Michigan Tech GlobalWatershed GK-12 Fellows Program

Handbook for Fellows

3/24/12

Contents

Welcome

Welcome to the Michigan Tech GlobalWatershed GK-12 Fellows program. The purpose of this handbook is to inform potential and current GK-12 Fellows of the activities, benefits, and expectations of the program, who should read this document carefully. In addition, we suggest that potential and current Fellows read the attached, short article "Bridging the gap: spanning the distance between high school and college education."[1]

Goals and Objectives of the Program

The GlobalWatershed GK-12 program is a joint effort between Michigan Tech and several school districts and individual schools in the Western Upper Peninsula of Michigan and Sonora, Mexico. The program is funded by the National Science Foundation (NSF).

In the GlobalWatershed GK-12 program, graduate Fellows conduct research in watershed science topics within a range of geographical, hydrologic, ecological, and cultural contexts, while working with middle and high school teachers to create lesson plans and activities that transfer this knowledge to their students. The goals of the program include:

- Expanding traditional science, technology, engineering, and mathematics (STEM) graduate student training to encompass improved teaching and communication skills and to help graduate students gain a greater appreciation of the context of their research, and making this expanded training a permanent fixture at MTU; and

- Enriching STEM learning and instruction in local K-12 schools serving low-income and predominantly Native American populations, as well as a K-12 school system in Sonora, Mexico, by translating state-of-the-art watershed research to the K-12 level and making this enrichment sustainable at these schools.

The GlobalWatershed program goals are supported by the following seven objectives:

1. Professionally prepare PhD Fellows who will (a) conduct research on local, regional, and global watershed science with mentors and teachers and (b) work with teachers to develop lesson plans to teach middle and high school students the research process and content knowledge that connects local watershed science with regional and global issues. Emphasis in lessons should be on hands-on, inquiry-based research approaches.

2. Train and involve secondary teachers from local schools in a wide range of research methodologies used in watershed science. These teachers, in turn, can use these tools skillfully

[1] Messinger, O., Schuette, S., Hodder, J. and Shan, A. 2008. Bridging the gap: spanning the distance between high school and college education. *Frontiers in Ecology*.

in their classrooms to provide "visions" of the effects of human activities on local, regional, and global watersheds and the ecological systems within these watersheds.

3. Provide secondary teachers with the necessary training to guide their own students in designing and conducting research projects in their local watersheds and to draw connections to other research projects at regional and global levels.

4. Increase global awareness among Fellows, teachers, and middle and high school students in a rural landscape and improve their ability to communicate effectively about the effects of decisions at local, regional, or global scales. Special emphasis is placed on communication in a context that is sensitive to Native American perspectives.

5. Develop educational modules and foster connections for Fellows, mentors, and teachers by partnering with national or international researchers and teachers and connecting local research with that occurring at regional and global levels.

6. Help teachers establish scientific research as an integral component of K-12 social and natural sciences, mathematics, and technology curricula.

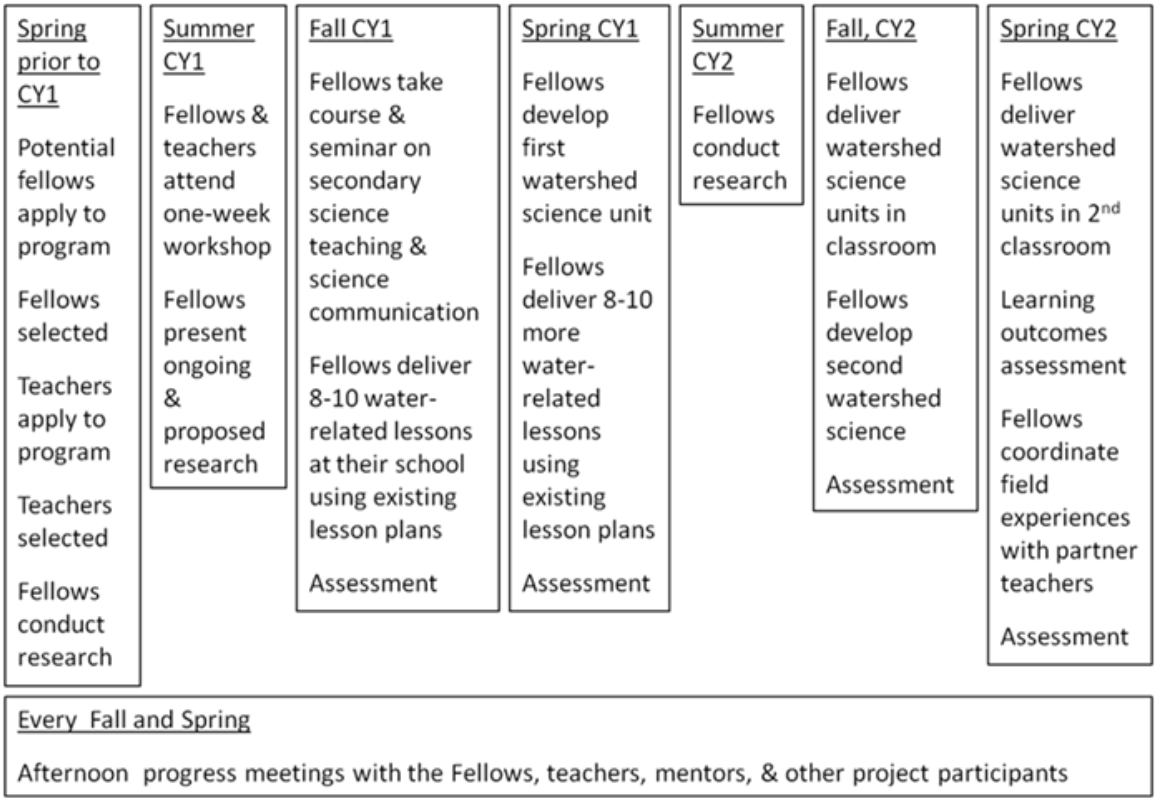
7. Disseminate the findings and products of the project through the GlobalWatershed website and by presenting papers at teaching and science conferences and publishing papers in the peer-reviewed literature.

Program Activities

A Fellow's participation in the GlobalWatershed GK-12 Fellows program lasts about two years, beginning in the summer and ending in the spring. Four overlapping cohorts of Fellows move through the program, with a total of four to nine Fellows in the program at any one time. A typical Fellow starts participating in the Fellowship program at least one year after beginning his or her PhD studies and research activities.

Figure 1 briefly describes the major activities in which a cohort of Fellows and teachers participate.

Figure 1: Major activities for Fellows and teachers*



*CY: cohort year

Fellows consist of PhD students in Biological Sciences, Environmental Engineering, Environmental Policy, Forest Sciences, and Geological Engineering programs. Most Fellows are assigned to work in middle-school classrooms, but some may be assigned to elementary or high school classrooms. All GK-12 Fellows work with an advisory team consisting of at least one teacher from a partner K-12 school and the Fellow's research advisor. This team mentors and advises the Fellow in both the research and teaching aspects of the water science unit, or series of lesson plans. The Fellow's advisory team meets regularly during their involvement in the GK-12 program. Fellows may work with more than one teacher in special cases. In these cases, a lead teacher is assigned to work with the Fellow and help coordinate his or her activities. Fellows and teachers interact with one another through workshops held throughout the duration of the project. Fellows collaborate with one another in their design of classroom activities through weekly meetings.

The partner K-12 schools and school districts in the U.S. are located in the Western Upper Peninsula of Michigan (see Figure 2 for locations). These schools were chosen based on proximity to MTU and the prevalence of Native American students. Alternatively, instead of working in a school in the Western U.P., Fellows may work with a partner school in Hermosillo, Sonora, Mexico (Colegio Muñoz). Some PhD Fellows conduct research on Sonora water issues because faculty participants have ongoing research in that region and active graduate students who are involved in this work.

In the fall of their first year, Fellows take a two-credit, lecture-based course, "Teaching Science to Secondary School Students." The course covers effective teaching techniques for grades 6-12, learning styles, lesson planning, classroom management, conducting field trips, ways of assessing science proficiency, and inquiry-based approaches for teaching science. In addition, the course covers how to teach concepts of scientific research to secondary school students. Fellows also take the one-credit "GK-12 Fellows Seminar" course where students and faculty discuss current issues in science education innovation and science communication.

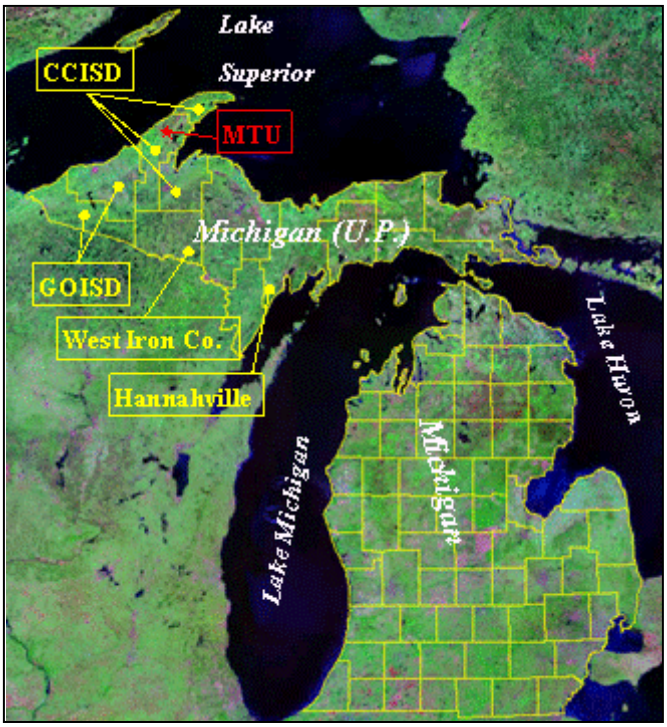


Figure 2: Map of Michigan indicating location of MTU and partner schools and school districts

During the two fall and two spring semesters spent in the K-12 school to which they have been assigned, Fellows are expected to spend approximately 10 hours per week in the school. In addition, Fellows will be expected to spend approximately five hours per week preparing for their in-school activities and another five hours on travel and in meetings with their advisory team and with the GlobalWatershed GK-12 program administrators.

The Fellows' activities in the classroom are designed to introduce them to lesson plan development and delivery, culminating in developing and delivering a watershed science unit. These watershed science units must (a) convey the context and methods associated with the Fellow's watershed science research to a middle-school audience, (b) satisfy relevant state standards, and (c) relate to the interests and cultural context of the partner schools. Fellows are expected to develop course materials that can be used by other teachers throughout the US, or even elsewhere in the world. These materials become available on the GlobalWatershed website, where teachers can download them for use in their classes.

Also during the two fall and two spring semesters spent in their assigned K-12 school, Fellows prepare semester-long and weekly plans for their GlobalWatershed GK-12 program activities, in conjunction with their advisory team. Fellows keep a daily journal of their activities in the classroom to document the extent of their involvement in their K-12 school. The partner teacher will sign the log to confirm the number of hours spent in the K-12 school.

Since improving Fellows' communication skills is a primary objective of the GlobalWatershed project, many opportunities exist for Fellows to develop these skills and obtain feedback from their peers, faculty, and K-12 teachers. For example, selected lessons delivered by Fellows in the K-12 classroom are

videotaped. Fellows review these videotapes with their team and peers, who offer constructive feedback.

In addition to the typical expectations of writing and submitting papers for publication on their graduate research, GK-12 Fellows are encouraged to write and submit papers to peer-reviewed journals on the teaching materials they develop or on another educational aspect associated with their GK-12 activities. The purpose of this effort is to demonstrate that the GK-12 activities are on the same scholarly level as typical graduate research activities. Fellows also may give presentations at professional conferences on their GK-12 work, including the annual, national GK-12 conferences.

Expectations of Fellows in the Program

GK-12 Fellows are expected to:

- Develop a life-long commitment to effective communication of scientific research to the public
- Act as the "visiting scientist" in their classroom(s)
- Bring their watershed science research topics into the curriculum and provide context for science curricula
- Demonstrate how scientists conduct research
- Act as a resource for their partner-teacher
- Act as a role model to "recruit" students into STEM careers
- Develop skills in:
    - developing and delivering classroom activities, lessons, and units
    - communicating science
- Weave Native American perspectives on the environment into classroom
- Interact with other GK-12 fellows
- Participate in MTU and NSF project evaluation activities
- Help teachers develop a network with other local scientists
- Attend NSF GK12 national meetings
- Produce the following deliverables:
    - Two watershed units
    - Activity plans and other lesson plans
    - Journal papers on watershed units and/or activities

Expectations of Partner-Teachers in the Program

Partner-teachers are expected to:

- Act as teaching mentors for Fellows
- Find time in their schedules to work with Fellows

- Learn about watershed science research from Fellows, including topical content and research methods
- Co-develop classroom materials with Fellows, especially the two watershed science units
- Keep administrators informed about progress and concerns
- Participate in project evaluation activities
- Confirm the Fellow's activities in the assigned school by reviewing the Fellow's journal periodically
- Attend NSF GK12 national meetings
- Work with Fellows to develop and submit journal papers

Schedule of Fellowship Milestones and Deadlines

GK-12 Fellows should plan to complete the following activities and milestones while in the program:

Summer of Year 1

- Attend workshop
- Develop a schedule for attending the assigned school and working with the partner-teacher

  Note: Fellows' classroom responsibilities follow the MTU calendar, but they should coordinate with their partner-teachers.

Fall of Year 1

- Take two courses at MTU:
  - ED5580 Science Instruction
  - ED5581 Communicating Scientific Research
- Spend at least 10 hours per week at the assigned school
- On the first day, give a talk about themselves, why they chose their career, and what it means to be a scientist
- Observe in classroom
- Inform their teachers about their research topics
- Become familiar with the teachers' classes and curricula
- Become familiar with teachers' Lake Superior Stewardship Imitative projects, where applicable
- Work with the teacher to develop and deliver activities
- Deliver 8 to 10 lessons from Michigan Environmental Education Curriculum Support (MEECS) curriculum

- Maintain a journal of their observations, activities, challenges, and successes
- Keep their advisor informed of their GK-12 activities
- Meet with the project director every two weeks
- Participate in informal afternoon sessions for exchanging information with other Fellows and teachers

Spring of Year 1

- Continue activities from the previous semester:
    - Spend at least 10 hours per week at their school
    - Work with their partner-teacher to develop and deliver activities
    - Deliver 8 to 10 lessons from MEECS curriculum
    - Meet with Alex Mayer every two weeks
    - Keep their advisor informed of their GK-12 activities
    - Maintain their journal
- Develop watershed unit and learning outcomes assessment with Shawn Oppliger
- Prepare for and attend the NSF National GK12 conference

Summer of Year 2

- Plan to participate informally in the workshop
- Develop a schedule for attending their school and working with their teacher

Fall of Year 2

- Continue activities from the previous spring semester:
    - Spend at least 10 hours per week at their school
    - Work with their partner-teacher to develop and deliver activities
    - Deliver 8 to 10 lessons from MEECS curriculum
    - Meet with Alex Mayer every two weeks
    - Keep their advisor informed of their GK-12 activities
    - Maintain their journal
- Deliver and refine watershed unit and learning outcomes assessment (**Note:** The watershed unit will be posted on MTU GK-12 website)
  Develop second watershed unit and learning outcomes assessment
- Involve teachers and students in their research

Spring of Year 2

- Continue activities from the previous semester:
    - Spend at least 10 hours per week at their school
    - Work with their partner-teacher to develop and deliver activities
    - Deliver 8 to 10 lessons from MEECS curriculum
    - Meet with Alex Mayer every two weeks

    - Keep their advisor informed of their GK-12 activities
    - Involve their teachers and students in their research
    - Maintain their journal
- Deliver and refine second watershed unit and learning outcomes assessment (**Note:** The watershed unit will be posted on MTU GK-12 website)
- Develop journal paper
- Prepare for and attend NSF National GK12 conference

Translating Research to the K-12 Classroom

Fellows use their backgrounds in their specific areas of research to design lesson plans and classroom activities that focus on their area of research and the role their research plays in current local and global watershed issues, such as water scarcity, water pollution, and watershed ecosystem problems and solutions. Fellows introduce examples, pictures, and samples from their own work to better explain and contextualize the connection between what the K-12 students see in the classroom and what actually happens in STEM research projects. The lesson plans and activities model what watershed scientists do in their own investigations, including formulating research questions and hypotheses, designing experiments to address the questions and test the hypotheses, and analyzing research results. Fellows conduct field trips to their research sites to demonstrate the link between classroom lessons and activities and the Fellow's research goals and activities. The field trips also demonstrate the use of state-of-the-art field methodologies for gathering data relevant to watershed science. Fellows demonstrate how their research connects with basic STEM principles that are part of the relevant Michigan or Sonoran curricular content standards.

Box 1 presents an example of how a Fellow's research project could be applied to K-12 instruction. This example illustrates a watershed science research topic that is integrated across scientific disciplines and is well-suited for inquiry-based instruction.

Box 1: Example of a research project applied to the K-12 classroom

Research Topic. A hypothetical GK-12 fellow's research project is "Groundwater-Surface Water Interactions and Coaster Brook Trout Spawning Habitat." Coaster brook trout (CBT) are a unique life history variant of the brook trout species that have existed in Lake Superior for thousands of years. Currently, only a few populations of CBT remain in the Lake Superior basin. The decline of the CBT is associated with over-fishing and habitat degradation. The Salmon Trout River is the only river on the southern shore of Lake Superior that sustains a naturally reproducing population of CBT. Since little is known about the ecology of the CBT, this research project involves investigation of adfluvial (migration) patterns, spawning density and distribution, behavioral characteristics, and genetic linkages of the CBT population in the Salmon Trout River.

To support conservation efforts in the Salmon Trout River and rehabilitation efforts along the southern shore of Lake Superior, researchers are characterizing the habitat conditions associated with naturally

Box 1, continued

reproducing CBT populations. Since several studies have shown a connection between groundwater seepage and brook trout spawning habitat, this research project further focuses on quantifying groundwater seepage in the river at sites that both support and do not support a naturally reproducing population of CBT. The research includes installing networks of monitoring wells equipped with vertically stratified temperature sensors into these sites and inverting the temperature data to estimate groundwater seepage as a function of time and space.

K-12 Classroom Topics and Activities. In the following table, we have listed three general themes of this research project, corresponding to K-12 classroom topics that the GK-12 Fellow will teach, the general principles associated with each theme, and suggested activities for illustrating the principles. The principles can be connected to specific Michigan Content Standards for curricula.

Research and Classroom Topics	**General Principles**	**Sample Activities**
Life history of the CBT (4-8 classroom days)	Ecosystems Evolution Genetics Aquatic biology Physiology Experimental design Data analysis	Lectures Readings Exercise: How does a CBT decide it's time to spawn? Exercise: How does a CBT sense its environment? Exercise: How do we determine if the CBT is a distinct species? Field trip: Observing fish spawning behavior Field trip: Observing instrumentation used in genetic analyses
Decline and renewal of the CBT (4-8 classroom days)	Impacts of humans on ecosystems Ecosystem management and restoration Experimental design Data analysis	Lectures Readings Exercise: How would we choose a site for reintroducing CBT? Exercise: How do we set fishing catch limits for CBT? Exercise: Debate on a local natural resource extraction conflict Field trip: Observing operations of a fish hatchery Field trip: Observing methods for counting fish populations

Influence of groundwater seepage on CBT spawning (4-8 classroom days)	Hydrologic cycle Ecohydrology Stream hydrology Physics of heat transfer Experimental design Data analysis	Lectures Readings Exercise: How do we measure streamflows? Exercise: How and why do streamflows vary over a year and from year to year? Exercise: Why is groundwater seepage important for stream ecology? Exercise: What do variations in temperature underneath a streambed tell us about groundwater seepage? Exercise: How do we design an instrument for detecting temperatures underneath a streambed? Field trip: Measuring streamflows Field trip: Collecting data from a seepage well network

Program Evaluation

An external evaluator from the Science and Mathematics Program Improvement (SAMPI) at Western Michigan University evaluates the GK-12 program continuously. The primary purposes of the evaluation are to 1) determine the impact of the program on participants (Fellows and partner teachers) and the MTU graduate program, 2) provide evaluative information to project staff to help improve the program, and 3) identify strengths and limitations of the program. The primary audiences for the evaluation include project staff and NSF.

Evaluators gather both quantitative and qualitative data when evaluating the program, including conducting electronic surveys and in-person and telephone interviews with Fellows and their partner teachers, observing selected classroom activities conducted by Fellows, and documenting how each Fellow's research project interfaces with the assigned K-12 classroom. Evaluators also review samples of the Fellow's work. Fellows are expected to cooperate with the GlobalWatershed external evaluator and must complete a Human Subjects Consent form, which allows evaluators to collect evaluation data.

Financial Support

Fellows receive a stipend of $30,000 per year. The program also covers Michigan Tech tuition and fees, as well as expenses associated with travel to partner schools. A small fund is available for supplies associated with lesson plan and activity development.

Program Application

Fellows must be U.S. citizens, nationals, or permanent residents at the time of application. All candidates applying to the GK-12 Fellows program must also submit applications to their respective degree programs. In addition to the degree program application, GK-12 Fellow candidates must submit the following materials.

1. Statement of interest
2. An essay related to their interests and capabilities related to the Sonora program, if applicable
3. Curriculum vitae
4. Recommendation form

These materials should be submitted to the program director, Alex Mayer (asmayer@mtu.edu) **by February 15**. We strongly prefer that these materials be submitted electronically.

We will review these materials, along with the applicant's degree program application. If we consider the application to be competitive, we will contact the applicant to arrange an interview, either by videoconference or on campus if convenient. During the interview, applicants are asked about their career goals and anticipated benefits from the program. Ideal candidates understand issues of diversity, possess a passion for the natural and social aspects of watershed science, demonstrate an excellent potential for research, express dedication to working with a team, and possess a desire to commit to all aspects of the project.

Once admitted into the program, Fellows are required to complete a Human Subjects Consent form to allow evaluation data to be collected. In addition to submitting an application to the degree program, we require the following materials.

GK-12 Program Contact Information

Contacts for MTU's GlobalWatershed GK-12 program include:

- Project Director: Dr. Alex Mayer, Department of Civil & Environmental Engineering/Department of Geological & Mining Engineering & Sciences, Dow Environmental Science & Engineering Building Room 809, 906-487-3372, asmayer@mtu.edu.
- Administrative Assistant: Lori Witting (lori@mtu.edu)
- Liaisons in the following schools and departments:
    - Biological Sciences: Dr. Nancy Auer (naauer@mtu.edu)
    - Civil & Environmental Engineering: Dr. Alex Mayer (asmayer@mtu.edu)
    - Forest Resources & Environmental Science: Dr. Linda Nagel (lmnagel@mtu.edu)
    - Geological & Mining Engineering & Sciences: Dr. Alex Mayer (asmayer@mtu.edu)
    - Social Sciences/Environmental Policy Program: Dr. Kathleen Halvorsen (kehalvor@mtu.edu)