

Part I – Principal Investigator Report

A. Participants

Our GK-12 Program, *Graduate Teaching Fellows in STEM High School Education: An Environmental Science Learning Community at the Land-Lake Ecosystem Interface* will complete year two of NSF funding in May 2010. This document serves as our annual report for the time period from April 2009-June 2010.

1. *Senior Personnel (Table 1)* The PI (Stepien) and the four co-PIs (Bridgeman, Gruden, Fisher, and Moorhead) shared the project's responsibilities throughout the year with each assuming different roles. The program manager (Lohner) handled the logistics of the grant and the program evaluator (Mentzer) handled our evaluation. The lead PI (Stepien) was in charge of program coordination and teamwork, and led the fall 2009 course for the fellows and the Environmental Science Learning Community and GK-12 group meetings throughout the year. Gruden was the lead co-PI, led the spring 2010 course for the fellows, and also helped to coordinate the summer training, focusing on teaching method development and fellow-teacher teamwork. Fisher taught a very successful summer 2009 one-week training course for the teachers and fellows, focusing on a glacial geology theme in relation to the schoolyard streams.

2. *Graduate Fellows (Table 2a and 2b)* Our second cohort of graduate fellows began in May 2009, consisting of six returning fellows who continued from our initial 2008-9 cohort and two new fellows. Specifically, we replaced a M.S. student fellow who graduated and a Ph.D. student who relocated to Washington D.C. with her husband to write her dissertation. Seven of our eight 2009-10 cohort fellows were Ph.D. candidates and one was an M.S. student. Each fellow was paired with a science teacher from seven area high schools along an urban-suburban gradient (including four school districts). All schools participated in Student Watershed Watch and the Lake Erie Center's high school student research poster gala. Most schools participated in the regional Science Fair, which was not typical of those schools prior to our GK-12 program.

3. *Organizational Partners (Table 3)* Our fellows are all placed in Toledo, Ohio area high schools, which span four school districts and are varied in terms of student composition, diversity, socioeconomics, and academics as well as school setting. Each fellow-teacher team has a unique interaction and designs his/her own plan for the best ways to utilize the fellow in the classroom, with oversight by the management team. Each team has some required activities that they participate in (including the Student Watershed Watch program), but they are free to be creative with the rest of their time. All teams regularly develop creative hands-on activities and participatory active learning exercises. They share these with the other teacher-fellow teams during our monthly learning community meetings.

4. *Other Collaborators (Table 4)* A primary goal of our program is the establishment of an exciting and stimulating Environmental Science Learning Community. All GK-12 team members actively engage in a monthly meeting exchange, casual dinner, and seminar presentation by an area scientist to the Learning Community, along our central program theme. Our Learning Community members work for federal and state conservation and management agencies, non-profit environmental groups, citizen conservation organizations, and other universities. The program PI is the director of the University of Toledo's field station, The Lake

Erie Center (LEC), whose mission is research and education. The LEC provides extensive support to the GK-12 program in terms of infrastructure, supplies, field trips, and the coordination and funding of the Learning Community Lecture Series. Our university contributes to our program in terms of infrastructure and tuition waivers. NSF provides the funding essential to our GK-12 program.

B. Project Summary

1. Goals and Activities - A main goal of our program is to build an Environmental Science Learning Community at the land-lake ecosystem interface. Through this learning community, we build student STEM skills through developing hands-on solutions for environmental problems in local schoolyard streams and waterways feeding the Great Lakes. We plan to continue our work as a permanent, internally supported GK-12 program in the Departments of Environmental Sciences and Civil Engineering. Our GK-12 program links collaborative watershed research projects and builds on the existing high school Student Watershed Watch program (SWW) (www.maumeerap.org/SWW) developed by the Toledo Metropolitan Area Council of Governments (TMACOG) that originally was founded by a former University of Toledo Professor (now deceased). Our GK-12 graduate fellows, teachers, and high school students together gain hands-on environmental science research experience and appreciation of the history, social development, and future vitality of the Great Lakes region. We have seen the past two years of our GK-12 program develop into an inspiring synergy, resulting in a plethora of creative activities.

Through their GK-12 experience, our graduate fellows develop inquiry-based methods to improve their teaching competence, and build their communication, collaboration, mentoring, and team-building skills. They translate research experience from their STEM graduate studies into mentoring high school students in meaningful research projects towards resolving environmental problems. For example, Ph.D. fellow Todd Crail built a running stream flow model with his minority Scott High School student mentees on the positive role of vegetation to decrease run-off. The students demonstrated and explained the stream flow model at our annual GK-12 high school student research poster gala at the Lake Erie Center in April 2010. Another example is that Ph.D. fellow Kristen DeVanna built a program at Ottawa Hills High School in which all 9th grade honors biology students conduct an independent research project and enter the regional Northwest Ohio Science Fair competition. As role models, fellows exemplify the excitement and the possibility of university studies and careers in STEM disciplines. In turn, fellows are gaining an enduring professional working relationship with K-12 education, broadening their career options and enhancing their ability to communicate their research to the public.

Our GK-12 high school teachers, through extensive professional development opportunities, are gaining experience in inquiry-based methods and exposure to state-of-the-art developments in STEM research knowledge to help meet and exceed content standards. During the summer, the teachers each spent a day shadowing their fellow through laboratory or field research related to the fellow's graduate work. They also partnered with the fellows in the week-long summer training course on geology of streams. As a consequence of our program, many of our teachers now are utilizing more advanced tools in the classrooms, including dichotomous identification keys for macroinvertebrates (notably the inner-city Scott and Start High Schools), classroom aquaria (Scott, Start, Northview), polymerase chain reaction diagnostics (TECHs and Start), and hypothesis design and experimental methods (Bowsher, Scott, Ottawa Hills, TECHs,

and Northview). Most of our schools now are participating in science fair projects, and many of the students have won awards and scholarships. The teachers are establishing long-lasting professional relationships with our professors, the graduate fellows, and the learning community members, and are gaining increased appreciation for scientific research and its integration.

Our high school students are developing their STEM skills within the broader environmental science learning community, gaining enriched learning experiences that lead to greater understanding of the nature and conduct of science inquiry and its integration as a means of exploring the world. They are engaging in hands-on environmental research and use of cyberinfrastructure in their individual science fair projects and classroom activities, mentored by the fellows. We reach ~420 high school students each year. The learning community links our GK-12 program with federal and state environmental agencies and community organizations, fostering change in society's foundations and strengthened and sustained partnerships in STEM.

a. *Training and Professional Development* Graduate fellows in our program enroll in a two credit hour seminar each semester throughout the academic year. Our Fall 2009 class titled, *Improving Student Watershed Watch for GK-12* was led by PI Stepien. The goal of this course was to improve the Student Watershed Watch program, by rewriting the instruction and background guide and developing a training power point presentation for use by the entire SWW program. Specifically, our fellows developed a quick guide for teachers entering the Student Watershed Watch program, and the data analysis procedure was simplified and clarified.

Our Spring 2010 class titled *Science Education Writing and Publishing of GK-12 Program results* was led by co-PI Gruden. During this course, we worked on a science-education publication by our program to submit for peer-review to a journal. Also, we created additional assessments to be implemented by our program.

A key program feature is our summer training institute, which is a two week themed course taught by our PI and co-PIs. Our 2009 Summer Institute, Environmental Education Field Methods II, was led by co-PIs Fisher and Gruden and focused on the geology of the land-lake interface through classroom lectures and many field experiences. It featured geologic events, including stream and river processes, which have resulted in our modern landscape. Contaminants and their potential sources and pathways were covered as well. This intensive week-long summer course further enhanced communication and team building amongst participants.

Our 2010 Summer Institute will be two weeks long and four credit hours, led by co-PIs Bridgeman and Moorhead. Week one, titled *Aquatic Ecology and Student Watershed Watch for GK-12*, will consist of field and lab activities, with lectures on biology, chemistry, and physics of aquatic systems, concentrating on techniques for water quality measurements. Week two, titled *Diversity and Environmental Gradients*, will examine the effects of a local power plant on aquatic ecology.

b. *Curriculum materials adopted/developed* Our graduate fellows have developed 15 hands-on lesson plans. Teacher-fellow teams guide the rest of the team through their activities during our monthly combined meetings. We have developed these lesson plans into kits that can be checked out by members of our team and used in all of our schools. Lessons presented to our GK-12 team during our weekly fellow and monthly large group meetings include:

An Introduction to Water Quality – P. Cole & B. Bodamer (TECHs)
Introduction to Solar Energy, Climate, and Ozone – J. Blosser & T. Crail (Scott)
Macropolis Macroinvertebrate Game – T. Bollin and A. Haponski (TECHs)
Life in a Lake: Modeling the effects of phosphorus on aquatic organisms – K. Singler & K. DeVanna (Ottawa Hills)
Invasive Species Game – C. Kolinski and C. Gorey (Clay)
Race to the drains: How your school returns rainwater to the soil – W. Wilson & O.J. Sepulveda Villet (Start)
Lake Erie Center Fieldtrip – W. Wilson and O.J. Sepulveda Villet (Start)
Introduction to Experimental Design-The Paper Towel – K. Singler & K. DeVanna (Ottawa Hills)
Beak of the Finch Activity: Natural Selection – K. Singler & K. DeVanna (Ottawa Hills)
Creating a paper GIS: Interpreting watershed landscape patterns using Google Earth imagery – J. Blosser & T. Crail (Scott)
Glacier Movement Activity – M. Bogue & B. Bodamer (Northview)
Great Lakes Fish Identification – P. Cole & J. Banda (TECHs)
What type of soil should be used for constructing landfills? – D. Bourland & K. Barnswell (Bowsher)

c. *Communication (Appendix 1)* Our GK-12 team is actively engaged in the scientific and educational communities; we have given 89 presentations during the first two years of our program. We gave 21 research presentations in year one and 44 in year two. Fellows gave 9 synergistic presentations in year one and 15 in year two.

We have been well-represented each year at the GK-12 Annual Meeting in Washington, D.C. Eight members of our team attended the 2010 meeting: the PI, two co-PIs, the Program Manager, two teachers, and two fellows. We led a well-attended interactive break-out session in collaboration with the University of Louisville titled, “Challenges to Implementing GK12 projects...Dos & Don'ts”. We also presented our program poster and a poster highlighting the research of our fellows. Graduate fellow Colleen Gorey presented her research at the Graduate Student Poster Session held at NSF. As a result of this meeting Program Manager Lohner has been sharing our contracts and other forms with Program Managers from other GK-12 programs and she joined the newly formed Program Manager Task Force.

d. *Published Articles (Appendix 1)* Our fellows have published 18 scientific articles in peer-reviewed scientific journals, 5 in year one and 13 in year two; all of which credit the NSF GK-12 program.

e. *Website Developed* The homepage of our GK-12 website is http://www.utoledo.edu/as/lec/GK12_grant/GK12_main.html. This site includes information on all our current and past personnel and high schools. We also report on our activities here and post pictures. Our program is represented via Facebook (<http://www.facebook.com/lakeeriecenter>) and Twitter (<http://twitter.com/lakeeriecenter>) through the Lake Erie Center.

f. *Additional Program Activities* PI Stepien facilitated “*Darwin Day at the University of Toledo*” to celebrate the 100th anniversary of the University of Toledo College of Arts and Sciences, the 150th anniversary of the publication of Charles Darwin's "*On the Origin of Species*", and the 200th birthday of Charles Darwin on November 7, 2009. The day consisted of two presentations by three time Fulbright Award winning scientist and presenter, Dr. Tim Berra. Dr. Berra led a lunchtime brown bag seminar at the Lake Erie Center titled “*Chasing nurseryfish and avoiding crocodiles in Northern Australia*” that was attended by much of our GK-12 team. That evening Dr. Berra presented his multi-award winning talk (acclaimed by the journal *Science* and universities around the world), "*Charles Darwin: The Concise Story of an Extraordinary Man*", featuring the impact of Darwin's life, thoughts, and work. Many of our high school students attended the event, along with our GK-12 fellows and teachers. Ottawa Hills High School Biology Honors class went to dinner at a restaurant preceding the talk, and were surprised there to meet Dr. Berra (Dr. Stepien took Dr. Berra to dinner there, too, to meet the students). Following his presentation Dr. Berra did a book signing of his book "*Charles Darwin: The Concise Story of an Extraordinary Man*". Over 600 people attended “*Darwin Day*” including many local high school and college students, our GK-12 team, university administrators, and members of the public.

Co-PI Gruden presented lesson plans developed through our GK-12 program to a graduate level course (*CI5950: Using Sustainability Engineering Activities to Teach Math and Science*), which is a distance learning course that targets K-12 teachers in Ohio who have a high population of migrant students.

The signature event of our GK-12 program is an annual high school student poster show held at the Lake Erie Center each April. The 2010 competition featured 28 presentations by 44 high school students from all eight teams of our GK-12 schools; 17 (43%) of the presenting students are minorities. Through this poster show our GK-12 program interfaced with the University of Toledo NSF-URM Program (“*Undergraduate Research and Mentoring in Environmental Biology at the Land-Lake Ecosystem Interface*”, PIs V. Sigler and C. Stepien) by using URM fellows as judges. Awards were presented to the top three presentations in two different categories, individual projects and group projects. We also presented “*outstanding GK-12 fellow*” and “*excellence in mentoring*” awards to two of our fellows. The show was attended by over 130 guests including high school and university administrators, teachers, politicians, graduate students, and professors. See Appendix 2 for a table of presentations.

Our program has worked to increase Science Fair participation by our participating schools. None of our seven schools had participated in the Science Fair for at least a decade prior to our program. In 2010, one of our schools hosted its own science fair featuring 30 projects mentored by a GK-12 fellow and sponsored by our program. Several of our faculty and other fellows attended and served as judges. Three of our schools presented at the Northwest Ohio District Two Science Fair this year. We sponsored 34 projects and seven won sponsored awards, 13 received “*superior*” ratings, and 15 received “*excellent*” ratings. Thirteen projects qualified for the State Science Fair in Columbus, Ohio where they competed for additional awards and scholarships on May 8, 2010.

Our GK-12 program also sponsored two high school student class field trips to The Lake Erie Center. Graduate fellow Jhonatan Sepulveda-Villet and his partnering teacher Wendy Wilson brought 40 students from Start High School for a day trip at the Lake Erie Center. These students toured the building, sampled fish from Lake Erie, and conducted various hands on activities. Graduate fellow Todd Crail and partnering teacher Jahnine Blosser brought 8 students from Scott High School for an evening trip prior to our poster gala. The students toured the building and then spent some one on one time talking to graduate students about their research and what it is like to be a graduate student.

Our fellows have won several awards this year. In October 2009, graduate fellows Osvaldo Jhonatan Sepulveda Villet and Kris Barnswell each won 1st place awards in the Environmental Sciences Division of the 2009 Sigma Xi/Scholars' Celebration Student Research Symposium. In January 2010, graduate fellow Todd Crail was awarded the \$500 Robert Brundage Scholarship by the nonprofit Western Lake Erie Waterkeeper Association. In April 2010 our program awarded an outstanding graduate fellow award to Todd Crail and an Excellence in Mentoring award to Kristen DeVanna. In May 2010 graduate fellow, Amanda Haponski was awarded the \$6000 Norman S. Baldwin fishery scholarship award.

Our monthly Environmental Science Learning Community features a meeting, dinner, and a public lecture by a professor/agency professional, which interact with our GK-12 team. These monthly meetings give our entire GK-12 team an opportunity to discuss our program activities and participate in a hands-on demonstration developed and led by one of our teacher-fellow pairs. The seminar speaker attends a portion of our meeting to interact with the group and is seated with our team, members during dinner, allowing more interaction. These talks are attended by graduate, undergraduate, and high school students, agency personnel, professors, members of the community as well as teachers participating in a University of Toledo, U.S. Department of Education IMPACT program (PI: D. Moorhead). The titles of our learning community talks during 2009-2010, and their presenters included:

- Movie Screening, “*Waterlife*”, a Documentary by Kevin McMahon, June 18, 2009.
- Dr. Gary Winston, Director, National Center for Water Quality Research, Heidelberg University, "*Oxygen toxicity in aquatic invertebrates.*" Sept. 17, 2009.
- Dr. Steven N. Francoeur, Eastern Michigan University, "*The stream, its valley, and us: How landuse affects Michigan streams.*" Oct. 15, 2009
- Dr. David J. Schwab, NOAA Great Lakes Environmental Research Laboratory, "*The role of weather in the sinking of the Edmund Fitzgerald.*" Nov. 12, 2009. Dr. David B. Baker, Director Emeritus, National Center for Water Quality Research, Heidelberg University, "*Healthy Row Crop Agriculture and a Healthy Lake Erie: An Impossible Dream?*" Jan. 21, 2010.
- Dr. Richard Becker, University of Toledo, "*Lake Erie from space: environmental parameters and harmful algal blooms.*" Feb. 18, 2010.
- Dr. George S. Bullerjahn, Bowling Green State University, "*Nitrification in the Great Lakes -- microbes rule!*" March 18, 2010.

- Dr. Richard Moore, Ohio State University, "*Bridging the social and natural sciences in watershed ecology: The Sugar Creek case.*" April 15, 2010. (Dr. Moore is the PI of the GK-12 Program at The Ohio State University's –Wooster Campus.
- Dr. Thomas Nalepa, NOAA Great Lakes Environmental Research Laboratory, "*The offshore expansion of quagga mussels and its ecological impacts.*" May 13, 2010.

Table 1. Senior Personnel

Senior Personnel	Description of the Position	Time on the Project	Institutional Affiliation and Position	Statement of Contribution
Carol Stepien	PI	Two years	Director, Lake Erie Center Professor, Department of Environmental Sciences.	Dr. Stepien is in charge of the overall plan, coordination, and output for the project as well as communication with NSF. She led teaching of the 2-unit course for the fellows during fall semester. Dr. Stepien also has coordinated the Environmental Science Learning Community monthly seminar seminars that all GK-12 participants attend.
Thomas Bridgeman	Co-PI	Two years	Assistant Professor, Department of Environmental Sciences	Dr. Bridgeman has the lead responsibility for training teachers and fellows the theory and practice of water quality.
Timothy Fisher	Co-PI	Two years	Professor, Department of Environmental Sciences	Dr. Fisher led the instruction of the summer 09 course for fellows and teachers focused on glacial geology.
Cyndee Gruden	Co-PI	Two years	Associate Professor, Department of Civil Engineering	Dr. Gruden served as the lead co-PI for the 2009-2010 academic year. She coordinates the engineering interface for our program. She led teaching of the 2-unit course for the fellows during spring semester.
Daryl Moorhead	Co-PI	Two years	Professor, Department of Environmental Sciences	Dr. Moorhead participates in our summer courses for teachers and graduate fellows emphasizing basic knowledge of aquatic ecosystems, laboratory and field methods.
Rachel Lohner	Program Manager	Two years	Education Program Manager, Lake Erie Center	Rachel Lohner serves as a mediator between graduate fellows, teachers, and the principal investigators of the project. She handles program logistics including ordering supplies, budget management, organizing meetings, and disseminating project information.
Gale Mentzer	Evaluation Consultant	Two years	Director of Evaluation Services, Curriculum and	Dr. Mentzer is responsible for project evaluation and reporting.

Table 2a. Graduate students during year one (May 2008-May 2009)

Name	Year in graduate program	Major	Research Topic	Statement of graduate location & nature of graduate work	Ethnicity & gender
Betsy Bodamer	2nd year of PhD	Biology (Ecology Track)	Yellow perch response to aquatic anoxia	Department of Environmental Sciences & doing Ph.D. research	White, female
Melinda Campbell	2nd year of M.S.	Geology	Mapping the surficial geology of the Oak Openings Region	Department of Environmental Sciences & M.S. data collection and writing thesis	White, female
Todd Crail	2nd year of PhD	Biology (Ecology Track)	Community assemblage, niche and interspecific interactions in North American lotic aquatic systems	Department of Environmental Sciences & doing Ph.D. research	White, male
Kristen DeVanna	2nd year of PhD	Biology (Ecology Track)	Interaction of mayflies and dreissenid mussels in the Great Lakes	Department of Environmental Sciences & doing Ph.D. research	White, female
Colleen Gorey	3rd year of PhD	Chemical and Environmental Engineering	Post-synthesis modification of water filtration membranes	Department of Chemical and Environmental Engineering & doing Ph.D. research	White, female
Amanda Haponski	2nd year of PhD	Biology (Ecology Track)	Molecular genetics of temporal stock structure of yellow perch and walleye in the Great Lakes	Department of Environmental Sciences & doing Ph.D. research	White, female
Olga Mileyeva-Biebesheimer	4th year of PhD	Civil Engineering	Developing a membrane-based sensor for selected bacteria in drinking water	Department of Civil Engineering & post-qualifying exams, writing Ph.D. dissertation	White, female
Oswaldo Jhonatan Sepulveda-Villet	4th year of PhD	Biology (Ecology Track)	Population genetics of yellow perch	Department of Environmental Sciences & post-qualifying exams, Ph.D. data collection	Hispanic/Latino, male

Table 2b. Graduate students during year two (May 2009-May 2010)

Name	Year in graduate program	Major	Research Topic	Statement of graduate location & nature of graduate work	Ethnicity & gender
Jo Ann Banda	3rd year of M.S.	Biology (Ecology Track)	Examining the temporal and spatial genetic patterns among Lake Erie walleye spawning groups	Department of Environmental Sciences & data collection, writing thesis	White, female
Kristopher Barnswell	5th year of PhD	Biology (Ecology Track)	Restoration ecology and design of an alternative cover for landfills in northwest Ohio	Department of Environmental Sciences & defended Ph.D. dissertation	White, male
Betsy Bodamer	3rd year of PhD	Biology (Ecology Track)	Yellow perch response to aquatic anoxia	Department of Environmental Sciences & post-qualifying exams, doing Ph.D. research	White, female
Todd Crail	3rd year of PhD	Biology (Ecology Track)	Community assemblage, niche and interspecific interactions in North American lotic aquatic systems	Department of Environmental Sciences & post-qualifying exams, doing Ph.d. research	White, male
Kristen DeVanna	3rd year of PhD	Biology (Ecology Track)	Interaction of mayflies and dreissenid mussels in the Great Lakes	Department of Environmental Sciences & post-qualifying exams, doing Ph.D. research	White, female
Colleen Gorey	3rd year of PhD	Chemical and Environmental Engineering	Post-synthesis modification of water filtration membranes	Department of Chemical and Environmental Engineering & post-qualifying exams, doing Ph.D. research	White, female
Amanda Haponki	3rd year of PhD	Biology (Ecology Track)	Molecular genetics of temporal stock structure of walleye in the Great Lakes	Department of Environmental Sciences & post-qualifying exams, doing Ph.D. research	White, female
Oswaldo Jhonatan Sepulveda-Villet	5th year of PhD	Biology (Ecology Track)	Population genetics of yellow perch	Department of Environmental Sciences & writing dissertation	Hispanic/Latino, male

Table 3. Organizational Partners

GK-12 School Statistics	Bowsher	St. John's	Northview	Scott	Start	TECHS (1)	TECHS (2)	Ottawa Hills
Total Students	1423	823	1349	1353	1732	202	202	490
Teacher:Student Ratio	1:17	1:9	1:16	1:18	1:18	1:19	1:19	1:14
White	64%	84.4%	93%	2%	61%	44%	44%	91%
African American	27%	8.1%	2%	97%	32%	43%	43%	0%
Hispanic	7%	2.7%	1%	1%	4%	8%	8%	1%
Asian	1%	3.7%	2%	0%	1%	0%	0%	7%
Unknown	1%	1.1%	2%	0%	3%	0%	0%	1%
Unspecified	0%	0%	0%	0%	0%	6%	6%	0%
Economically Disadvantaged	34%	15%	7%	53%	34%	21%	21%	N/A
Attendance Rate	93%	98%	95%	79%	93%	98%	98%	96%
Eligible for Free/Reduced Lunch	22%	12.4%	6%	67%	24%	N/A	N/A	N/A
Location	Urban	Suburban	Suburban	Urban	Urban	Urban	Urban	Suburban
Fellow	Kris Barnswell	Colleen Gorey	Betsy Bodamer	Todd Crail	O.J. Sepulveda Villet	Amanda Haponski	Jo Ann Banda	Kristen DeVanna
Teacher	Dave Bourland	Todd Aseityne	Michelle Bogue	Jahnine Blosser	Wendy Wilson	Tim Bollin	Paulette Cole	Kathy Singler
Subject	Environmental Science	Environmental Science	Environmental Science	Environmental Science	Honors Biology	Science Research	Biology	Biology
Grade(s)	11, 12	11, 12	11, 12	11, 12	10	11, 12	9, 10	9
<i>N</i> classes fellow interacted with	2	2	4	2	2	1	1	5
<i>N</i> students fellow interacted with	20	35	95	38	42	19	13	90
<i>N</i> of these students who are minorities	10	10	3	37	16	5	12	1
<i>N</i> of students who were involved in research projects	2	1	2	8	4	18	7	28
<i>N</i> of students who participated in SWW activities	2	35	95	22	40	15	12	28
Description of Fellow's Activities	Mentored Sr. interns in environmental engineering research methods, led data collection & analysis for SWW; implemented special activities.	Led hands on activities involving nature, basic science, and introductory engineering principles; led data collection & analysis for the SWW	Guided student research projects; facilitated a guest speaker; assisted with class activities & SWW; presented water pollution lesson.	Led SWW data collection & analysis; mentored 8 students on projects; created two lessons to examine the landscape scale and resources usage.	Collaborated with teacher in lesson plan design and enrichment; supplemented class material; participated in SWW; led field trips to the Lake Erie Center.	Taught students about water quality, their local watershed, conducting scientific research and presenting their findings; led students in the SWW.	Guided students through standard water quality techniques, the scientific method, and presenting their results in a professional setting.	Created labs and lesson plans; led field data collection and data analysis for the SWW; and mentored 30 science fair projects.

Table 4. Other Collaborators

Name	Description of activities/contribution
Toledo Metro Area Council of Governments	A major component of our project is built upon the 'Student Watershed Watch' (SWW) framework created by the Toledo Metropolitan Area Council of Governments (TMACOG) and Ohio EPA, and originated by a (now deceased) University of Toledo Faculty member ~20 years ago. TMACOG staff members have assisted our project by providing contacts with their local network of teachers, providing us with their knowledge of local stream sites located near participating schools, and facilitating our participation in the annual Student Watershed Summit meeting. SWW director Matt Horvath visited our program several times in 2009-2010, providing feedback, and served as a judge at our April 2010 high school student poster gala.
Ohio EPA	The Ohio EPA has been helping with our program by participating in the Environmental Science Learning Community, and as a likely end user for our stream monitoring program.
Partners for Clean Streams & Maumee RAP	PCS and Maumee RAP (Remedial Action Program) are members of our Environmental Science Learning Community and end-users of our data.
American Rivers & Joyce Foundation	Non-profit environmental organizations American Rivers and the Joyce Foundation are participating in our GK-12 Environmental Science Learning Community, helping to restore the Maumee River.
Lake Erie Center (LEC)	The LEC provides numerous resources including support staff, supplies, and infrastructure that our essential to the facilitation of our GK-12 Program. Our monthly Environmental Science Learning Community features a meeting, dinner, and a public lecture by a professor/agency professional, which interact with our GK-12 team are held at the LEC. All of our GK-12 courses as well as our annual poster show are held at the LEC. Many of our graduate fellows are members of labs housed at the LEC.
University of Toledo (UT)	UT provides graduate fellow tuition and fee supplementation for our fellows. Additionally, UT provides tuition waivers for teachers in our program as well.
National Science Foundation	NSF provides the majority of the funding for our program as well as the framework for the program. NSF offers professional development for our team through National and Regional GK-12 meetings.

Part II: External Evaluator's Report

A) NSF GK-12 Programmatic and Project Goals (revised for 2009-10)

1) Goals and Measures

Fellows' Goals	Measures
Enhanced understanding of one's own research subject area	Presentation skills protocol & number of presentations made
Its societal & global contexts	Presentation skills protocol & number of presentations made
Improved communication skills	Presentation skills protocol & number of presentations made
Improved leadership skills	Presentation skills protocol & number of presentations made
Experience working on teams	Semi-annual reflections
Enhanced teaching capabilities	Direct observation of teaching inquiry-based lessons

Teachers' Goals	Measures
Professional development in STEM content	Summer program content tests
Professional development in hands-on science activities	Student Watershed Watch training and implementation observations
**Establish long-lasting professional relationships with the Environmental Science Learning Community	Teachers will provide a record of collaborative activities in May.

Students' Goals	Measures
Energize students to pursue STEM careers	Attitude towards science survey
Become better prepared for STEM education opportunities	Standardized tests (OAT, ACT)
**Improve understanding of the nature and conduct of science inquiry	Items 1 - 17 of Student Survey
**Increase participation in hands-on environmental research	Items will be added to Student Survey to explore amount of hands-on research students have experienced over the previous year.
**Increase participation in SWW and science fairs	SWW & science fair participation numbers
**Increase interest in science-related careers	Items 18 - 39 of Student Survey--Items added to explore future education and career goals

University/Community Goals	Measures
Create strong and enduring partnerships with K-12 schools.	Participation of local schools in LEC sponsored poster session
Transform graduate programs	Feedback from graduate advisors & fellows
Enhance the impact of graduate education on society	Combination of all outcomes

****Indicates project only goal**

2) *Explanation of Measures and Instruments*

We used a quasi-experimental design to measure project effects. Each teacher participant and the teacher's science class(es) that interacted with a fellow were carefully matched with a control teacher and classroom using teacher, student, and content demographics. Pretests were compared to verify group equivalencies. While there was no control group for the fellows, we plan to add a graduate assistant control group next year in order to measure the effects of working with K-12 schools has on fellow perceptions of education and outreach (see graduate faculty survey below). Data gathering from graduate student faculty advisors also utilized a quasi-experimental design with all faculty from the two departments participating in the project (Environmental Science and Chemical Engineering) providing data. Since only some of the faculty members in the departments participate in the project, the remaining faculty members serve as the control group.

Fellow data was gathered using three instruments. First a performance assessment based upon research on effective science explanations (Sevian and Gonsalves, 2008) was used for *direct observations of the fellows as they presented their research* to a variety of audiences (mostly high school students) throughout the year. The rubric includes assessment for the following categories: Organization, delivery, relevance to the audience, appropriate language, use of audio-visual aids, and fielding of questions. The rubric is divided into three basic levels of measurement—proficient, developing, and needs attention—with subcategories within each to allow for degrees of achievement. *Fellows' ability to provide inquiry-based instruction* was measured through direct observation of the training and implementation of the Northwest Ohio Student Watershed Watch program (SWW). We used the Horizon Research Inc., “Inside the Classroom Observation” protocol which measures the quality of an inquiry-based lesson through the examination of design, implementation, content, and classroom culture. A qualitative analysis of fellow reflections of the experience was used to triangulate data collected from the two instruments as well as to provide information that is relevant but may not have been directly sought out. By examining themes and language and comparing with reflections collected during the first year, changes in fellow perspectives of community outreach and working with K-12 schools were documented.

Teacher gains were measured using a content test developed by the faculty teaching in the summer institute. We used a pretest/ post test design in order to examine both fellow and teacher content knowledge gains. Evidence of content validity was provided by the project environmental science faculty and the test was examined by the external evaluator prior to administration to assure sound assessment techniques were followed. Like the fellows, the *teachers were observed as they led students in the SWW program* using the “Classroom Observation” protocol. In the case of teachers, content proficiency was of particular interest. To validate improved networking and awareness of community science resources, teachers will be asked in May to provide a list of collaborations in which they have engaged over the past year.

At this time they will also be asked to provide examples of lessons that integrate summer science content into the classes they taught to illustrate long-term effects of the summer program.

Project effects on students were examined through a project developed Student Science Interest Survey based upon an adaptation of the “Conceptions/Nature of Science” survey used by the NSF DUE project, *Creation of an Interdisciplinary Earth Materials Testing Laboratory to Enhance Undergraduate Science Education, University of Wisconsin - Stevens Point*. Our version of this survey has been edited to make it appropriate for high school students and pared down from the original 105 questions to 38. It has two subscales—nature of science and interest in science. Reliability is 0.864. Nature of science subscale had a reliability index of 0.76 and science interest reliability was 0.88. This survey was administered to over 500 students for both the pretest and the post test. The post test will not be administered until April and results will be included until next year’s report. Additional items on the survey explored student education and career goals/plans as well as engagement in extra-curricular science activities. Student performance on the science portion of the Ohio Graduation Test will be examined when available (summer) and included in next year’s report.

Impact on university faculty was explored using a project-developed survey that asked how active each faculty member is involved in K-12 education. It also asks how active their graduate students are in this activity and provides several typical graduate student duties or responsibilities and asks the graduate advisor to delineate the amount of time each of their advisees spends per academic year on the duties. It also asks them to provide, for comparison, their own ideal delineation of time spent on these duties. Feedback gathered from the fellows was used to verify faculty responses.

B) Executive Summary of Findings

1) Fellows: In addition to 44 research presentations and 13 published or pending scholarly articles, the fellows made a total 15 presentations to the general public (high school classrooms and community groups). Fellows scored consistently in the proficient category on the performance assessment with only minor areas of needed improvement (providing a summary at the conclusion, some questions asked of the audience were too general or too advanced for the audience to grasp). Overall, however, the audiences were engaged and asked many questions illustrating that the fellows were effective in presenting their research to the public in an interesting and thought-provoking manner. Direct observations of the fellows during the SWW lessons showed that fellows followed effective instruction practices by engaging students actively in meaningful work (average score on Horizon protocol a high 3 out of 5). While we did not have a goal to increase fellows’ content knowledge, we did measure that as part of the summer program. This past summer the content area was Geology of the Land Lake Interface.

The fellows showed a statistically significant knowledge gain going from a mean score of 17 prior to the summer course to a 26 on the post test (total possible points = 29).

The fellows completed an exit survey this year as most are completing their time with the program. Fellow plans include four hoping to teach at a college or university, three interested in a research or post doc position, and one interested in pursuing a career in private industry. Four fellows felt that the GK-12 experience has made them more open-minded about teaching careers and three felt that the program has made them more amenable to working on teams. One fellow provided the consensus: "I'm much more apt to work with people than do everything myself." Fellows gained the most in the area of sharing their research with the public. Prior to working on the project, most fellows were immersed in scientific jargon and the minute mechanisms of their research but this experience has opened their eyes to the fact that the general public is interested in scientific research but not at such a detailed level. Now the fellows feel they can relate to a wider audience outside of their scientific community. As one fellow noted, "Before I was really stuck on scientific jargon, but through my interactions with not only the students, but the teachers as well I feel I can make my research relatable." This is supported by the presentation observation findings reported above. The fellows felt that by sharing their research they were able to interest the public in environmental issues and debunk common stereotypes about science and scientists. In general, they agreed that working with the students and teachers has brought them some humility and has given them more respect for the knowledge and experience of non-scientists on scientific topics. They found the experience especially valuable in developing their ability to talk to non-scientists. To encourage more students to pursue science-focused fields in higher education and beyond, there was a consensus that students need to see the relevance of science through hands-on activities as well as understand the broad range of careers that are related to science (rather than just being a scientist). Fellows were also asked how they would change the typical undergraduate science class if they could (all agreed a typical class consists of lecture and note-taking unless a lab is involved). All suggested including more current topics, more interactive, problem-based learning opportunities, and more relevant to the students. All in all, the fellows felt participation in this project to be rewarding and valuable and would recommend it to other graduate students.

2) Teachers: Teachers also showed a significant gain in content knowledge as a result of the summer coursework. Their mean scores rose from 17 to 25. It was interesting that both the teachers and the fellows scored similarly on the pretest. All of the teachers felt that the content covered in the summer could be adapted and incorporated into their classrooms. Teachers will provide examples of how they incorporated both summer content and other content provided by the fellows in their exit interview in May. Teachers were also observed during the SWW activities and, like the fellows, employed inquiry-based instructional strategies that encouraged students to not only learn about science but to make sense of it as it applies to them. Teacher average scores on the Horizon were also a high 3 of 5 possible points. Teacher science resource networking data will be gathered in May and reported next year.

3) Students: Because of the timing of the annual report, data not reported last year will be presented first. Student responses on both the nature of science and the interest in science subscales showed no statistically significant difference between the control and treatment groups. Because we only conducted a post test last year, we were unable to determine group equivalency or measure growth. This year we did administer a pretest in September and statistical comparisons showed the 2009-10 groups to be equivalent. The post test will be given in April and findings will be reported next year. Further investigation into responses to the Student Attitudes about Science survey revealed some interesting misconceptions held by both groups as well as some differences. The control group students were much more likely to agree with the following statement about the nature of science: “If one scientist says an idea is true, most other scientists will agree with it.” Both groups tended to agree with these statements about the nature of science

1. Scientists sometimes de-emphasize or overlook evidence that does not support their favored ideas.
2. Scientific beliefs do not change over time.
3. Scientists discover laws which tell us exactly what is going on in nature.
4. Personal bias, preferences, and opinions can play a role in scientists’ findings.

This year the teachers and fellows have worked to address these misconceptions. Results of their efforts will be measured in April. An examination of responses to the science interest scale showed that students need a deeper understanding of the following or perhaps our science educators need to adjust their methods of instruction:

1. Scientists have to study too much. (most agreed)
2. I would like to work with other scientists to solve scientific problems. (disagreed)
3. Scientists do not have enough time for their families or for fun. (agreed)
4. I want to be a scientist. (disagreed)
5. I have to work hard to understand scientific concepts. (agreed)

Our 2010 post test has been adjusted to include items that address gaps in our data collection including education and career goals and perceived amount of hands-on science instruction experienced in the classroom.

Increased student interest in science activities has continued this year as evidenced by the number of students who have participated in science fairs. Twenty-three students participated in the Ohio science fair this past year. Three students working with GK-12 fellows earned superior ratings and took first, second, and third place in the Governor’s Award for Energy Research; 15 students earned an “Excellent” rating and the remaining 5 earned “Good” ratings. Additionally, 22 students participated in the Northwest Ohio District Science Day held at the University of Toledo. Three projects received a Superior rating and are now qualified for the State Science Day in Columbus, OH where they will compete for scholarships. We also surveyed students who participated in the SWW as well as equivalent control groups of students with no interaction with

fellows and groups who interacted with fellows but did not participate in the SWW to compare knowledge of the local watershed and its ramifications on the community. Results of this analysis showed that there was no statistically significant difference in responses from the three student groups. The test ranged from a 23 (best possible score) to a 92 (worst possible score) All three groups scored slightly above the midpoint at 50.87 (SWW), 51.17 (control), and 47.82 (control with fellow). There were some questions about the unidimensionality (and therefore validity) of the test (using Rasch analysis) and therefore the findings cannot be conclusive. In addition, this was a posttest only design and therefore group equivalency could not be verified.

Student scores on the Ohio Graduation Test will be collected in June when made available and reported next year.

4) University faculty & sustainability: All of the fellows felt their faculty advisors supported their participation in the GK-12 project although one fellow qualified that with “as long as I complete my research”. Examination of faculty responses to our survey supports this.

C) Recommendations

This project continues to reap positive results at all levels of engagement—fellows, teachers, students, and university.

Sevian, H. and Gonsalves, L. (2008). Analyzing how scientists explain their research: A rubric for measuring the effectiveness of scientific explanations. *International Journal of Science Education*, 30 (11), 1441-1467.

Part III – Collaborative Response Report

The Principal Investigator (Stepien), Lead co-PI (Gruden), and External Evaluator (Mentzer) collaborated on the Annual Report.

A. Respond to recommendations focusing on how to incorporate them into practice.

In 2009-2010 we implemented more teamwork activities into our GK-12 program, and will continue to do so in 2010-2011. These activities are designed to enhance the relationships amongst program participants, particularly between paired fellows and teachers. We also provided time and opportunity for the fellow-teacher teams to develop lesson plans and engage in team-building. During the monthly learning community group meetings at the Lake Erie Center, in 2009-2010 we capped the meeting with a classroom exercise activity led by one of the fellow-teacher teams. These were highly successful and very fun, and all led to adoptions of the activity/lesson plan by other teams. We are also committed to incorporating constructive feedback on a regular basis. Specifically, we provided more education-oriented activities in the 2009 summer institute, including a session led by Dr. Charlene Czerniak, one of our university's leading education professors.

Based upon a better understanding of the NSF GK-12 goals, we encouraged our fellows to present their research to a variety of audiences. The project evaluator modified a presentation rubric so that the fellows would first know what was expected of them as they presented, and, second, could get formative feedback in order to improve. As a result, the fellows not only improved their presentation skills but also gained a better understanding of the importance of science and scientific research to the community.

We fine-tuned our fellow, teacher, and advisor contracts for 2009-2010 and again for 2010-2011, incorporating feedback. These have proved popular at the GK-12 annual conference in D.C., leading to many requests by other teams. We redesigned our summer institute to be more hands-on and less repetitive, and it was very well-received by our teachers and fellows.

It was very valuable to take two of our teachers to the Washington D.C. annual GK-12 conference each year, and their feedback to other teachers about the program was important both times. It seemed less valuable to take graduate fellows this year who were ending their two-year GK-12 term, with the one who presented her research at NSF appearing to have a more valuable experience than the other. We will take this into consideration next year, and also stress to them that they are our “ambassadors”. We took a co-PI this year who has been only peripherally engaged in our program, and he appeared to enjoy the conference and offered insightful feedback toward improving our program. We would thus like to continue to take different members of our team each year.

In 2010-2011 we plan to incorporate a GK-12 teaching assistant, who will be a “veteran fellow” to help train and engage the new fellows. The teaching assistant will help to plan the activities of the spring and summer fellow seminar courses and will make some classroom visits to provide constructive feedback to the fellows.

Based upon evaluation findings, we will add more university outreach in order to affect change in university policy and practice concerning engaging the community in our research and with our graduate students. We will do this formally through university forums and informally through departmental meetings.

B. Develop timeframe for the appropriate actions

Summer Institute 2010: Incorporate teacher and veteran fellow feedback from the previous years. We redesigned the original water quality course for new fellows to be more useful for Student Watershed Watch (SWW) training, and also will have the fellow-teacher teams “practice” SWW data collection on Friday of the first week. That exercise will be enhanced by having one of our teachers with a long-running SWW program lead us by teaching her approach to our group. We also met with the other co-PI to help him restructure the 2nd summer institute course in order to ensure that it will meet the needs and goals of our program. This may be challenging as he is also involving another teacher training program (IMPACT) simultaneously, in this dual research training course. We thus have agreed to have the PI and lead co-PI (Stepien and Gruden) lead some specific GK-12 team-only activities that week to ensure that the GK-12 teams develop teamwork skills.

Fall Seminar Course 2010: We plan to have a veteran fellow serve as the teaching assistant, in order to help mentor and train the new fellows. The TA also will make classroom visits to give the new fellows tips. The fall 2010 course will focus on Student Watershed Watch and accompanying classroom activities. It also will focus on presentation skills, oral and poster, along with teaching methods and ways to effectively partner with teachers.

Spring Seminar Course 2011: This course will focus on the new fellows developing lesson plans and presenting them to the others. It also will focus on their research presentation skills, in relation to techniques for effectively presenting them to high school students. The third goal will be in developing skills for their mentoring of high school science fair projects.

C. Discuss project goals and measured outcomes and the potential impact on the issues surrounding sustainability.

This year we concentrated on improving our program through incorporating feedback from the teachers, fellows, and our evaluator. We changed the timing of our monthly meeting so that we no longer meet with just the fellows for an hour before the teachers arrive. We thus changed to begin with the group meeting, which was a suggestion by our teachers. We also moved the lecture time up ½ hour to shorten the evening. Our new schedule thus was: 4-5:15 group meeting, discussion, and classroom activity/lesson demonstration by a GK-12 fellow-teacher team, 5:45-6:15 dinner with learning community speaker and discussion, 6:30-7:30 Learning community public lecture and question and answer session.

We also concentrated on improving the summer institute training course to incorporate more group interactions and planning time. The feedback we obtained indicated that year 2 was much better received than was the summer institute in year 1. In 2009-10, the summer course was for 1 week (as opposed to the 2 weeks during year 1), and then the continuing fellows trained the two new incoming fellows in Student Watershed Watch approaches and procedures for a few days. The teachers also worked for a day in the laboratory or field with their fellow on the fellow’s graduate research project. This provided the teachers with greater insight into the research and lives of the fellows. Several commented on this activity’s effectiveness and value. We thus will retain this activity throughout our program.

Our university has committed in the grant award to support two GK-12 fellows after our program ends, one from the Department of Environmental Sciences and one from the Department of Civil Engineering. During 2010-2011, we plan to design classroom exercises and activities building upon the Student Watershed Watch theme that can be presented in a variety of classrooms. It is anticipated that the continuing fellows will travel to SWW schools to present these in the future. It also is anticipated that the continuing fellows will play a continuing role in

the TECHS research course (Toledo Early College High School), which has a very high proportion of minority students and where we teach an independent research course through the GK-12.

Appendix 1. Publications & Presentations **Bold**= GK-12 participants, including advisors and co-PIs. *= our GK-12 Fellows, **= our GK-12 Teachers

PUBLICATIONS 2009 -2010 (N=14)

- Barnswell, K.D.** and **D.F. Dwyer**, *Submitted 2010*. Assessing the field performance of evapotranspiration covers in northwest Ohio. *Journal of Environmental Engineering*, In review.
- Crail, T.D.***, **J.F. Gottgens**, and A.E. Krause, *Submitted 2010*. Fish community response to evolving channel complexity in an agricultural headwater system. *Canadian Journal of Fisheries and Aquatic Sciences*.
- DeVanna, K.M.***, C.A. Barrett, and **C.M. Mayer**. Effects of *Dreissena* on infaunal benthic communities: Consequences of ecosystem engineering. *Journal of the North American Benthological Society*, In review.
- DeVanna K.M.**, **B.L. Bodamer**, Wellington, C.G., Hammer, E., **J.M. Bossenbroek**, and **C.M. Mayer**. An alternative hypothesis for invasional meltdown: General facilitation by *Dreissena*. *Diversity and Distributions*, In review.
- Gorey, C.***, **I. Escobar**, **C. Gruden**, and G. Cai, 2010. Development of microbial sensing nanostructured membranes. *Desalination*, Vol:**248** 99-105.
- Grzybowski, M., **O.J. Sepulveda-Villet***, **C.A. Stepien**, D. Rosauer, F. Binkowski, R. Klaper, B. Shepherd, and F. Goetz. 2010. Genetic variation of 17 wild yellow perch populations from the Midwest and East coastal United States using microsatellites. *Transactions of the American Fisheries Society*. 139: 270–287.
- Gullinkala T., Digman B., **Gorey C***, Hausman R. and I. Escobar (in print, 2009), *Desalination – Reverse Osmosis and Membrane Distillation*, In: Escobar I. and A. Schäfer (eds.), *Sustainable Water for the Future - Water Recycling versus Desalination*, Elsevier Science, The Netherlands.
- Haponski, A.E.***, **T.L. Bollin****, M.A. Jedicka, and **C.A. Stepien**. 2010. Landscape genetic patterns of the rainbow darter: A watershed analysis of mitochondrial DNA sequences and nuclear microsatellites. *Journal of Fish Biology*, **75**:2244-2268.
- Mileyeva-Biebesheimer***, **O.N.**, A. Zaky, and **C.L. Gruden**. 2010. Assessing the Impact of Titanium Dioxide and Zinc Oxide Nanoparticles on Bacteria Using a Fluorescent-Based Cell Membrane Integrity Assay. *Journal of Environmental Engineering Science*, 27:329-335.
- Parker, A.D., **C.A. Stepien**, **O.J. Sepulveda-Villet***, C.B. Ruehl, and D.J. Uzarski. 2009. The interplay of morphology, ecological habitat, resource use, and population genetics in young yellow perch. *Transactions of the American Fisheries Society* 138: 899-914. doi: 10.1577/T08-093.1
- Sepulveda-Villet, O.J.***, A.M. Ford, J.D. Williams, and **C.A. Stepien**. 2009. Population genetic diversity and phylogeographic divergence patterns of yellow perch (*Perca flavescens*). *Journal of Great Lakes Research*. 35(2): 35: 107-119. Doi:10.1016/j.jglr.2008.11.009
- Stepien, C.A.**, D.M. Murphy, and **R.N. Lohner**. 2010. Status and delineation of walleye genetic stocks across the Great Lakes. Great Lakes Fishery Commission Special Publication. (peer-reviewed).
- Stepien, C.A.**, D.J. Murphy, **R.N. Lohner**, **O.J. Sepulveda-Villet***, and **A.E. Haponski***. 2009. Signatures of vicariance, postglacial dispersal, and spawning philopatry: Population

genetics and biogeography of the walleye *Sander vitreus*. *Molecular Ecology*. 18: 3411–3428. doi: 10.1111/j.1365-294X.2009.04291.x

Stepien, C.A. and **A.E. Haponski***. Systematics of the greenside darter *Etheostoma blennioides* complex revisited: Consensus from nuclear and mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution*. In review.

RESEARCH PRESENTATIONS 2009 – 2010 (N=44)

Banda, J.A.* and **Stepien C.A.** (2009) Fine-scale temporal genetic structure of Lake Erie walleye. International Association of Great Lakes Research conference, Toledo, OH. May 2009.

Banda, J.A.* and **Stepien C.A.** (2010) Analysis of genetic connectivity and divergence among Lake Erie walleye spawning groups. Ohio Fish and Wildlife Management Association conference, Columbus, OH. February 2010.

Banda, J.A.*, Haponski, A.E.*, and Stepien, C.A. (2010) Temporal and spatial patterns of genetic connectivity and divergence among Lake Erie walleye (*Sander vitreus*) spawning groups. Lake Erie Millennium Conference, Windsor, CA. April 2010.

Barnswell, K.D.* and Dwyer, D.F. (2009) Field water balance of evapotranspiration covers in northwest Ohio. Phytotechnologies 6th International Conference, St. Louis, MO.

Blosser, J.** and **Crail, T.*** (2009) Student-based ecological monitoring of two riffle classes in Swan Creek, an urban stream in NW Ohio. International Association for Great Lakes Research, Toledo, OH, May 2009.

Bodamer B.L.*, Bridgeman, T.B., Ruch, R.J., and Höök, T. (2009) Measuring Hypoxia-induced physiological stress in yellow perch (*Perca flavescens*). International Association of Great Lakes Research, Toledo, OH. May 2009.

Bodamer, B.L., Bridgeman, T.B., and Ruch, R.J. (2009) Measuring hypoxia-induced stress in yellow perch: Ecological applications for Hypoxia Inducible Factor 1a. Michigan Society of Toxicology Water Safety and Toxicology of the Great Lakes Region Annual Meeting. East Lansing, MI, November 2009.

Bodamer, B.L.*, Bridgeman, T.B., and Ruch, R.J. (2010) Physiological responses of Yellow Perch to Hypoxia: Ecological applications for Hypoxia Inducible Factor 1 α (Poster), Ohio Fish and Wildlife Managers Association Annual Meeting, Columbus, OH, February 2010

Bollin, T.L.**, **Haponski, A.E.***, and **Stepien, C.A.** (2009) Collaborative Science Research Experience for High School Students with a focus on Water Quality Testing on the Ottawa River Watershed. International Association for Great Lakes Research, Toledo, OH, May 2009.

Bogue, M.** and **Mileyeva-Biebesheimer, O.*** (2009) Student Water Quality Testing Engages Students in all Levels of Bloom's Taxonomy. International Association for Great Lakes Research, Toledo, OH, May 2009.

Bourland, D.**, **Campbell, M.***, and Stierman, D.J. (2009) Using Ground Penetrating Radar to Locate Unmarked Graves in Toledo, Ohio, USA. International Association for Great Lakes Research, Toledo, OH, May 2009.

Cole, P.** and **Bodamer, B.L.*** (2009) Introducing high school students to environmental monitoring: A look at water quality in the Ottawa River (Poster), International Association of Great Lakes Research, Toledo, OH, May 2009.

- Crail, T.D.*, Gottgens, J.F. and Bossenbroek, J.M.** (2009) Wind-derived seiches as a means for detecting and monitoring the unionid community in the western basin of Lake Erie. International Association for Great Lakes Research, University of Toledo, Toledo, OH. May 2009.
- Crail, T.D.*, Bossenbroek, J.M. and Gottgens, J.F.** (2009) Niche dimension of *Etheostoma darters* in the Ohio River Basin at multiple scales. American Fisheries Society, Nashville, TN. September 2009.
- Crail, T.D.*, Bossenbroek, J.M. and Gottgens, J.F.** (2009) A multiscale analysis of *Etheostoma darter* habitat in the Ohio River Basin. Southeastern Fishes Council, Lake Guntersville, AL. November 2009.
- Crail, T.D.*, Bossenbroek, J.M. and Gottgens, J.F.** (2010) Wind-derived seiches as a means for detecting and monitoring the unionid community in the western basin of Lake Erie. Lake Erie Millennium Network Conference, Windsor, ON. April 2010.
- DeVanna, K.M.*, Cope, P.M., and Mayer, C.M.** (2009) Biotic and abiotic habitat interactions determine predation risk for burrowing mayflies. International Association for Great Lakes Research, Toledo, OH. May 2009.
- DeVanna, K.M.*, Jain, N., Mayer, C.M., and Schloesser, D.W.** (2010) Mapping the spatial relationship of burrowing mayflies and dreissenid mussels in western Lake Erie. Lake Erie Millennium Network Conference, Windsor, ON. April 2010.
- Gorey C.*, Escobar, I., and Gruden, C.** (2009) Cellulose acetate ultrafiltration membranes modified with temperature-sensitive polymers for fouling resistance. International Association for Great Lakes Research Annual Meeting, Toledo OH. May 2009.
- Gorey C.*, Escobar, I., Zaky, A., and Gruden, C.** (2009) N-isopropylacrylamide(NIPAAM)-modified ultrafiltration membranes with bacterial sensing abilities. North American Membrane Society Annual Conference, Charleston, SC. June 2009.
- Gorey C.*, Escobar, I., Zaky, A., and Gruden, C.** (2009) N-isopropylacrylamide (NIPAAM)-modified ultrafiltration membranes with bacterial sensing abilities. American Institute of Chemical Engineers Annual Conference, Nashville, TN. November 2009.
- Gorey C.*** (2009) How to effectively engage the next generation in STEM careers. American Institute of Chemical Engineers Annual Conference, Nashville, TN. November 2009.
- Gorey, C.*, Escobar, I., and Bothum, G.** (2010) N-isopropylacrylamide (NIPAAM) modified ultrafiltration membranes. National Science Foundation National GK-12 Conference Graduate Student Poster Session, Washington, D.C. March 2010.
- Haponski, A.E.*, Sepulveda-Villet, O.J.*, and Stepien, C.A.** (2009) Spatial and temporal genetic patterns of Lake Erie yellow perch. International Association for Great Lakes Research, Toledo, OH. May 2009.
- Haponski, A.E.*, Sepulveda-Villet, O.J.*, and Stepien, C.A.** (2010) Genetic structure of walleye with fine-scale focus in Lake Erie. Great Lakes Fishery Commission Walleye and Yellow Perch Task Groups annual meeting, Old Woman Creek, OH. February 2010.
- Haponski, A.E.*, Sepulveda-Villet, O.J.*, and Stepien, C.A.** (2010) Spatial and temporal genetic patterns of Lake Erie yellow perch. Ohio Fish and Wildlife Managers Association Annual Conference, Columbus, OH. February 2010.
- Jain, N., **DeVanna, K.M.***, Mayer, C.M., and Schloesser, D.W. (2009) Mapping the spatial relationship of burrowing mayflies and dreissenid mussels in western Lake Erie. International Association for Great Lakes Research, Toledo, OH. May 2009.

- Karsiotis, S.R.*, Brown, J.E., Lohner, R., and Stepien, C.A.** (2009) Salinity tolerance of the exotic round goby: Experimental implications for seawater ballast exchange. International Association for Great Lakes Research, Toledo, OH. May 2009. (first author in undergrad GK-12 high school student)
- Kolinski, C.** and Gorey, C.*** (2009) Teaching Science to Make Good Citizens. International Association for Great Lakes Research, Toledo, OH. May 2009.
- Lohner, R.N. and Stepien, C.A.** (2009) Developing an environmental science learning community at the land-lake ecosystem interface. International Association for Great Lakes Research, Toledo, OH. May 2009.
- Lohner, R.N., Stepien, C.A., Moorhead, D.L., Bridgeman, T.B., Fisher, T.G., and Gruden, C.L.** (2009) Graduate Teaching Fellows in STEM High School Education: An Environmental Science Learning Community at the Land-Lake Ecosystem Interface. International Association for Great Lakes Research, Toledo, OH. May 2009.
- Penamon, W.A., and Mentzer, G.C.** (2009) The Role of Mentoring in Promoting Positive Attitudes of Minority Students Towards STEM Careers. International Association for Great Lakes Research annual meeting, Toledo, OH. May 2009.
- Sepulveda-Villet, O.J.* and Stepien, C.A.** (2009) Genetic structure of Great Lakes yellow perch: A landscape genetic approach. International Association for Great Lakes Research annual meeting, Toledo, OH. May 2009.
- Sepulveda-Villet, O.J.* and Stepien, C.A.** (2009) Genetic structure of Lake Erie yellow perch: A landscape genetic approach to test management unit congruency. University of Toledo chapter of Sigma Xi annual conference, Toledo, OH. October 2009.
- Sepulveda Villet, O.J.* and Stepien, C.A.** (2010) Population genetic basis for Lake Erie yellow perch stock structure and management units. Great Lakes Fishery Commission (GLFC) Lake Erie Walleye and Yellow Perch Task Groups Annual Meeting, Old Woman Creek, OH. February 2010.
- Sepulveda Villet, O.J.* and Stepien, C.A.** (2010) Population genetic structure of Lake Erie yellow perch using high-resolution microsatellite markers. Lake Erie Inland Waters Annual Research Review Meeting 2010, Columbus, OH. January 2010.
- Sepulveda-Villet, O.J.* and Stepien, C.A.** (2010) Population genetic basis for Lake Erie yellow perch stock structure and management units. Ohio Fish and Wildlife Managers Association annual meeting, Columbus, OH. February 2010.
- Sepulveda-Villet, O.J.* and Stepien, C.A.** (2010) Fine-scale population genetic structure of Lake Erie yellow perch: Any relation to management units? Lake Erie Millennium Network Conference, Windsor, CA. April 2010.
- Sepulveda-Villet, O.J.* and Gorey, C.*** (2010) Graduate research at the land-lake ecosystem interface at the University of Toledo. National Science Foundation National GK-12 Conference, Washington, D.C., March 2010.
- Singler, K.** and DeVanna, K.M.*** (2009) Engaging high school students in field research: Comparing two years of water quality data for the Ottawa River. International Association for Great Lakes Research, Toledo, OH. May 2009.
- Stepien, C.A., Bridgeman, T.B., Fisher, T.G., Gruden, C.L., Lohner, R.N., and Moorhead, D.L.** (2010) Graduate teaching fellows in STEM high school education: An environmental science learning community at the land-lake ecosystem interface. National Science Foundation National GK-12 Conference, Washington, D.C. March 2010.

Stepien, C.A., Bogue, M. , Cole, P.** , Fisher, T.G., Gorey, C.* , Gruden, C.L., and Haponski, A.E.*** (2010). Fellow, Teacher, and PI's Dos and Don'ts for GK-12 programs: Expectations and reality. National Science Foundation National GK-12 conference. Washington, D.C. March 2010

Stepien, C.A., Bridgeman, T.B., Fisher, T.G., Gruden, C.L., Lohner, R.N., and Moorhead, D.L. (2010) Graduate teaching fellows in STEM high school education: An environmental science learning community at the land-lake ecosystem interface. Lake Erie Millennium Network Conference, Windsor, CA, April 2010.

Wilson, W. and Sepulveda-Villet, O.J.*** (2009) Sixteen Years of Water Quality Monitoring: Shantee Creek at Roy C. Start High School. International Association for Great Lakes Research annual meeting, Toledo, OH. May 2009.

SYNERGISTIC ACTIVITIES/PRESENTATIONS 2009 – 2010 (N=15)

Banda, J.A.* (2010) Introduction to fish biology and identification of Great Lakes fish. Toledo Early College High School, Toledo, OH. April 2010.

Barnswell, K.D. (2010) Waste management using landfills. Northview High School, Sylvania, OH. February 2010.

Bodamer, B.L.* (2010) Thinking outside the Hach Kit: Implementing water quality in real-world research. Toledo Early College High School, Toledo, OH. March 2010.

Crail, T.D.* (2009) Farmertodd Institute for Senior Hiatus (FISH). Field trip with high school Seniors during their Senior Projects to understand local fish ecology. Toledo, OH, May 2009.

Crail, T.D.* (2009) See Real Live Fish Up Close – the Field Trip! Steps For Kids, Ann Arbor, MI, July 2009.

Crail, T.D.* (2009) Meet Your Stream – Fishes of the Maumee River. Field trip with the Maumee Valley Chapter of the National Wild Turkey Federation, Grand Rapids, OH, August 2009.

Crail, T.D.* (2009) Meet Your Stream – Fishes and Mussels of the River Raisin. Field trip with the Toledo Naturalists Association, Toledo, OH, August 2009.

Crail, T.D.* (2009) The Secret Sex Lives of Unionid Mussels. Student Watershed Watch 2009 Keynote Speaker, Toledo, OH, November 2009.

Crail, T.D.* (2009) The Secret Sex Lives of Unionid Mussels. Royal Oak Nature Society, Royal Oak, MI, December 2009.

Crail, T.D.* (2010) Enhancing Environmental Education and Careers: Restoration Project for the Ottawa River at the University of Toledo. Toledo Early College High School, Toledo, OH, monthly January - May 2010.

Crail, T.D.* (2010) Ecological dimension and adaptation of fish community in Ten Mile Creek. Lourdes College, Sylvania, OH, March 2010.

Crail, T.D.* (2010) Interviewed on *Environmentally Sound with Larry Burns*. WJR760 April 27, 2010.

DeVanna, K.M.* (2010) Analyzing Environmental Data, Toledo Early College High School, Toledo, OH. March 2010.

Gorey, C.*, (2010) Engineering Disasters, Scott High School, Toledo, OH. February 2010.

Haponski, A.E.* (2010) What is a geneticist? Roy C. Start High School, Toledo, OH. February 2010.

Appendix 2. LEC GK-12 2010 Poster Show Presentations

Authors	School	Title	# Minorities
Shelton, McGee	Bowsher	The Effects of Plants on the Drainage of a Landfill Cover	1
Gasser, Northrup	Northview	Affects of Caffeine on the Human Heart Rate and Temperature	0
Rosler, Yeager	Northview	An Examination of the Water Quality of Ten Mile Creek	0
Mitchell	Ottawa Hills	Bacteria Growth and Cleaning Products	0
Burns	Ottawa Hills	Can you fry an egg on the sidewalk?	0
Jenkins	Ottawa Hills	Liquid Light	1
Hargrove-Barfield	Ottawa Hills	What Kills Bacteria?	0
Wolff	Ottawa Hills	Soybeans: Genetically Modified vs. Organic	0
Isenberg	Ottawa Hills	The Biodegradability of Disposable Drinkware	0
Bodziak III	Ottawa Hills	Underclocking	0
Bhatt	Ottawa Hills	Which Brand Pops the Most at a Lower Price?	1
Pryor, Lucas	Scott	The effect of woody debris on sediment processing	2
Sharp	Scott	The effect of sediment removal on the shape of the channel	1
Jaynes	Scott	The effect of plants on the amount of erosion from a system	1
Rowser	Scott	Two Riffles at Highland Park – Swan Creek	1
McKinney, Dixon	Scott	The effect of plant diversity on the amount of erosion from a system.	2
Sanders	Scott	Stream table model - the effects of human influence on stream processes...	1
Cole	St. John's	Influence of Road Salt on Water Quality at the St. John's Jesuit High School Wetland	0
Petkovska	Start	Environmentally impacted water and its effect on humans	0
Scisson, Hyttenhove	Start	What is the water quality of two urban ponds?	0
Mathis	Start	Benefits of breakfast on human health	1
Najjar, Spencer	TECHS	Otter Creek and The Sunoco Refinery	0
Casano	TECHS	Did Modifications to the Ottawa River Change the Fish Population?	1
Bousonville, Haley	TECHS	Differences between Toledo Metroparks and Toledo City Parks	0
Smith	TECHS	Hecklinger Pond vs. Maumee Bay	0
Parga, Catchings	TECHS	Is Bottled Water Worth the Cost?	0
James, Beatty	TECHS	Lake Goshorn Water Quality Study	0
Finch, Jacobs, Morehead, Nunez, Torres, Thomas, Valentine	TECHS	Rural vs. Urban water quality in the Ottawa River	6

