, ME,
Ga Tech

Kirk
President

Noel
Engineering
Faculty

Tim (son) & Tricia
Schulz
MS CS
Mitre and Sandia
Washington DC



Outline

- My family, my background and past activities
- Why should the state of Washington worry about STEM?
- WSU and STEM Education, Research and Outreach
 - PK-12
 - Undergraduate
 - Graduate, Research and Innovation
- Food, Energy and Water Nexus
- Q&A



- Dad, PhD Electrical Engineering & Faculty Member
- Mom, Elementary Teacher
- BS and MS, Electrical Engineering 
- PhD, EE with CS minor 
- Faculty Experience at
 - Virginia Tech 
 - University of North Dakota 
 - Michigan Tech 
 - Mississippi State 
 - Kansas State 
 - Washington State 
- Research & Teaching Interests
 - Electric power engineering, smart grid, renewable energy, micro-grids

Our Changes -- 1987-2019



Noel's Passion – Women in Engineering & STEM

- Started a Women in EE Program as Graduate Student at Minnesota
- Created Networks for Women Engineering Faculty at Michigan Tech and Mississippi State
- Involved in ASEE Women in Engineering Division including Chair of Division
- Created Faculty Women in Power Network – grown from 4 to 30 in 20 years
- Started Women in Engineering receptions and events at IEEE PES meetings in 1998
- As IEEE PES President 2012 and 2013, helped initiative women in power events on six continents and other activities
- Received IEEE HP/Harriett B. Rigas Award in 2014
- Various talks, workshops and networks for women faculty, graduate students and UG students
- WSU Representative on Washington STEM Board
- Co-Chair, Governor's Choose Washington NMA Council



Harriett B. Rigas
WSU Faculty 1965-1980



UI-ASSIST

US-India collaborative for smart diStribution System with Storage



Supported by



In partnership with

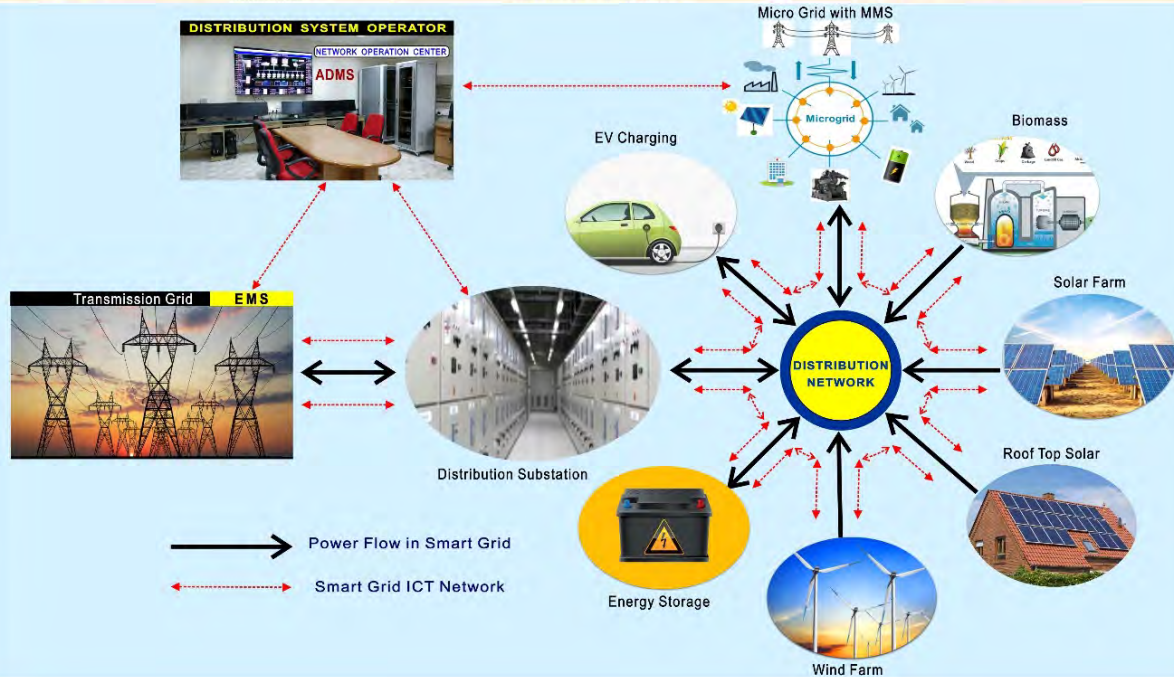


IUSSTF
Indo-US Science and Technology Forum

Lead Institutes



WASHINGTON STATE
UNIVERSITY



PROJECT TEAM



S. C. Srivastava
 INAE Fellow and past Deputy Director, IITK
 Past Dean R&D, IITK
 PI



N. Schulz
 IEEE Fellow and past IEEE PES President,
 Professor, WSU PI



Why is it important for Washington to get more people into STEM from PK-20?

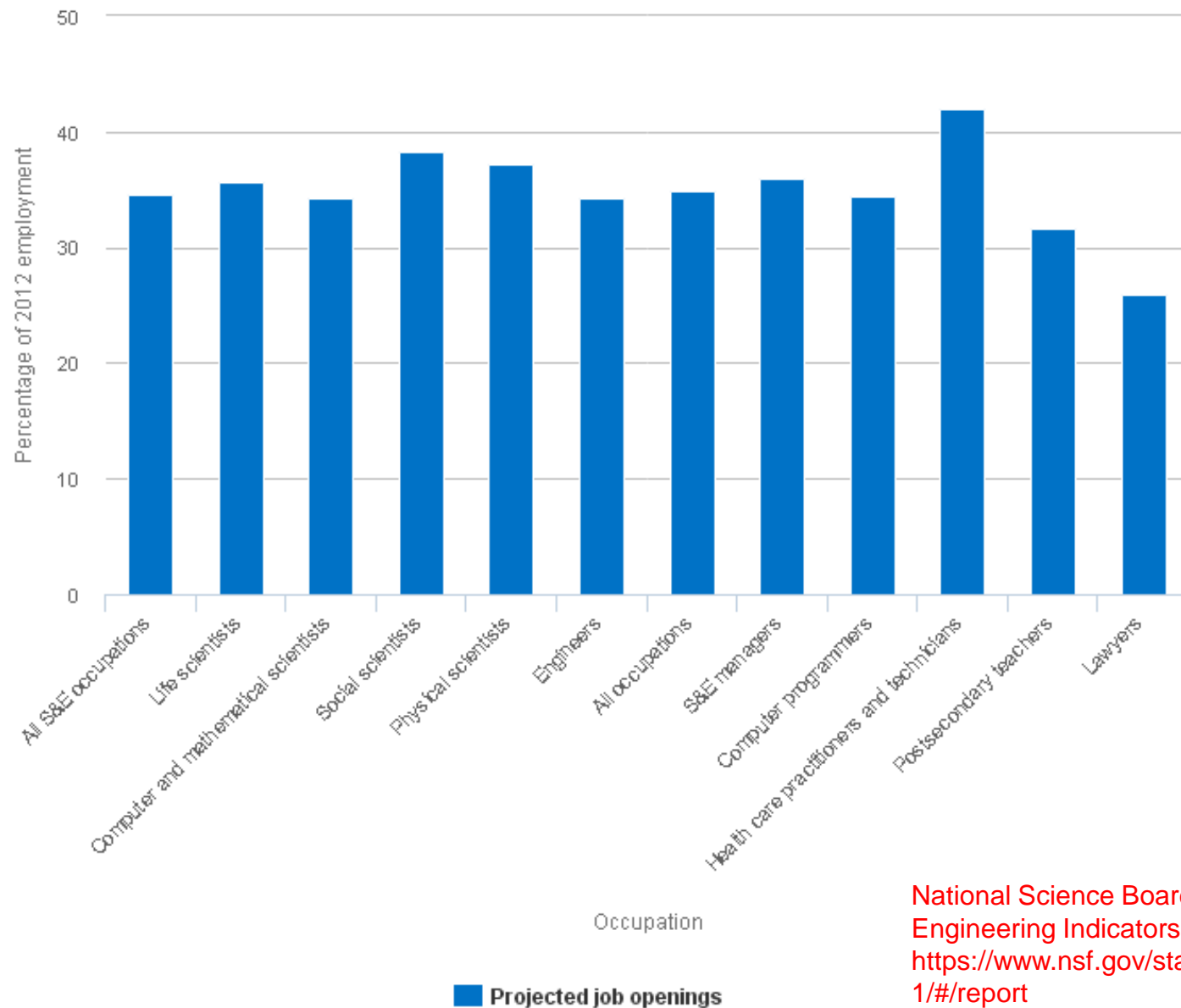
- Numbers
- Global Competition
- Diversity of thought & experiences



WHY?

Figure 3-B

Projected job openings in S&E and other selected occupations: 2012–22

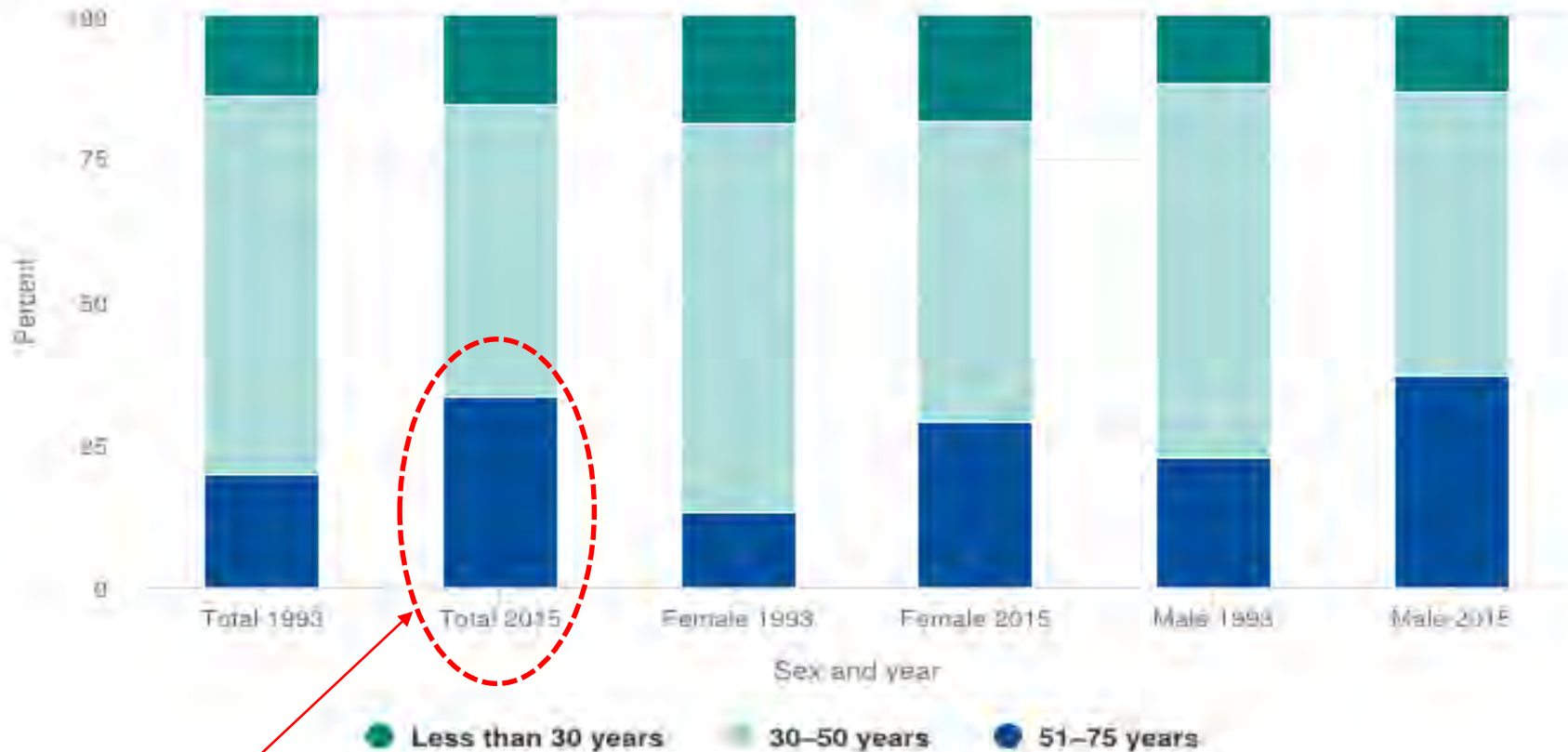


National Science Board Science & Engineering Indicators 2016
<https://www.nsf.gov/statistics/2016/nsb20161/#/report>

Numbers

Figure 3-22

Age distribution of scientists and engineers in the labor force, by sex: 1993 and 2015



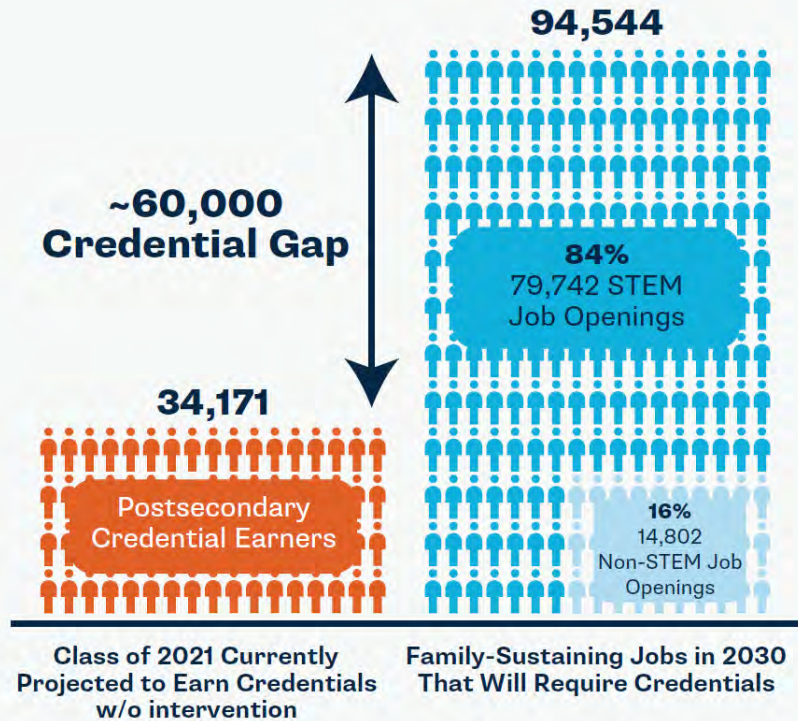
Aging STEM Workforce

National Science Board – Science and Engineering Indicators 2018

<https://www.nsf.gov/statistics/2018/nsb20181/>

Numbers - Washington

BRIDGING THE GAP: A STRONG DEMAND FOR STEM TALENT



*The class of 2021 will have completed credentials by 2030 and be ready to enter the workforce.

Numbers - Washington

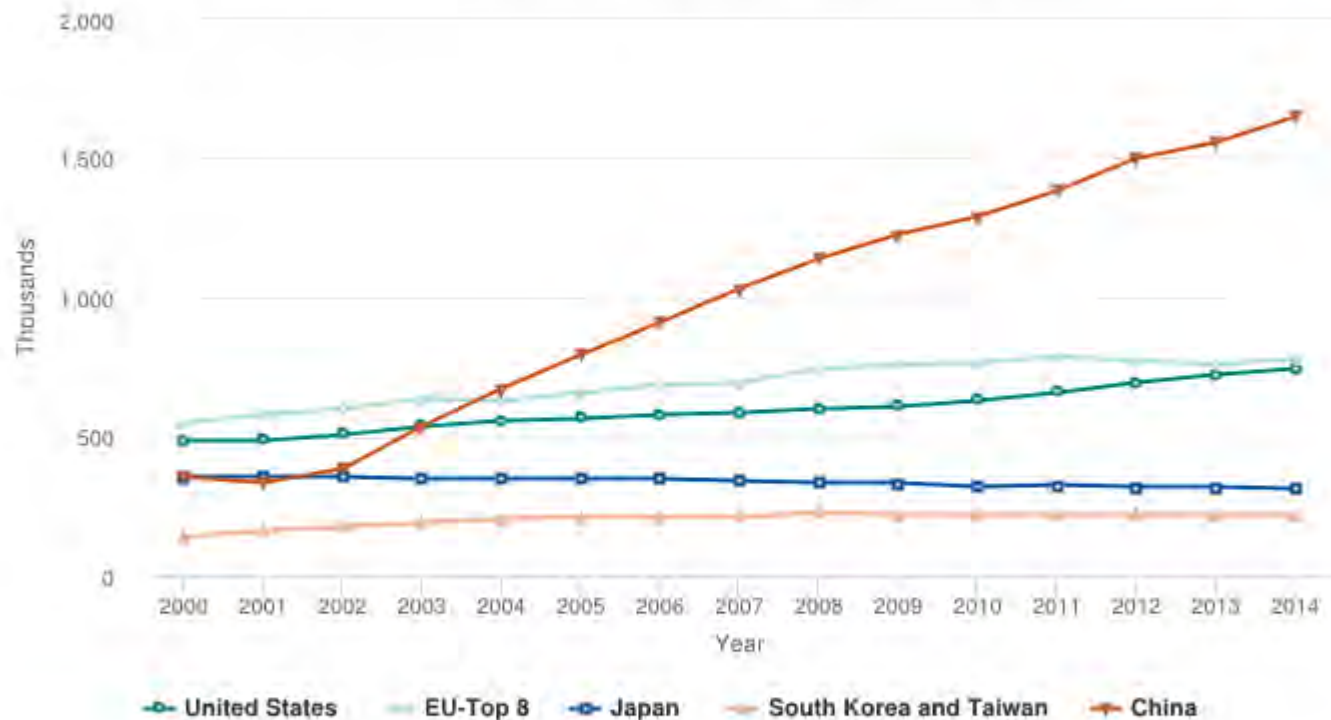
By 2030, it is estimated that 70% of all Washington state jobs will require education beyond high school.

- 67% of those jobs will require STEM skills
- 40% of students in the state are on track
- 23% of rural youth, youth growing up in low-income households, and youth of color are on track

Global Competition – Science & Engineering

Figure O-1

Bachelor's degree awards in S&E fields, by selected region, country, or economy: 2000–14



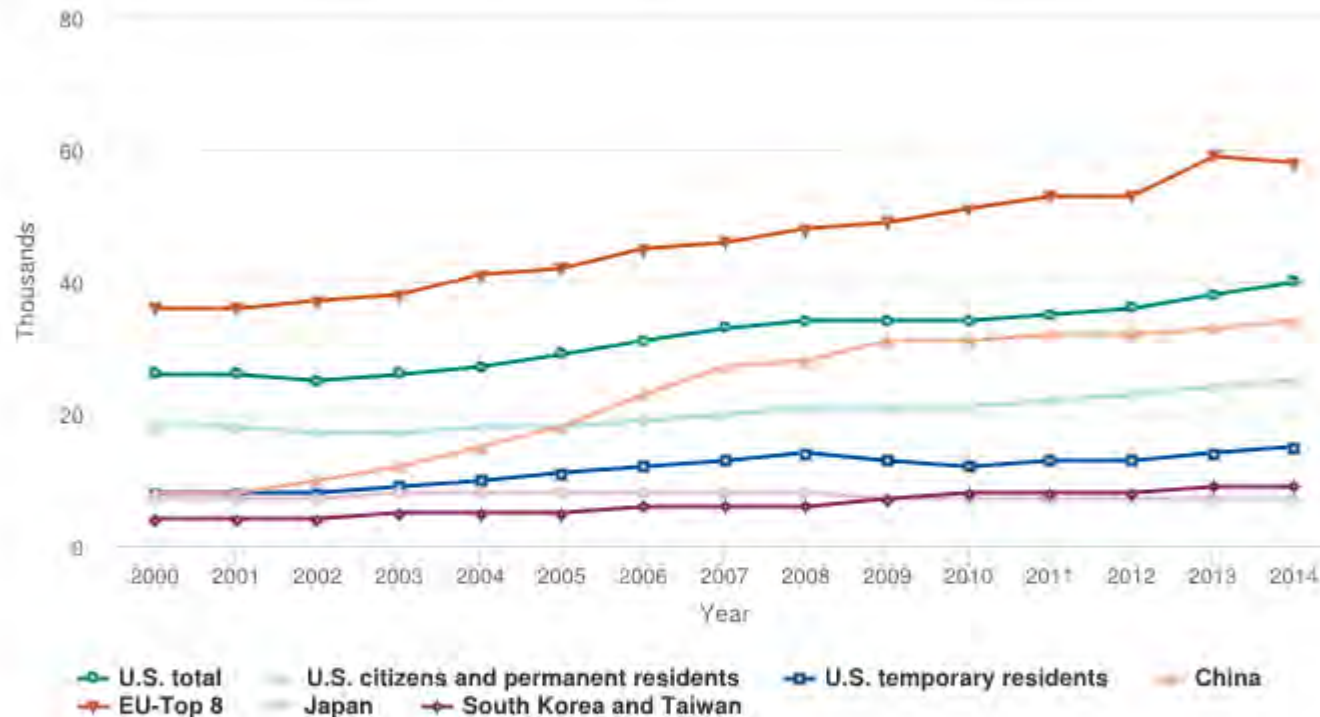
EU = European Union.

Note(s): Data are not available for all countries for all years. EU-Top 8 includes the eight EU countries with the largest numbers of bachelor's degree awards in 2014: United Kingdom, Germany, France, Poland, Italy, Spain, Romania, and the Netherlands.

Global Competition – Science & Engineering

Figure O-3

Doctoral degree awards in S&E fields, by selected region, country, or economy: 2000–14



EU = European Union.

Note(s): U.S. citizens and permanent residents and U.S. temporary residents are estimated using their represented shares in the Integrated Postsecondary Education Data System (IPEDS). EU-Top 8 includes the eight EU countries with the largest numbers of doctoral degree awards in 2014: Germany, United Kingdom, France, Spain, Italy, Portugal, Sweden, and Romania.

Diversity of Thought & Experience

Innovative solutions mean diverse teams

“Collective diversity, or diversity of the group - the kind of diversity that people usually talk about - is just as essential to good engineering as individual diversity. At a fundamental level, men, women, ethnic minorities, racial minorities, and people with handicaps, experience the world differently. Those differences in experience are the "gene pool" from which creativity springs”

William Wulf – President, US National Academy of Engineering, 1998



Diversity and Inclusion in 2019 ...

Women

First
Generation

People with
Disabilities

Men

Different Ages

Different Parts of
US and World

Veterans

Rural
background

Urban
Background

Educational
Backgrounds
(AA, BS, MS,
PhD)

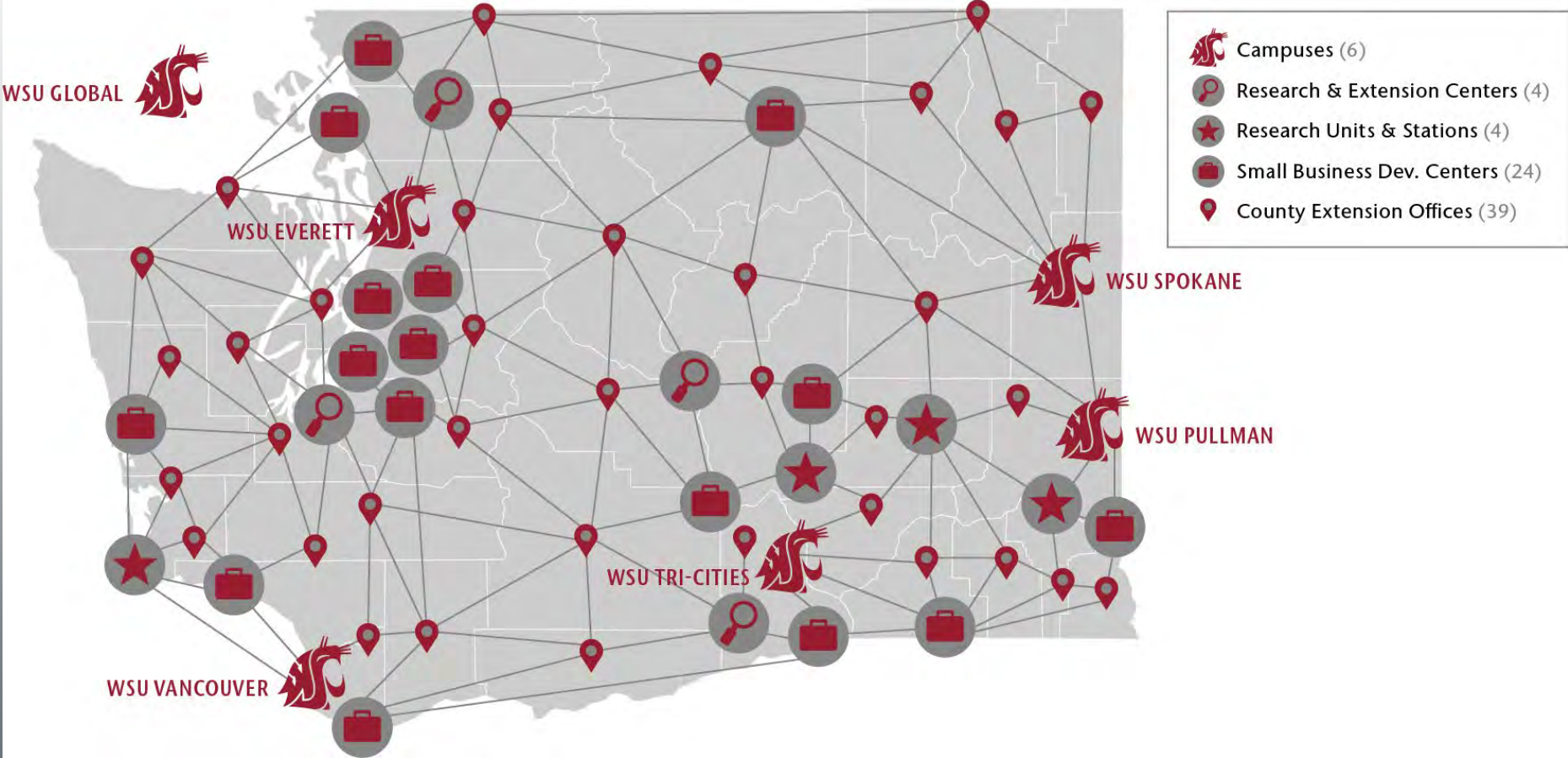
People
of Color

Different Socio-
Economic
Backgrounds

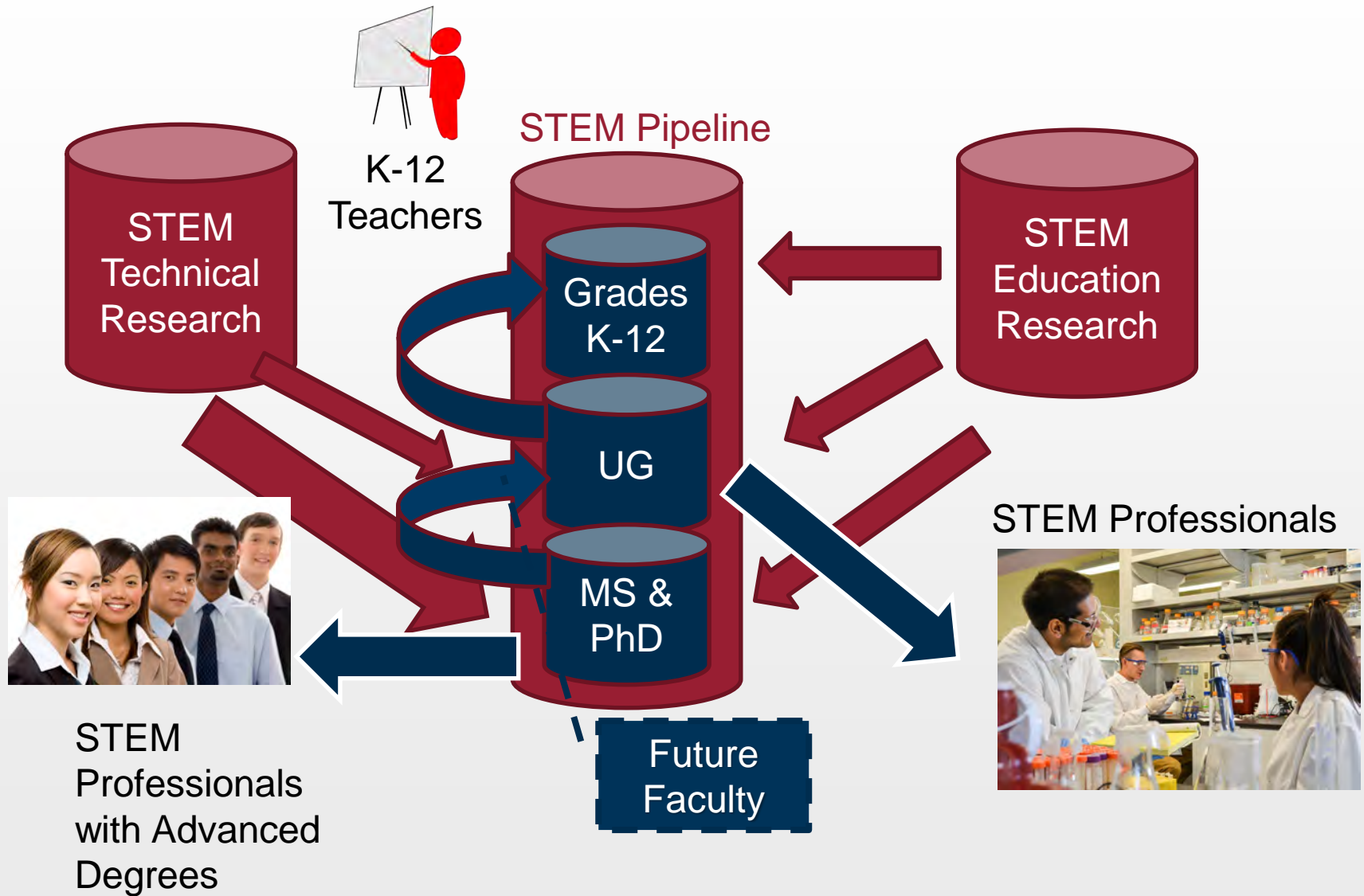
LGBTQ+

...

WSU System



What is WSU (WA Higher Ed) doing in STEM Education and Research



STEM Activities Across All Colleges

- Agriculture
- Engineering
- Architecture
- Sciences
- Education
- Health Sciences (Medicine, Nursing & Pharmacy)
- Computer Science and Data Analytics – Business
- Vet Medicine
- Social Sciences
- Communications – Communicating STEM

STEM & Under-represented minorities

- Multicultural students
- Women
- First Generation
- Veterans

STEM Role Models

- Alumni and Partners sharing in classrooms & with student organizations

PK-12

Pipeline & Recruitment

- STEM not always seen as a family friendly career
- Today's students want to save the world – how do we share the STEM stories so they see these connections?
- First generation students may not know about opportunities in STEM
- Set up for success through exposure to opportunities and education





STEM and Agriculture

4-H STEM programs provide 4-H youth the opportunity to learn about Science, Technology, Engineering and Math (STEM) through fun, hands-on activities and projects.



Helping Kids Succeed

4-H STEM and agriculture programs equip young people with the skills they need to succeed in life, and are available through local clubs, schools and grant-funded programs. Focus areas include computer science, robotics, environmental science, agri-science, financial literacy, entrepreneurship, and veterinary science.

CAHNS | EXTENSION | 4-H YOUTH DEVELOPMENT PROGRAM

STEM

4-H science programs provide 4-H youth the opportunity to learn about Science, Technology, Engineering and Math (STEM) through fun, hands-on activities and projects. For kids who are curious about science-oriented jobs, 4-H offers the STEM Career Pathway, an easy to follow, 4-step framework for exploring, learning, practicing and experiencing STEM careers.

4-H science programs are available through local clubs, schools and grant-funded programs.

Engineering & Technology	Environmental Sciences	Plant & Animal Sciences
Aerospace	ATV Safety	Agriculture
Computer	Backyards and Beyond	Amphibians
Electricity	Bicycle	Beef
Food Science	Butterfly	Butterfly
Geospatial Science	Entomology	Cat
Robotics	Exploring Your Environment	Dairy Cattle
Science Discovery	Fishing	Dog
Small Engines	Forestry	Entomology
Wind Energy	Gardening	Fishing
	Outdoor Adventures	Gardening
	Shooting Sports	Goat
	Water Conservation	Horse
	Wind Energy	Pets
		Poultry
		Rabbit
		Sheep
		Swine
		Veterinary Science

Click the project link to visit the project page to learn more!

Want to create your own STEM Project? Check out [Self-Determined Projects](#).

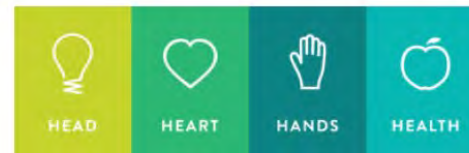
Learn more about making informational posters with

STEM Program

Program Contact: Michelle Green, 4-H STEM Coordinator
(206) 263-1915 • michelle.green@wsu.edu



Ready... Set.... Launch! A 4-H club member measures her launch angle before testing her rocket as part of the 2014 National Youth Science Day Experiment: Rockets to the Rescue!



Robotics. Aerospace. Alternative energy. Engineering. Environmental science. Agri-science. Veterinary science. These are just a few of the programs that 4-H youth participate in everyday and learn new skills that make a difference in our communities. Our hands-on programs empower youth and provide them with opportunities to grow, learn, and become confident kids.

4-H STEM is based on inquiry-based learning, in which youth construct their own learning by using science skills to explore and gather evidence in an investigative manner. To learn more about this instructional method, check out the [Inquiry-based Learning Fact Sheet](#).

West Sound
STEM Network

Skagit
STEM Network

Snohomish
STEM Network

King County
STEM Partners

Tacoma
STEAM Network

Capital Region
STEAM Network

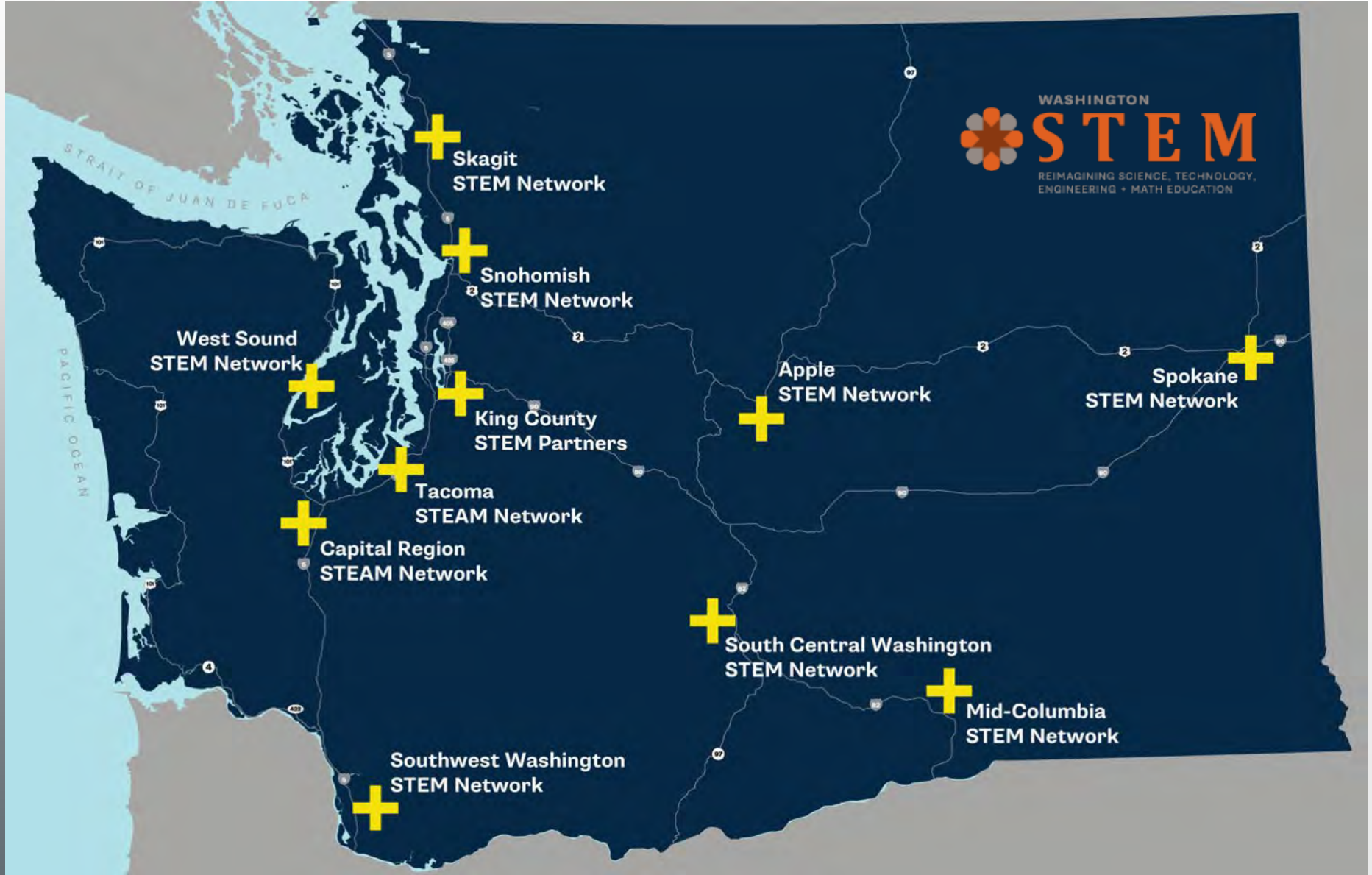
Southwest Washington
STEM Network

Apple
STEM Network

South Central Washington
STEM Network

Mid-Columbia
STEM Network






Spokane
STEM Network





WASHINGTON
STEM
REIMAGINING SCIENCE, TECHNOLOGY,
ENGINEERING + MATH EDUCATION

WA STEM KEY ACTIVITIES

 <p>Identify local solutions and provide resources to support wide-spread local adoption</p>	 <p>Convene partners to solve important problems</p>	 <p>Use measurement and data to identify and overcome barriers to opportunity</p>
 <p>Tell stories about partners' successes and challenges</p>	 <p>Advocate for change by informing and educating leaders</p>	 <p>Provide direct support to partners</p>

Early STEM Skills

Computer Skills

Career Connected Learning

STEM by the Numbers

Strengthen STEM in K-12

HEAL: Health education through arts-based learning



Photographing
mosquito habitat

SEPA SCIENCE EDUCATION
PARTNERSHIP AWARD
SUPPORTED BY THE NATIONAL INSTITUTES OF HEALTH

Grant # 1R25GM129814-01, \$1.2 million

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- College of Education (PI Dr. Molly Kelton)
- College of Agricultural, Human, and Natural Resource Sciences
- Elson S. Floyd College of Medicine
- WSU Extension

HEAL: Health education through arts-based learning

- Address disparities in STEM education, career development, and health outcomes for rural minorities
- Increase rural STEM education capacity
- Increase representation of rural minorities in biomedical fields
- Innovative use of Arts in STEM-to-STEAM research
- Partnerships with Central Washington Latinx communities



Using sculpture to model the human microbiome

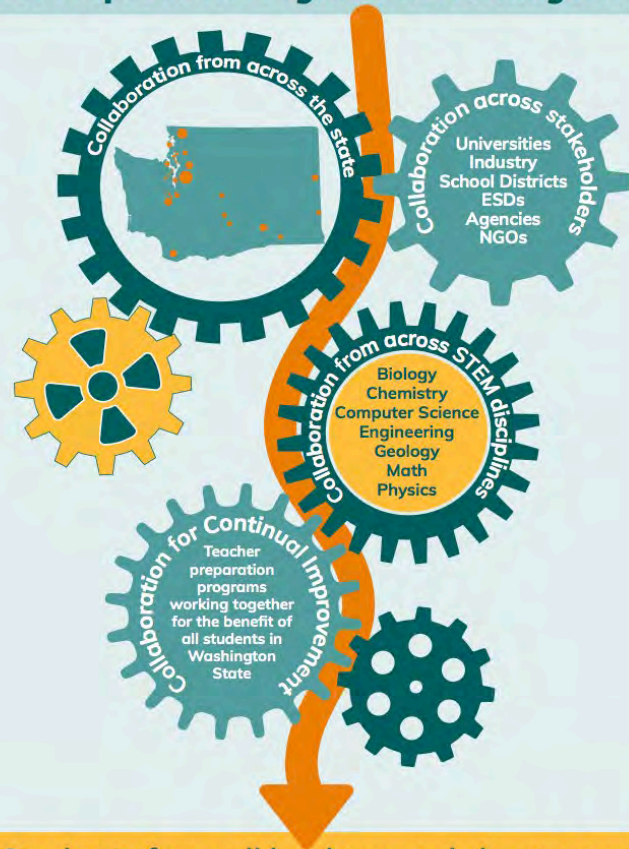
Teacher Preparation

K-12 Methods

- Next Generation Science Standards
- Computer Science Standards



The Next Generation of STEM Teacher Preparation Programs in Washington State



Students from all backgrounds have a path
to becoming a STEM teacher

Preparing the Next Generation of Students for Washington's STEM Workforce

This work funded in part by a grant from the National Science Foundation

Lead Institutions:

- Western Washington University
- Washington State University Vancouver
- Eastern Washington University
- Central Washington University
- Seattle Pacific University



The three primary goals of NextGen-WA are:

- Improve the preparation of future teachers in Science, Technology, Engineering and Math (STEM) statewide
Institutions in this project prepare more than 90% of Washington's future STEM teachers.
- Increase recruitment of qualified and diverse STEM students into teaching
- Create an adaptive, research-based model for improving STEM teacher preparation through collaboration.

https://serc.carleton.edu/nextgen_wa/index.html



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TRI-CITIES

Computer Science Teacher Education Program (CSTEP)

- Designed to create a 5-course certification, and eventual state level endorsement, for K-12 computer education. This will help satisfy the state legislation calling for computer science educators in all Washington state schools.
- The program is targeting working K-12 teachers, but will also be available for undergraduates at WSU.
- The classes for the certificate are being created by the Colleges of Education and Engineering on the Tri-Cities campus.

<https://tricity.wsu.edu/education/>

Culturally Responsive Indigenous Science:

- Connecting Land, Language, and Culture

College of Education:

- Dr. Paula Groves Price (PI)
- Dr. Zoe Higheagle Strong

Center for Digital Scholarship and Curation

- Dr. Kimberly Christen



DRK-12 Award #1720931

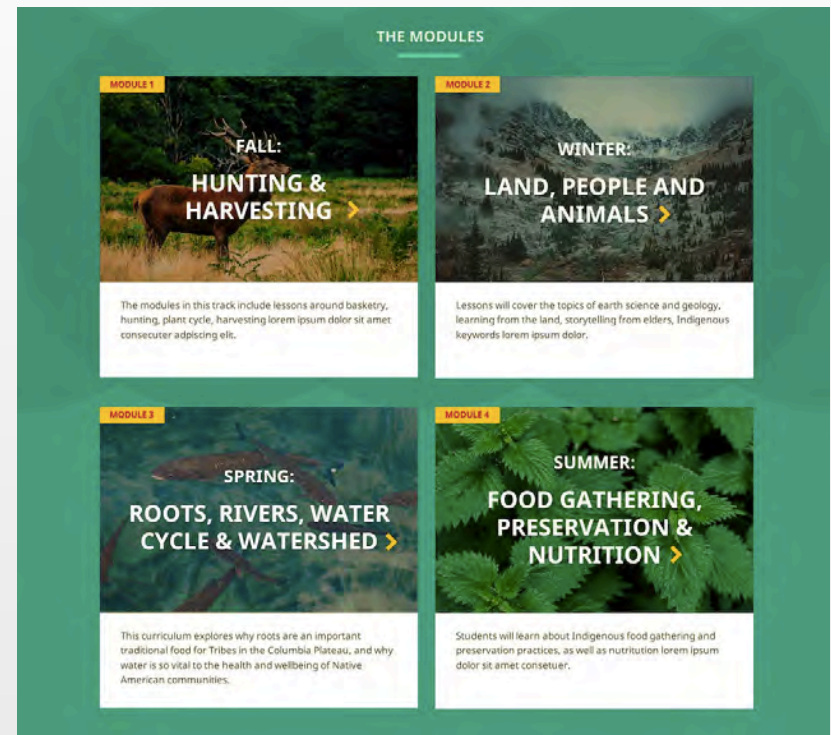


In collaboration with:

The Confederated Tribes of the Colville Reservation (WA), The Confederated Tribes of Warm Springs (OR), and the Coeur d'Alene Tribe (ID)

Key Features of the CRIS project 2017-2021 (\$2.5 million)

- ▶ Science curriculum modules for grades 4-9 connected to the seasonal round, Indigenous Cultures, Languages, and the Plateau People's Web Portal
- ▶ Unique website and Application for iOS and Android systems for teaching and learning with iPads
- ▶ Annual Enrichment activities on the WSU campus (field trip and residential summer camp) to increase Native American participation in STEM



Undergraduate

TEAM MENTORING PROGRAM

Building Connections for Success!

GOALS:

- Retention within STEM
- Graduation
- Graduate/Prof. School
- Transition to leadership and Workforce
- Networking
- Identity: Scientist, Engineer, Health Professional
- Learning/Changing STEM Culture

BENEFITS

- Networking
- Research, Study Abroad
- Textbook Scholarships
- Internships
- Fieldtrips and workshops
- Tutoring/Study Tables
- Social/Cultural Activities

Multicultural Student Services

Community, Equity, and Inclusive Excellence – Division of Student Affairs Program direction and Graduate Assistantship

Private Partners

The Boeing Company
Washington Research Foundation, NSF

LSAMP

Provost Office
LSAMP Liaison and Resources

College of Agricultural, Human, and Natural Resource Sciences

Faculty Mentors
College Liaison and Resources

College of Arts Sciences

Faculty Mentors
College Liaison and Resources

MENTEE

Sophomore and New Transfer URM's

College of Veterinary Medicine

Faculty Mentors
College Liaison and Resources

Voiland College of Engineering and Architecture

Faculty Mentors
College Liaison and Resources

PROGRAMMING TRACKS

- Academic activities
- Research, careers, internships
- Getting the most of your major
- Preparing for graduate, professional school or the workforce

TRAINING

- Retreats
- UNIV 497 Class
- Mentoring: Experiential Learning and Internship
- Mentoring and Leadership Portfolio

STUDENT MENTORS



RESPONSIBILITIES

Contact and connect mentees to respective college, faculty mentor y resources
Provide guidance, support, and relevant information

TMP ALUMNI AND INDUSTRY PARTNER MENTORING TRACK

- Job Shadowing
- Resume and Interview Tips
- Networking
- Internship at company
- Consultant on Career Path & Other

WASHINGTON STATE UNIVERSITY

Impact

80 percent of active participants stayed or graduated, and 66 percent stay in a STEM major or graduated

70 percent of active participants from the Voiland College of Engineering and Architecture stayed in a STEM major or graduated

169 students have participated in research projects with faculty

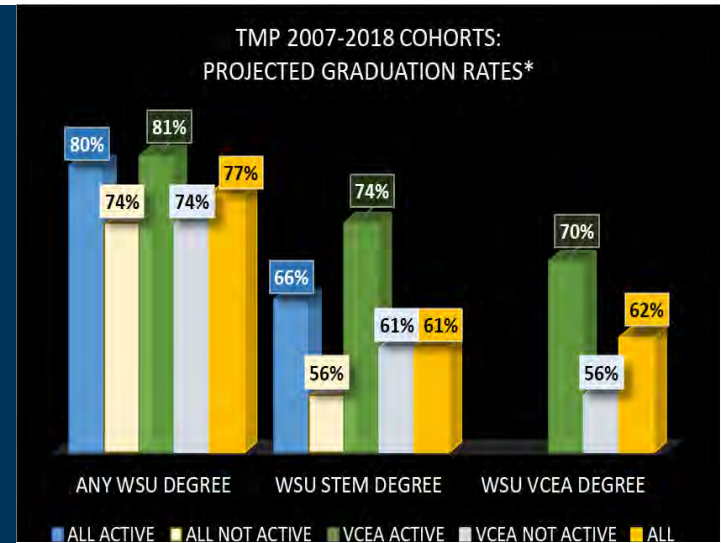
178 TMP mentoring scholarships have been awarded to Student Mentors

96 study abroad & travel grants awarded to attend regional, national, and international conferences

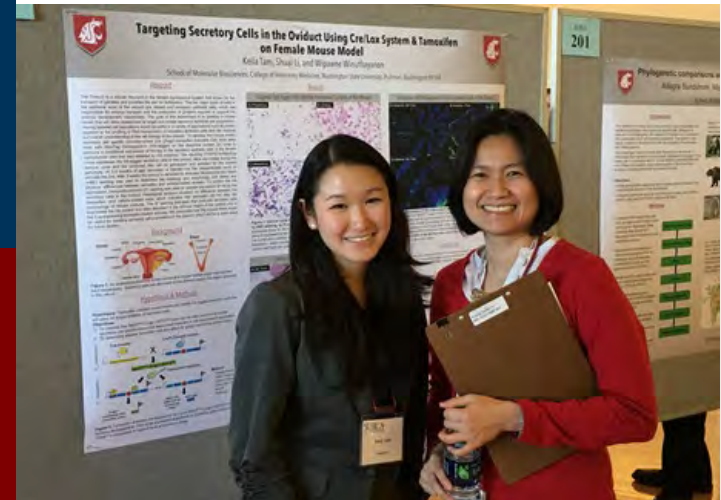
502 textbook scholarships awarded to students

Awards

TMP received the **Presidential Award For Excellence in Science, Mathematics, and Engineering Mentoring** given by the Office of the President of the United States and the National Science Foundation, in June 2018



*Have graduated or still enrolled at WSU in Spring of 2019



Research in Interdisciplinary STEM Education (RISE): A summer undergraduate research experience

Project Goal: Contribute to a more vibrant and inclusive STEM workforce by advancing research in STEM Education.

Mechanism: Engage undergraduate in research focused on STEM workforce development, specifically to investigate questions related to

- bolstering STEM pathways,
- informal STEM education, and
- development of authentic disciplinary practices in STEM undergraduates.

This project is being led by an interdisciplinary team of WSU faculty from molecular biosciences, biological sciences, chemistry, mathematics, and education.

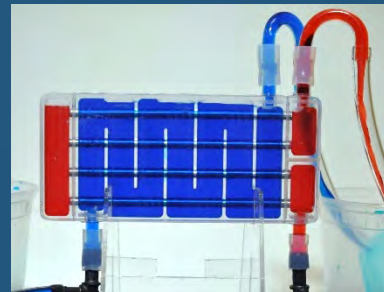
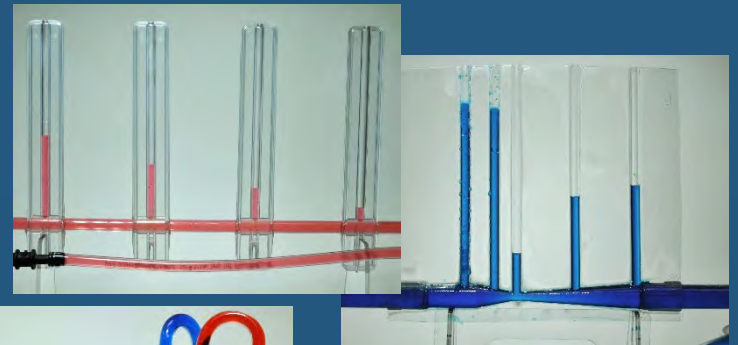


Award to Drs. Erika Offerdahl and Molly Kelton, NSF-EHR 1852235

EDUC-ATE

EDUCATING DIVERSE UNDERGRADUATE COMMUNITIES – AFFORDABLE TRANSPORT EQUIPMENT

- Miniaturized Industrial Equipment: Visual, Interactive format Desktop Learning Module (DLM) kits for concepts such as:
 - Hydraulic Loss
 - Venturi Meter
 - Shell & Tube HtX
 - Double Pipe HtX
- LC-DLMs fostered statistically significant learning and engagement compared to lecture
- Low-cost (~\$350/kit), injection molded designs



Low-Cost Desktop Learning Modules (LC-DLMs)

NSF Sponsored Programs
DUE 1821578 & 1821679

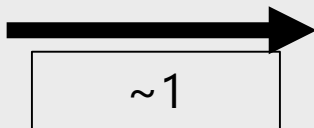
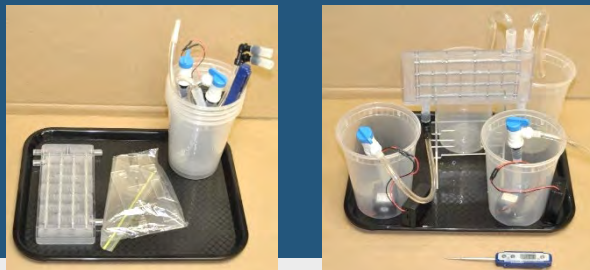
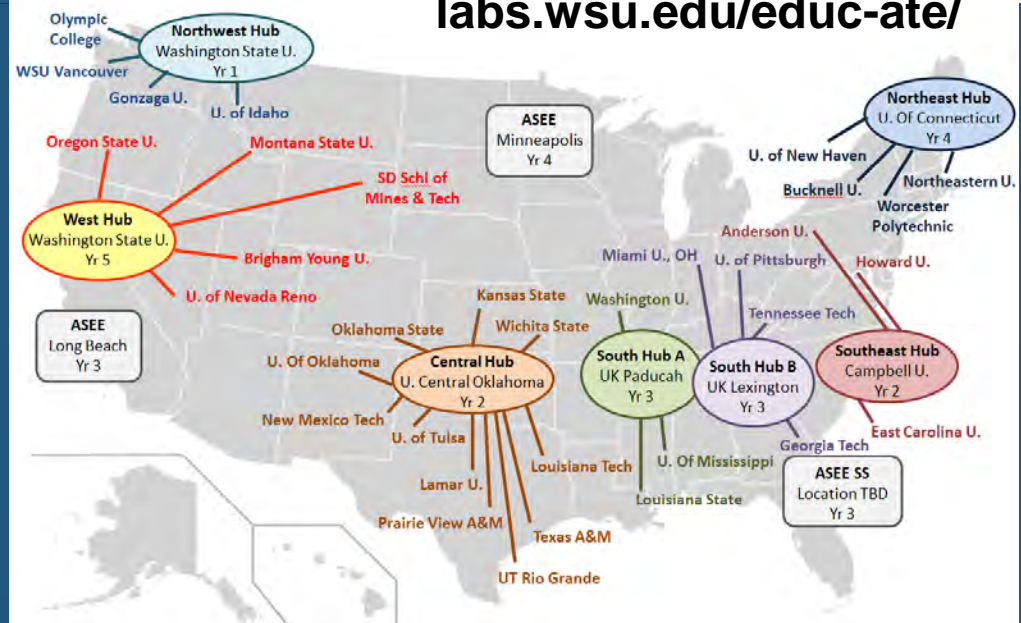


NATIONAL DISSEMINATION OF LC-DLMS

\$2.64 MILLION EFFORT

- 50 universities/programs
- Suitable for high school STEM ed.
- Regional hub-based distribution
- Website development
- Assess student learning gains
- Visit implementation sites
- ASEE Workshops

Learn more about us at labs.wsu.edu/educ-ate/



~1 minute
setup & operation = fast & simple

Investigators: Van Wie, B.¹ (PI), Dutta, P.², Thiessen, D.¹, Adesope, O.³, and Gartner, J.⁴ (Campbell University)

¹Voiland School of Chem. Engr. & Bioengr.

²School of Mech. & Materials Engr.

³Educational Psychology, College of Education

⁴Dept. of Chem. & Mech. Engr., Campbell Univ., NC

Graduate Students: Kaiphanliam, K.¹, Khan, A.², Reynolds, O.¹, Oje, O.³

Postdoc: Dahlke, A.¹



Graduate Programs, Research and Innovation

Communicating STEM to non-STEM Audiences



Ask Dr. Universe



Certificate program for
Communicating STEM



Developing Post-Graduate Workforce



4,414

Scientists, engineers, and professional staff



\$960M

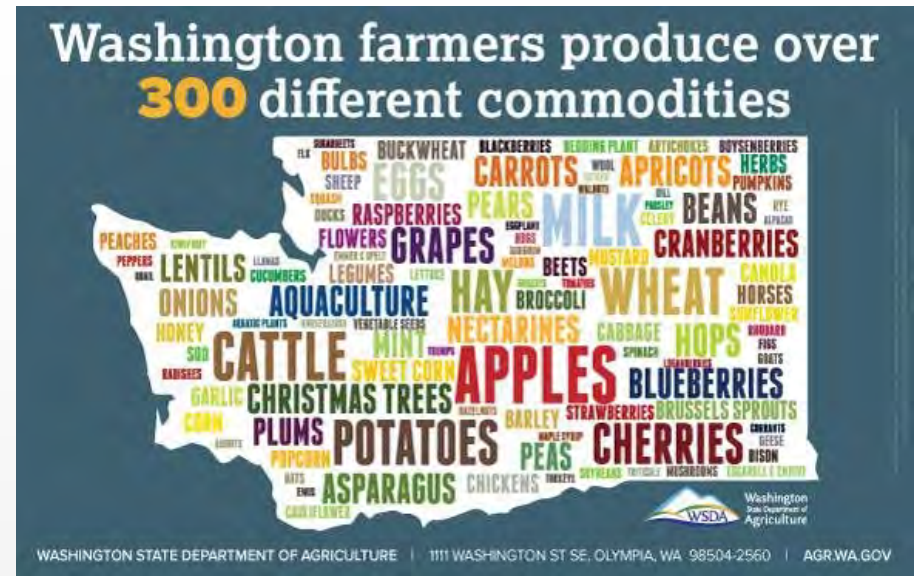
Annual operating budget

Joint Research Institutes

<https://thewsu-pnnlinstitutes.labworks.org/>

STEM Education Efforts

Food, Energy and Water Nexus



Food

Education

Soil Science

Biotechnology

Entomology

Chemistry

Veterinary
Medicine

Biology

Food
Science



Plant
Pathology

Health
Sciences

Crop Science

Agricultural
Engineering

Economics

Data Science

Twitter - @wsucahnrns 10/01/19

Water and Energy

Engineering



Computer Science



Social Sciences

Education

Architecture



Math

Physics

Economics

STEM + Washington = Great Future!

**Thank you for opportunity to
participate!**

Dr. Noel N. Schulz, WSU First Lady
Edmund O. Schweitzer III Chair in Power Apparatus & Systems
School of EE and CS
Voiland College of Engineering and Architecture
Washington State University Pullman
Noel.Schulz@wsu.edu
[@wsu_noel_schulz](#)

Tree Fruit: Innovative Research, Innovative Education

Jim McFerson

Former Director, Professor of Horticulture
Washington State University Tree Fruit
Research and Extension Center



Climate Change Brings New Challenges for the Pacific Northwest Tree Fruit

Lee Kalcsits

Assistant Professor: Tree Fruit Physiology
Washington State University Tree Fruit
Research and Extension Center



Climate Change Brings New Challenges for the Pacific Northwest Tree Fruit

Lee Kalcsits, Assistant Professor

100% Research

WSU Tree Fruit Research and Extension Center

Department of Horticulture

Wenatchee, WA



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Sustaining Orchard Productivity



Growing Fruit in a Desert





Decreasing Physiological Disorders in Tree Fruit

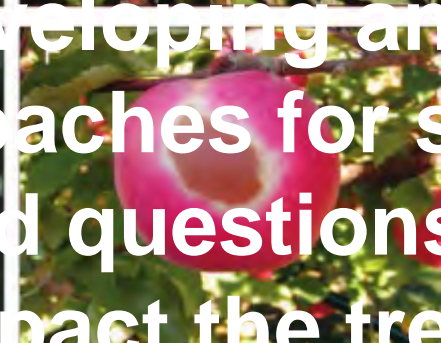
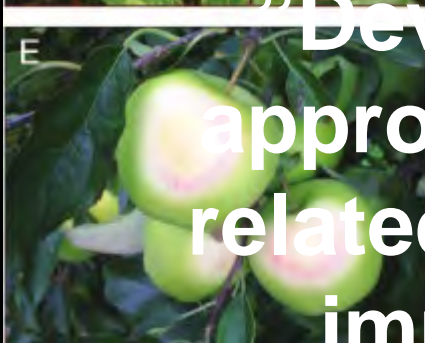
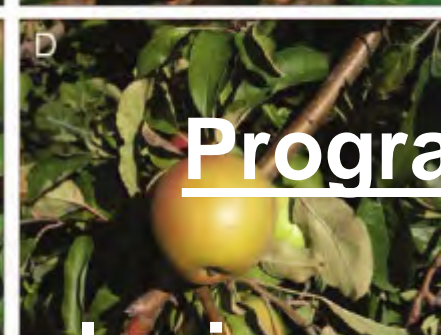


Sunburn and bitter pit in Washington State

15% of fruit is lost to these two disorders annually in Washington State (\$450 million)

Program Focus

“Developing and integrating new approaches for solving physiology-related questions that will positively impact the tree fruit industry”

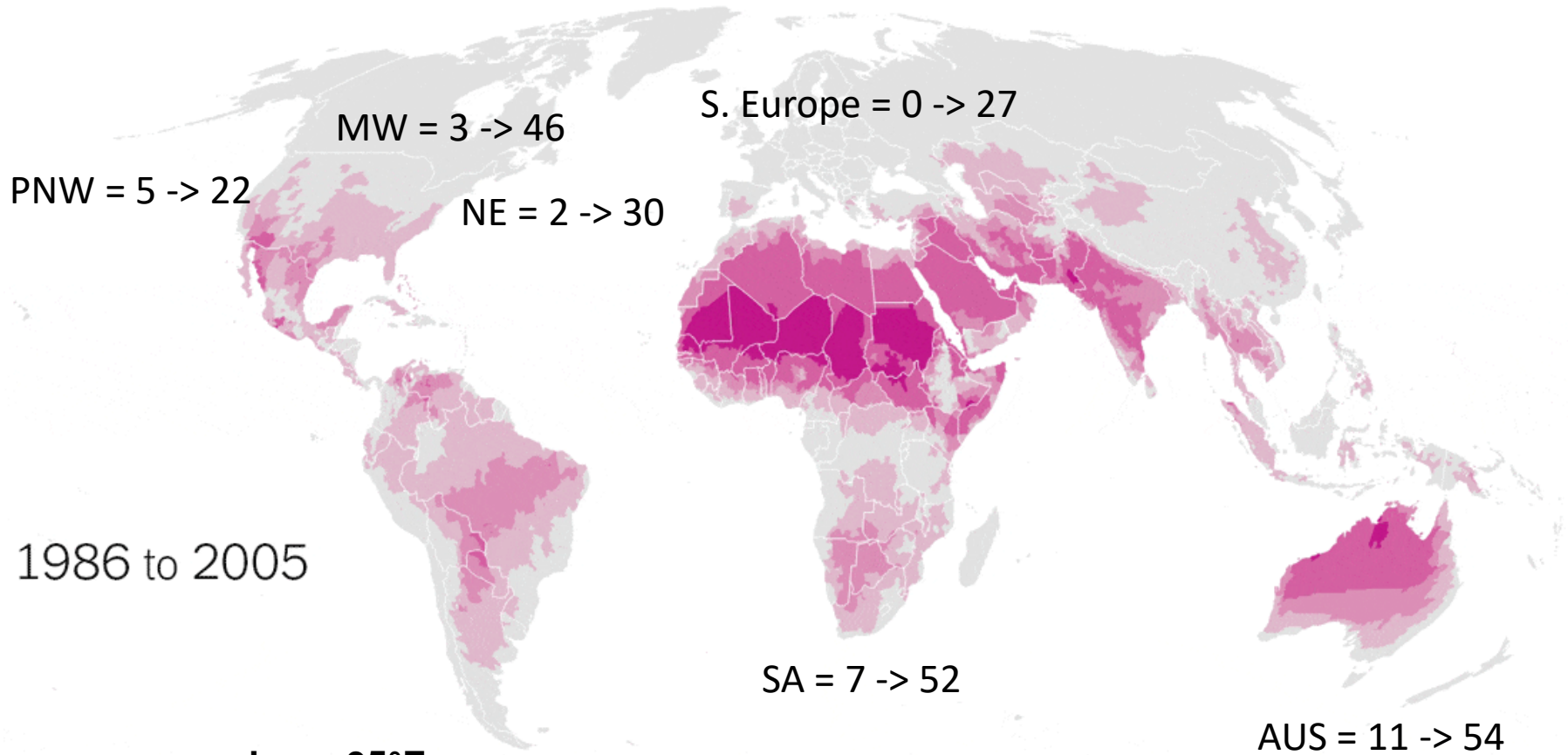




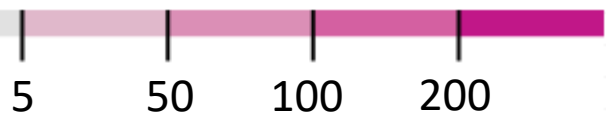
Sustaining Orchard Productivity



Changes in Sunburn Risk



Days per year above 95°F



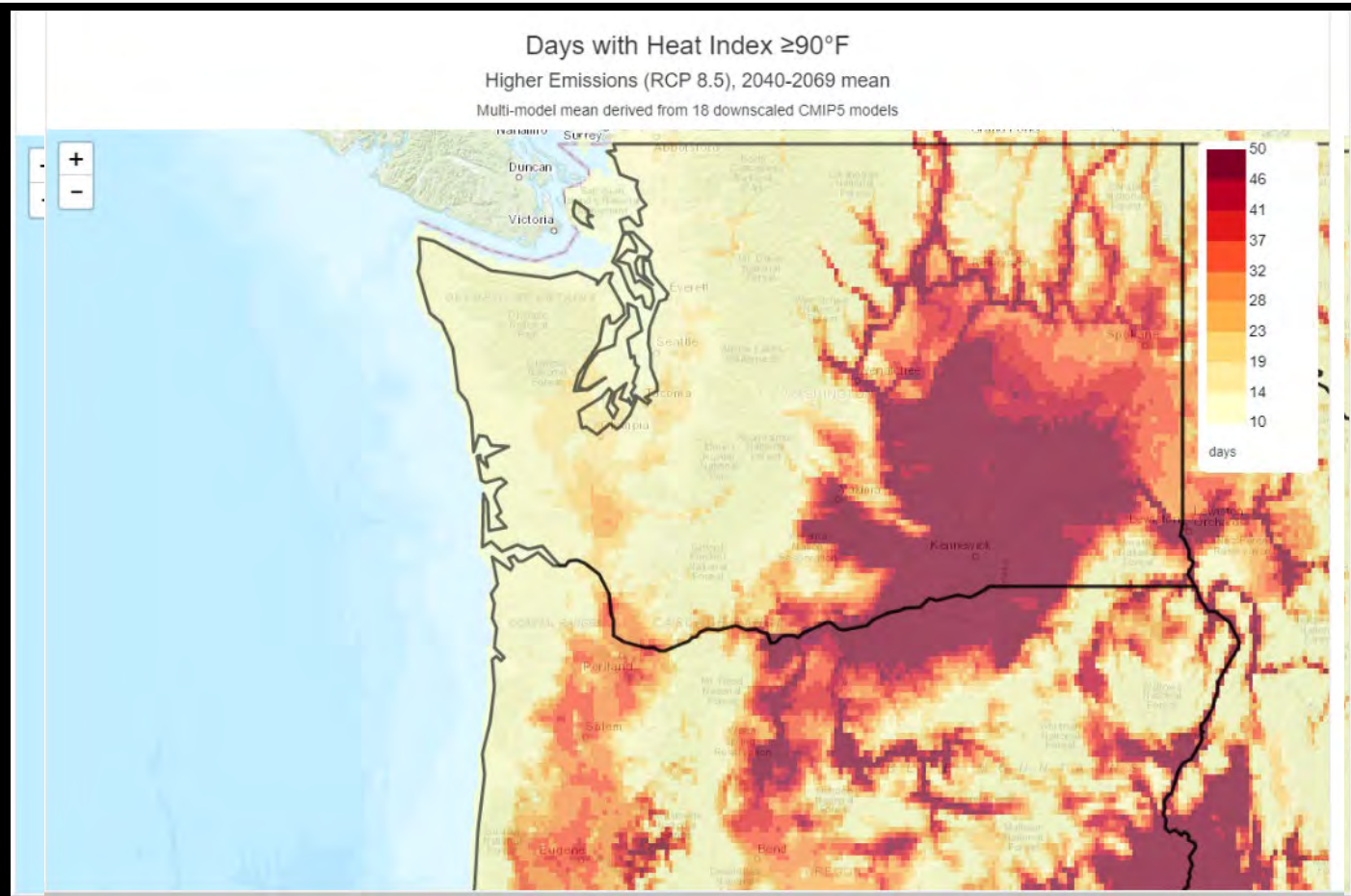


Sustaining Orchard Productivity



Changes in Sunburn Pressure in WA

90 °F = Fruit Surface Temps of ~112 °F





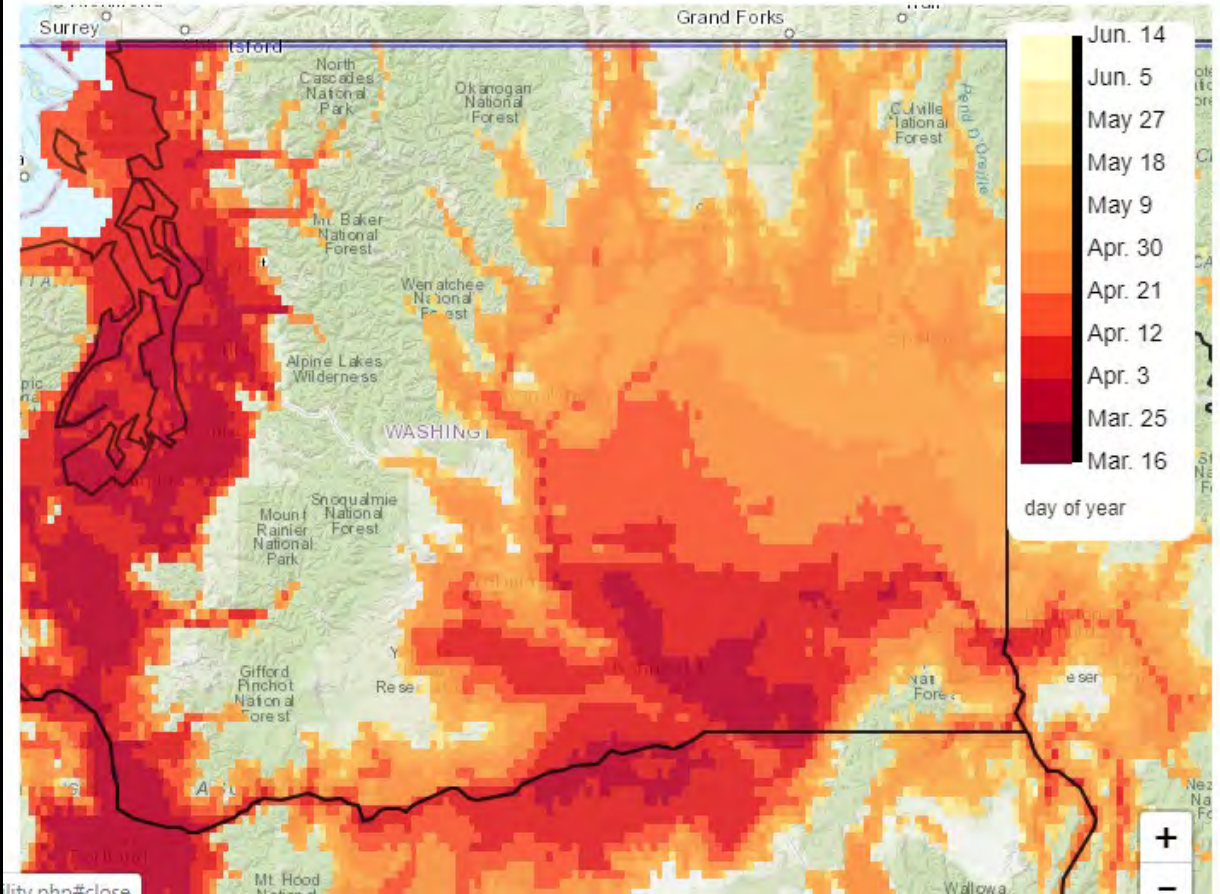
Sustaining Orchard Productivity



Shifting Phenology

2017-2089 Wenatchee = April 24 (Bloom)

Average Bloom Date for Apples (Gala)
2040-2069, Higher Emissions (RCP 8.5)

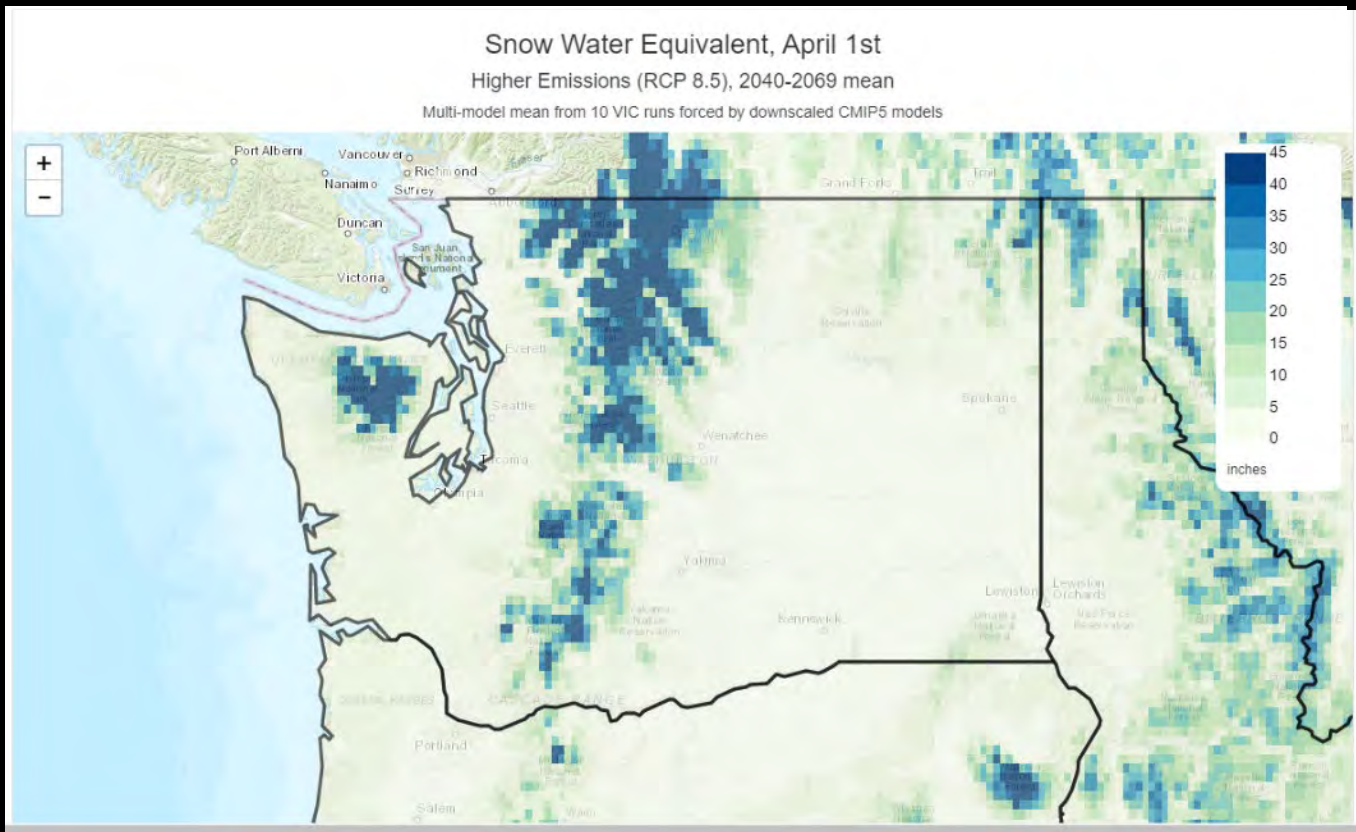




Sustaining Orchard Productivity



Washington Snow Pack





Sustaining Orchard Productivity



Solving Current Problems as well as Anticipating Future Needs





Decreasing Physiological Disorders in Tree Fruit



Team Members

2017



2018



2019



Local and Global Lab Members



Local and Global Collaborators





Decreasing Physiological Disorders in Tree Fruit



Netting to Reduce Sunburn

The New York Times

From Apples to Popcorn, Climate Change Is Altering the Foods America Grows

In every region, farmers and scientists are trying to adapt an array of crops to warmer temperatures, invasive pests, erratic weather and earlier growing seasons.



Apple growers in Washington are starting to install netting, like this system being tested at Washington State University, to prevent fruit from sunburn. TJ Mullinax/Good Fruit Grower

Hotter temperatures can subject both organic and conventionally grown apples to sunburn, which causes defects on the fruit's skin. Some growers have taken to installing large nets over orchards to reduce the intensity of the sunlight, but the process is expensive. Unlike many row crops, which can be replanted from year to year, orchards can take a decade or two to regrow, and farmers expect them to produce for at least a generation.

1,000 to more than 7,000 acres of protective netting in Washington State since 2015.

Estimated returns of about \$3,600/acre in additional revenue = about \$22 million/year

Viable for high-value cultivars and a water-savings tool and replacement for evaporative cooling



Dr. Giverson Mupambi

Assistant Professor –
Cranberry Physiology,
University of Massachusetts



Decreasing Physiological Disorders in Tree Fruit



GOOD FRUIT GROWER

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Our Magazine Advertising Topics Varieties en Español

High-res Honeycrisp

Cell structure scans offer new insight into why Honeycrisp is so prone to bitter pit.

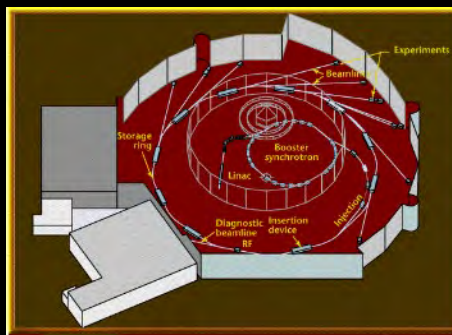
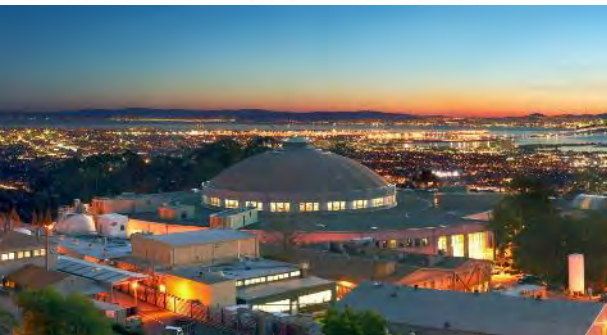
< Plan before you plant US Apple denounces as "harmful" and "inaccur..."

Kate Frengeman // Apr 10, 2018 // Apples // Diseases // New Developments // Production // Research // Varieties

f t in e



Imaging of an apple's structure reveals a network of veins, which transport calcium throughout the fruit. But a lack of veins near the calyx, as shown in this Honeycrisp, explains why bitter pit typically develops first in the calyx, said Washington State University physiologist Lee Kalcsits.



Bi Tan

Visiting Ph.D. Student

U. Of Tasmania

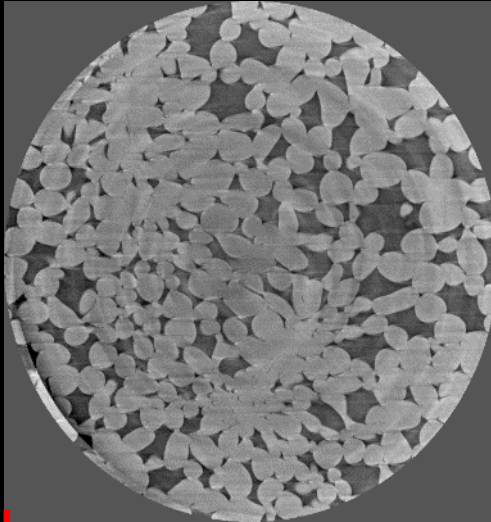


Fruit Structure and Vasculature

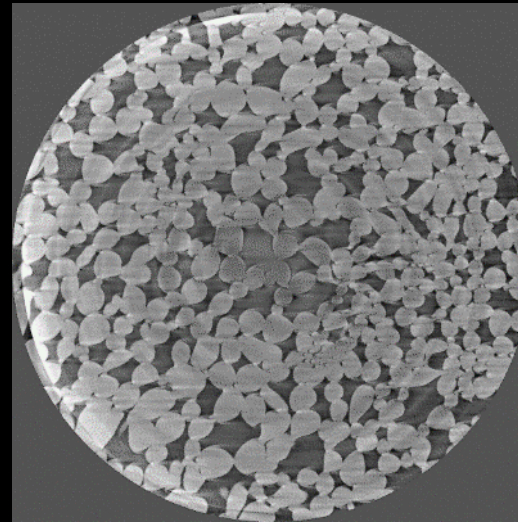


Internal bitter pit and cellular structure

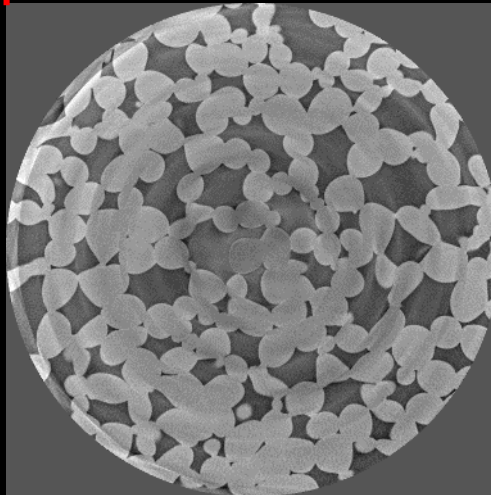
Fuji



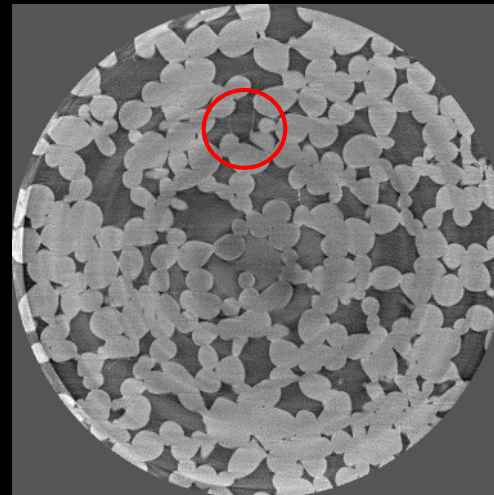
Pink Lady



0.04" (1 mm)



Honeycrisp
Healthy



Honeycrisp
Bitter Pit

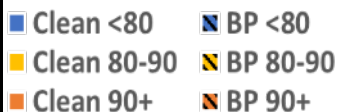
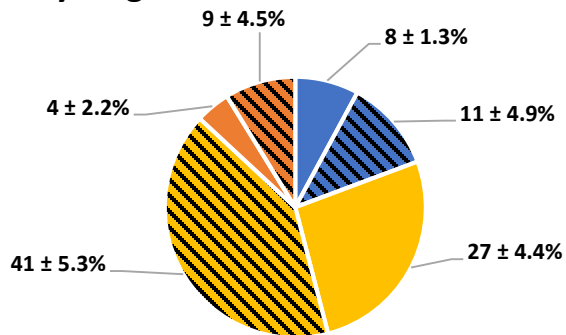


Decreasing Physiological Disorders in Tree Fruit

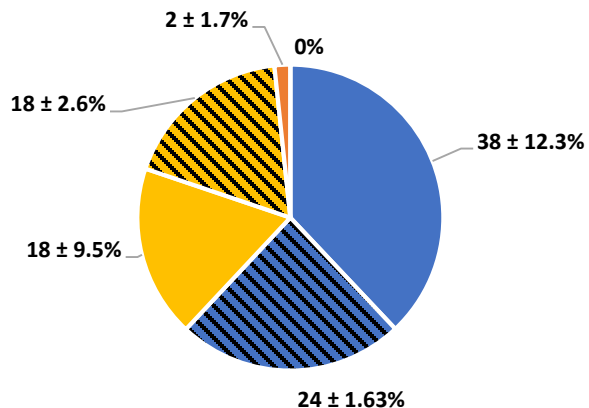


Irrigation Management to Improve Honeycrisp Fruit Quality

Fully Irrigated



Deficit Irrigation



Calcium sprays and crop load are current tools to reduce bitter pit

Irrigation has been tested as a tool over three years

5-15% decrease in bitter pit incidence

Potential \$30-\$60 million/year impact

Rapidly being adopted throughout the state

Growers try fighting vigor with water

Control over irrigation offers Washington growers more ways to manage vigor.

< How to get water right in the orchard

A Cosmic collective of ideas and insights >

Kate Prengaman // Apr 9, 2019 // Apples // Hort Show // New Developments // Production // Varieties



Growers and researchers increasingly recognize that a one-size-fits-all approach to irrigation is not the best fit for maximizing fruit quality and controlling vigor.

(T.J. Mullinax/Good Fruit Grower photo illustration)



Michelle Reid BS., MS.
Eastmont Alum
WVC Alum
WSU Alum



Decreasing Physiological Disorders in Tree Fruit



Summary

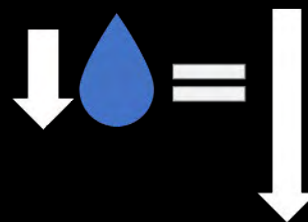
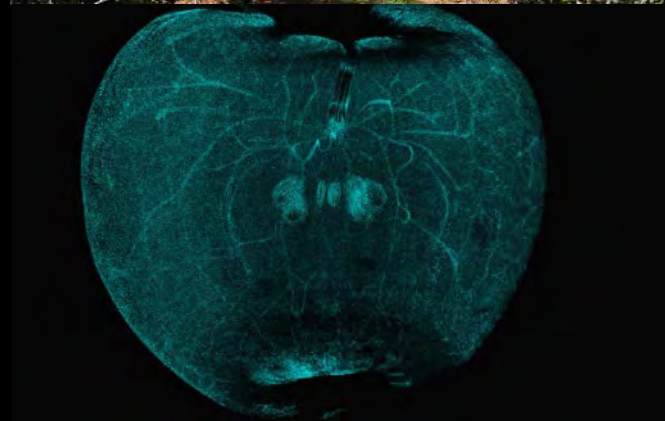
Global Collaborations and Global Trainees to Improve Fruit Production in WA

Protective cropping will continue to grow throughout WA

Improved fruit quality
Improved tree health
Water conservation

Better understanding of how fruit structure affects disorder development

Applied approaches to alter fruit structure and reduce losses to bitter pit
Irrigation and fertilizer management





Decreasing Physiological Disorders in Tree Fruit



Challenges and Opportunities

WSU TFREC is perfectly positioned to be a world leader in the research and training area of adaptation to- and mitigation of abiotic stress for tree fruit



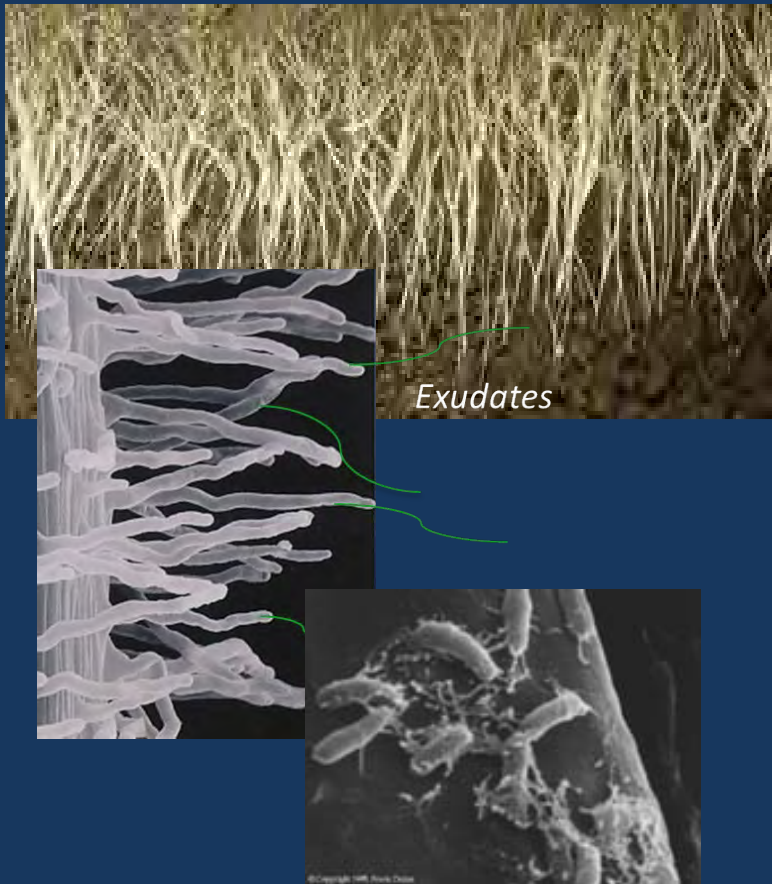
Underground Frontiers and the Soil Microbiome

Mark Mazzola

Research Plant Pathologist United States
Department of Agriculture – Agricultural
Research Service



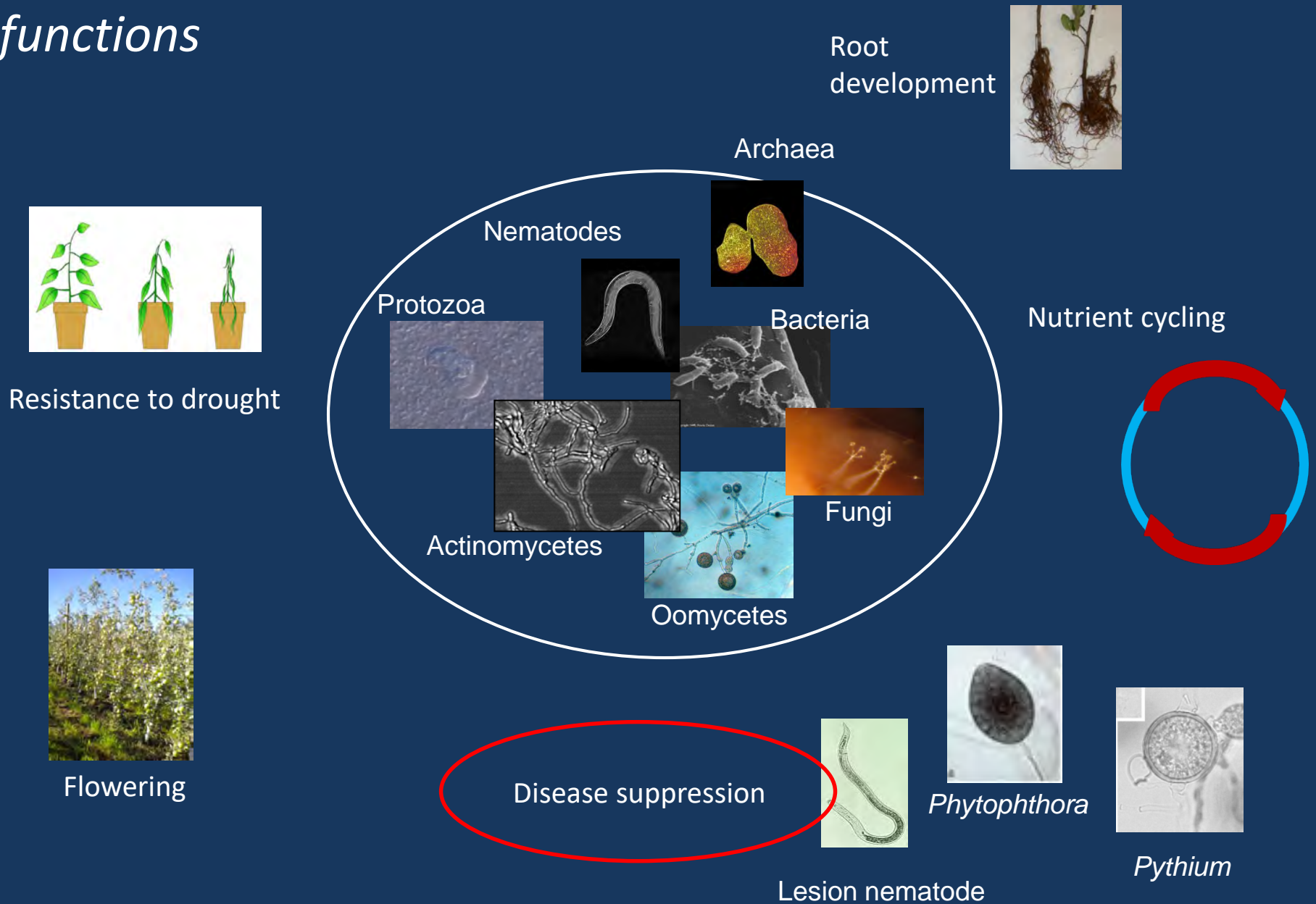
Underground Frontiers and the Soil Microbiome



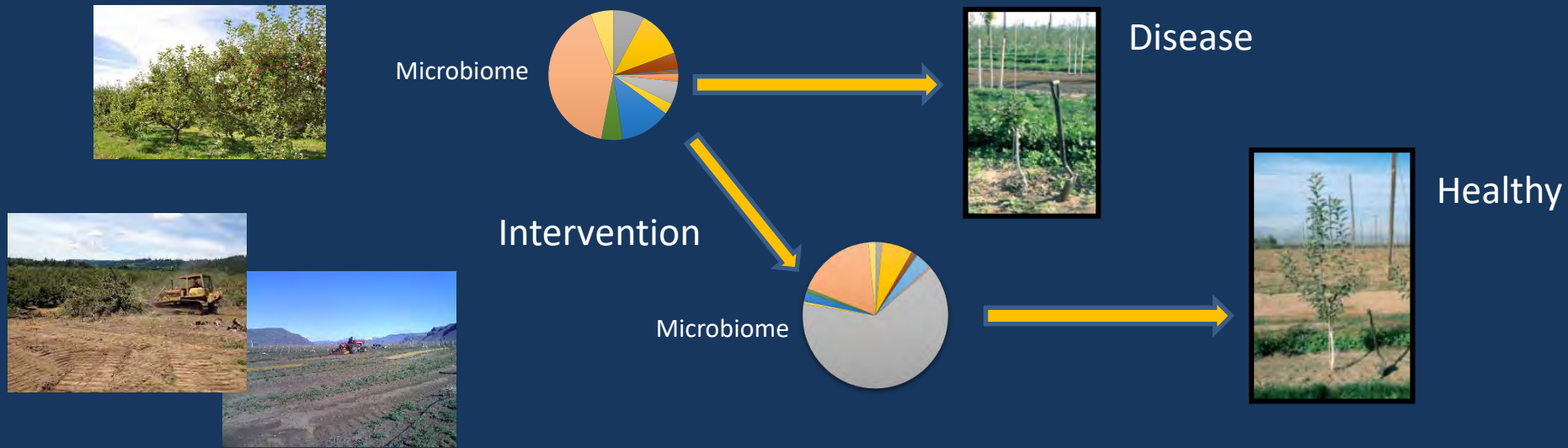
Mark Mazzola & Emmi Klarer
USDA-Agricultural Research Service
Wenatchee, Washington, USA



Soil/Rhizosphere microbiome functions



Program Goal: Engineer the native soil microbiome and metabolome to optimize plant health and productivity



1. Utilization of host genetics to recruit an “effective” microbiome
2. Soil amendment driven assembly of a functional microbiome

Requirements to engineer microbiome for soil-borne disease control:

- Who is there

High throughput sequencing

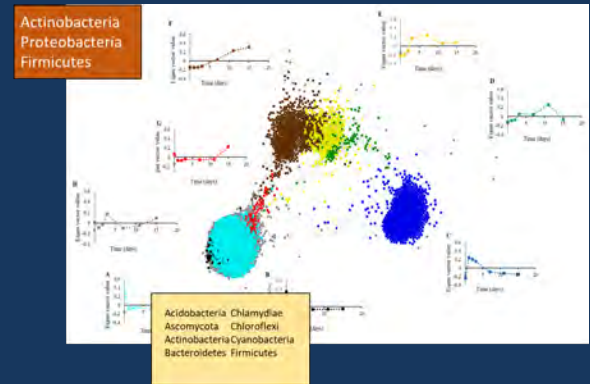
- What beneficial attributes (weapons) do they possess

Shotgun metagenomic sequencing

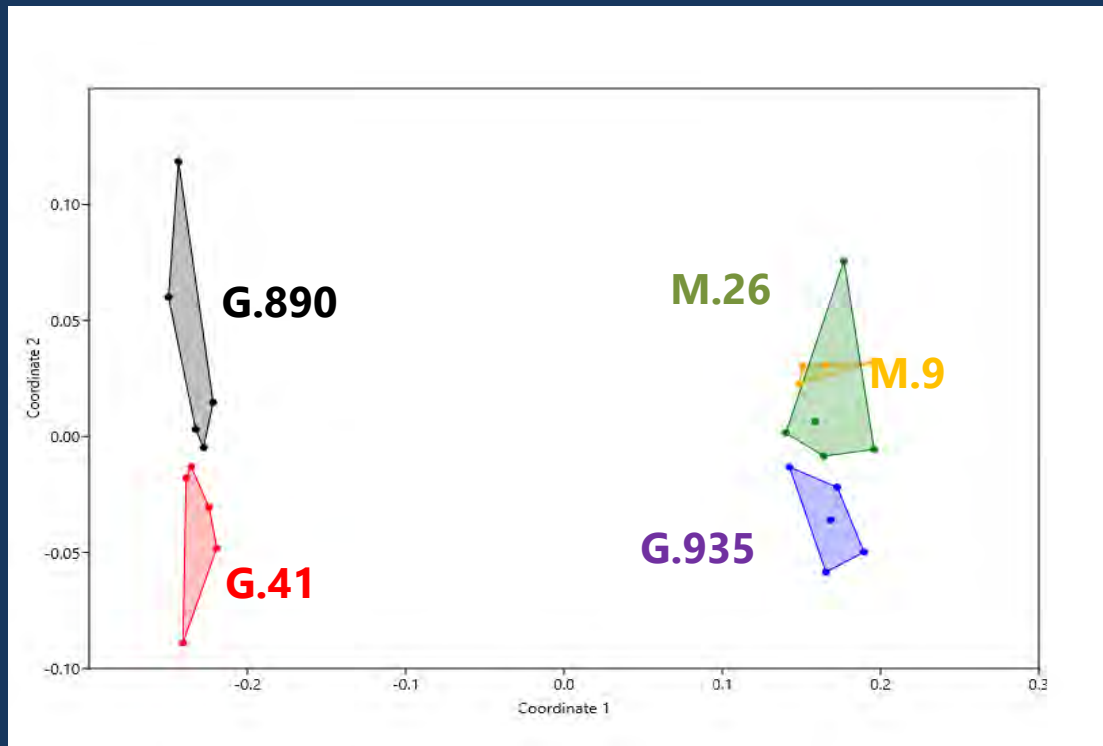
- How does altered microbiome regulate plant response

Comparative transcriptome analysis

- Develop tactic(s) can be used to selectively amplify the desirables



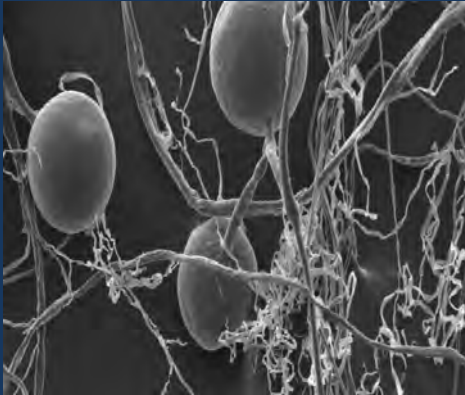
Plant-driven selection: Rootstock genotypes host distinct microbiomes



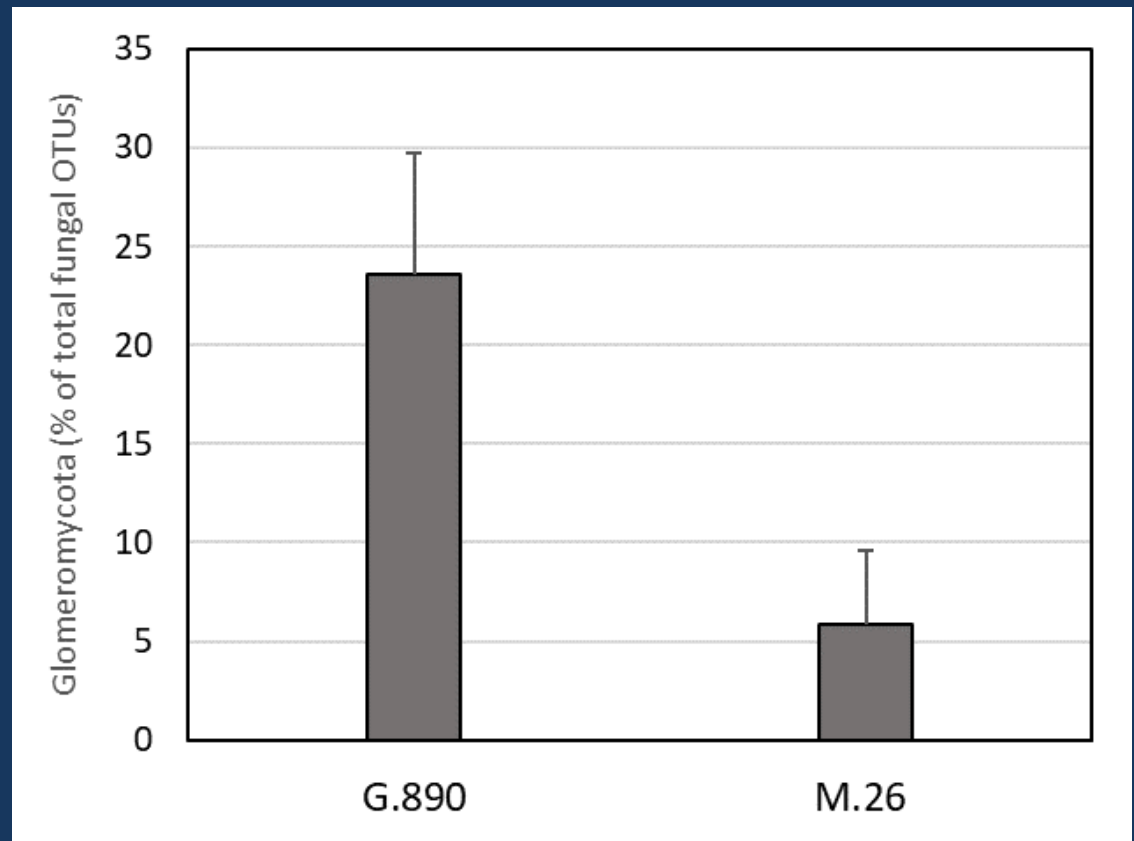
Relative similarity of microbiome composition as influenced by apple rootstock genotype

Plant-driven selection: Rootstock genotypes possess differential ability to support functional microbial consortia

Mycorrhizal fungi



Gardnerspantry.ca



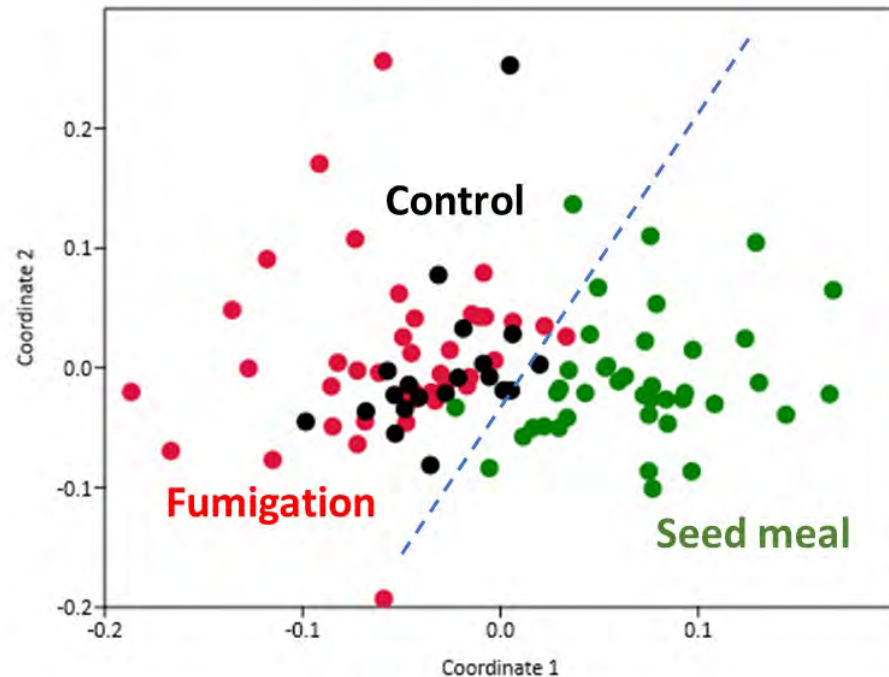
Soil amendment driven engineering of microbiome



Brassicaceae
seed meal



Similarity of Rhizosphere Microbiome:



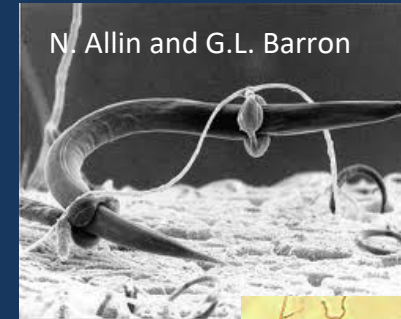
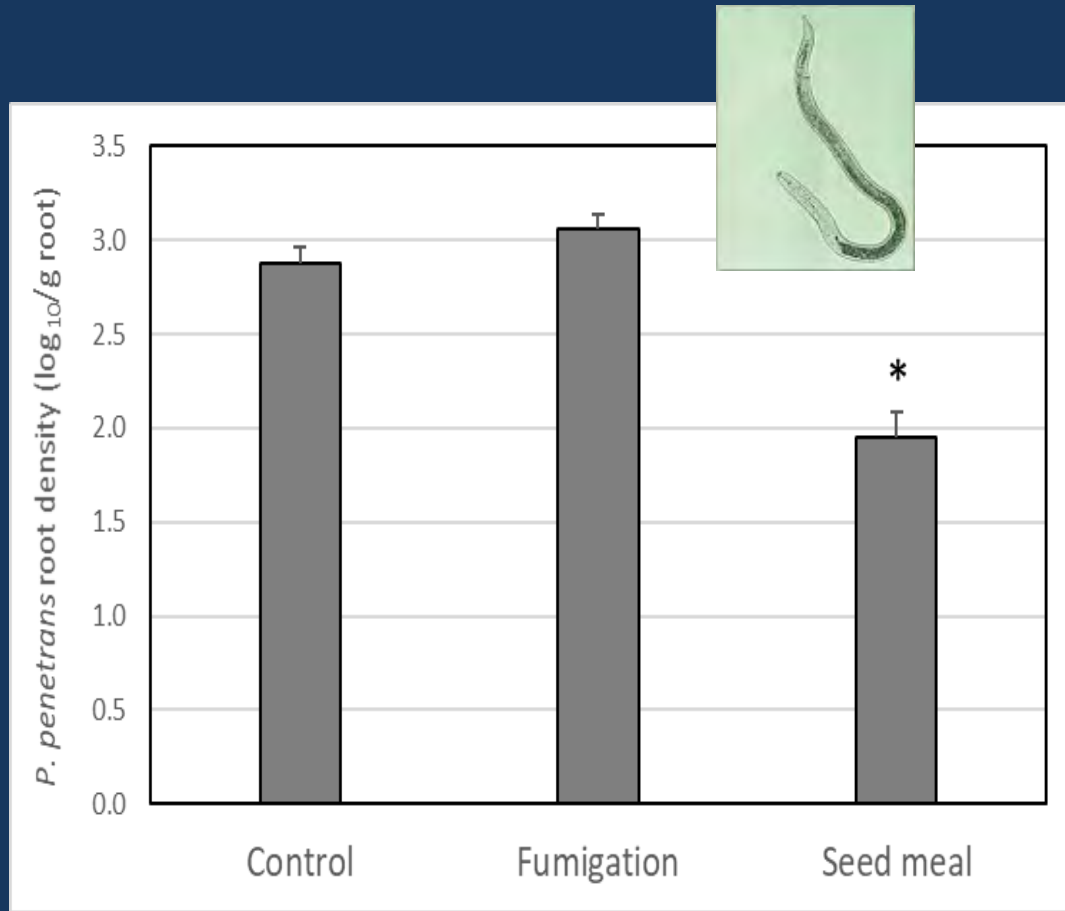
Pairwise comparison (ANOSIM):

Con vs Fum: $P = 0.4127$

SM vs Con: $P = 0.0001$

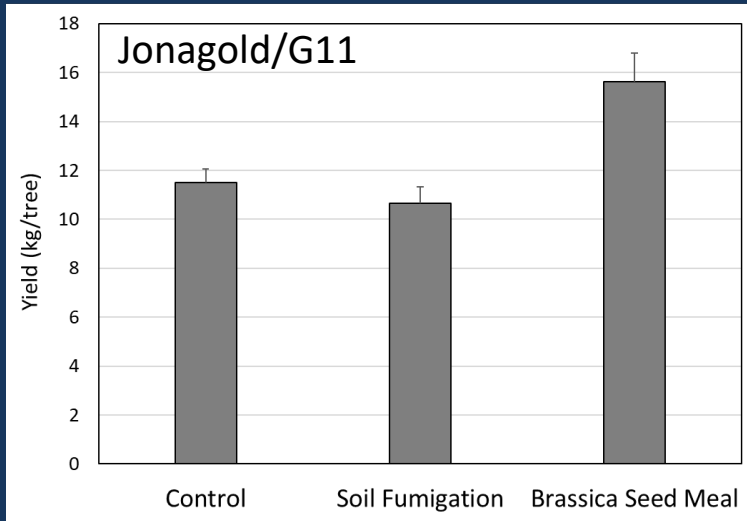
SM vs Fum: $P = 0.0001$

Brassica SM amendment provides prolonged suppression of multiple pathogens including root lesion nematode (*Pratylenchus penetrans*)

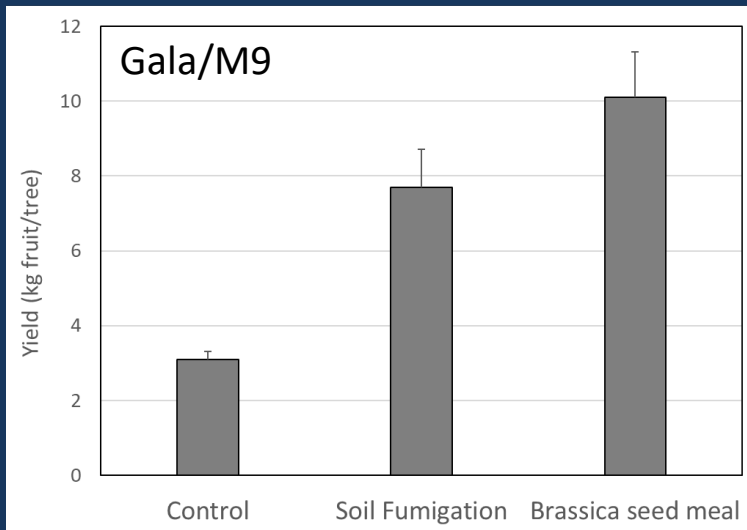


Long-term nematode control corresponded with amplification of specific microorganisms having nematicidal activity

Brassica SM amendment for soil-borne disease control:



Cumulative fruit yields



Ensuring Fruit Quality via Next Generation Biomarkers

Loren Honaas

Research Molecular Biologist United States Department of Agriculture – Agricultural Research Service



Ensuring Fruit Quality via Next Generation Biomarkers



Loren Honaas, PhD

Research Molecular Biologist, USDA-ARS

Physiology and Pathology of Tree Fruits Research Unit

Wenatchee, WA USA



Tree Fruit Research Lab



Postharvest Fruit Quality



The Postharvest Period



Apples and pears stored up to 1 year

The Postharvest Period



Apples and pears stored up to 1 year

← research chambers

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature
Controlled atmosphere

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature

Controlled atmosphere

Hormone blockers

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature

Controlled atmosphere

Hormone blockers

Antioxidants

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature

Controlled atmosphere

Hormone blockers

Antioxidants

Real-time monitoring

-chlorophyll fluorescence

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature

Controlled atmosphere

Hormone blockers

Antioxidants

Real-time monitoring

-chlorophyll fluorescence

-fruit respiration

The Postharvest Period



Apples and pears stored up to 1 year

Controlled temperature

Controlled atmosphere

Hormone blockers

Antioxidants

Real-time monitoring

-chlorophyll fluorescence

-fruit respiration

Wealth of horticulture work,
lots from ARS and WSU



Postharvest Physiological Disorders



Molecular Mechanisms of Postharvest Disorders

Plant Genomics

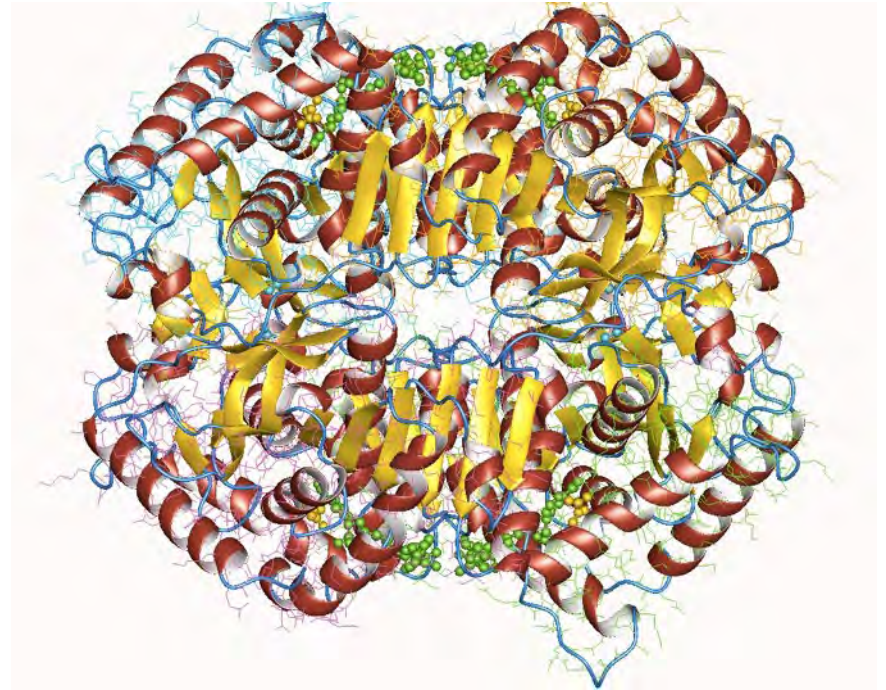


Daccord et al. 2017

Plant Genomics



Daccord et al. 2017



Plant Genomics



Daccord et al. 2017

Plant Genomics



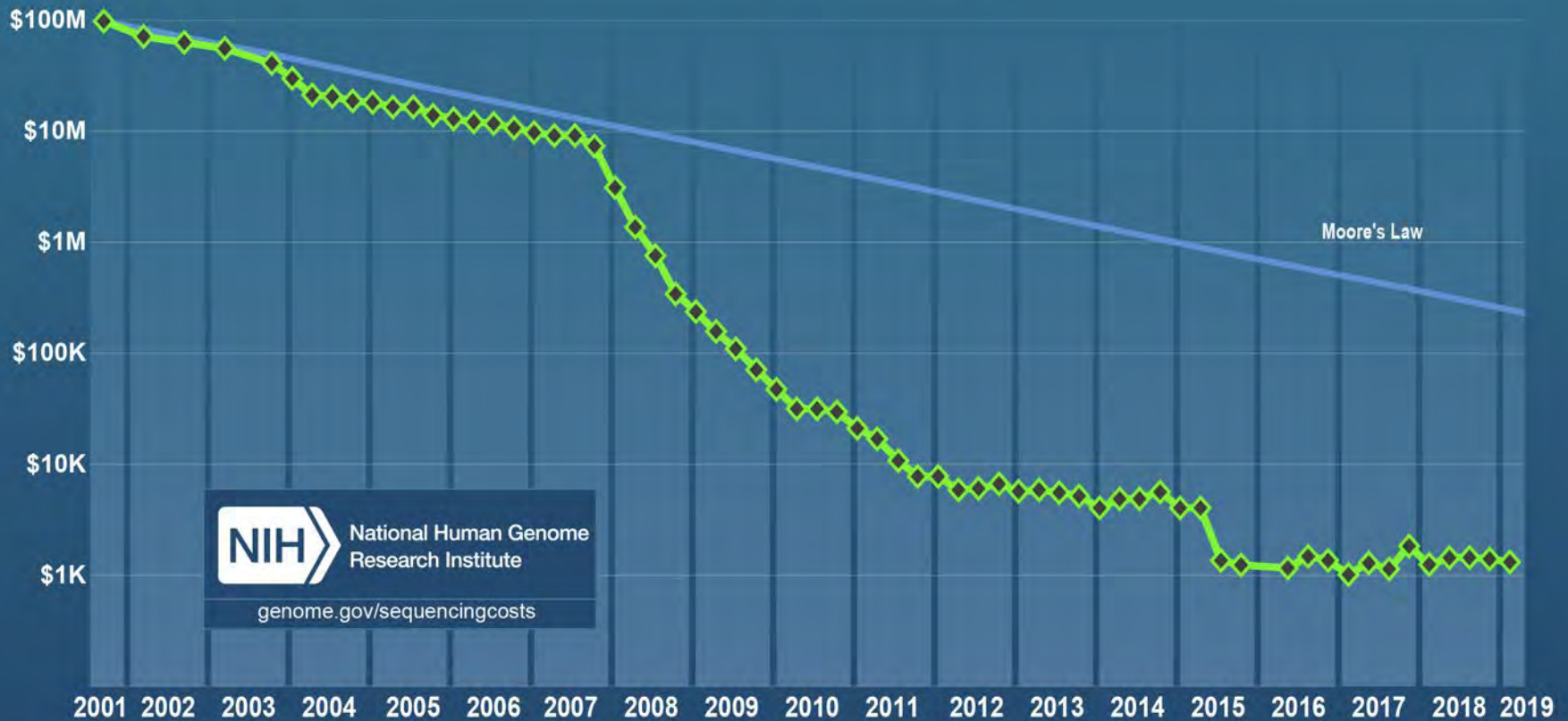
Daccord et al. 2017



Stemilt.com

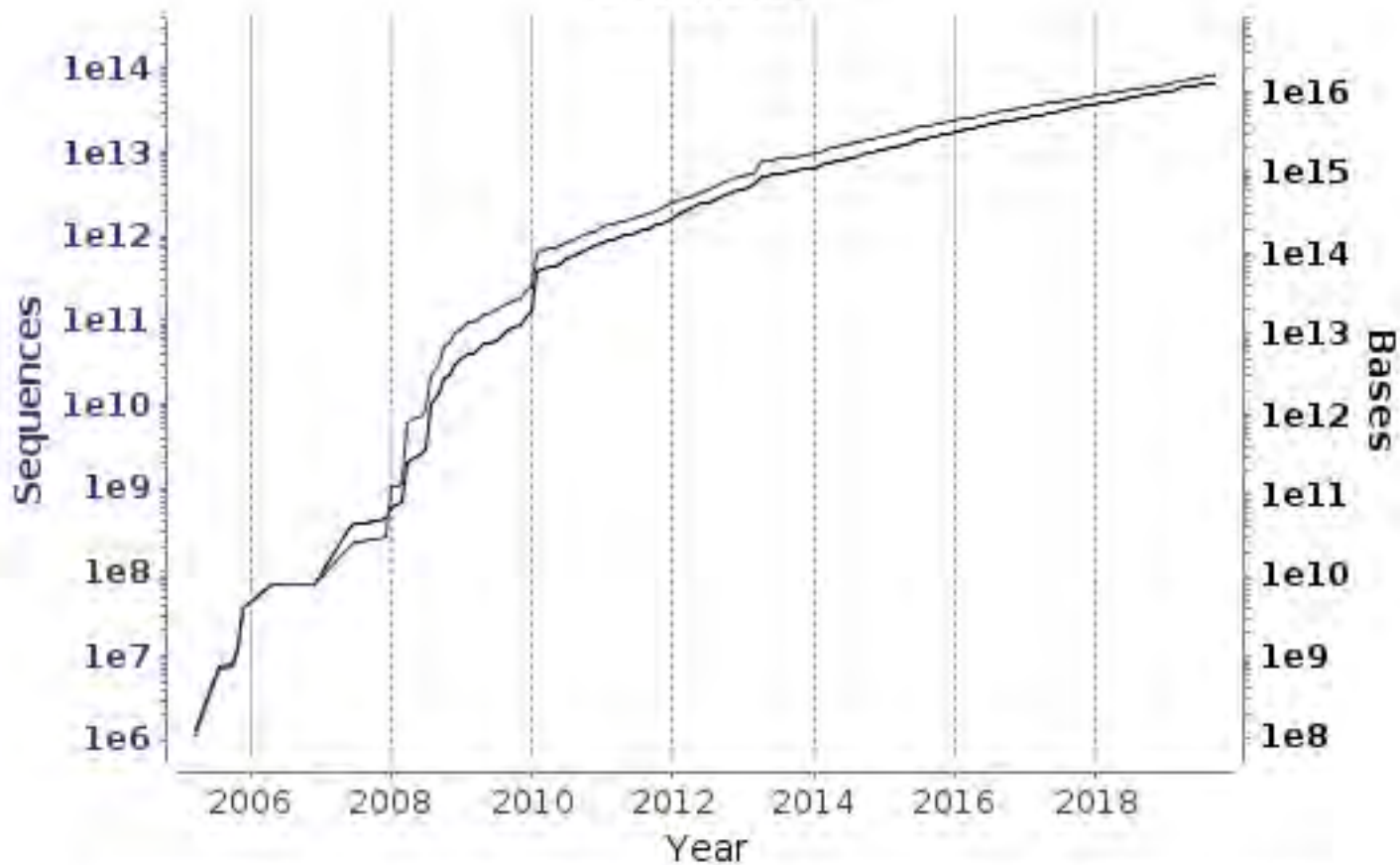
Complex Genomes

Cost per Genome



Reads growth

23-Sep-2019



— Sequences (80.7 trillions) — Bases (12,880.5 trillions)

illumina®



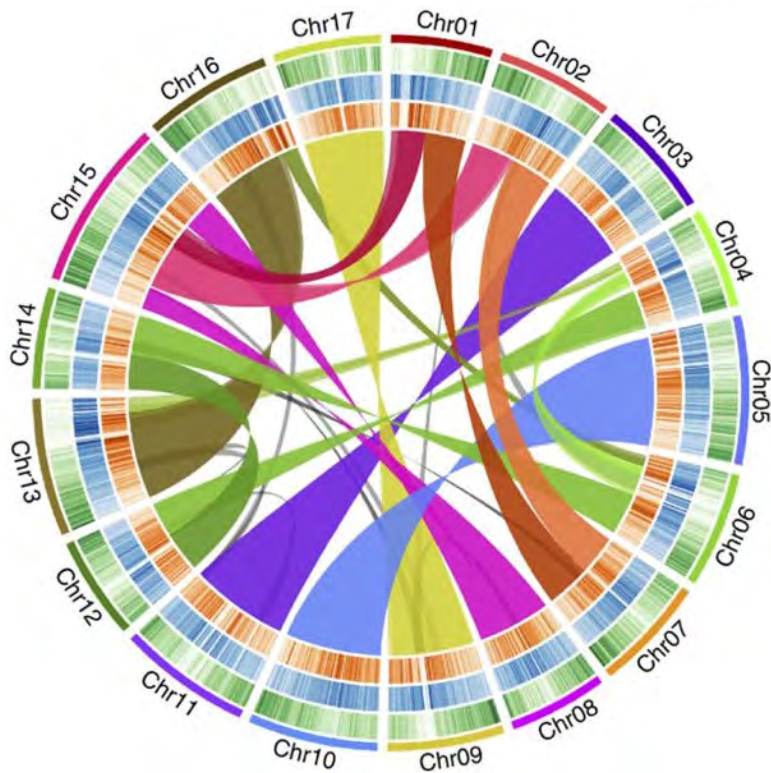
3,000 apple
genomes in 1 run



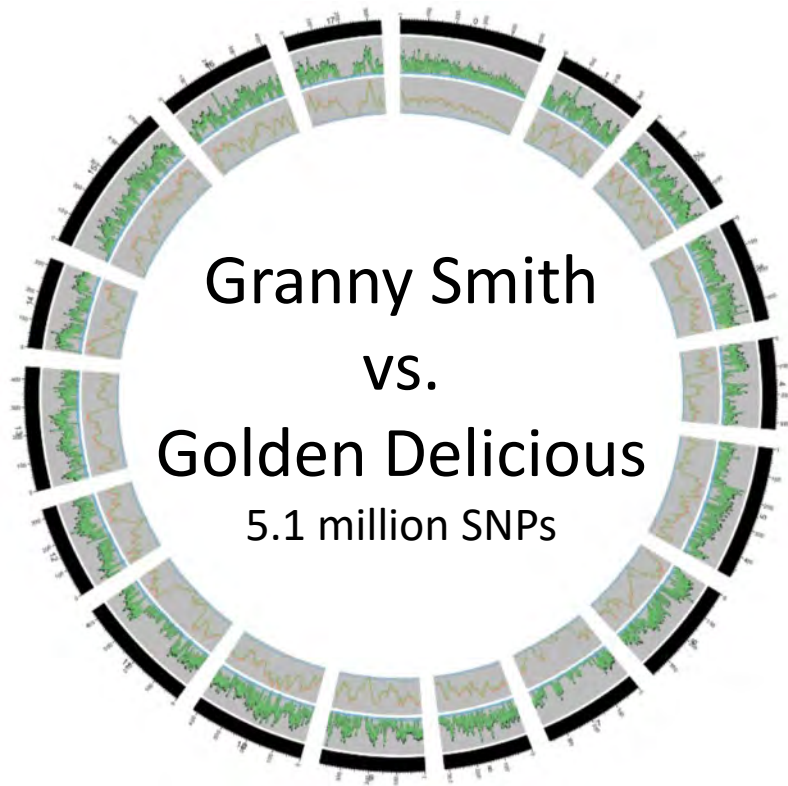
We need a picture for each puzzle



We need genomes for each cultivar



Daccord et al. (2017)



Research Team and Collaborators



Heidi Hargarten, Dave Rudell, Jim Mattheis



Dr. Stephen Ficklin, John Hadish, Tyler Biggs,
Dr. Stefano Mussachi, Dr. Sara Serra, Dr. Lee Kalcsits,
Dr. Carolina Torres, Tianna Dupont



Dr. Claude dePamphilis, Eric Wafula



Dr. Joshua Der, Mathew C. Simenc,
Brittany Cook



Funding

Sample Control

Sample TE-1

Sample DT-1

4 Months



Sample Control

Sample TE-1

Sample DT-1

4 Months



5 Months

Sample Control

Sample TE-1

Sample DT-1

4 Months



5 Months



6 Months



Sample Control

Sample TE-1

Sample DT-1

4 Months



5 Months

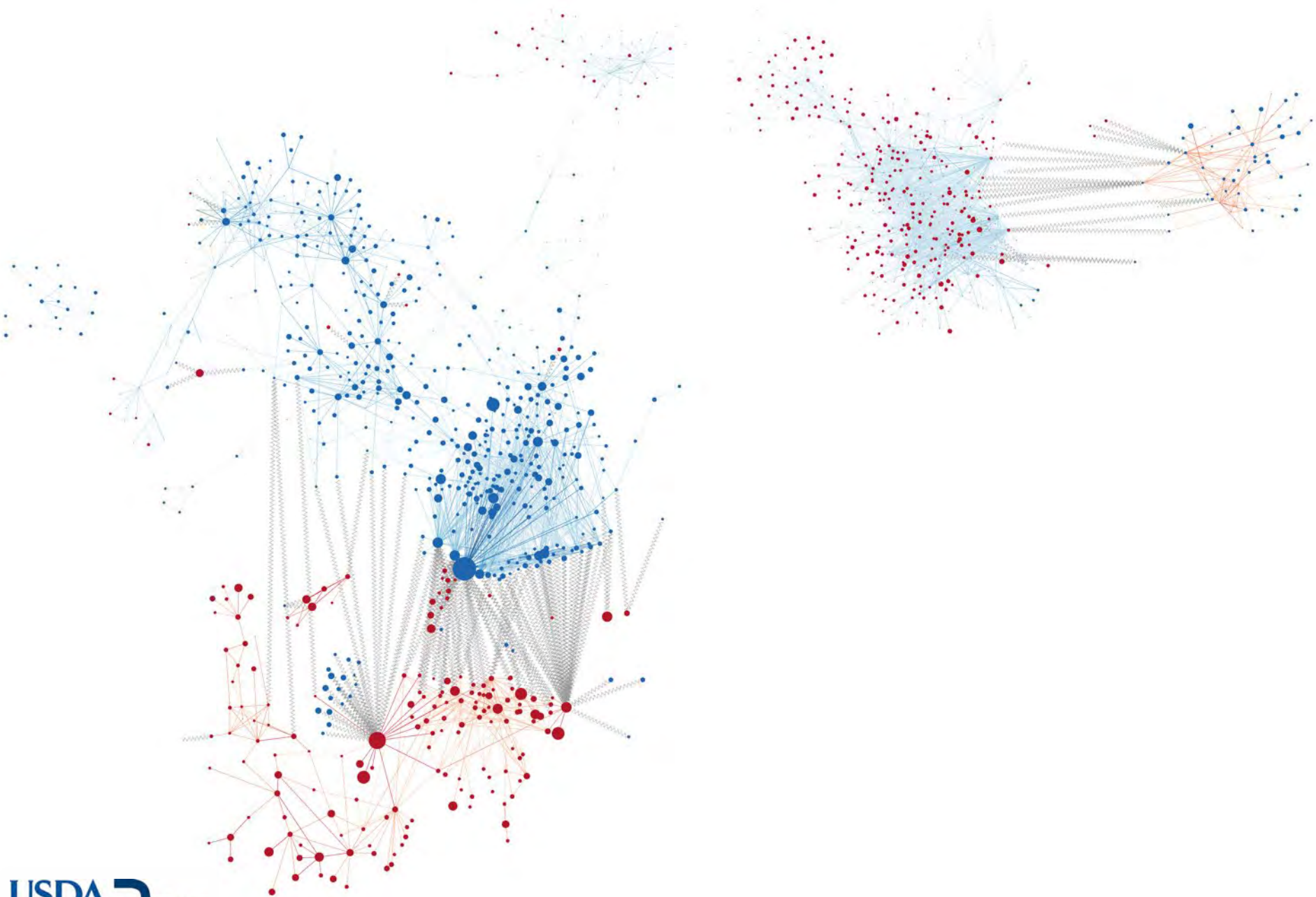


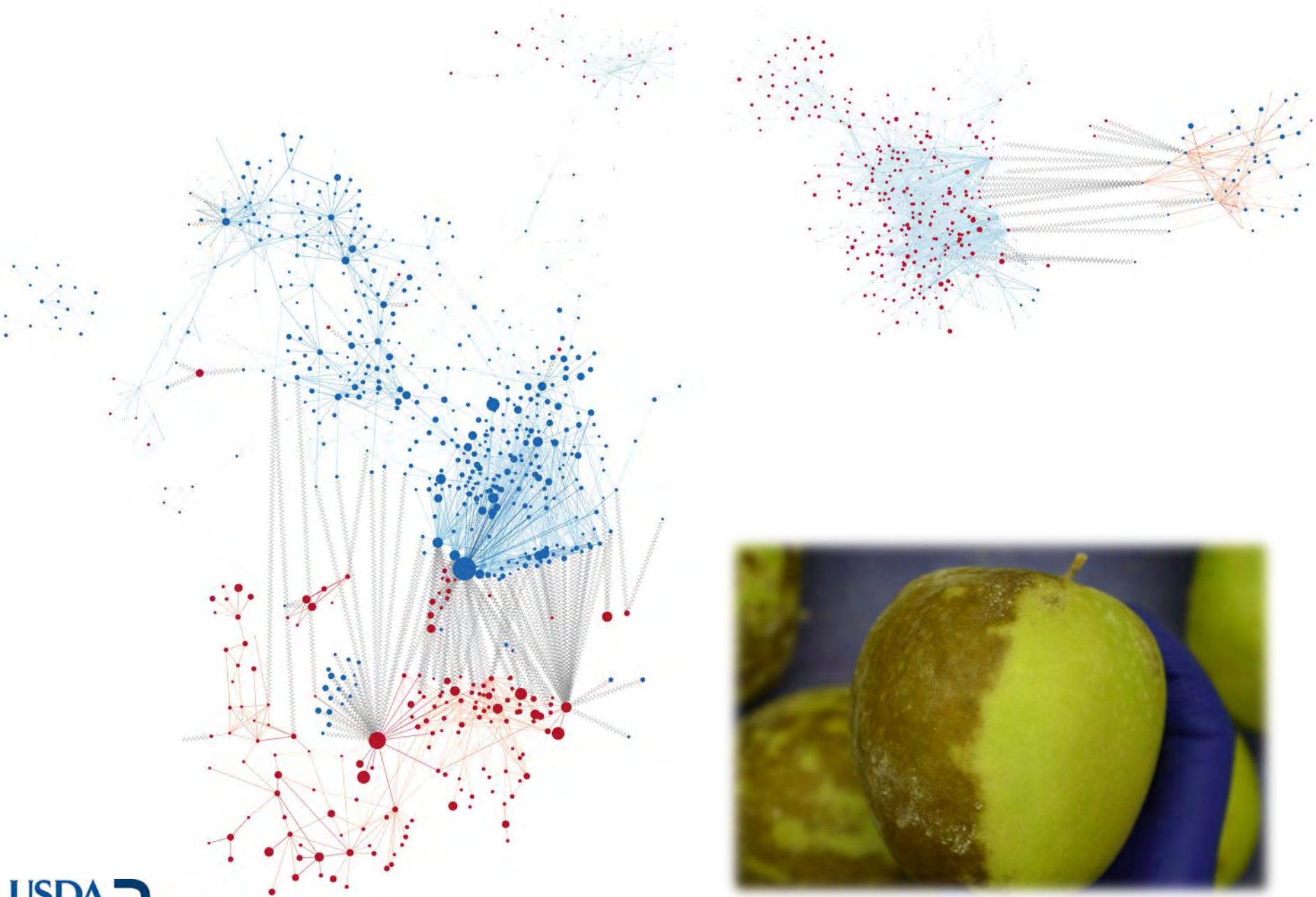
6 Months



6 Months +
7d







Honaas Lab



Elena Kahn (UW grad, Fred Hutch Cancer Institute Technician)

Rebecca Schmidt (UW grad, applying to Grad school)

Aria Tornabene (UW undergrad)

Emilie Carrol (Army medic in Bangladesh)

Bruno Diaz (UW engineering freshman)

Sophia Reed (Wenatchee HS grad, Pre-med Immersion - Italy)

Brittany Cook (CalState undergrad)

Matthew Simenc (CalState MS)

Shashika Hewavitharana (Cal Poly Asst. Prof, Dr. Mazzola)

Likun Wang (IGDB CAS, Dr. Mazzola)

John Hadish (WSU grad student)

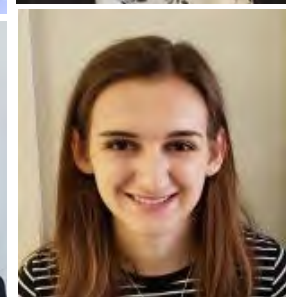
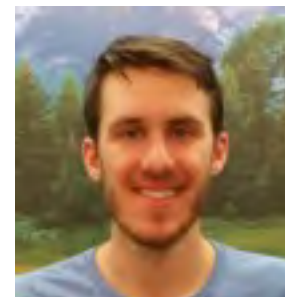
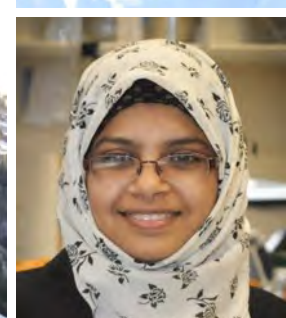
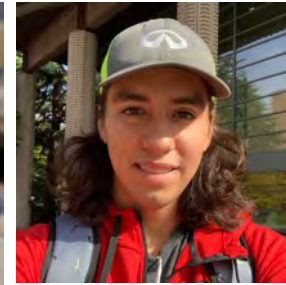
Eric Wafula (PSU grad student)

Sumyya Waliullah (PostDoc w/ Dr. Kalcsits)

Jessica Waite (PostDoc w/ Dr. Kalcsits)

Tyler Biggs (WSU postdoc)

Lindsay Hildorfer (Wenatchee School District Teacher)



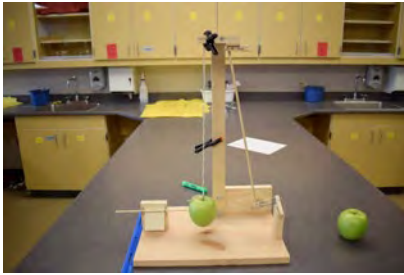
Honaas Lab STEM outreach



Stake Holders

>500 students

>30 volunteers from 4 local STEM organizations





Tree Fruit Research Lab



Breeding Apples for Washington State

Kate Evans

Professor: Pome Fruit Breeding
Washington State University Tree Fruit
Research and Extension Center



A photograph of a strawberry field. The plants are growing in rows, with green leaves and several ripe, red strawberries. The background is slightly blurred, showing more of the field. A black text box is overlaid on the top half of the image.

Anaerobic Soil Disinfestation

for Control of Soil-borne Diseases in Strawberry

Anaerobic Soil Disinfestation (ASD) Process

1



2

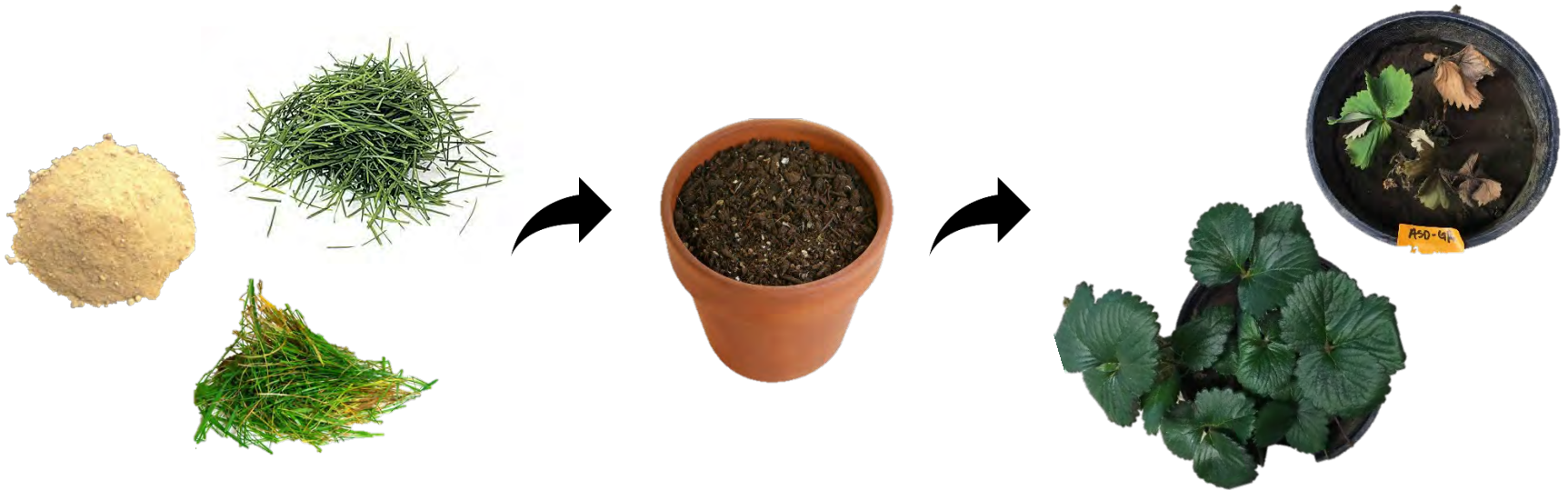


3



ASD for Control of Soil-borne Diseases

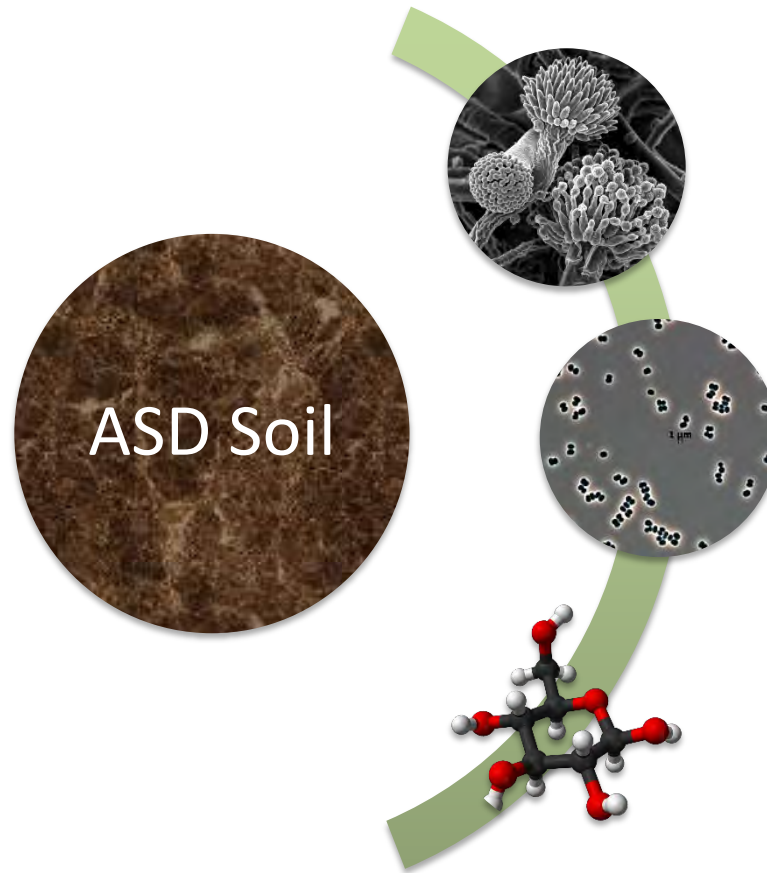
- Efficacy is highly dependent on carbon source used and target pathogen
- Goal: evaluate different carbon amendments with ASD for control of Fusarium wilt in strawberry



Mechanisms of Disease Suppression

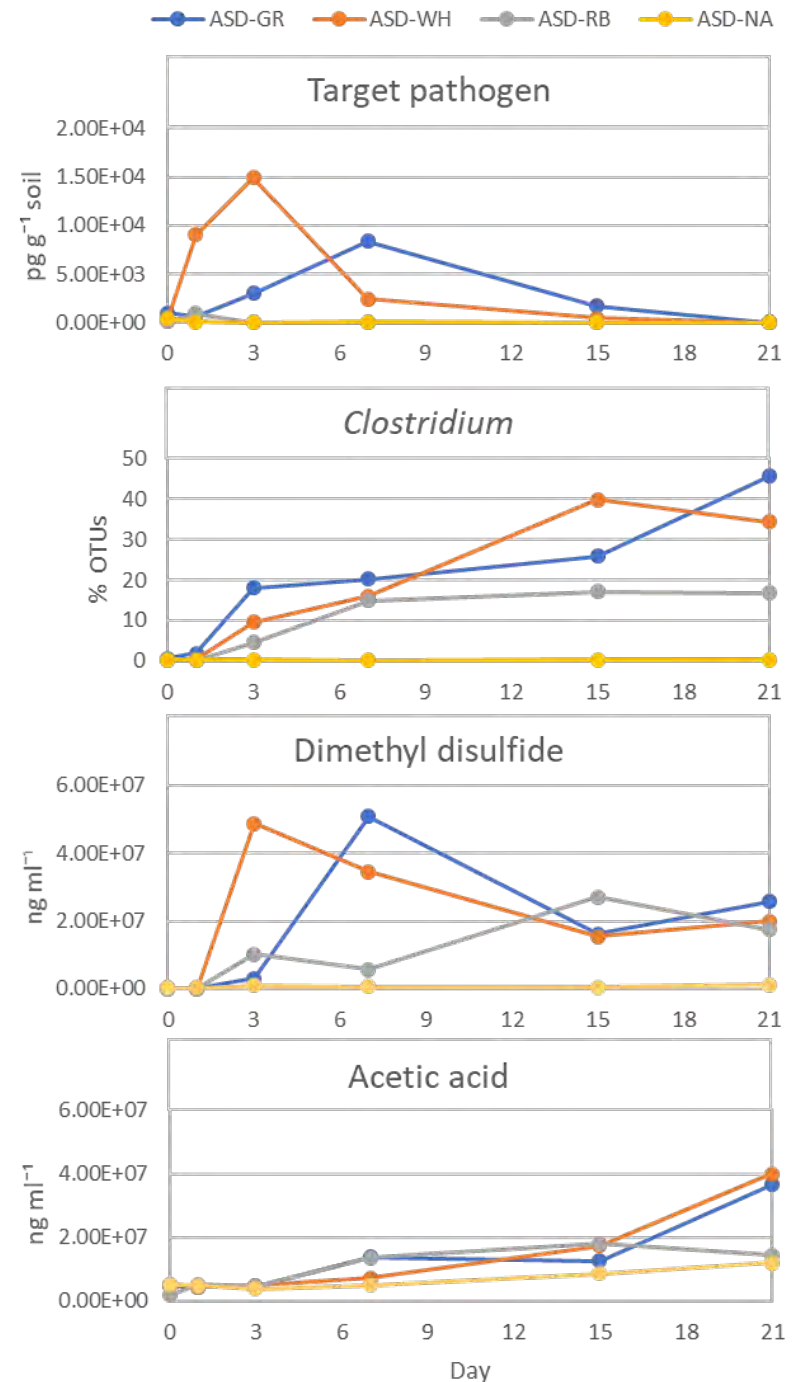
Goals:

- Characterize the chemical and biological components of soil during ASD treatment
- Identify key groups of organisms and/or compounds involved in disease suppression



Results and Future Research

- Resulting differences in soil microbial communities were carbon source dependent
- Corresponding dynamics of indigenous anaerobic bacteria and select metabolites
- Functional role of specific organisms and compounds requires further evaluation



Breeding apples for Washington State

Kate Evans



Team:

Bruce Barritt

Soon Li Teh

Bonnie Schonberg

Lisa Brutcher

Nancy Buchanan

Ines Hanrahan

Sarah Kostick

Zara York

Manoella Mendoza



Apple breeding aim:

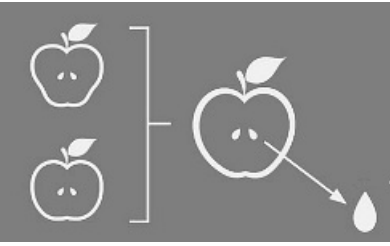
to produce a portfolio of new improved unique varieties, especially selected for the environment of central Washington and available to Washington's growers





WA 38 Cosmic Crisp[®]

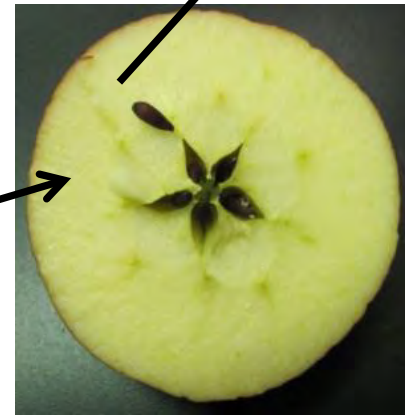
- Enterprise × Honeycrisp (1997)
- Very crisp, juicy and sweet/tart
- Exceptional storage potential



1997: Pollination



Conventional breeding





1997: Pollination



1998-2000: Germination & budding on M.9 rootstock



2001-4: Phase 1
Seedling evaluation





1997: Pollination



1998-2000: Germination & budding on M.9 rootstock



2001-4: Phase 1
Seedling evaluation

2006-9: Phase 2
Advanced selection
Data collection





1997: Pollination



1998-2000: Germination & budding on M.9 rootstock

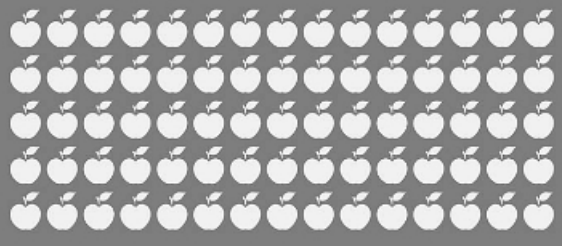


2001-4: Phase 1
Seedling evaluation

2006-9: Phase 2
Advanced selection
Data collection

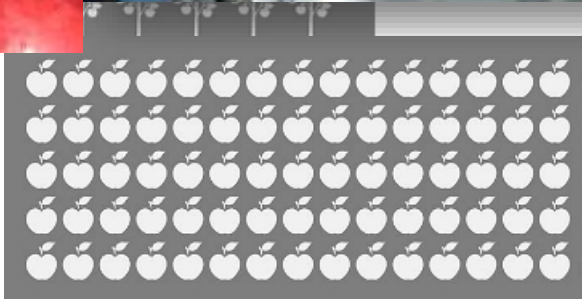


2008-2013: Phase 3
Elite selection.
Large volume
evaluation &
consumer tests



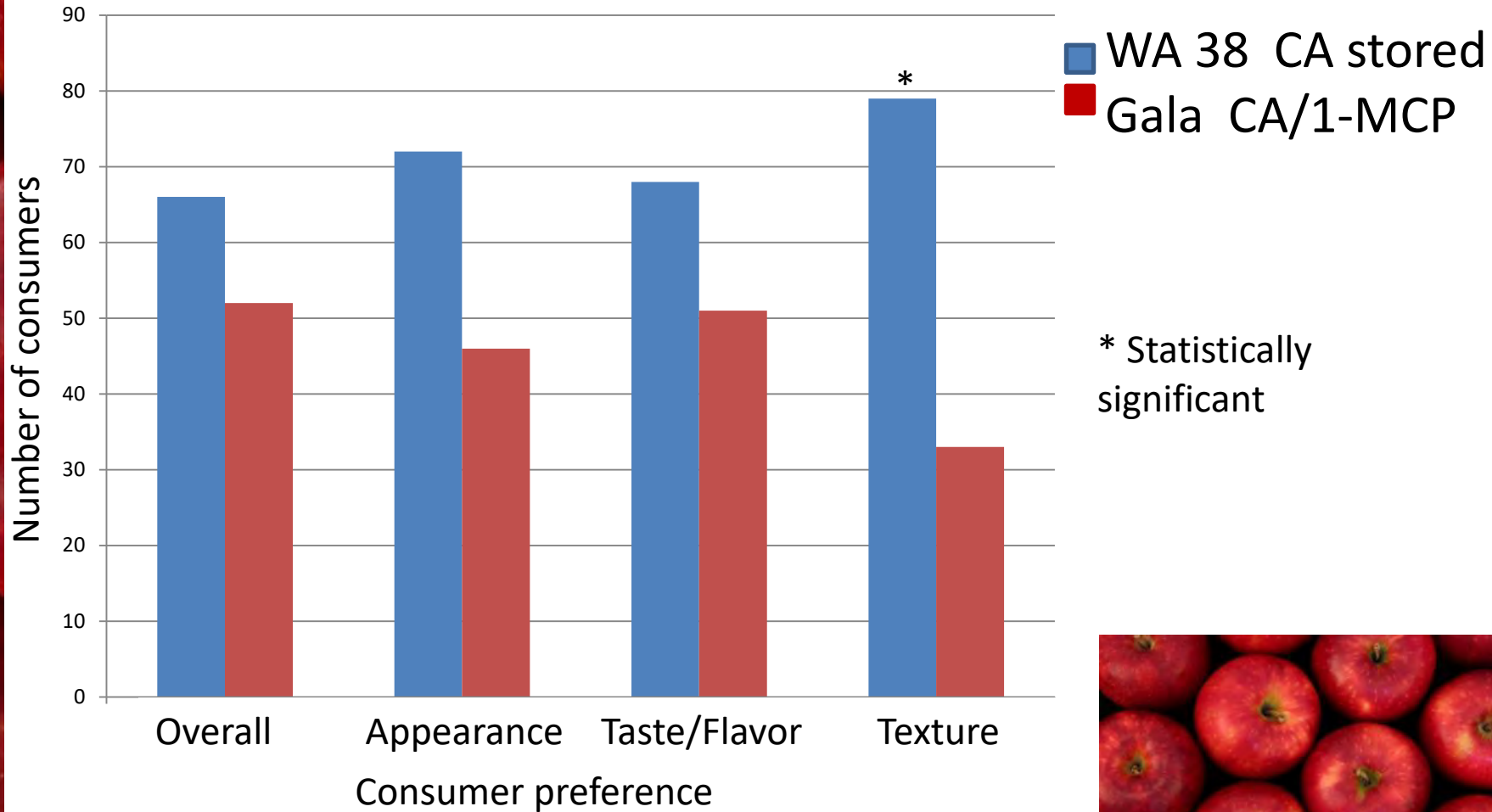


2008-2013: Phase 3
Elite selection.
Large volume
evaluation &
consumer tests



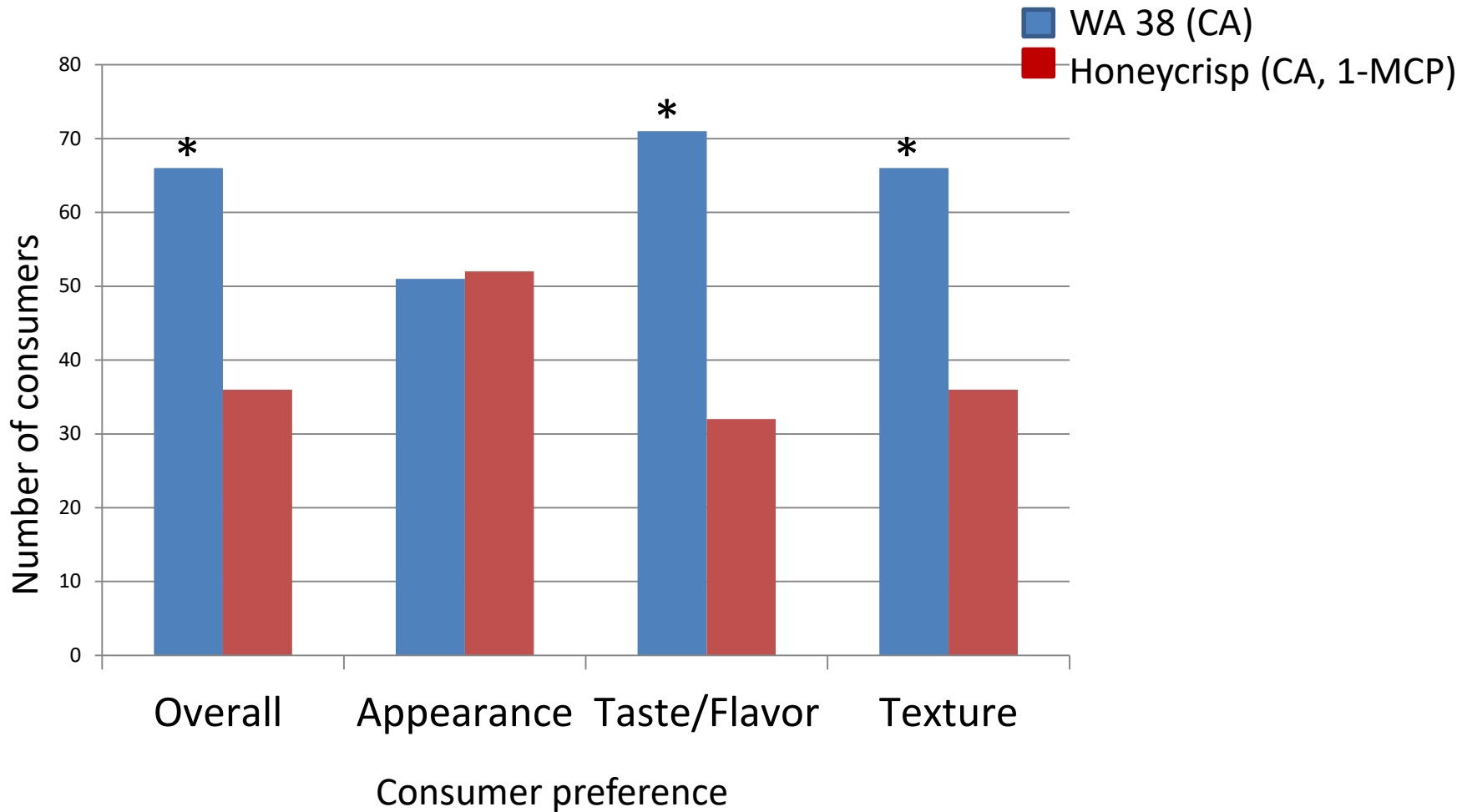
WA 38 vs Gala

– Consumer testing March 2012



WA 38 vs Honeycrisp

- Consumer testing March 2014



* Statistically significant



1997: Pollination



1998-2000: Germination & budding on M.9 rootstock

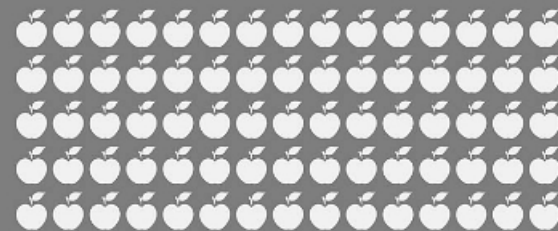


2001-4: Phase 1
Seedling evaluation



2006-9: Phase 2
Data collection

2008-2013: Phase 3
Evaluation & consumer tests



2013: Release



Release progress

- Washington-only apple (in US) for 10 years
- ~600,000 trees planted spring 2017
- ~ 6M trees planted 2018
- ~ 5M trees planted 2019
- First fruit sales Dec 1, 2019



Brand Development

PVM, Yakima



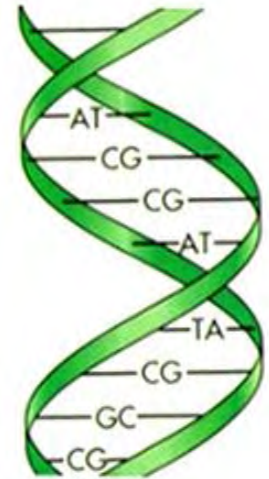
What's next?

- more new varieties!



What's next?

- Continued development and application of breeding science

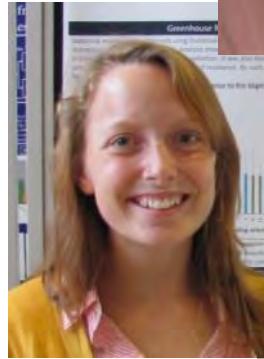
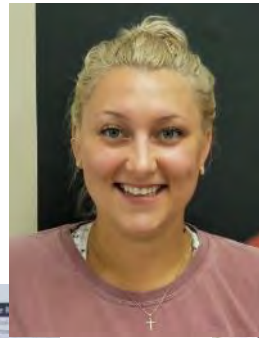


	1	2	3	4	5	6	7	8	9	10	11	12
A	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
B	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
C	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
D	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
E	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
F	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
G	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
H	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022
I	110-000	110-002	110-023	110-024	110-027	110-030	110-007	110-008	110-000	110-011	110-041	110-022



What's next?

- more new scientists and plant breeders into the workforce!



What's next?

- more STEM!



Synopsis

Sue Kane

Director of STEM Initiatives and Strategic Partnerships North Central Educational Service District





Welcome to

THE GREATER
Wenatchee
AREA

*Apple Capital
of the World*



Science In Our Valley

SCIENCE IN OUR VALLEY SEMINAR SERIES

DR. VINCENT P. JONES

PROFESSOR & ENTOMOLOGIST
DIRECTOR OF WSU-DECISION AID
SYSTEM, WASHINGTON STATE
UNIVERSITY



Using Decision Science tools to understand the past, improve the present, and anticipate the future of tree fruit IPM

Decision support tools developed at WSU allow us to evaluate historic pest management programs and develop and provide users with new programs that minimize costs, provide the best crop protection, and reduce unintended environmental conditions. The same tool set also allows us to evaluate how climate change will affect crop production, pollination, and pest management in the future.

OCTOBER 2, 2019 | 4:00PM - 5:00PM

CONFLUENCE TECHNOLOGY CENTER
285 Technology Center Way, Wenatchee WA 98801





September 25, 2019

Innovator Awards Luncheon

Celebrating and recognizing the innovators in technology, entrepreneurship, and STEM education in North Central Washington.

JP

19TH ANNUAL INNOVATOR AWARDS

**FUTURE TECHNOLOGY
LEADERS OF THE YEAR:
GALACTIC FARMERS**



Galactic Farmers

Galactic Farmers

Almira-Coulee-Hartline Middle School

Shauna Schmerer, Superintendent

Susan Douglas, Teacher

Max Horrell, *2019 Future Innovator Award Winner*

Christine Keeley, *2019 Future Innovator Award Winner*

Beth Okamoto, *2019 Future Innovator Award Winner*

Kady Murray, *2019 Future Innovator Award Winner*

Kayleigh Elder, *2019 Future Innovator Award Winner*

Nathan Hinkle, *2019 Future Innovator Award Winner*



INSPIRE - ENGAGE - CONNECT

www.applestemnetwork.org



Postsecondary/Computer Science

Sue Kane

Director of STEM Initiatives and Strategic
Partnerships North Central Educational
Service District



“Technology, especially the current state of technology, is inherently the result of human capital and abstract reasoning abilities. As such, educational attainment and the ability to be entrepreneurial are key to technological development and industry growth.”

— Wenatchee Valley Technology and Innovation Development Analysis Report

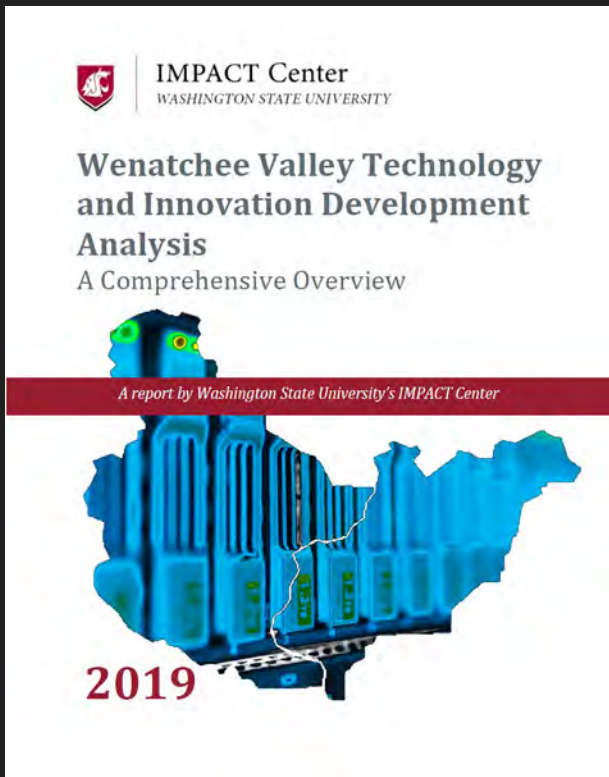
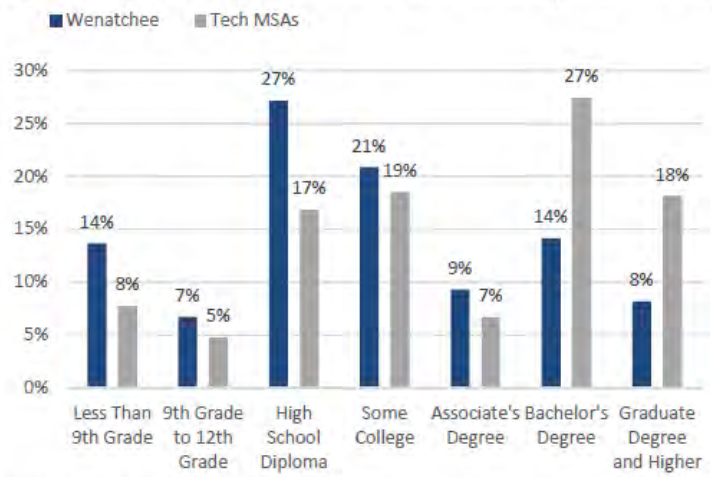


Figure 1.3: Educational Attainment Distributions for Wenatchee and Major Tech MSAs



Source: EMSI 2019.2

Comparison of the collective educational attainment level distribution of Austin-Round Rock-Georgetown, TX; San Francisco- Oakland-Berkeley, CA; and San Jose-Sunnyvale-Santa Clara, CA, and Wenatchee.



Central WA Pathway Alignment

Business and educational leaders coming together to align the path for rural students to have access to computer science credentials.

Current Programming Education Redundancy

Legend

- High School
- 2-Year College
- 4 Year College/University

Worst Case - No Articulation - No AP Score Credit - Most Common



Better Case - Some Articulation/Credit - Different Programming Language - Limited



Best Case - Good Articulation/Credit - Same Programming Languages - Very Rare



Proposed Programming Pathway

Ideal Case - Full Credit or Articulation - Language Neutral

** May be integrated at either institution or low-credit options, common course*



INDUSTRY & CAREER READY

CWU | Central Washington University

b *Big Bend*
COMMUNITY COLLEGE

WENATCHEE VALLEY
COLLEGE

Wenatchee
Public Schools



Organizational Structure/Communications/Career Connect Washington

Dennis Conger

CCL @ CTE Graduation Pathways Director
Northeast Educational Service District &
North Central Educational Services District

Susan Adams

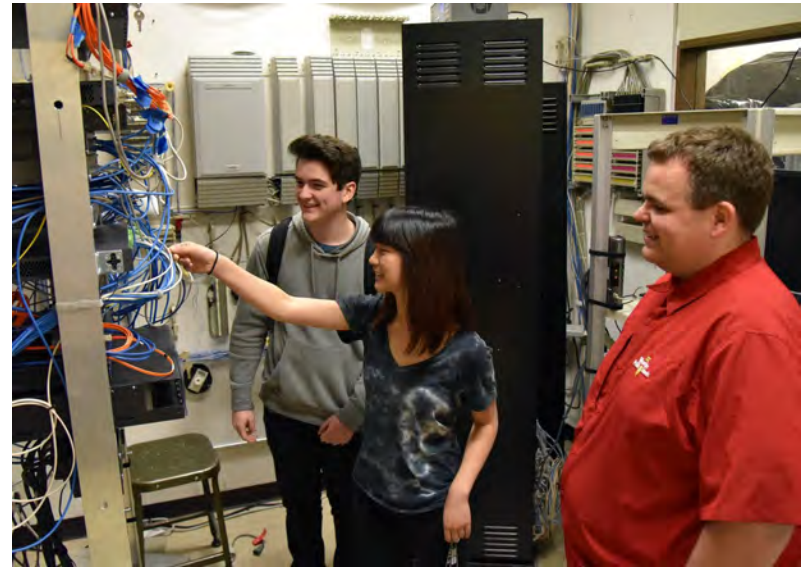
Center Manager, SkillSource, North
Central Workforce Development Council



Computer Tech I Apprenticeship - Overview and Introductions



Brandon Marsh & Amy Technivol - Sharing



A look back at our journey

2014-2015: Career Readiness for a Working Washington

- ES and OSPI funded 5 pilots in Wenatchee, Spokane, Vancouver, Yelm, and Renton

2016-2017: Youthworks Grant

2017-2019: Career Connect WA Grant

- Computer Tech I Apprenticeship

Next Steps for Computer Tech I Apprenticeship

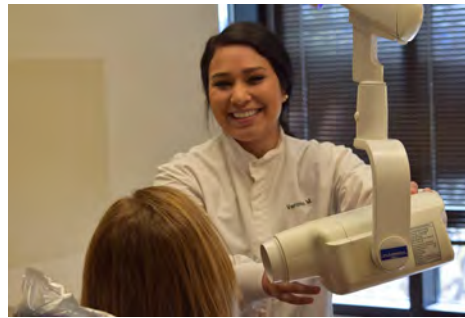
- NCESD the current WSD Computer Tech I Apprenticeship Program
 - 29 Districts within NCESD
- Training Agents (Districts & NCESD):
 - Provide OJT and pay apprenticeship wages
 - Generate FTE through Career Launch program
 - Align RSI per District
 - Reporting in ARTS
- Standards Revision due to L&I by November 8 for January Apprenticeship Council meeting
- NEWESD considering sponsoring Computer Tech I Apprenticeship Program in Spokane

Next Steps in North Central Washington

Implement Career Connect WA statewide system for career-connected learning:

- **Intermediary Grant –**
North Central Workforce
Development Council
- **Regional Network Grant -**
North Central Educational
Services District

QUESTIONS?



MESA: A Pathway to STEM Success

Karina Vega-Villa

MESA (Mathematics, Engineering, Science
Achievement) Program Director
Wenatchee Valley College



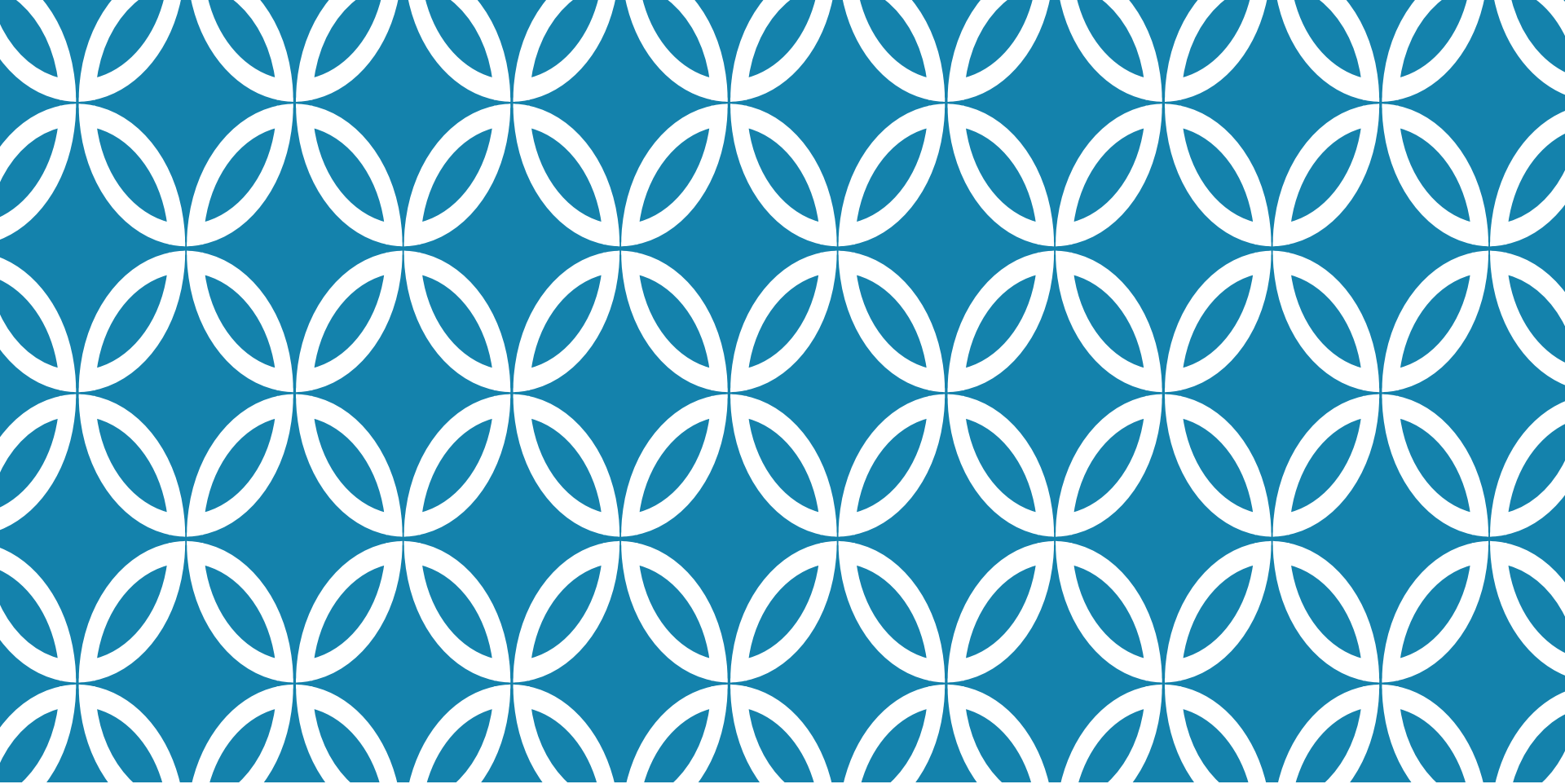


WENATCHEE VALLEY COLLEGE
Mathematics
Engineering
Science
Achievement

A Pathway to STEM Success

MESA
Mathematics
Engineering
Science
Achievement

Karina Vega-Villa, PhD
WVC MESA



WHAT IS MESA?

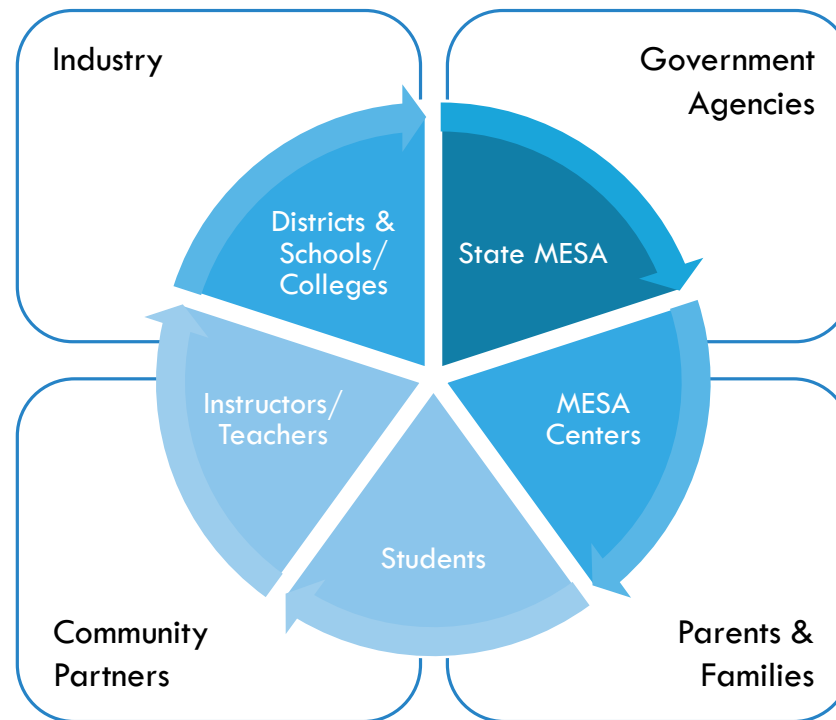


MATHEMATICS, ENGINEERING, SCIENCE ACHIEVEMENT

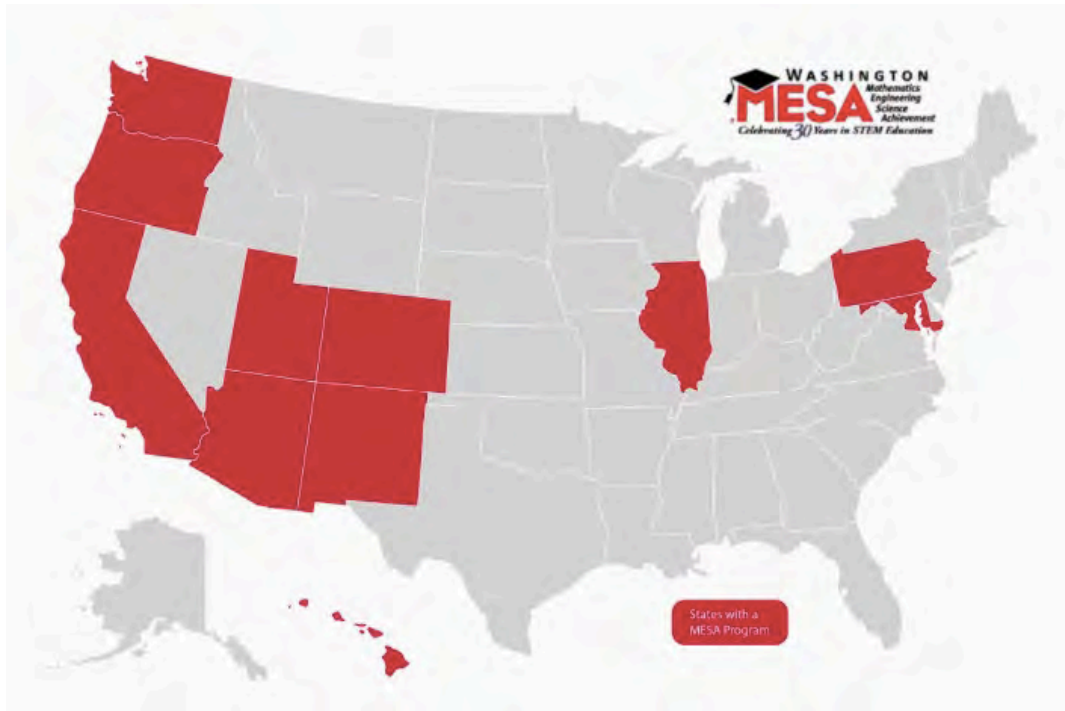
Nationally recognized academic development program that advocates for education, equity, and access in science, mathematics, and engineering.

Aims to diversify the STEM workforce and prepare a new generation of STEM leaders by addressing the challenges historically underrepresented students face in their educational and career development.

THE WORLD OF WASHINGTON MESA



MESA NATIONALLY



1. Arizona
2. California
3. Colorado
4. Hawaii
5. Illinois
6. Maryland
7. New Mexico
8. Oregon
9. Pennsylvania
10. Utah
11. Washington

<http://www.washingtonmesa.org/who-we-are.html>

MESA

Providing enrichment opportunities in mathematics, engineering, and science for underrepresented minorities in STEM nationwide since 1970

MESA origins

Oakland Tech High School teacher and University of California Berkeley professor collaborate to increase representation of African-American students in Engineering



70

70



California MESA

Formally launches from the University of California. Funded by state legislature, corporate contributions, and grants.

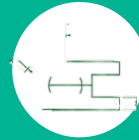
MESA USA

Established as the governing body of K-16 MESA programs nationwide



70

76



School of Engineering

University of Washington develops a School of Engineering

Washington MESA

Formally launches from School of Engineering at the University of Washington



82

85



MESA Student Center

First student Center in Washington serves 80 students

MESA Middle School Bill

Establishes state funding for middle schools expansion in 4 regional centers



99

01



K-12 MESA

4,935 students
78 schools engaged
25 schools district represented

MESA Community College Program

National Science Foundation supports first MESA programs in 4 community colleges.



09

10



First MCCP Expansion

Two community colleges added
Over 300 students served
6 community colleges engaged

WA State Fund Allocation

State allocates funding in state operating budget to secure funding for 6 MCCP programs.



14

Second MCCP Expansion

State allocates additional funds to MCCP to expand program to 12 community colleges



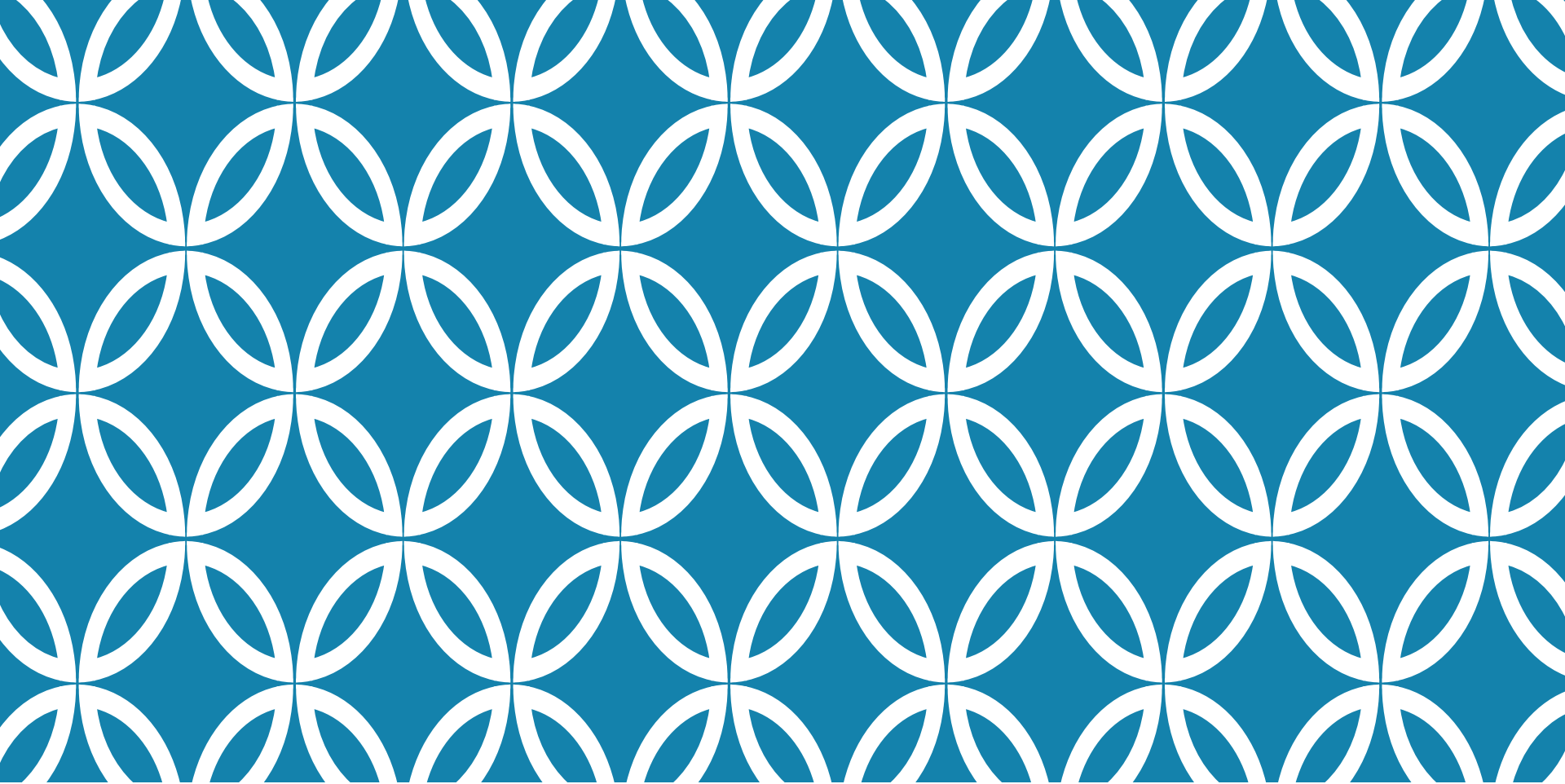
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MESA

numbers. Since 2010, over 45,000 K-14 students have enrolled in WA MESA. Approximately 32,000 have gone to a college or university.

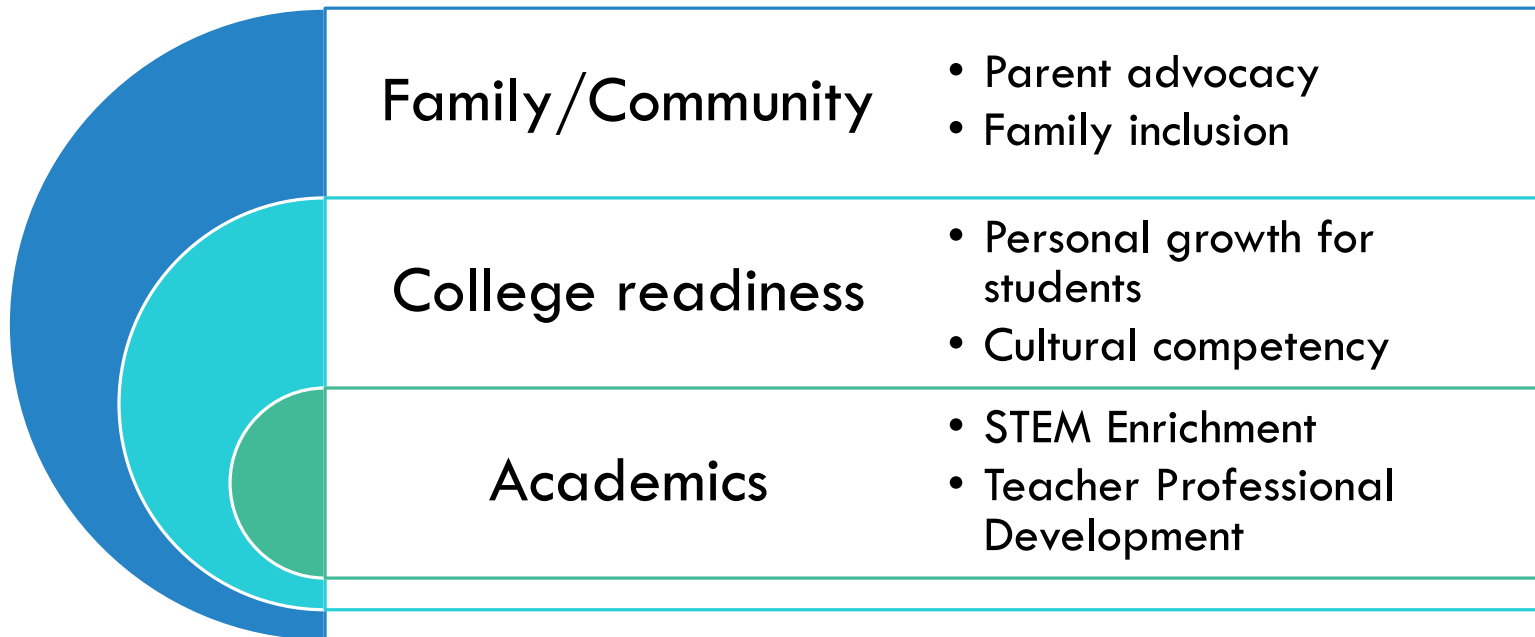


K-12 MESA



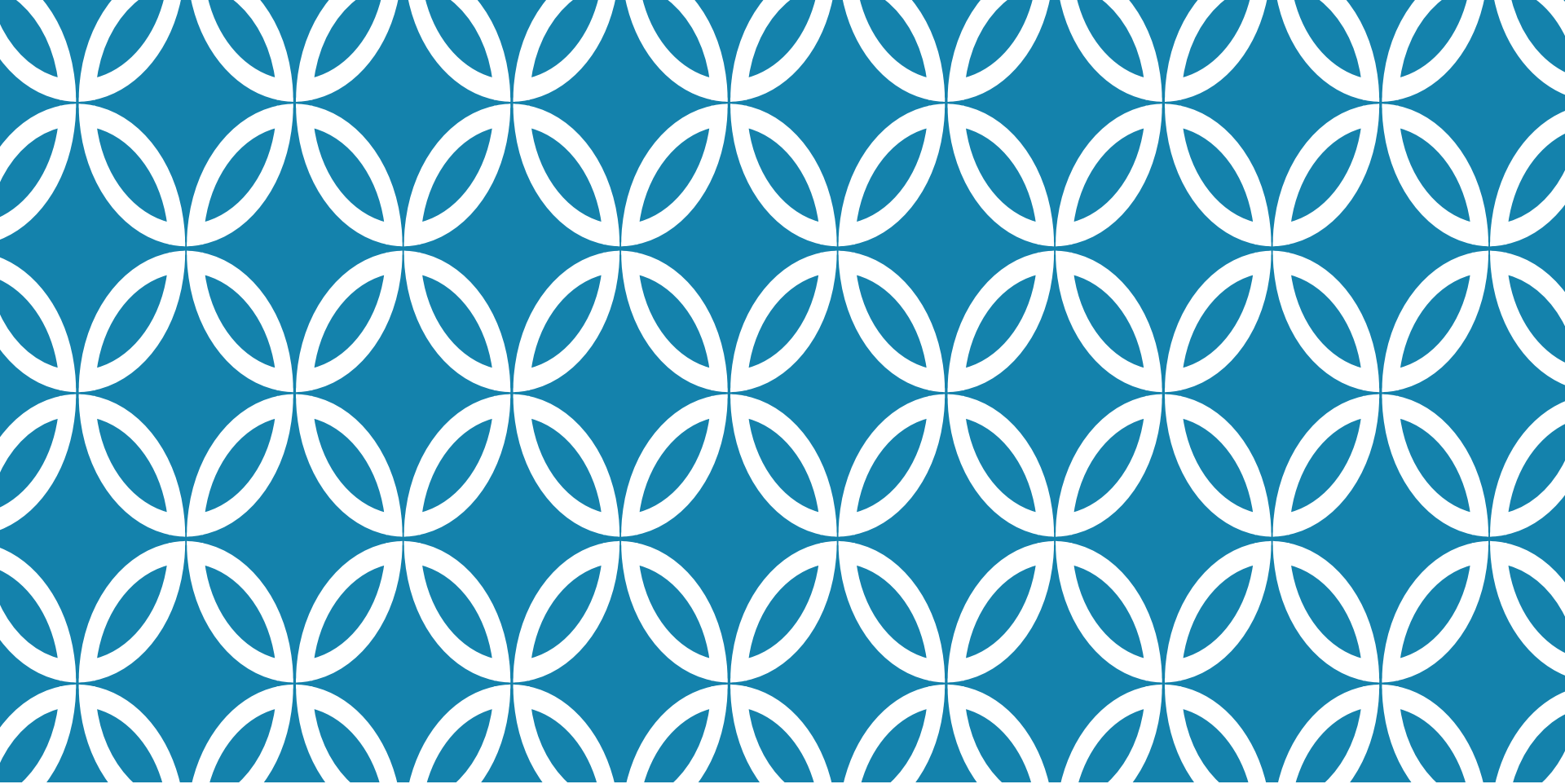
THE FOUNDATION OF ACADEMIC SUCCESS

“IT TAKES A VILLAGE”



WASHINGTON MESA





WVC MESA



WVC MESA OBJECTIVES



Increase the **number** of **URM** and **women** students earning undergraduate STEM degrees.



Increase the **retention** of **URM** and **women** students within STEM.



Increase & support the successful **transfer** of **URM** and **women** students.

MESA SERVICES

Academic Excellence Workshops

STEM
Orientation
Course

Professional
Development

Student
Center &
Textbooks

Transfer
Assistance

MESA
Scholarships

Career &
Academic
Advising

Cohort Enrollment Model

MESA SERVICES

Academic Excellence Workshops

STEM
Orientation
Course

Professional
Development

Student
Center &
Textbooks

Transfer
Assistance

MESA
Scholarships

Career &
Academic
Advising

Cohort Enrollment Model

Concurrent
enrollment
through course
series

Proven
method for
success

MESA SERVICES

Academic Excellence Workshops

STEM
Orientation
Course

Professional
Development

Student
Center &
Textbooks

Transfer
Assistance

MESA
Scholarships

Career &
Academic
Advising

Cohort Enrollment Model

STEM and college skills

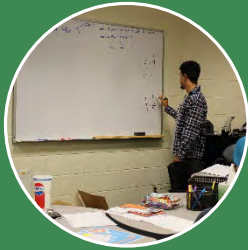
Study center with staff,
tutors, lending library

Internships & mentoring

Dedicated scholarships
and scholarship training

Diverse advising

DIRECT SERVICES TO STUDENTS



Student
events



Campus
visits



Academic
advising

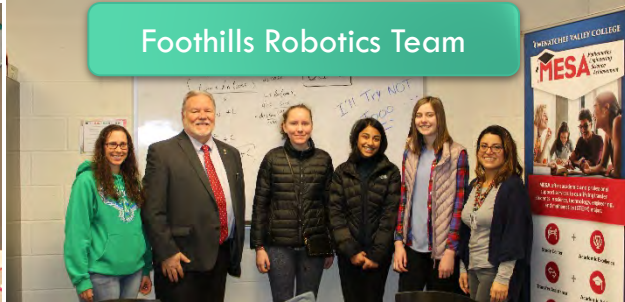


STUDENT EVENTS AT WVC

MESA Student Orientation



Foothills Robotics Team



Meet the Scientist Series



CAMPUS VISITS

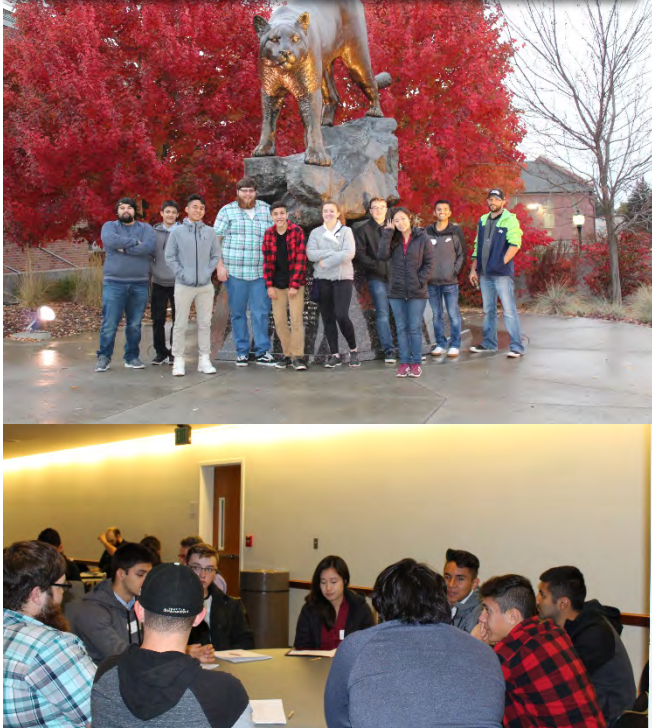
WSU – Wenatchee and USDA visit



LSAMP Conference at UW



Connecting Community Colleges to WSU



ACADEMIC ADVISING



“They helped me know what I needed to take and not stress too much about my schedule.”

- Graduate on time
- Increase number of transferable credits
- Advising with transfer institution and field in mind

“Having an adviser who knows about your degree really, really makes a difference.”

MESA ACADEMIC ADVISORS



Prof. Kerin Keys
MATHEMATICS



Prof. Sharon Wiest
MATHEMATICS



Prof. Awanthi Hewage
SCIENCE



Prof. Janna Goodyear
ENGLISH



Prof. Sai Ramaswamy
ENGINEERING

COMMUNITY PARTNERSHIPS

Our Valley Our Future Community
Development Initiative

Greater Wenatchee Area Technology
Alliance



MESA SERVICES

Academic Excellence Workshops

STEM
Orientation
Course

Professional
Development

Student
Center &
Textbooks

Transfer
Assistance

MESA
Scholarships

Career &
Academic
Advising

Cohort Enrollment Model

Skill focused

Gatekeeper
courses

Peer taught

Faculty
mentor

ACADEMIC EXCELLENCE WORKSHOPS (AEWS)

How do students benefit?

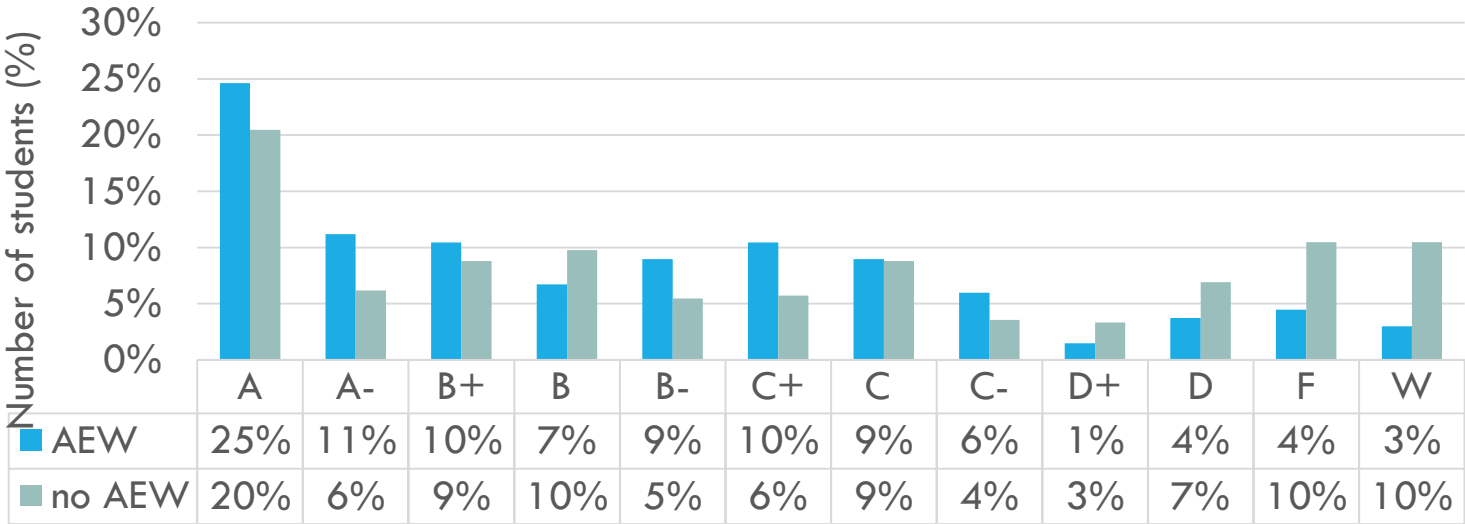
- Work in a small group
- Have a trained student facilitator lead the sessions
- Learn successful study strategies
- Gain test-taking skills

How do instructors benefit?

- Higher grades
- Higher retention rate
- Continuous status/progress reports between faculty member and student facilitator

AEWS IMPROVE GRADES

Grade distribution comparison



*Grade distribution comparison for WVC courses that offered AEWs Math, Chemistry, and Physics in 2018-2019. n=554)

THE POWER OF AEWs

What students are saying...

“Problems that exceeded the difficulty of homework forced you to think more about the concepts behind them, which I believe helped on understanding the materials and on the test.”

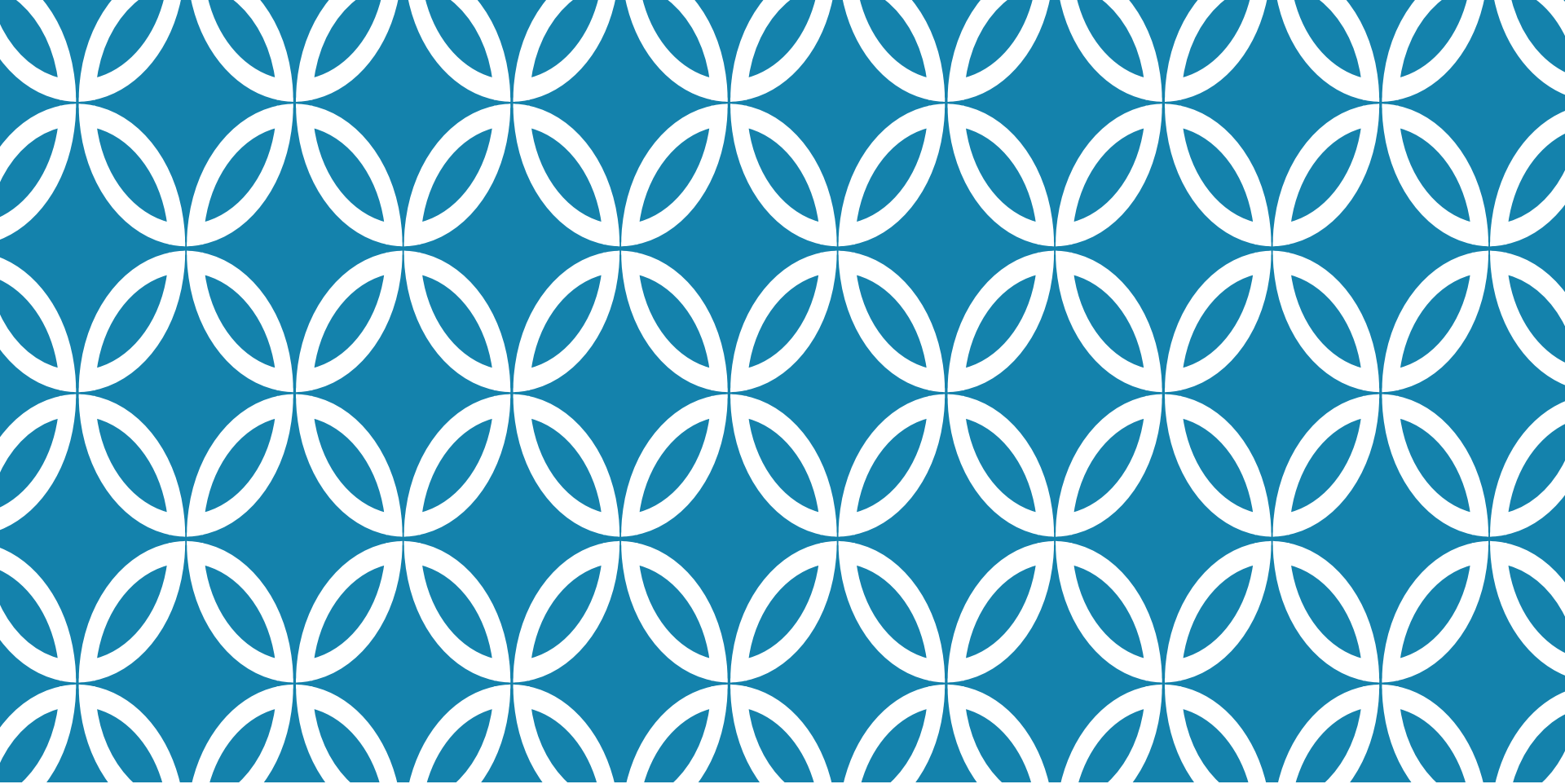
“[The student facilitator] has gone above and beyond to create workshops that directly apply to the contents of the class. I would not have succeeded without AEWs.”

*Data from WVC surveys in 18-19, n=26, n=9

What instructors are saying...

“I get to influence what the students are working on outside of class with help. I like to suggest more challenging problems than they see in homework to fully prepare them for tests.”

“I have enjoyed having an extra hand in class to help answer questions during work times. [...] Students have another student dedicated to their class that they can go to for questions without insecurity.”



STUDENT TESTIMONIALS



A PATH TO SUCCESS IN STEM

[Amanda Jeffries](#)

[Francisco Sanchez](#)





**IF YOU WANT TO GO FAST, GO ALONE.
IF YOU WANT TO GO FAR, GO
TOGETHER.
AFRICAN PROVERB**

509.682.6583

MESA@wvc.edu

Hydropower Research Institute and Microsoft Strategic Partnership

Kirk Hudson

Managing Director - Generation
and Transmission Chelan County
Public Utility District (PUD)



Douglas County PUD Hydrogen Production Initiative

Gary Ivory

General Manager Douglas County PUD



Legislative Priorities – The Work Ahead

STEM Education and Workforce

Senator Brad Hawkins

12th Legislative District (Wenatchee)

Representative Mike Steele

12th Legislative District (Chelan)

