SMART START
EVALUATION & RESEARCH

Evaluation of the Tristate NSF EPSCoR Track 2 Project

Summative External Evaluation Report

July 2016

Prepared for:

Gayle Dana, Ph.D.
Project Lead
Nevada NSF EPSCoR
Desert Research Institute
2215 Raggio Parkway
Reno, Nevada 89512

Peter Goodwin, Ph.D.
Project Lead
Idaho NSF EPSCoR
University of Idaho
322 E. Front Street, Suite 340
Boise, ID 83702

Bill Michener, Ph.D.
Project Lead
New Mexico NSF EPSCoR
University of New Mexico
MSC04 2815
1312 Basehart SE
Albuquerque, NM 87106

Prepared by:
Lisa Kohne, Ed.D.
Elizabeth McGee, M.A.
Tyler Johnson, M.A.
Lily Nuñez, B.A.
SmartStart Evaluation and Research
4482 Barranca Pkwy Ste. 220
Irvine, CA 92604

Table of Contents

Section 1. Executive Summary....1

1.1 Overview of the project....1

1.2 Summary of findings....1

Section 2. Introduction....3

2.1 Background of the project....3

2.2 Background of the evaluation....4

A. Guiding evaluation questions....4

B. Evaluation approach....4

C. Data collection....5

Section 3. Evaluation Findings....6

3.1 Project participation....6

A. Participants by institution....6

B. Participants by gender and race....7

C. Participants by role....8

3.2 Increasing knowledge generation and dissemination....9

A. Presentations, posters, proposals, and talks....9

B. Published articles and book chapters....9

C. Impact of journals (submitted and published)....10

3.3 Effectiveness of WC-WAVE in meeting project components....11

Project baseline and post-survey....11

A. Baseline to post change in knowledge and participation of project members....11

3.4 Overview of activity key findings and recommendations....28

A. Project activity for Components 2 & 3 (Cyberinfrastructure)....28

B. Project activity for Component 4 (Workforce Development)....29

C. Project-wide meetings....31

3.5 Project Sustainability Assessment Tool (PSAT)....33

A. Background of the assessment tool....33

B. Overall project sustainability....33

Section 4. Overall project findings and recommendations....39

Appendix A. PSAT indicators by rating....41

List of Figures

Figure 1. Project components, statuses, findings, and recommendations 1
Figure 2. Guiding evaluation questions 4
Figure 3. Evaluation approaches 5
Figure 4. Evaluation data sources 5
Figure 5. Representation of project members by institution 6
Figure 6. Gender and race of participants by project year 7
Figure 7. URM and female participants by role and project year 8
Figure 8. Professional presentations, posters, proposals by component and year 9
Figure 9. Published journal articles and book chapters by component and year-published 9
Figure 10. Journals submitted, articles published, and impact of articles for Year 1-3 10
Figure 11. WC-WAVE components and objectives 12
Figure 12. Component 1, Objective 1 knowledge 13
Figure 13. Component 1, Objective 2 knowledge 14
Figure 14. Component 1, Objective 3 knowledge 15
Figure 15. Component 2 knowledge 16
Figure 16. Component 3 knowledge 18
Figure 17. Component 4 (collaborative fieldwork) participation 19
Figure 18. Component 4 (Graduate Interdisciplinary Training) participation 20
Figure 19. Component 4 (Capstone and Leadership Institute) participation 21
Figure 20. Component 4 (Undergraduate Visualization and Modeling Network) participation .. 22
Figure 21. Extent participant thinking/approach to work was influenced by project knowledge 24
Figure 22. Participant reported areas of impact of project 24
Figure 23. Participant comments on areas of impact 25
Figure 24. Extent project has fostered collaborative/multidisciplinary teams 26
Figure 25. Participant likelihood of continuing partnerships/collaborations 26
Figure 26. Components 2 & 3 activities (key findings and recommendations) 28

Figure 27. Component 4 activities (key findings and recommendations) 29
Figure 28. Project-wide meetings, key findings, and recommendations 31
Figure 29. Sustainability capacity domains by rating 34
Figure 30. Program evaluation domain ratings 34
Figure 31. Program adaptation domain ratings 35
Figure 32. Organizational capacity domain ratings 35
Figure 33. Environmental support domain ratings 36
Figure 34. Strategic planning domain ratings 36
Figure 35. Communication domain ratings 37
Figure 36. Partnerships domain ratings 37
Figure 37. Funding stability domain ratings 38

Section 1. Executive Summary

1.1 Overview of the project

On August 1, 2013, the Idaho, Nevada, and New Mexico NSF EPSCoR projects were awarded a Track 2 EPSCoR (Experimental Program to Stimulate Competitive Research) grant for their "Western Consortium for Watershed Analysis, Visualization, and Exploration" (WC-WAVE) project.

There are four components of this EPSCoR project:

Project Components

Component 1: Watershed Sciences - Advance understanding of hydrologic interactions and their impact on ecosystem services using a virtual watershed (VW) framework.

Component 2: Cyberinfrastructure-Visualization - Accelerate collaborative, interdisciplinary watershed research and discovery by creating innovative visualization environments.

Component 3: Cyberinfrastructure-Data

- **Objective 1**: Accelerate integrated watershed scale modeling through streamlined data access, transfer of outputs and associated metadata to data management systems, visualization, model configuration
- **Objective 2**: Enable accelerated and broad access to research products, data and metadata through integration with national networks through interoperable data services
- **Objective 3**: Streamline data intensive research through improved data management skills

Component 4: Workforce Development and Education - Engage university faculty and graduate students in interdisciplinary team-based watershed research, and broaden undergraduate student participation in STEM through modeling and visualization.

1.2 Summary of findings

Based on the results of this evaluation, Figure 1 presents a summary of key findings and recommendations for the Tristate WC-WAVE EPSCoR project. A complete list of key findings and recommendations can be found in Section 4 of this report.

Figure 1. Project components, statuses, findings, and recommendations

Sustainability	
Key findings	• The project currently has an overarching vision and *Benchmarks* and *Milestones documents* that has informed directions in Years 1-3. A refined direction specific to the no-cost-extension year (*and beyond*) is outlined in the submission that provided to the NSF for a no-cost-extension year. • Sustainability directions based on the PSAT results are currently in place. • No external evaluator will be utilized for the no-cost-extension year. It is unclear if the project has plans to evaluate some key activities (*internally*) in the project's no-cost-extension year.

Recommendations	• Ensure the refined directions specific to the no-cost-extension year (and beyond) as outlined to the NSF are operational (i.e. clearly outlines what precisely will be done, who will do it and by when). Within this, review the results of the PSAT to inform planning specific to sustainability.
	• In determining whether current project activities should be continued and which should be scaled down or eliminated, strategically assess: breadth (*how many*), depth (*how great of impact*) and potential for sustainability (*what is the chances of continuation beyond the no-cost-extension year*).
	• Identify formal and informal state-specific champions within the program. Consider having this group form a Community of Practice/Working Group that could extend beyond the no-cost extension year.
	• Explore no-cost/low-cost ways of evaluating key components of the project going into the no-cost-extension-year.
	• To support the continuation/legacy of the WC-WAVE project, inform and formal teams, working groups and/or Communities of Practice developed over the duration of the project or within the no-cost extension year should continue to:
	  ○ Explore funding sources specific to their institutions
	  ○ Actively submit research proposals
	  ○ Explore other NSF funding sources (i.e. REU's)
	  ○ Explore unique funding streams that focus on supporting interdisciplinary teams/team science projects

Component 1: Watershed Sciences, Component 2: Cyberinfrastructure-Visualization, Component 3: Cyberinfrastructure-Data	
Key findings	• Project has Benchmarks and Milestones that contains project components 1, 2 & 3 for Years 1 to 3.
Recommendations	• Continue collaborative research activities (Components 1, 2 and 3) as planned in the (revised) operationally-based plan. • Explore the potential of leveraging existing capabilities made possible through the CSDMS Web Modeling Toolkit and Basic Model Interface (previously supported by the NSF) within the Virtual Watershed Platform (VWP). This will ensure redundancies are reduced and that the VWP remains relevant moving forward.
Component 4: Workforce Development and Education	
Key findings	• Project currently has Benchmarks and Milestones that outline project components 4 for Years 1 to 3.
Recommendations	• Consider building off the existing Nevada, Idaho and New Mexico STEM website that provide pipeline resources and visually map a workforce STEM pipeline for each state to better assess the ways in which the project has contributed to the pipeline and where there are gaps in each state's contribution to the pipeline in each of the respective states. • Identify a champion(s) that could continue to advocate the growth of the project's STEM educational and workforce trajectories. Ideally this champion(s) would have a long-term investment in their respective state's STEM educational-workforce trajectories, so that their involvement could extend beyond the scope of the project. Their role could include leveraging support within their respective state's educational institution (or other relevant community groups or institutions) around the project's next steps re: STEM educational and workforce trajectories.

Section 2. Introduction

2.1 Background of the project

The mission of the EPSCoR program is to assist the NSF in its statutory function to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education.[1]

The components of the NSF EPSCoR program aim to:

- Provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their research and development capacity and competitiveness.
- Advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

The objectives of the NSF EPSCoR program are as follows:

- Catalyze key research themes and related activities within and among EPSCoR jurisdictions that empower knowledge generation, dissemination and application.
- Activate effective jurisdictional and regional collaborations among academic, government and private sector stakeholders that advance scientific research, promote innovation and provide multiple societal benefits.
- Broaden participation in science and engineering by institutions, organizations and people within and among EPSCoR jurisdictions.
- Use EPSCoR for development, implementation and evaluation of future programmatic experiments that motivate positive change and progression.

The three-year award funds watershed science research, CI-enabled discovery and innovation, and workforce development and education, which are part of each state's Science and Technology Plan. The project is creating a new immersive virtual reality environment that fosters "interdisciplinary discussion and creative insight into complex scientific questions" and enables "innovations that result in groundbreaking discoveries"[2] about watershed science.

[1] http://www.nsf.gov/od/oia/programs/epscor/about.jsp
[2] http://www.nsf.gov/awardsearch/showAward?AWD_ID=1329469&HistoricalAwards

2.2 Background of the evaluation

A. Guiding evaluation questions

Evaluation questions help guide the direction of inquiry for the project's evaluation. Figure 2 outlines the connection between project components and the corresponding evaluation questions.

Figure 2. Guiding evaluation questions

Evaluation questions and sub-questions
Did the project advance understanding of hydrologic interactions and their impact on ecosystem services using a virtual watershed framework?
• What progress has been made in achieving the project's scientific benchmarks and milestones? • How have the watershed models and adapters provided by the EPSCoR project enabled scientists to advance their understanding of hydrologic interactions and their impact on ecosystem services? • In what way have the addition of watershed models and adapters increased the WC-WAVEs' competitiveness in this scientific field? • How have these watershed models and adapters influenced scientists' ability to serve as experts in their fields?
Did the project develop a comprehensive approach that leads to an increase in the number of underrepresented students who graduate from STEM degree-granting programs?
• What value-added effect has this project provided for underrepresented students?
Did the project accelerate collaborative, interdisciplinary watershed research and discovery through innovative visualization environments and through streamlined data management, discovery and access?
• What progress has been made in achieving the project's CI Visualization and Data benchmarks and milestones? • What visualization resources have been accessed and how have they been used by researchers, faculty, and students? • How have the visualization environments and streamlined data management, discovery and access affected the pace at which scientists can conduct hydrologic and ecosystem research? • What long-term impacts will development of this visualization environment have on ecosystem research and discoveries?
Did the project engage university faculty and graduate students in interdisciplinary team-based watershed research, and broaden undergraduate student participation in STEM through modeling and visualization?
• What progress has been made in achieving the project's workforce development benchmarks and milestones? • In what ways has participation in the EPSCoR programs increased participants' understanding of issues related to hydrology and ecosystems? • What impact has participation in the EPSCoR programs had on the development and direction of participants' educational and career opportunities and choices? • In what ways did participants' take the knowledge they acquired in EPSCoR programs and transfer it back into the classroom, university, and workplace in a meaningful, productive way? • What value-added effect has this project provided for students and participants who are traditionally underrepresented in STEM?

B. Evaluation approach

The evaluator used two major evaluation approaches, *formative* and *summative*, to assess different stages in the project's lifetime. These approaches are not mutually exclusive and are used in combination throughout the project, helping to explore different evaluation questions. These approaches are outlined in Figure 3, including a description of the conditions under which this approach should be used, and the strategic questions that can be explored using the described approach.

Figure 3. Evaluation approaches

Approach	Approach description	Strategic questions
Formative Evaluation	Used when the project team is implementing strategies and activities. This approach is appropriate at this stage as outcomes are becoming more predictable. The project's context is increasingly well known and understood.	**How well is it working?** • How can the project enhance what is working well and improve what is not? • What effects or changes are appearing in targeted systems? • What factors are limiting progress and how can these be managed or addressed?
Summative Evaluation	Used when the project is stable and well established. Leads have greater certainty about '*what works'* and the project is evaluated to determine impact, value, and significance.	**What difference did it make?** • What about the process has been most effective, for whom, and why? • What ripple effects did the initiative have on other parts of the system/state?

C. Data collection

These evaluation approaches included the analysis of both qualitative and quantitative data, and utilized a variety of data collection strategies including: benchmark and milestone tracking, baseline and annual post-surveys, evaluation forms, interviews and focus groups, and data obtained from project documentation. A description of the project's key data sources and their purpose in this evaluation is outlined in Figure 4.

Figure 4. Evaluation data sources

Data source	Purpose
Benchmarks and milestone tracking	Track progress made towards achieving project benchmarks and milestones.
Baseline and end of project post-surveys	Assess year to year progress made towards achievement of project components and objectives.
Activity evaluations	Assess satisfaction, usefulness, and achievement of activity objectives. Provide feedback to improve project's implementation and quality of project activities and identify participant needs for future events. Results help project activities remain adaptive, flexible and promote an iterative approach.
Project documentation	Project reports, plans, agendas, minutes and other documents to provide information on plans and accomplishments.
Project data	Project data on participants, proposals, awards, presentations, publications, and collaborations are collected and analyzed to track progress made on project outputs and outcomes compared against identified targets and components.

D. Assessment development

SmartStart developed and/or administered the following evaluation tools for the WC-WAVE EPSCoR project:

- Evaluation forms (and questions) assessing the logistics, satisfaction and impact key project activities (*e.g. seminars, workshops, and meetings*).
- Annual project baseline/post-survey
- Project Sustainability Assessment Tool (PSAT)[3]

[3] Developed by researchers at Washington University. Retrieved from http://www.sustaintool.org.

Section 3. Evaluation Findings

This external evaluation report presents overarching project findings. Specific project activities, workshops, and meeting evaluation results can be found in quarterly reports that were completed throughout the duration of this project.

3.1 Project participation

Increasing the involvement of women and underrepresented minorities (URMs) in STEM fields is a primary objective of NSF, EPSCoR, and the WC-WAVE project. This section provides information regarding project participants, with special attention paid to the number of women and URMs. There are different levels of project participation for the WC-WAVE project. Primary project participants contribute directly to project coordination and/or research and remain in the project throughout the five project years. These include component leads, activity coordinators, graduate students, researchers, and project administrators. Other participants, such as K-12 teachers and students and undergraduates participate in activities, but do not have sustained, long-term participation.

A. Participants by institution

Figure 5 shows the number of project participants by institution and Figure 6 shows the number by gender and race. This information is important to determine if the number of women and URMs are increasing in overall project participation. Results illustrate that overall participation in the project increased, with a net growth of eight individuals from Year 1 to Year 3.

As displayed in Figure 5, the institutions in Nevada and New Mexico increased their participant numbers, at the end of Year 3, when compared to Year 1. Idaho institutions decreased in representation from Year 1 to Year 3 (-13%). At an institutional level, the University of New Mexico and Lewis Clark State College had the largest increase in the number of participants in the project, with both increasing their representation by six participants. It should be noted that some PUI numbers may have dropped or increased, intermittently, due to the nature of undergraduate participation in the project. For example, Western Nevada College was a part of the UVMN in the beginning but their contract ended before Year 3.

Figure 5. Representation of project members by institution

Institution	Year 1 (*n*=100)		Year 3 (*n*=108)		Change from Year 1 to Year 3	
Idaho	**38**	**38%**	**36**	**33%**	**-2**	**-13%**
Boise State University	7	7%	4	4%	-3	
College of Southern Idaho	3	3%	2	2%	-1	
College of Western Idaho	3	3%	2	2%	-1	
Idaho State University	7	7%	5	5%	-2	
Lewis Clark State College	-	-	6	6%	+6	
University of Idaho	17	17%	17	16%	-	
USDA	1	1%	-	-	-1	
Nevada	**30**	**30%**	**33**	**31%**	**+3**	**+10%**
Desert Research Institute	4	4%	2	2%	-2	
Nevada State College	2	2%	4	4%	+2	
Nevada System of Higher Education	2	2%	4	4%	+2	
Sierra Nevada College	2	2%	2	2%	-	

Institution	Year 1 (*n*=100)		Year 3 (*n*=108)		Change from Year 1 to Year 3	
Truckee Meadows Community College	-	-	2	2%	+2	
University of Nevada, Las Vegas	3	3%	4	4%	+1	
University of Nevada, Reno	15	15%	15	14%	-	
Western Nevada College	2	2%	-	-	-2	
New Mexico	**32**	**32%**	**39**	**36%**	**+7**	**+13%**
Luna Community College	2	2%	-	-	-2	
Mesalands Community College	2	2%	2	2%	-	
Navajo Technical University	2	2%	4	4%	+2	
New Mexico Highlands University	1	1%	2	2%	+1	
New Mexico Institute of Mining and Technology	4	4%	5	5%	+1	
New Mexico State University	1	1%	1	1%	-	
Southwestern Indian Polytechnic Institute	2	2%	1	1%	-1	
University of New Mexico	18	18%	24	22%	+6	

B. Participants by gender and race

As displayed in Figure 6, the number of female (42%) and URM (15%) participants increased from Year 1 to Year 3. The largest gain among reported URMs was among Hispanic/Latino participants, who increased 75% from Year 1 to Year 3.

Figure 6. Gender and race of participants by project year

	Year 1 (*n*=100)		Year 3 (*n*=108)		Change from Year 1 to Year 3	
Gender						
Male	58	58%	63	58%	+5	+9%
Female	42	42%	45	42%	+3	+7%
Race						
Non-URM	90	90%	92	85%	+2	+2%
Hispanic/Latino	4	4%	7	6%	+3	+75%
Black or African American	2	2%	1	1%	-1	-50%
Other	4	4%	8	7%	+4	+100%

C. Participants by role

Figure 7 shows project participation by role in the project. This information demonstrates whether the number of females and URMs is increasing at all project levels. Results show that the representation of URMs increased or remained stable in all but one role, support staff (-40%). Female representation decreased in two roles, undergraduates (-29%) and support staff (-25%), while other project roles increased or remained stable.

Figure 7. URM and female participants by role and project year

	Year 1 (*n*=100)		Year 3 (*n*=108)		Change from Year 1 to Year 3	
Faculty	**27**	**27%**	**27**	**25%**	**-**	**-**
URM	-	-	2	7%	+2	+200%
Female	9	33%	12	44%	+3	+33%
Project Leaders	**15**	**15%**	**16**	**15%**	**+1**	+7%
URM	-	-	-	-	-	-
Female	5	33%	5	31%	-	-
Post docs	**-**	**-**	**1**	**1%**	**+1**	**+100%**
URM	-	-	1	100%	+1	+100%
Female	-	-	-	-	-	-
Graduate Students	**20**	**20%**	**30**	**28%**	**+10**	**+50%**
URM	4	20%	5	17%	+1	+25%
Female	9	45%	14	47%	+5	+56%
Undergraduates	**18**	**18%**	**17**	**16%**	**-1**	**-6%**
URM	1	6%	6	35%	+5	+500%
Female	7	39%	5	29%	-2	-29%
Support Staff	**20**	**20%**	**17**	**16%**	**-3**	**-15%**
URM	5	25%	3	18%	-2	-40%
Female	12	60%	9	53%	-3	-25%
Total	**100**	**-**	**108**	**-**	**+8**	**+8%**
URM	10	10%	17	16%	+7	+70%
Female	37	37%	45	42%	+8	+22%

3.2 Increasing knowledge generation and dissemination

A. Presentations, posters, proposals, and talks

Figure 8 shows the combined total for professional presentations, posters, proposals, and invited talks by component for each year of the project. Results show that the number of knowledge generation and dissemination activities given by participants doubled between Year 1 and Year 3. While all components are encouraged to submit publications and presentations to conferences, the research and cyberinfrastructure components have been the source of all professional presentations, posters, proposals, and invited talks.

Figure 8. Professional presentations, posters, proposals by component and year

Component	Year 1	Year 2	Year 3	Total
Research	0	0	8	**8**
Cyberinfrastructure	5	4	3	**12**
Workforce Development	0	0	0	**0**
Overall	**5**	**4**	**11**	**20**

B. Published articles and book chapters

Figure 9 shows the combined total for journal articles and book chapters published by WC-WAVE project participants by component for each year of the project. As shown in Figure 9, the number of journal articles and book chapters published, as reported to the external evaluators, totaled six at the end of the project. All of the journal articles and book chapters published were from the research component of the project.

Figure 9. Published journal articles and book chapters by component and year-published

Component	Year 1	Year 2	Year 3	Cumulative total
Research	0	4	2	**6**
Cyberinfrastructure	0	0	0	**0**
Workforce Development	0	0	0	**0**
Overall	**0**	**4**	**2**	**6**

C. Impact of journals (submitted and published)

Figure 10 contains the journals to which project members have submitted articles, Eigenfactors (standard and normalized) of the journals (used to assess impact and reach), and publication status. An Eigenfactor is the level of importance a journal has in the scientific community and includes the numbers of articles published by the journal in comparison to all scientific articles published. There is no set range for Eigenfactors, as they are a percentage of a whole that each journal holds in regards to its influence in the top 1000 journals from Thomson Journal Citation Reports, which includes all journals from 1997-2014.

The most impactful journal that accepted a publication from the project was *Landscape and Urban Planning*, which has a Normalized Eigenfactor of 1.3, which translates to it having an average amount of impact on the general body of scientific knowledge. The most impactful journal submitted to was *Water Resources Research*, with a Normalized Eigenfactor of 6.0, which means it has an impact that is six times that of the average journal. Project members submitted to journals that, on average, have a Normalized Eigenfactor of 1.1, indicating that project members are submitting to journals that have about an average impact on the body of scientific knowledge.

Figure 10. Journals submitted, articles published, and impact of articles for Year 1-3

Journal	Eigenfactor	Normalized Eigenfactor	Published	Number of publications within this Journal
Water Resources Research	0.054	6.0	Submitted	0
Landscape and Urban Planning	0.012	1.3	Published	1
Journal of Transport Geography	0.008	0.8	Published	1
Journal of Construction Engineering and Management	0.005	0.5	Published	1
Concurrency and Computation: Practice and Experience	0.003	0.4	Under Review	0
Photogrammetric Engineering and Remote Sensing	0.004	0.4	Accepted	0
Journal of Bioinformatics and Computational Biology	0.002	0.2	Awaiting Publication	1
Journal of Map and Geography Libraries	0.000	0.0	Accepted	0
Intelligent Automation and Soft Computing (Autosoft)	< 0.001	< 0.1	Awaiting Publication	1
Journal average	**0.010**	**1.1**	**44.4%**	

3.3 Effectiveness of WC-WAVE in meeting project components

Project baseline and post-survey

The baseline and post survey is based on the WC-WAVE project's components and objectives. To develop the surveys, at the commencement of the project the evaluator discussed the impact intended for the project with the principal investigators. Questions are featured in baseline are repeated on post-surveys to measure changes in intended outcomes. The purpose of reporting baseline levels (and post levels thereafter) is to inform project leaders of areas of growth from Year 1 and Year 3 of the project.

The baseline/post survey assesses:

- Demographics
- Implementation of the project
- Progress made towards achievement of project components

A. Baseline to post change in knowledge and participation of project members

Respondents' change in knowledge and participation of component achievements from Year 1 to Year 3 is displayed in Figure 11. Fifty-nine participants completed the baseline survey, while fifty-five participants completed the end of project post-survey. For Components 1-3, participants rated their knowledge on a scale of 1-5, 1 = *not knowledgeable at all* to 5 = *extremely knowledgeable*. For Component 4, participants selected which activities they participated in that support the component.

Figure 11 displays the WC-WAVE project Components and Objectives, along with the ratings from Year 1 (2014) and Year 3 (2016). P-values for statistical significance are also reported. Asterisks (*) denote significance values that are less than $p < 0.5$. Ratings can be considered to trend towards positive or negative based on the following scale:

Extremely knowledgeable	4.21 – 5.00
Very knowledgeable	3.41 – 4.20
Somewhat knowledgeable	2.61 – 3.40
Slightly knowledgeable	1.81 – 2.60
Not knowledgeable at all	1.00 – 1.80

Overall, the WC-WAVE project members (n = 55) increased their knowledge at a statistically significant level (2.12 to 2.45). While not all sub-objectives achieved statistically significant growth, the average knowledge gain of all project components increased significantly, with project members reporting the largest gain in Component 3 knowledge (2.10 to 2.53). Participants reported increased knowledge of all project sub-objectives, however, of the 21 sub-objectives, five (24%) achieved statistically significant increases.

Figure 11. WC-WAVE components and objectives

	2014 Baseline	2016 Rating	P-value
Component 1	**2.20**	**2.42**	**<.001***
Objective 1	**2.38**	**2.91**	**<.001***
Which environmental variables are important for developing test data sets for models in the VW platform	2.18	2.68	.217
How to parameterize and coordinate model runs	2.34	2.65	.062
Why one-way or "loose" coupling among models via cyberinfrastructure is desirable	2.38	3.00	.325
Which watershed models are appropriate to use	2.49	3.12	.021*
What is required to visualize watershed model outputs and inputs	2.50	3.10	.442
Objective 2	**1.70**	**2.17**	.002*
How modeling system adapters are developed	1.80	2.29	.153
How to ensure that the code for model adapters is sustainable	1.68	2.15	.036*
How to ensure the reliability of adapters	1.63	2.08	.025*
Objective 3	**2.00**	**2.35**	<.001*
How initial test cases for the Virtual Watershed are defined based on the climatology of study watersheds	1.66	2.31	.005*
How to develop synthetic datasets for the Virtual Watershed models	1.66	2.74	.698
How to run synthetic test cases for models	2.23	2.31	.664
How to characterize and quantify value added through two-way model coupling	2.10	2.37	.020*
Component 2	**1.90**	**2.44**	.004*
How data required by models and visualization tools are defined	1.96	2.50	.508
The model and visualization tool data format requirements	1.96	2.46	.154
How interfaces for the visualization environments are developed	1.87	2.43	.925
How visualization environments interface with virtual watershed platform adapters	1.79	2.38	.876
Component 3	**2.10**	**2.53**	<.001*
How data are integrated within and into larger networks	2.27	2.68	.935
Strategies for accelerated and broad access to large data sets related to the project	2.13	2.55	.205
How streamlined data access, transfer of outputs and associated metadata impact visualization and model configuration	2.15	2.54	.447
Understanding of opportunities for streamlining data intensive research through improved data management skills	2.00	2.51	.295
Strategies for the acceleration of integrated watershed scale modeling	1.93	2.37	.054
Project total	**2.12**	**2.45**	**<.001***

Component 1: Watershed Science

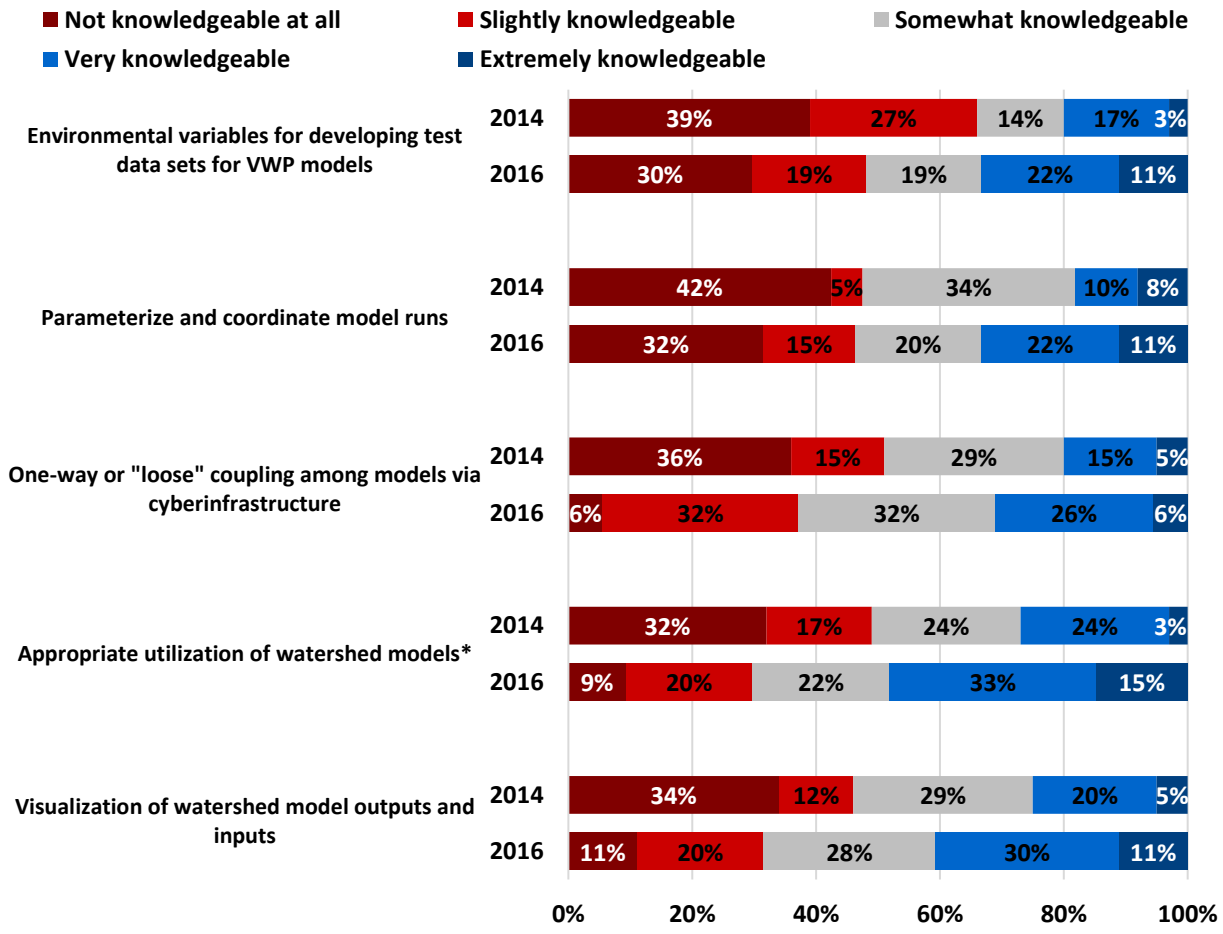
Component 1: Advance understanding of hydrologic interactions and their impact on ecosystem services using a virtual watershed (VW) framework.

Component 1, Goal 1 objectives include:

1. Parameterize and validate watershed models
2. Develop CSDMS adapter for models
3. Test VW applications and answer research questions using the VW platforms to investigate watershed ecosystem services

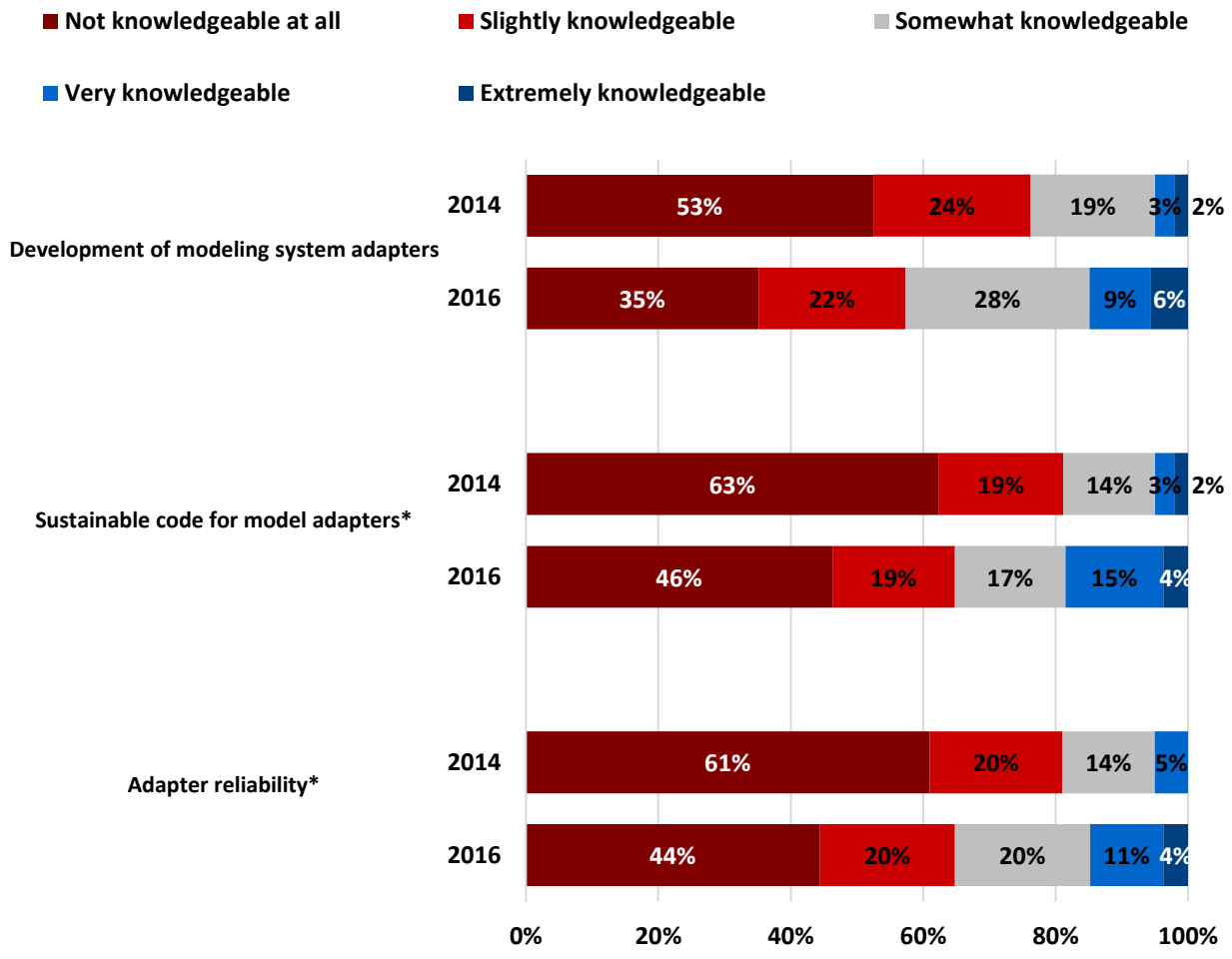
As shown in Figure 12, participants (n = 55) rated knowledge of Objective 1, on average, as *somewhat knowledgeable* (2.91), which was the only objective, goal, or component to be rated at this level of knowledge. Participants rated knowledge of all Objective 1 objectives as *somewhat knowledgeable*. Of the Objective 1 sub-objectives, participants experienced the largest gain in knowledge of "which watershed models are appropriate to use," which increased from *slightly knowledgeable* (2.49) to *somewhat knowledgeable* (3.12). "Which watershed models are appropriate to use" was the only sub-objective that achieved statistically significant growth (p = .021) from 2014 to 2016. Breakdowns of participant responses are shown in Figure 12.

Figure 12. Component 1, Objective 1 knowledge



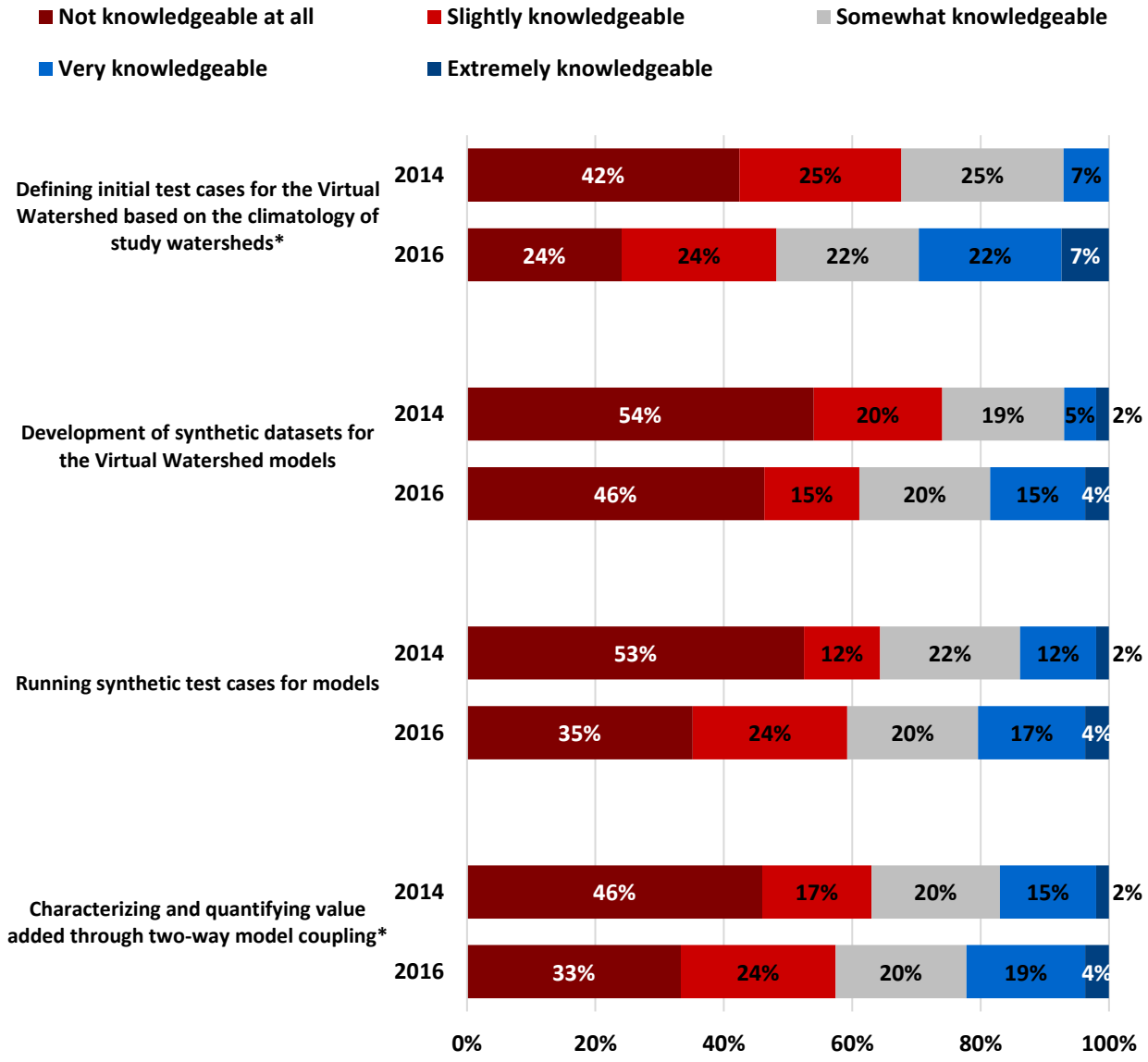
As shown in Figure 13, participants (n = 55) rated knowledge of Objective 2, on average, as *slightly knowledgeable* (2.35), which remained constant from Year 1 (2.00). Participants rated knowledge of all Objective 2 objectives as *slightly knowledgeable*. Of the Objective 2 sub-objectives, participants experienced the largest gain in knowledge of "how modeling system adapters are developed," which increased from *not knowledgeable at all* (1.66) to *slightly knowledgeable* (2.74). "How to ensure that the code for model adapters is sustainable" and "how to ensure the reliability of adapters" were the sub-objectives that achieved statistically significant growth (p = .036, p = .025) from 2014 to 2016. Breakdowns of participant responses are shown in Figure 13

Figure 13. Component 1, Objective 2 knowledge



As shown in Figure 14, participants (n = 55) rated knowledge of Objective 3, on average, as *slightly knowledgeable* (2.17), which increased from *not knowledgeable at all* (1.70). Of the Objective 3 sub-objectives, participants experienced the largest gain in knowledge of "how to develop synthetic datasets for the Virtual Watershed models," which increased from *not knowledgeable at all* (1.80) to *somewhat knowledgeable* (2.29). "How initial test cases for the Virtual Watershed are defined based on the climatology of study watersheds" and "how to characterize and quantify value added through two-way model coupling" were the sub-objectives that achieved statistically significant growth (p = .005, p = .020) from 2014 to 2016. Breakdowns of participant responses are shown in Figure 14.

Figure 14. Component 1, Objective 3 knowledge



Component 2: Cyberinfrastructure-Visualization

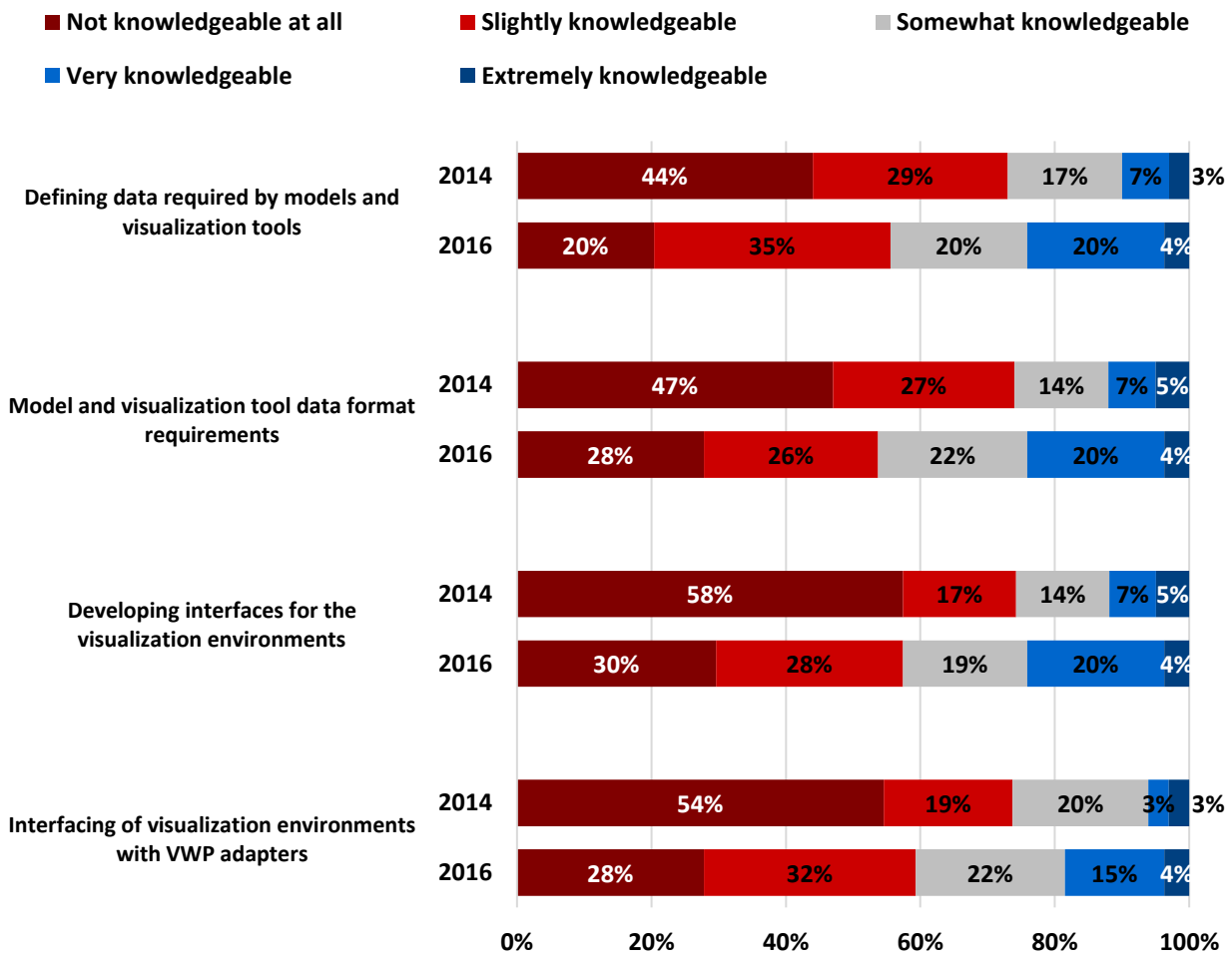
Goal 1: Accelerate collaborative, interdisciplinary watershed research and discovery by creating innovative visualization environments.

Component 2 Goal 1 objectives include:

1. Develop and deploy visualization environment
2. Develop user interfaces
3. Train users on how to use the visualization environment
4. Educate graduate students on CI for watershed research
5. Disseminate results

As shown in Figure 15, participants (n = 55) rated knowledge of Goal 1, on average, as *slightly knowledgeable* (2.44), which remained constant from Year 1 (1.90). Of the Goal 1 objectives, participants experienced the largest gain in knowledge of "how visualization environments interface with virtual watershed platform adapters," which increased from *not knowledgeable at all* (1.79) to *slightly knowledgeable* (2.38). None of the sub-objectives achieved statistically significant growth from 2014 to 2016. Breakdowns of participant responses are shown in Figure 15.

Figure 15. Component 2 knowledge



Component 3: Cyberinfrastructure-Data

Goal 1: Accelerate integrate watershed scale modeling through streamlined data access, transfer of outputs, and associated metadata to data management systems, visualization, model configuration.

Component 3 Goal 1 objectives include:

1a. Define data required by models and visualization tools
1b. Define model and visualization tool data format requirements
1c. Define model configuration options to be exposed through the VW and visualization tool
2. Define model integration workflow
3. Deploy virtual watershed data and service platform
4. Deploy data source to Virtual Watershed Platform adapters
5. Deploy virtual watershed model adapters
6. Deploy virtual watershed to Visualization Environment adapter

Goal 2: Enable accelerated and broad access to research products, data, and metadata through integration with national networks through interoperable data services.

Component 3 Goal 2 objectives include:

1. Integrate data management system with CUAHSI HIS WaterOneFlow service network
2. Integrate data management system with DataOne network as Tier 4 member nodes

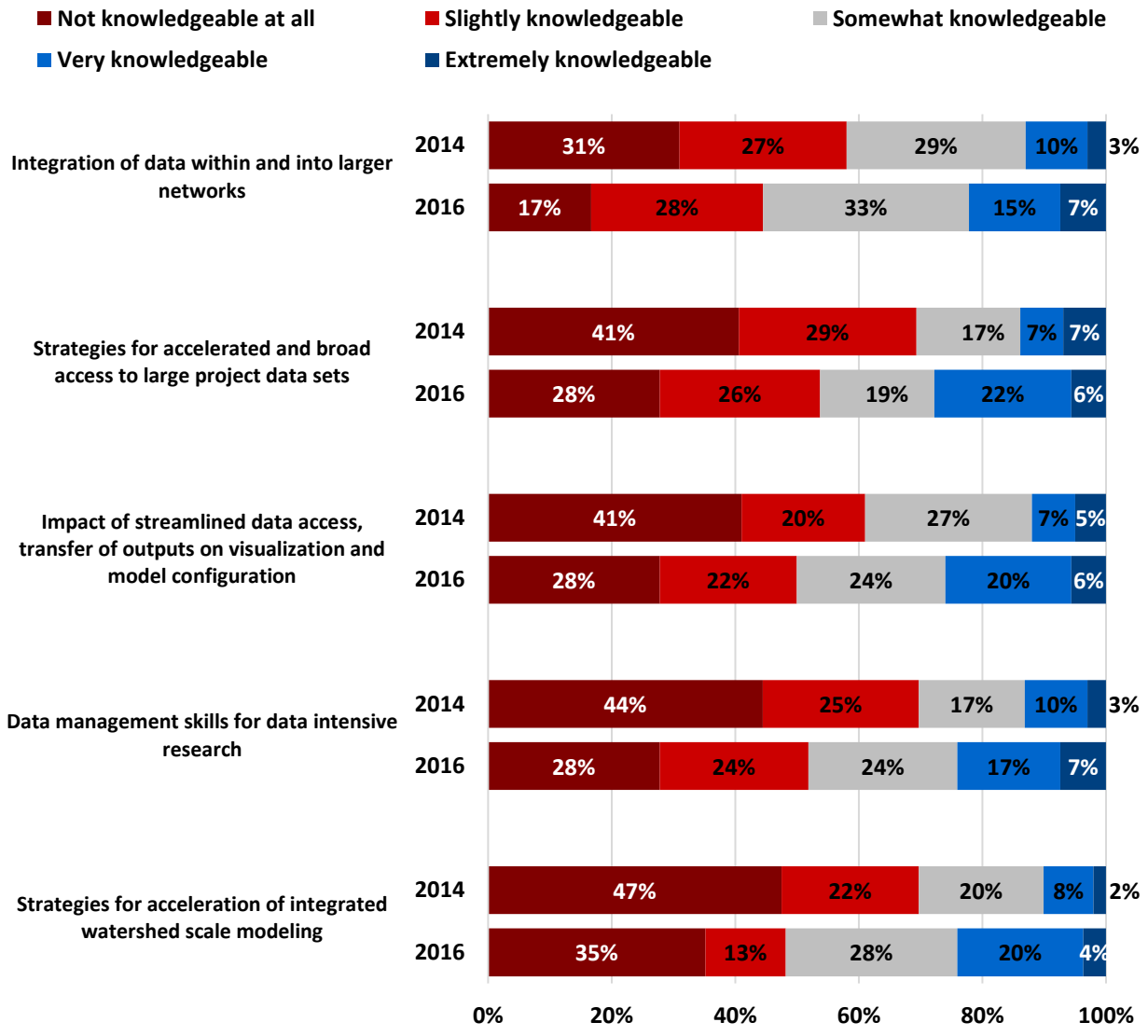
Goal 3: Streamline data intensive research through improved data management skills.

Component 3 Goal 3 objective is to:

1. Provide annual data management workshops for EPSCoR researchers and their students

As shown in Figure 16, participants (n = 55) rated knowledge of Component 3, on average, as *slightly knowledgeable* (2.53), which remained constant from Year 1 (2.10). Of the Component 3 objectives, participants experienced the largest gain in knowledge of "understanding of opportunities for streamlining data intensive research through improved data management skills," which remained at *slightly knowledgeable* from Year 1 (2.00) to Year 3 (2.51). "How data are integrated within and into larger networks" increased from *slightly knowledgeable* (2.27), in Year 1, to *somewhat knowledgeable* (2.68), in Year 3. None of the sub-objectives achieved statistically significant growth from 2014 to 2016. Breakdowns of participant responses are shown in Figure 16.

Figure 16. Component 3 knowledge



Component 4: Workforce Development

Goal 1: Engage university faculty and graduate students in interdisciplinary team-based watershed research, and broaden undergraduate student participation in STEM through modeling and visualization.

Component 4 Goal 1 objectives include:

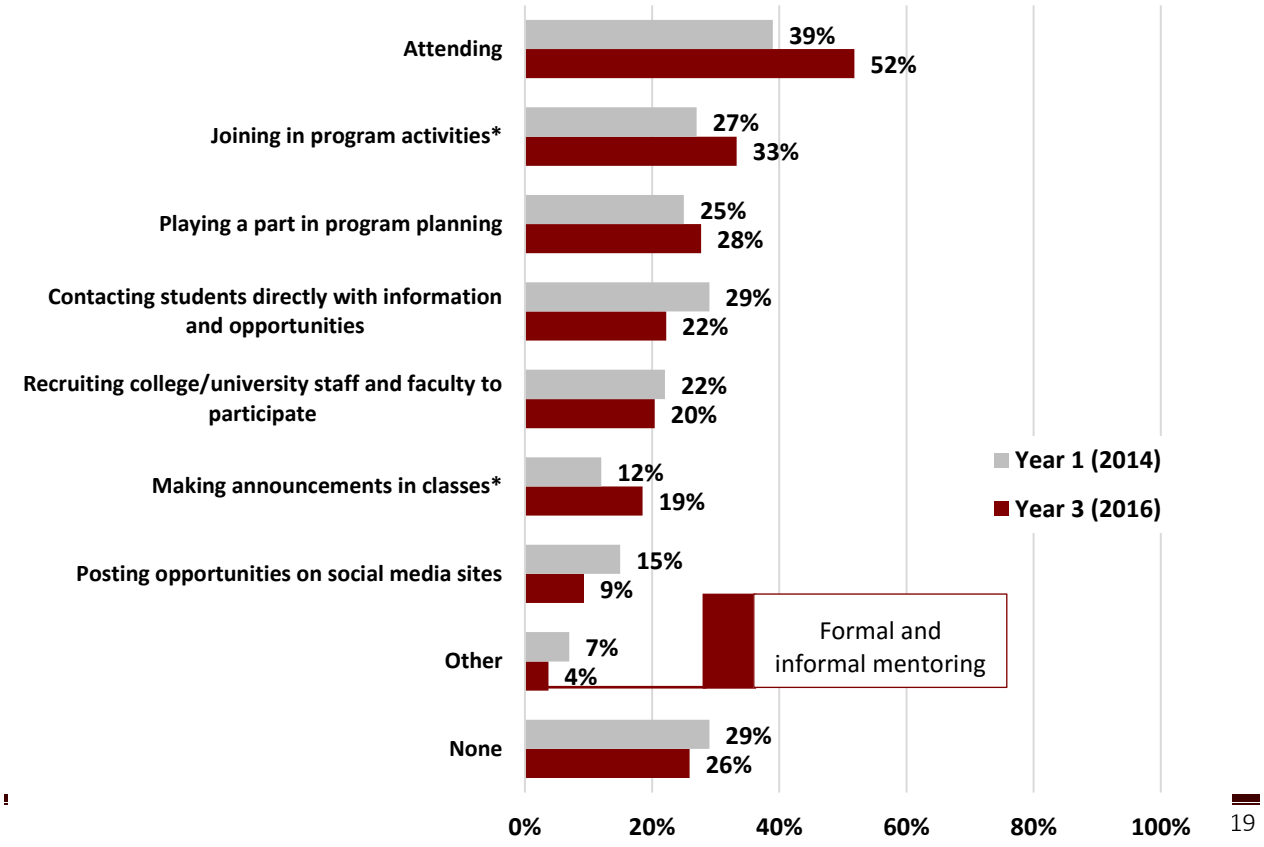
1. Develop a Graduate Interdisciplinary Training (GIT) Program
2. Develop an Undergraduate Visualization and Modeling Network (UVMN)

Project members were asked about their involvement in various aspects of workforce development. Four sets of items were presented to participants regarding their involvement in the following four domains:

- Collaborative fieldwork activities involving students and faculty
- Ongoing Graduate Interdisciplinary Training
- Capstone and Leadership Institute
- Undergraduate Visualization and Modeling Network

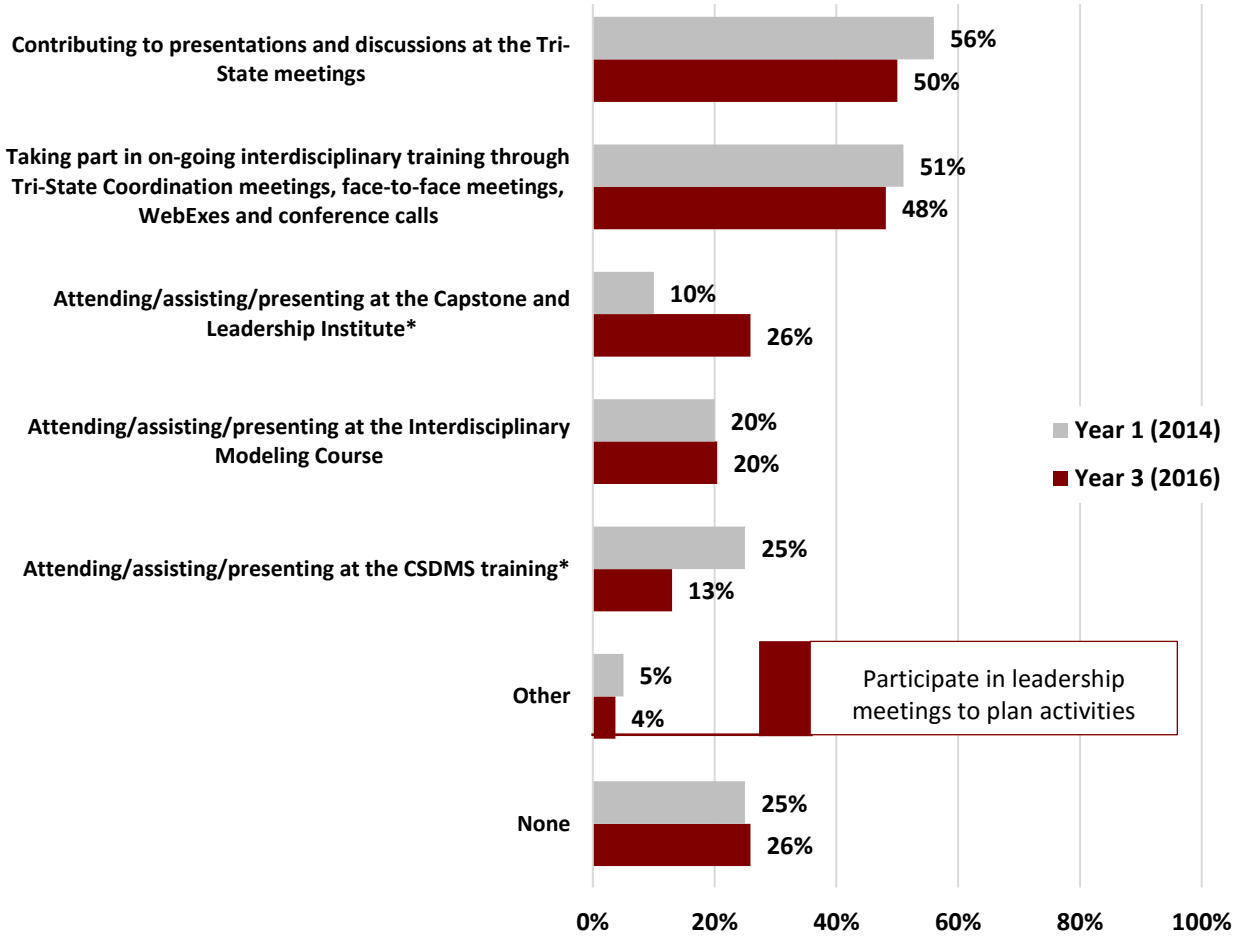
As shown in Figure 17, participants (n = 55) were asked how they "participate in collaborative fieldwork activities involving students and faculty such as pre-meeting camps." Compared to Year 1 of the project, the percentage of project members involved in, at least, one collaborative fieldwork activity, increased from 71% to 74%. Project members increased their "attend[ance]" of collaborative fieldwork activities the most, which increased from 39% in Year 1 to 52% in Year 3. Project members decreased their "contact [with] students directly with information and opportunities," which decreased from 29% in Year 1 to 22% in Year 3.

Figure 17. Component 4 (collaborative fieldwork) participation



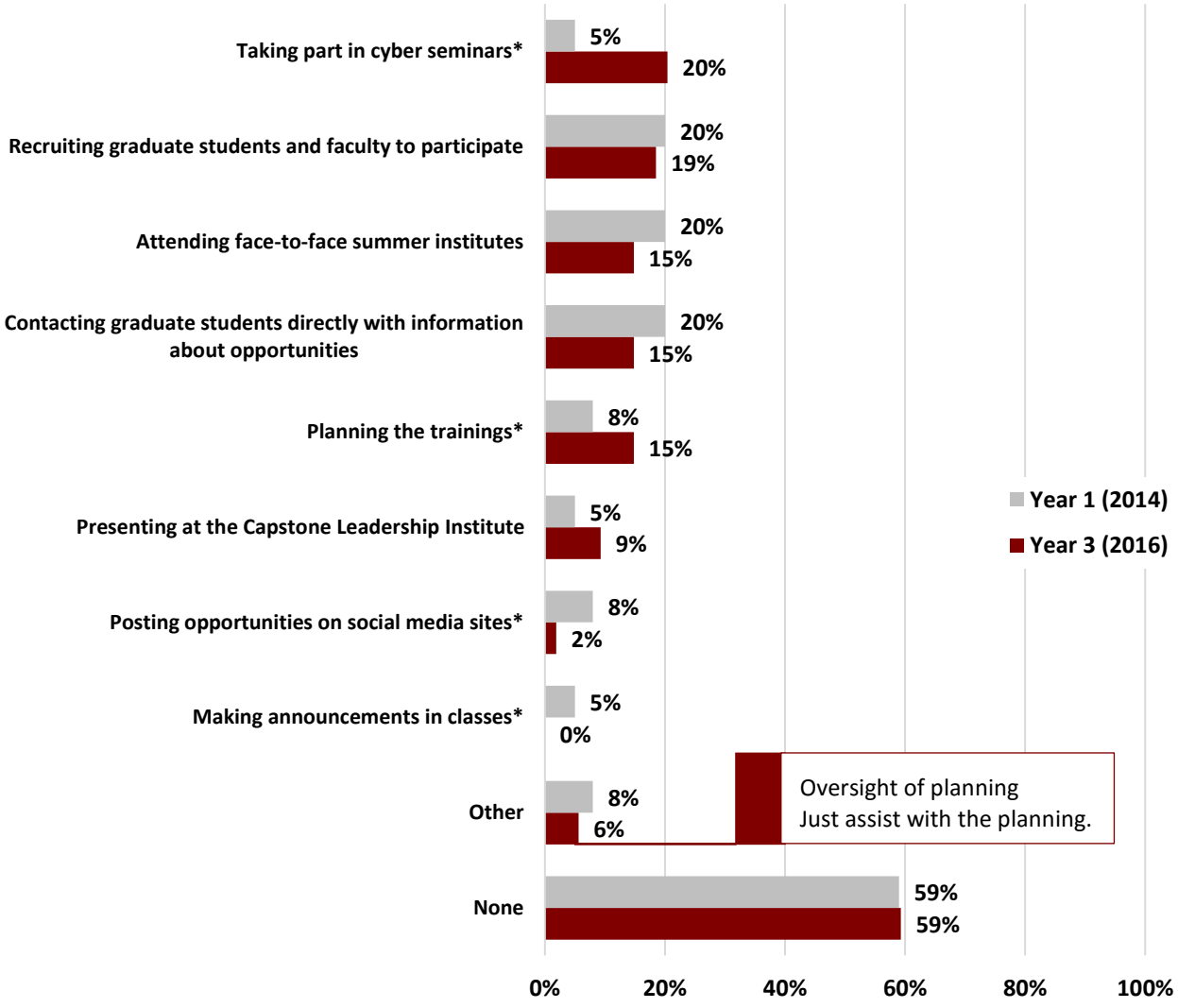
As shown in Figure 18, participants (n = 55) were also asked about how they "participate in ongoing Graduate Interdisciplinary Training." Compared to Year 1 of the project, the percentage of project members involved in, at least, one Graduate Interdisciplinary Training activity, decreased from 76% to 75%. Project members increased their "attend[ance]/assist[ance]/presenting at the Capstone and Leadership Institute" the most, which increased from 10% in Year 1 to 26% in Year 3. Project members decreased their "attend[ance]/assist[ance]/presenting at the CSDMS training," which decreased from 29% in Year 1 to 22% in Year 3.

Figure 18. Component 4 (Graduate Interdisciplinary Training) participation



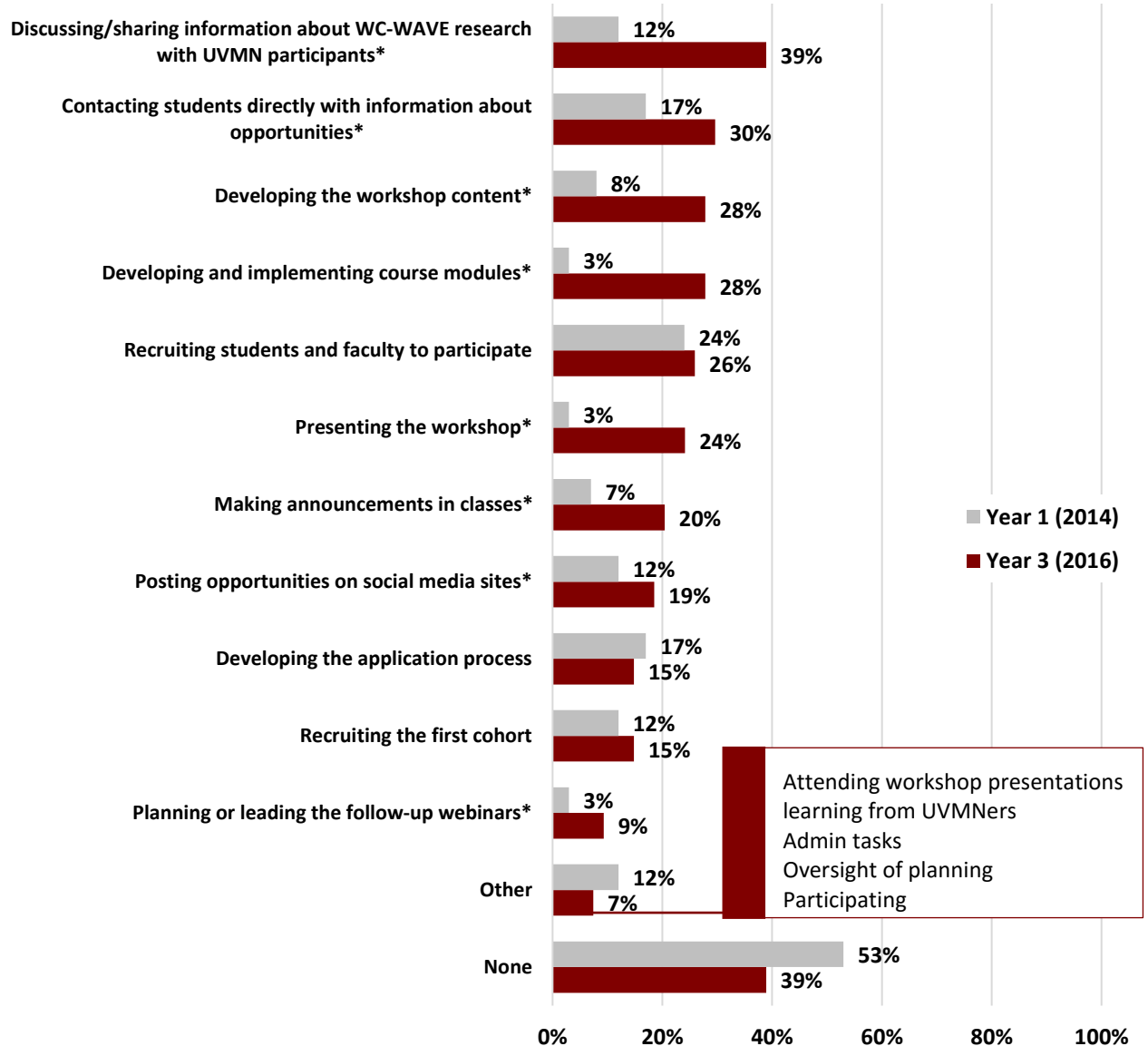
As shown in Figure 19, participants (n = 55) were, additionally, asked about how they "participate in the Capstone and Leadership Institute." Compared to Year 1 of the project, the percentage of project members involved in, at least, one Capstone and Leadership Institute activity, remained constant at 41% involvement. Project members increased in "taking part in cyber seminars" the most, which increased from 5% in Year 1 to 20% in Year 3. Project members decreased their "attending of face-to-face summer institutes" and "contacting graduate students directly with information about opportunities," which decreased from 20% in Year 1 to 15% in Year 3. Participants reported no involvement in "making announcements in classes," which dropped from 5% involvement in Year 3.

Figure 19. Component 4 (Capstone and Leadership Institute) participation



As shown in Figure 20, participants (n = 55) were then asked about how they "participate in the Undergraduate Visualization and Modeling Network (UVMN)." Compared to Year 1 of the project, the percentage of project members involved in, at least, one collaborative fieldwork activity, increased from 47% to 61%. Project members increased "discussing/sharing information about WC-WAVE research with UVMN participants" the most, which increased from 12% in Year 1 to 39% in Year 3. Project members decreased their involvement in "other" activities, which decreased from 12% in Year 1 to 7% in Year 3.

Figure 20. Component 4 (Undergraduate Visualization and Modeling Network) participation



Student education and career plans

The undergraduate and graduate students in the project were asked several questions about their future educational and career plans. Participant responses are displayed below.

Undergraduate students (n = 6)

What are your plans to apply to graduate school?

5 of 6 undergraduate students plan to attend graduate school.

1 of 6 was undecided

What area of study do you plan to purse in graduate school?

- Civil engineering (1)
- Environmental science (1)
- GIS and environmental science (1)
- Mathematics (1)
- Wildlife ecology (1)

Undergraduate students (n = 8) **Graduate students** (n = 11)

What are your plans to enter into the STEM workforce?

8 students plan to enter the STEM workforce (42%)

1 student did not plan on entering the STEM workforce (5%)

10 students were undecided (52%)

What STEM field they planned on entering?

- Environmental science (1)
- GIS analyst (1)
- Hydrology (4)
- Research geology (1)
- Wildlife research (1)

Do you feel prepared (*knowledge and skills*) to enter the STEM workforce?

100% of students feel prepared to enter the STEM workforce

Students with plans to enter the STEM workforce (n= 8)

Do you plan on working within the state?

4 students indicated they would stay within the state (50%)

1 student indicated they would not work in the state (13%)

3 students indicated they were undecided (38%)

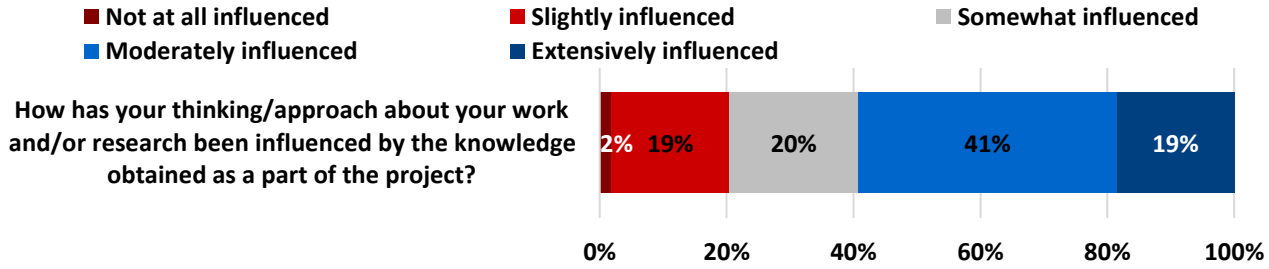
Impact on work

All participants in the project were asked three questions about the impact of the project on themselves and their work/research. The questions were as follows:

- How has your thinking/approach about your work and/or research been influenced by the knowledge obtained as a part of the project?
- Has the project fostered the creation of collaborative and/or multidisciplinary teams?
- What is the likelihood of you continuing to work in the partnerships and collaborations that you have formed as a result of the project?

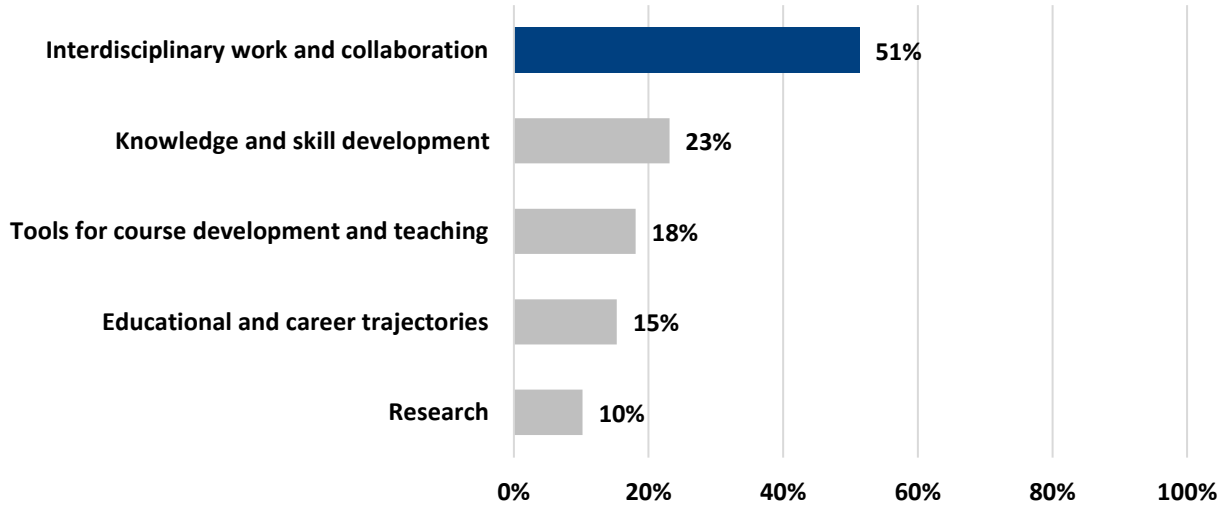
Participants (n = 55) were asked, "how has your thinking/approach about your work and/or research been influenced by the knowledge obtained as a part of the project?" Results are shown in Figure 21. A majority of project participants (60%) reported that they had been *moderately* or *extensively influenced* by the knowledge gained from the project.

Figure 21. Extent participant thinking/approach to work was influenced by project knowledge



The project participants (n = 55) were asked to elaborate on how the project has impacted their thinking/approach to work and/or research. Figure 22 displays the most commonly occurring impact areas and the percentage of comments containing the areas. "Interdisciplinary work and collaboration" was mentioned in 51% of participant comments, more than twice that of the next most mentioned impact area, "knowledge and skill development" (23%).

Figure 22. Participant reported areas of impact of project



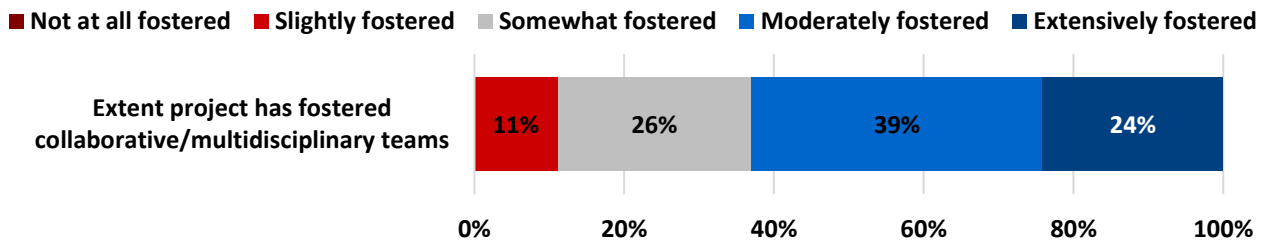
Exemplary comments from participants concerning areas of impact are shown below in Figure 23.

Figure 23. Participant comments on areas of impact

Impact Area	Comments
 **Research**	• *"Skills and information learned are applicable to both my work and research."* • *"My research has been influenced by the fact of making connections and sharing information and ideas with other researchers involved in watershed sciences."*
 **Knowledge and skill development**	• *"Learning about computer visualization has opened the door to making GIS and other computer programs less intimidating. "* • *"I am not a scientist, so I do not understand all of what they are doing. However, I have picked up more knowledge about watersheds and the VWP throughout the project."* • *"My use of online resources for data visualization was minimal before participating in UVMN. Now I am more aware of online resources, and I actively look for them."*
 **Interdisciplinary work and collaboration (opportunities, challenges, and skill development)**	• *"WC-WAVE has been a great model for promoting inter-institutional, inter-disciplinary team science."* • *"I do not perform watershed research or visualization for my work or research but I take value in the collaboration and believe I will apply some aspects of team work from the project to other places in my career."* • *"I was able to learn new online resources/applications useful to coordinating with large groups/research teams."* • *"It's prompted me to think about strategies for effective interdisciplinary work and collaboration and how to engage with other researchers."* • *"Through the face-to-face talk with professionals, I learnt the critical thinking and the challenges inter-discipline."* • *"I am more aware of the challenges and opportunities of interdisciplinary work."*
 **Tools for course development and teaching**	• *"I have been thinking more about how to improve interdisciplinary approaches in our undergraduate programs. I have incorporated mapping tools into several course modules."* • *"I greatly benefitted from the UVMN in understanding and using visualization as a learning delivery tool."* • *"This project influenced the choice of textbook for the semester, provided resources to overhaul the final semester project and enhanced several labs and lecture topics throughout the semester."*
 **Educational and career trajectories**	• *"This has helped me become more focused on where I am going with my education and degree. I now know I would like to be more involved with watershed research in internships and as I continue my education in graduate school."* • *"Before starting research, I had just a vague idea of my goals and plans. After engaging with faculty members, post-doc scholars and graduate students, I realized that doing research was perfect, not just for my learning style, but also for my goals."* • *"Doing research gave me the opportunity to network and learn from the same people that I would only see presenting lectures otherwise. In the end, I am now gearing all my efforts for a strong researcher career, even before finishing college."*

Next, participants (n = 55) were asked, "Has the project fostered the creation of collaborative and/or multidisciplinary teams?" As shown in Figure 24, a majority of the project participants (63%) felt that the project *moderately* or *extensively fostered* the creation of collaborative/ multidisciplinary teams. Participant exemplary quotes related to collaboration/multidisciplinary teams are displayed below.

Figure 24. Extent project has fostered collaborative/multidisciplinary teams



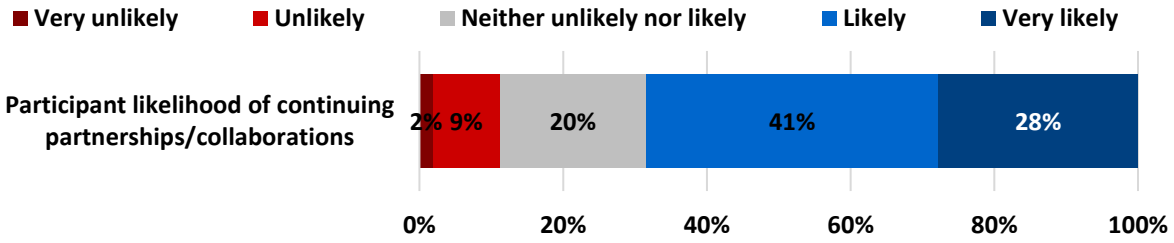
"WC-WAVE fostered extensive teamwork across state, institutional, and disciplinary boundaries; and strong interaction among graduate students and faculty."

"The project brought together faculty and students from different departments on campus. Without this project, we may not have worked together. We will be building on the relationships made through this project to continue building interdisciplinary components into various majors."

"The UVMN project has been a unique model of co-learning with faculty and students. In addition, there has been collaboration across teams as well."

Finally, participants (n = 55) were asked about the "likelihood of…continuing to work in the partnerships and collaborations…formed as a result of the project." As shown in Figure 25, a majority of participants (69%) stated that they were *likely* or *very likely* to continue working in the partnerships and collaborations formed as a part of the project.

Figure 25. Participant likelihood of continuing partnerships/collaborations



Participants commented on how the project facilitated transdisciplinary work through providing *communication* and *collaboration* opportunities. These exemplary comments are displayed below.

Communication and collaboration opportunities

- *"Learning to collaborate and communicate with each other in a group and come up with ideas."*
- *"In the Tristate meetings opportunities were given to form groups for discussing topics of interest and research ideas."*
- *"Attending meetings with, and discussing our projects."*
- *"It's a collaborative project, which means the efficient communication and understanding are as important as the technical skill we have."*
- *"Project has fostered tristate discussions on how best to address State diversity initiatives."*
- *"Folks from across disciplines were at least talking in meetings... not always effectively communicating though"*

Furthermore, participants commented on *outputs* that resulted from the projects collaborative efforts.

What came about as a result of collaborative efforts

Publications and proposals

- *"Several publications and proposals have resulted from the project."*
- *"We are making plans to submit future proposals."*
- *"We're talking about publishing some of our work as a collective"*

3.4 Overview of activity key findings and recommendations

A. Project activity for Components 2 & 3 (Cyberinfrastructure)

Displayed in Figure 26 are the project activities conducted under the Cyberinfrastructure (Data Management/Services & Visualization) during project years 1, 2, and 3. A star (*) denotes the year the corresponding activity was offered. Demographic participation, key findings and recommendations from the evaluations conducted for these activities are also summarized in Figure 26. Key findings and recommendations that are reported are from when an activity was last held or conducted.

Figure 26. Components 2 & 3 activities (key findings and recommendations)

Project year offered			Key Findings	Recommendations
2013-14	2014-15	2015-16		
Community Surface Dynamics Modeling System (CSDMS) Training (with Watershed Science Component)				
*			• Women comprised 44% of CSDMS participants. • African Americans, American Indians, and Hispanics/Latinos were under represented compared to WC-WAVE participants. • 100% of program components were rated *very* or *extremely useful* • Participants showed statistically significant gains for 75% of knowledge gains related to the training objectives.	• Efforts should be made to recruit URMs as well as to encourage attendance of current students who are underrepresented minorities and/or female. • Integrate audience engagement strategies into the workshop. • Focus on the input and output targets for model wrapping and model integration challenges and solutions.

B. Project activity for Component 4 (Workforce Development)

Displayed in Figure 27 are the project activities conducted under the Workforce Development component during project years 1, 2, and 3. A star (*) denotes the year the corresponding activity was offered. Demographic participation, outcome findings and recommendations from the evaluations conducted for these activities are also summarized in Figure 27. Key findings and recommendations that are reported are from when an activity was last held or conducted.

Figure 27. Component 4 activities (key findings and recommendations)

Project year offered			Key Findings	Recommendations
2013-14	2014-15	2015-16		
Undergraduate Visualization and Modeling Network [*No evaluation conducted in Year 3, key findings and recommendations are from Year 2]*				
*	*	*	• American Indians were well represented; Women, Hispanics, and African Americans were underrepresented compared to WC-WAVE participants. • All Morning and Afternoon sessions were rated extremely useful and the Mentor Mixer was rated very useful. However, the Discovery Field Trip and WC-WAVE Conference were low-rated and poorly attended. Comments suggest extending the course to one week due to the overabundance of information presented. • Participants extremely satisfied with 100% of logistics. • Participants reported statistically significant knowledge gains in all objectives.	• Focus on recruitment of Hispanic participants. • Track students' progress from one level of education) to the next (e.g. undergraduate to graduate if they remain active in WC WAVE activities. • Document the activities (such as meetings and research progress) of the watershed – based research groups. Share these with the group as a whole. • Add opportunities throughout the year for UVMN participants to implement what they learn in their summer workshops.
Snow Camp (with Watershed Science Component)				
*			• On average, logistical aspects of the camp were rated highly (4.5/5.0). • On average, all four program aspects were rated *very* or *extremely useful*. • Participants had knowledge gains in all program objectives and statistically significant gains were seen in 85% of objectives. • Participants showed gains in their interest in pursuing STEM careers.	• Send information on topics before the camp and holding a follow-up session after returning • Give students more opportunities to develop connections with faculty to discuss their research, future research opportunities, and how their interests align with faculty research and the WC-WAVE project.
Stream Flow Camp (with Watershed Science Component)				
*			• African Americans, American Indians and Hispanics/Latinos were under	• Increase outreach attend Stream Flow

Project year offered			Key Findings	Recommendations
2013-14	2014-15	2015-16		
			represented compared to WC-WAVE participants. • Participants were *very* or *completely satisfied* with most (89%) logistical aspects of the Stream Flow Camp. • 100% of program components were rated *very* or *extremely useful*. • Faculty participants composed 27% of the total group, with graduate students composing 64%. • Participants demonstrated statistically significant knowledge gains in 100% of program objectives.	Camp and the other field experiential activities for under-represented minority and first-generation college students. • Provide background information, educational links, and current publications on topics to attendees prior to camp to support them in their preparation. • Consider creating small groups and providing more challenging measurement work in future iterations of the program.
Interdisciplinary Modeling Course				
	*		• Women and Hispanics were underrepresented compared to Nevada, Idaho, and New Mexico higher education student populations. • American Indians and African Americans were well represented compared to Nevada, Idaho, and New Mexico higher education student populations. • Most participants rated course logistics as *good* or *excellent*. • Participants reported statistically significant gains in 66.6% (four of the six) course components. • 33.3% (two of six) course components did not achieve statistically significant gains.	• Focus recruiting efforts on Hispanic participants. • Create systems to track students' progress from one level of education to the next (e.g. undergraduate to graduate) if they remain active in WC-WAVE activities.

C. Project-wide meetings

Figure 28 displays project-wide meetings conducted for all members of the project. A star (*) denotes the project year the project-wide activity was offered. The demographic participation, key findings and recommendations from the evaluations conducted for these activities are summarized in Figure 28. Key findings and recommendations that are reported are from when an activity was last held or conducted.

Figure 28. Project-wide meetings, key findings, and recommendations

Project year offered			Key Findings	Recommendations
2013-14	2014-15	2015-16		
WC-WAVE Annual Meeting				
*	*	*	• Females, American Indians, and African Americans were well-represented at the Consortium Annual Meeting compared to WC-WAVE project participants. • Hispanics/Latinos were underrepresented, compared to WC-WAVE project participants. • Pacific Islanders/Native Hawaiians were not represented. • All aspects of the Consortium's Annual Meeting were perceived by attendees as beneficial. The highest rated session was the Working Groups (4.51/5.00), while the Virtual Watershed Presentation training session (3.16/5.00) was the lowest rated. • In comparing pre-post scores related to knowledge, attendees reported significant gains in all areas. The lowest scored item in both the pre (2.20/5.00) and post (3.13/5.00) scores was the knowledge item 'my ability to interact with the virtual watershed platform in a way this is beneficial to me'. • Attendees cited opportunities to celebrate success, learn, generate new ideas, as well as discuss and collaborate with other attendees, as benefits of the Consortium's Annual Meeting. • Of those who participated in the survey, 92% indicated that they have viewed (or viewed/ presented) the UVMN presentations featured at the Consortium's Annual Meeting. All meeting attendees stated their experiences, both as presenters and/or viewers, as beneficial.	• Build on existing strengths, and formulate new strategies, in efforts toward recruiting, retaining, and supporting the advancement of URM and females. • Build on the success of the Consortium Annual Meeting, including the UVMN presentations, as an effective format to foster cross-team and cross-state collaboration. • Explore other mediums to educate WC-WAVE participants about the virtual watershed platform. • Devise strategies to mobilize and implement paper and proposal ideas and collaborations proposed at the Consortium Annual Meeting. • Ensure there are formalized mechanisms in place to follow through on next steps established by working groups at the Consortium's Annual Meeting.

Project year offered			Key Findings	Recommendations
2013-14	2014-15	2015-16		
WC-WAVE Virtual Meeting				
*	*	*	• The demographics of meeting attendees were fairly representative of the project's demographics, with a few exceptions: American Indian members were well-represented (10%) and Hispanic/Latino members were underrepresented (3%), both in comparison to the project's members. • Female participants were representative of project membership (43%). • No African American participants were present at the meeting. • All of the logistics of the meeting were rated well by meeting attendees, with 54% of attendees *very satisfied* with them. • A majority of participants found each of the three session *very* or *extremely useful*. "Capstone planning" was the lowest rated session in usefulness to participants (3.97/5.00). This was due to some attendees feeling that the session could have been facilitated more efficiently through another medium. • Despite most attendees starting with high levels of knowledge of meeting objectives, gains were experienced. Three of the gains experienced achieved statistical significance at ($p < .05$).	• Seek out more efficient ways to facilitate team building through other channels, such as at in-person meetings or through email. • Provide detailed session information to project members, such as providing a more comprehensive meeting agenda, to ensure relevance and meaningfulness of sessions to members of the project. • Continue to utilize online methods to disseminate information about future meetings and expectations of project reporting guidelines and deliverables, e.g. creating a project dropbox or other online sharing platform that contains schedules for future meetings, reporting and deliverable guideline documentation.
WC-WAVE Summer Meeting				
*	*		• American Indians were well represented compared to WC-WAVE project participants; Women, Hispanics, and African Americans were underrepresented compared to WC-WAVE project participants. • All Morning and Afternoon sessions were rated *extremely useful* and the Mentor Mixer was rated *very useful*. However, the Discovery Field Trip and WC-WAVE Conference were low-rated and poorly attended. Comments suggest extending the course to one week due to the overabundance of information presented. • Participants were *extremely satisfied* with 100% of logistics. • Participants reported statistically significant knowledge gains in all objectives.	• Focus recruitment efforts on Hispanic participants. • Add opportunities throughout the year for UVMN participants to implement what they learn in their summer workshops.

3.5 Project Sustainability Assessment Tool (PSAT)

As part of the evaluation activities, project team members completed the Program Sustainability Assessment Tool (PSAT). The PSAT assesses project sustainability and demonstrates which project areas may need more of a sustainability focus.

A. Background of the assessment tool

Eight project leaders, including the project director and four component leads, completed the Program Sustainability Assessment Tool (PSAT). The PSAT (https://sustaintool.org) assesses the extent to which a project has processes and structures in place that will increase the likelihood of project sustainability. The PSAT defines capacity for sustainability as the ability to maintain programming and its benefits over time. According to the researchers at the University of Washington, St. Louis, who developed the PSAT Framework, eight key domains are believed to influence a program's capacity for sustainability.

Domains	Domain Descriptions
Program Evaluation	Assessing your program to inform planning and document results
Program Adaptation	Taking actions that adapt your program to ensure its ongoing effectiveness.
Organizational Capacity	Having the internal support and resources needed to effectively manage your program
Environmental Support	Having a supportive internal and external climate for your program
Strategic Planning	Using processes that guide your program's directions, components, and strategies.
Communications	Strategic communication with stakeholders and the public about your program.
Partnerships	Cultivating connections between your program and its stakeholders.
Funding Stability	Establishing a consistent financial base for your program

Building program sustainability capacity requires assessment and planning. The PSAT was designed to identify a program's areas of sustainability strength and challenge. Program leadership can then use results from this assessment to inform sustainability planning.

B. Overall project sustainability

Project leaders rated the WC-WAVE project's capacity for sustainability across the eight domains on a scale of 1-7, 1 = *to little or no extent*, 7 = *to great extent*. Ratings can be considered to trend towards positive or negative based on the following scale:

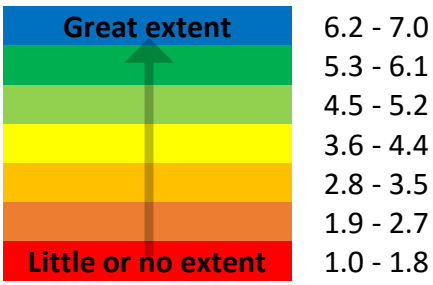


Figure 29 contains the PSAT domains and their ratings for both 2014 and 2016, as well as the point change between the two disseminations of the PSAT. Overall, the project increased its sustainability capacity by 7% (4.1 [2014] to 4.4 [2016]). Of all of the components in the PSAT, 13 (33%) increased in qualitative level, 24 (60%) remained the same, and 3 (8%) decreased in

qualitative level. Domains with the highest ratings were *program evaluation, program adaption,* and *organizational capacity*. Domains with the lowest ratings were *partnerships* and *funding stability*. The domain with the largest increase is *Environmental Support*, which increased from 4.2 to 4.6, a 10% increase from 2014 to 2016.

Figure 29. Sustainability capacity domains by rating

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Overall Capacity for Sustainability	**4.1**	**4.4**	**+0.3**
Program Evaluation	**5.3**	**5.9**	**+0.6**
Program Adaptation	**5.7**	**5.7**	**+0.0**
Organizational Capacity	**5.5**	**5.5**	**+0.0**
Environmental Support	**4.2**	**4.6**	**+0.4**
Strategic Planning	**3.6**	**3.9**	**+0.3**
Communications	**3.2**	**3.6**	**+0.4**
Partnerships	**2.9**	**3.1**	**+0.2**
Funding Stability	**2.7**	**2.6**	**-0.1**

The individual components of each domain were analyzed individually to determine areas of strength and weakness within each domain. Each of the eight domains are presented in order from highest to lowest overall mean rating.

Program evaluation

Program evaluation is defined by the PSAT as assessing your program to inform future planning. Indicators within the program evaluation domain are displayed in Figure 30. This domain experienced the highest overall rating gain with an 11% increase. *Evaluation results inform project planning and implementation* was rated highest in 2016. *The project provides strong evidence to the public that the program works* received the lowest rating in both 2014 and 2016. *Project evaluation results are used to demonstrate successes to funders and other key stakeholders* had the largest increase among ratings, a 33% increase.

Figure 30. Program evaluation domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Program Evaluation	**5.3**	**5.9**	**+0.6**
Evaluation results inform project planning and implementation.	5.9	6.5	+0.6
The project reports short term and intermediate outcomes.	6.5	6.4	-0.1
The project has the capacity for quality program evaluation.	5.7	6.3	+0.6
Project evaluation results are used to demonstrate successes to funders and other key stakeholders.	4.5	6.0	+1.5
The project provides strong evidence to the public that the program works.	4.1	4.3	+0.2

Program adaptation

Program adaptation is defined as taking actions that adapt your program to ensure its ongoing effectiveness. Indicators within the program adaptation domain are displayed in Figure 31. *The project adapts strategies as needed* received the highest score in both 2014 and 2016. *The project makes decisions about which components are ineffective and should not continue* received the lowest rating in both 2014 and 2016. *The project periodically reviews the evidence base* received the highest rating increase, a 2% increase.

Figure 31. Program adaptation domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Program Adaptation	**5.7**	**5.7**	**+0.0**
The project adapts strategies as needed.	6.1	6.1	+0.0
The project adapts to new science.	5.8	5.8	+0.0
The project proactively adapts to changes in the environment.	5.7	5.6	-0.1
The project periodically reviews the evidence base.	5.5	5.6	+0.1
The project makes decisions about which components are ineffective and should not continue.	5.3	5.3	+0.0

Organizational capacity

Organizational capacity is defined as having the internal support and resources needed to effectively manage your program. Indicators within the organizational capacity are displayed in Figure 32. *The project has adequate staff to complete the project's components* received the highest ratings in 2016. *Leadership effectively articulates the vision of the program to external partners* received the lowest rating. *The project has adequate staff to complete the project's components* received the highest rating increase, a 9% increase.

Figure 32. Organizational capacity domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Organizational Capacity	**5.5**	**5.5**	**+0.0**
The project has adequate staff to complete the project's components.	5.5	6.0	+0.5
Leadership efficiently manages staff and other resources.	6.0	5.9	-0.1
Organizational systems are in place to support the various project needs.	5.6	5.4	-0.2
The project is well integrated into the operations of the organization.	5.9	5.3	-0.6
Leadership effectively articulates the vision of the project to external partners.	4.6	4.9	+0.3

Environmental Support

Environmental support is defined as having a supportive internal and external climate for your program. Indicators within the environmental support domain are displayed in Figure 33. *Champions exist who strongly support the project* received the highest ratings in 2016. *The project has strong public support* received the lowest rating. *The project has leadership support from outside of the organization* received the highest rating increase, a 24% increase.

Figure 33. Environmental support domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Environmental Support	**4.2**	**4.7**	**+0.4**
Champions exist who strongly support the project.	4.6	5.3	+0.7
The project has leadership support from within the larger organization.	5.4	5.0	-0.4
The project has strong champions with the ability to garner resources.	4.3	4.6	+0.3
The project has leadership support from outside of the organization.	3.7	4.6	+0.9
The project has strong public support.	2.8	3.4	+0.6

Strategic planning

Strategic planning is defined as using processes that guide your program's directions, components, and strategies. Indicators within the strategic planning domain are displayed in Figure 34. *The project plans for future resource needs* received the highest ratings in both 2014 and 2016. *The project has a long-term financial plan* received the lowest rating. *The project's components are understood by all stakeholders* received the highest rating increases, 16% increase.

Figure 34. Strategic planning domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Strategic Planning	**3.6**	**3.9**	**+0.3**
The project plans for future resource needs.	4.5	4.6	+0.1
The project's components are understood by all stakeholders.	3.7	4.3	+0.6
The project clearly outlines roles and responsibilities for all stakeholders.	3.8	3.9	+0.1
The project has a sustainability plan.	3.4	3.5	+0.1
The project has a long-term financial plan.	2.7	3.1	+0.4

Communications

Communications is defined as strategic communication with stakeholders and the public about your program. Indicators within the communications domain are displayed in Figure 35. *The project has communication strategies to secure and maintain public support* received the highest ratings in 2016. *The project increases community awareness of the issue* received the lowest rating. *Project staff communicate the need for the project to the public* received the highest rating increase, a 27% increase.

Figure 35. Communication domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Communications	**3.2**	**3.9**	**+0.4**
The project has communication strategies to secure and maintain public support.	3.3	3.9	+0.6
The project is marketed in a way that generates interest.	3.5	3.8	+0.3
Project staff communicate the need for the project to the public.	3.0	3.8	+0.8
The project demonstrates its value to the public.	2.9	3.5	+0.6
The project increases community awareness of the issue.	3.2	3.4	+0.2

Partnerships

Partnerships are defined as cultivating connections between your program and its stakeholders. Indicators within the partnerships domain are displayed in Figure 36. *Diverse community organizations are invested in the success of the project* received the highest rating in 2016. *The community is engaged in the development of project components* received the lowest rating. *Diverse community organizations are invested in the success of the project* received the highest rating increase, a 23% increase.

Figure 36. Partnerships domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Partnerships	**2.9**	**3.3**	**+0.2**
Diverse community organizations are invested in the success of the project.	3.1	3.8	+0.7
The project communicates with community leaders.	3.2	3.5	+0.3
Community members are passionately committed to the project.	2.7	3.2	+0.5
Community leaders are involved with the project.	3.0	2.6	-0.4
The community is engaged in the development of project components.	2.5	2.3	-0.2

Funding Stability

Funding stability is defined as establishing a consistent financial base for your program. Indicators within the funding stability domain are displayed in Figure 37. *The project exists in a supportive state economic climate* received the highest ratings in both 2014 and 2016. *The project has sustained funding* received the lowest rating. *The project implements policies to help ensure sustained funding* received the highest rating increase, a 3% increase.

Figure 37. Funding stability domain ratings

PSAT Domain	2014 Ratings	2016 Ratings	Change 2014-2016
Funding Stability	**2.7**	**2.7**	**-0.1**
The project exists in a supportive state economic climate.	4.0	4.0	+0.0
The project implements policies to help ensure sustained funding.	3.5	3.6	+0.1
The project is funded through a variety of sources.	2.4	1.9	-0.5
The project has a combination of stable and flexible funding.	1.9	1.8	-0.1
The project has sustained funding.	1.7	1.6	-0.1

Section 4. Overall project findings and recommendations

Based on the results of this evaluation, the following is a complete summary of key findings and recommendations for the WC-WAVE EPSCoR project. Specifically, the following is based on the results of the baseline Program Sustainability Assessment Tool (PSAT) administered in November 2014, the post PSAT administered in July 2016, and recommendations the External Evaluator discerned from their 3-year involvement in the WC-WAVE project. Recommendations are designed to focus and inform the direction of the WC-WAVE project as it moves into its no-cost-extension-year (2016-2017).

Findings	Recommendations
Sustainability	

• The project currently has an overarching vision and *Benchmarks* and *Milestones documents* that informed directions in Years 1-3. A refined direction specific to the no-cost-extension year (and beyond) is outlined in the submission that provided to the NSF for a no-cost-extension year.
• Sustainability directions based on PSAT results on currently in place.
• No external evaluator will be utilized for the no-cost-extension year. It is unclear if the project has plans to evaluate some key activities (*internally*) in the project's no-cost-extension year.
	• Ensure the refined directions specific to the no-cost-extension year (and beyond) as outlined to the NSF are operational (i.e. clearly outlines what precisely will be done, who will do it and by when). Within this, review the results of the PSAT to inform planning specific to sustainability.
	• In determining whether current project activities should be continued and which should be scaled down or eliminated, strategically assess: breadth (*how many*), depth (*how great of impact*) and potential for sustainability (*what is the chances of continuation beyond the no-cost-extension year*).
	• Identify formal and informal state-specific champions within the program. Consider having this group form a Community of Practice/Working Group that could extend beyond the no-cost extension year.
	• To support the continuation/legacy of the WC-WAVE project, inform and formal teams, working groups and/or Communities of Practice developed over the duration of the project or within the no-cost extension year should continue to:
	  ○ Explore funding sources specific to their institutions
	  ○ Actively submit research proposals
	  ○ Explore other NSF funding sources (i.e. REU's)
	  ○ Explore unique funding streams that focus on supporting interdisciplinary teams/team science projects

Component 1: Watershed Science, Component 2: Cyberinfrastructure: Data Management and Services, Component 3: Cyberinfrastructure: Visualization & Sustainability	
• Project currently has Benchmarks and Milestone that outline project components (1, 2 & 3) for Years 1 to 3.	• Continue collaborative research activities (Components 1, 2 and 3) as planned in the (revised) operationally-based plan. • Explore the potential of leveraging existing capabilities made possible through the CSDMS Web Modeling Toolkit and Basic Model Interface (previously supported by the NSF) within the Virtual Watershed platform. This will ensure redundancies are reduced and that the VWP remains relevant moving forward.
Objective 4: Workforce development & sustainability	
• Project currently has Benchmarks and Milestone that outline project components (4) for Years 1 to 3.	• Consider building off the existing Nevada, Idaho and New Mexico STEM website that provide pipeline resources and visually map a workforce STEM pipeline for (Idaho, New Mexico, Nevada) and assess the ways in which the project has contributed to the pipeline and where there are gaps in Tristate's contribution to the pipeline in each of the respective states. • Identify a champion(s) that could continue to advocate the growth of the project's STEM educational and workforce trajectories. Ideally this champion(s) would have a long-term investment in their respective state's STEM educational-workforce trajectories, so that their involvement could extend beyond the scope of the project. Their role could include leveraging support within their respective state's educational institution (or other relevant community groups or institutions) around the project's next steps re: STEM educational and workforce trajectories.

Appendix A. PSAT indicators by rating

ES (Environmental Support)	**FS** (Funding Stability)	**P** (Partnerships)	**OC** (Organizational Capacity)
PE (Program Evaluation)	**PA** (Program Adaptation)	**C** (Communications)	**SP** (Strategic Planning)

Domain	Indicator	Rating
PE	Evaluation results inform project planning and implementation.	6.5
PE	The project reports short term and intermediate outcomes.	6.4
PE	The project has the capacity for quality program evaluation.	6.3
PA	The project adapts strategies as needed.	6.1
PE	Project evaluation results are used to demonstrate successes to funders and other key stakeholders.	6.0
OC	The project has adequate staff to complete the project's components.	6.0
OC	Leadership efficiently manages staff and other resources.	5.9
PA	The project adapts to new science.	5.8
PA	The project proactively adapts to changes in the environment.	5.6
PA	The project periodically reviews the evidence base.	5.6
OC	Organizational systems are in place to support the various project needs.	5.4
PA	The project makes decisions about which components are ineffective and should not continue.	5.3
OC	The project is well integrated into the operations of the organization.	5.3
ES	Champions exist who strongly support the project.	5.3
ES	The project has leadership support from within the larger organization.	5.0
OC	Leadership effectively articulates the vision of the project to external partners.	4.9
ES	The project has strong champions with the ability to garner resources.	4.6
ES	The project has leadership support from outside of the organization.	4.6
SP	The project plans for future resource needs.	4.6
PE	The project provides strong evidence to the public that the program works.	4.3
SP	The project's components are understood by all stakeholders.	4.3
FS	The project exists in a supportive state economic climate.	4.0
SP	The project clearly outlines roles and responsibilities for all stakeholders.	3.9
C	The project has communication strategies to secure and maintain public support.	3.9
C	The project is marketed in a way that generates interest.	3.8
C	Project staff communicate the need for the project to the public.	3.8
P	Diverse community organizations are invested in the success of the project.	3.8
FS	The project implements policies to help ensure sustained funding.	3.6
SP	The project has a sustainability plan.	3.5
C	The project demonstrates its value to the public.	3.5
P	The project communicates with community leaders.	3.5
ES	The project has strong public support.	3.4
C	The project increases community awareness of the issue.	3.4
P	Community members are passionately committed to the project.	3.2
SP	The project has a long-term financial plan.	3.1
P	Community leaders are involved with the project.	2.6

Domain	Indicator	Rating
P	The community is engaged in the development of project components.	2.3
FS	The project is funded through a variety of sources.	1.9
FS	The project has a combination of stable and flexible funding.	1.8
FS	The project has sustained funding.	1.6