# NARA | GOAL FIVE

August 2011 - March 2013 Cumulative Report

BIOENERGY LITERACY

Northwest Advance Renewables Alliance


NARA is led by Washington State University and supported by the Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

# Goal Five: Bioenergy Literacy

**Improve bioenergy literacy to develop a future energy workforce, provide professional development, and enhance citizen understanding.**

## Summary

The NARA project is designed to enable a new and technically complex industry in the Pacific Northwest. Elevating general knowledge around energy literacy serves an important role to ensure biofuels industry sustainability by: 1) educating and providing training to a future energy workforce; 2) providing timely information and resources to stakeholders and professionals in industries connected to the biofuels supply chain; and 3) enhancing citizen understanding to improve public support and participation in political decision making.

To secure an effective and sustainable workforce and generate future leaders who can move the biofuels industry forward, training and educational opportunities related to Science, Technology, Engineering and Mathematics (STEM) topics and specific to the biofuels supply chain need to be created and promoted. For this purpose, NARA provides opportunities tailored to engage students along the education pathway from K-12 students and educators; to undergraduate and graduate students; and finally to practicing professionals.

Programs targeted to **K-12 students and teachers** provide curriculum development and educational programs. The NARA Education Team developed ten energy and biofuels related lesson plans for middle and high school students. These lesson plans were field-tested with students and educators at the University of Idaho's McCall Outdoor Science School (MOSS) and through webinars sponsored by Facing the Future (FtF). Once field-testing is complete, FtF will offer the lesson plans to educators worldwide through web-based delivery (Task E-2; each task progress is detailed in progress reports following this summary).

NARA has partnered with the annual Imagine Tomorrow Renewable Energy challenge for $9^{th}$-$12^{th}$ graders at Washington State University. In 2012, NARA's involvement expanded the competition to attract student teams from Oregon, Idaho and Montana as well as Washington, and to include a new "biofuels" competition category. As a result, 433 students participated in 2012 as compared to 363 students in 2011, and the number of biofuels projects increased from 3 to 14 teams over the same time period. An assessment team has been established to evaluate the effects of Imagine Tomorrow on students' STEM career choices and energy literacy. In 2012, this team conducted a preliminary student survey with a 35% response rate and results suggests that participation is having positive effects on students' STEM career related attitudes and interests (Task E-4).

MOSS provided workshops to educate K-12 teachers on bioenergy lesson plans. In addition, MOSS graduate students mentored teachers in preparing students to participate in the Imagine Tomorrow Competition. Assessments that measured teacher literacy and experience followed the workshops. To provide educational resources to K-12 teachers, a web-based bioenergy matrix (http://energyliteracyprinciples.org) was developed that allows teachers to locate bioenergy related

resources (lesson plans, images, reference materials) based on energy literacy concepts outlined by the U.S. Department of Energy (Task E-2).

Programs targeted to **undergraduate and graduate students** provide research opportunities that contribute directly to NARA project outcomes. The Summer Undergraduate Research Experience in Biofuels (BF-SURE) is a summer (10 week) research experiences for undergraduate students that provides laboratory, fieldwork, and research skills in the broad area of biofuels and bio-products research. In 2012, eleven students applied and eight were selected and teamed with NARA principal investigators to conduct research and showcase their projects at a poster symposium sponsored by Washington State University. Demographics of 2012 applicants were 36% women, 64% men; and 18% Hispanic, 9% Native American, 9% Asian, and 64% Caucasian (Task E-5).

The IDX course involved undergraduate and graduate students representing a variety of disciplines including engineering, environmental studies, chemistry, community planning, architecture, landscape architecture, construction management and law, to develop the Clearwater Basin and Western Montana Corridor atlases described in the Goal 4 segment of this report. (Task E-5)

Graduate students associated with the University of Washington, Salish Kootenai College and IDX comprise a NARA Tribal Team who are working with tribal foresters on biomass and cost of transport assessments that integrate with landscape management goals for the Confederated Salish and Kootenai Tribe (CSKT) reservation (Task T-E1, T-E6).

Lastly, as of March 31, 2013, NARA funds have supported 43 graduate students working on tasks assigned to the NARA project.

To promote **stakeholder professional development**, web-based mechanisms are established to receive and disseminate information to stakeholders. These mechanisms include a knowledge base repository, a monthly E-newsletter with over 230 subscribers as of March 2013 and a presence in social media. NARA maintains a stakeholder mailing list of over 120 individuals who receive updates to NARA's progress. The NARA project is also linked to various websites hosted by extension groups within the Outreach Team. NARA has co-hosted three symposia/conferences in 2011 and 2012 and has had representative speakers at over 40 conferences worldwide. Eight "NARA one-pagers" have been produced, disseminated to audiences, and posted on the NARA website (Goal 4; Task O-1).

To raise **public energy literacy**, 35 news articles have been published about NARA. The NARA project, in connection with WSU, is featured on a display at the Future of Flight Aviation Center and Boeing Tour, Mukilteo, Washington and was featured at the 2012 Smithsonian Folklife Festival at the Washington Mall. The Future of Flight Aviation Center and Boeing Tour attracts over 225,000 regional, national, and international visitors annually. An additional 75,000 people visit the facility to participate in special events, such activities surrounding delivery of Boeing aircraft, receptions, and school activities. The Smithsonian Folklife Festival attracts over one million visitors each year. To inform policy makers about NARA, the NARA Outreach Team, led by the Ruckelshaus Center, assembled a list of over 1,500 policy-makers in Washington, Oregon, Idaho, Montana and Northern California (Goal 4; Task O-7).

Policy-makers receive quarterly reports of NARA's progress that direct these stakeholders to the NARA web assets. NARA maintains a website which experienced 20,539 individual visits with 83,270 page views from September 2011 to March 2013. Visitations were from all 50 US states and from 114 countries. The term "NARA" in Google now ranks nararenewables.org third. Analytics provided by Alexa indicate that the nararenewable.org web traffic was ranked 2,059,772 worldwide in May, 2013. Rankings for similar AFRI projects during the same time period are 23,772,075 for Advance Hardwood Biofuels

Northwest and 18,970,588 for the Southern Partnership for Integrated Biomass Supply Systems (Goal 4; Task O-1).

Significant internal outputs to date for this team are listed below. Additional outputs are listed at the end of each progress report.

- Based on measured outcomes, both the K-12 student and teacher programs have elevated the level of bioenergy literacy of participants. As a result, the three-pronged approach of direct K-12 student programming, teacher professional development, and development of the web-based Energy Literacy Principle Matrix will be continued (Task E-2).

- The collaborative investment by the K-12 group in teacher mentoring, education in energy literacy and student team support for Imagine Tomorrow has generated increased awareness and participation. Over 20 biofuel projects are entered for the 2013 competition compared to 14 in 2012. This event draws news coverage (see outputs in Task E-4) and introduces NARA to over 140 science and resource based industry leaders as judges to the event. In addition, over 400 high-school students interested in science are exposed to the NARA project. The marketing campaign for 2013 also includes the distribution of energy-based literature in news media (see outputs in Task E-4) that is expected to enhance the interest in the competition and also increase energy knowledge in those who are not able to directly participate (Task E-2, Task E-4).

- The NARA SURE program exposed students to biofuels research work. In 2013, the number of applications tripled from the previous year and the trend should provide a pipeline for research assistance and increase the number of undergraduate students with work experience related to the NARA project. To date, a total of 38 applicants have been received and offers are currently being made to selected students (3 to date). Demographics of 2013 applicants are 61% women, 39% men; and 11% Hispanic, 3% Native American, 8% African American, 34% Asian/Pacific, and 39% Caucasian (Task E-5).

- The Knowledge Base repository contains unbiased information that covers a broad coverage of biofuels development. It is available to the general public and to date has had a total of 1710 visits from 23 states and 10 countries (Task O-1).

- Establishing a biofuel display at the Future of Flight Aviation Center and Boeing Tour has spurred discussions with Boeing's education outreach staff to include biofuel lessons to K-12 students (Task O-1).

# Outcomes/Impacts:

- K-12 Teachers are more knowledgeable about biofuels, biofuels research, and energy. All participants in teacher workshops showed a statistically significant increase in content knowledge related to biofuels, water resources and climate change. K-12 Teachers apply knowledge in energy literacy to assist students successfully develop an approach to answering a problem-based energy issue. In a 9-month follow-up survey, 68% of teachers report being more likely to use a problem-based learning pedagogy after being involved in a MOSS teacher workshop. 90% of teachers report that they learned new ways of teaching. 66% percent of teachers agree or strongly agree that they have a good understanding of biofuels, that they understand key parts of the supply chain and that they have enough of an understanding to have developed an informed opinion about the feasibility of a woody biomass biofuel program in the Pacific Northwest. 45.8% of teachers say that they have been able to incorporate biofuels into their teaching (Task E-2).

- NARA's partnership with the Imagine Tomorrow competition changed this event from a statewide to a Pacific Northwest regional activity and injected biofuels research as a main focus (Task E-2).

## Training

| Name | Affiliation | Role | Contribution |
|---|---|---|---|
| Kenneth Faires (Lumbee) | Univ of WA | Undergraduate Student | Tribal project organization |
| Ikechwuku Nwaneshiudu | Univ of WA | Undergraduate Student | ASPEN Simulation, data |
| Blake Hough | Univ of WA | Undergraduate Student | Biomass quantities, data |
| Beth Kochevar<br>Brett Miller<br>Carmen DeLeon<br>Claire Deters<br>Carrie Anderson<br>Christa Shier<br>Dawn Harfmann<br>Elinor Israel<br>Kate McGraw<br>Kelly Martin<br>Jim Casey<br>Joy Adams<br>Jyoti Jennewein<br>Lauren Smith<br>Nell Davis<br>Sara Anderegg | University of Idaho | Graduate Students | Understand NARA objectives, goals, and scientific advances. Creating lesson plans using NARA concepts for K12 students. Mentoring and coaching K12 teacher/student teams for the WSU IT competition. |
| Quinn Langfitt | WSU Student | Assessment team member | Energy literacy assessment activities |
| Chad Gotch | Research Associate –WSU | Assessment team member | Database development and management; supervisor of graduate student for survey research |
| Jessica Beaver | WSU Doctoral Student | Assessment team member | Survey research, data analysis, and assist with writing of reports |

| | | | |
|---|---|---|---|
| Burdette Birdinground* | Univ. WA | Undergraduate Student | Scale up of an ultra-low cost in-forest thermal processing of biomass |
| Maggie Buffum | OSU | Undergraduate Student | Moisture Content in Biomass Piles |
| Lucy Cheadle | Univ. WA | Undergraduate Student | Analysis of Bioproducts from Ultra-Low Cost Biomass Processing |
| Brady Do | OSU | Undergraduate Student | Assessing Risks of Arson in Biomass Piles |
| Madeline Fuchs | WSU | Undergraduate Student | NARA Biofuels Production Emissions |
| Pedro Guajardo Jr. | WSU | Undergraduate Student | Diluted acid and peroxide pretreatments of Douglas fir biomass |
| Anthony Lathrop | WSU | Undergraduate Student | Effect of Hot Water Extraction on Mechanical Properties of Ponderosa Pine Chips |
| Ellen Simonsen | WSU | Undergraduate Student | Biobased Curing Agent for Epoxy |
| Cody Siford | SKC | intern | GIS support to CSKT Tribe |
| Burdette Birdinground | SKC | intern | Portable Pyrolysis blanket research |
| Hannah Funke | SKC | intern | CSKT woody biomass availability |

## Resource Leverage

| Resource Type | Resource Citation | Amount | Relationship or Importance to NARA |
|---|---|---|---|
| Everett Isaac | NSF IGERT | $20,000 | Tribal forestry expertise |
| Gift | Steven C. Luethold Family Foundation | $15,000 | Provides general operating support for the MOSS program. |
| Award | Albertson Foundation ID21 program | $50,000 | Provides general operating support for the MOSS program. |

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|---|---|---|---|
| Gift | Idaho Community Foundation Shelton Fund | $2,500 | Provides general operating support for the MOSS program. |
| Gift | Whittenberger Foundation | $4,300 | Provides general operating support for the MOSS program. |
| Gift | Lightfoot Foundation | $10,000 | Provides general operating support for the MOSS program. |
| Donations | | | NARA partially supports the cost of the Imagine Tomorrow program, leveraging over $200,000 in other private donations to run the program. |
| Assessment donations | | $15,000<br>$15,000 match | Ecoworks<br><br>Bank of America |
| Financial support for end of the summer poster symposium. | | | NARA SURE organization is being co-advertised and co-hosted with existing NSF funded REU programs on the WSU campus. The Office of Undergraduate Research, University College at WSU, is assisting in setting up housing and running the summer poster symposium. |
| | USDA NIFA Tribal College Research Grant | | Two NARA interns assisted research to investigate woody biomass availability for the Confederated Salish and Kootenai Tribes. One focused on GIS, the other on field measurement and biomass assessment. |
| | | | Summer intern Burdette Birdinground attended SACNAS (Society for the Advancement of Chicanos and Native Americans in Science) |

# EDUCATION

## Education Team

### Task E-1: Bioenergy and Bioproducts Graduate Education and Research in Partnership with Northwest Tribes

| Key personnel | Affiliation |
|---|---|
| Daniel T Schwartz | University of Washington |

#### Task Description

The goal of this task is to educate next-generation scholars with unique skills for devising integrated resource management and technical designs that deliver bioenergy and bioproduct systems tailored to the resource, ecologic, and economic development needs of a community. To accomplish this, we will work with tribes, tribal organizations, and each partner campus to offer graduate student tribal research projects that integrate with other student activities in an area. Specifically, student teams will work collaboratively with Northwest tribes to provide integrative research on technical issues tied to feedstocks, their sustainable production and logistics, and conversion to value-added products. System metrics will assess the overall performance of the integrated student design. Students will benefit from outstanding training in interdisciplinary communications and research. Tribes will benefit by collaborating to define, research, and assess a technical problem that is deemed a tribal priority for ecologic or economic development purposes. Each student team will make several trips to the partner tribe's reservation. A field trip initiates each project. After the field trip, a statement of work is developed, and then students typically reconvene two more times at the reservation to present oral and written reports. Because this is a multi-campus activity, the reservation trips are a key mechanism for building team synergy. Each student team is expected to perform publishable work. To have maximum impact, this task has significant liaison activities with tribes, tribal organizations, and campus offices that coordinate with tribal student recruiting and retention programs.

#### Activities and Results

During the project period, the NARA Tribal Projects Partnership Team had in-person project discussions and presentations with the Confederated Tribes of the Umatilla Indian Reservation (OR), Confederated Tribes of the Warm Springs Reservations (OR), and Confederated Salish and Kootenai Tribes (MT), as well as telephone and e-mail communications with representatives of the Nez Perce (ID) and Colville Tribes (WA). In January 2013, the NARA Tribal Partnership Projects established a Memorandum of Agreement (MOA) with the Confederated Salish and Kootenai Tribes (CSKT), Forestry Department. The

MOA is in effect for the year 2013. Students, faculty, and staff have made several trips to the reservation to clarify the project goals and to acquire continuous forest inventory data. Because the CSKT are also located within the Western Montana Corridor, we are coordinating with this year's BioIDEX team. Our MOA allows for data sharing between the BioIDEX team, UW graduate student team, and Tribe. The ongoing project has two dimensions; an assessment of biomass residues and cost of transport to Pablo Montana based on the ten-year harvest schedule developed by the tribe, and an ASPEN simulation of sugar production at the scale of biomass resources available on the reservation and in the Western Montana Corridor. The work is being coordinated with CSKT forest management to ensure our approach matches their goals and practices, including potential fuels prescriptions for fire prevention Biomass generated by fuels reduction, and forest structural change, will rely on CSKT Forest Inventory datasets and the Forest Service Forest Vegetation Simulator (FVS), with assessments provided by our contract forester, during the current NARA quarter. The Inland Empire calibration set is appropriate for the Western Montana landscape. Inventory data will be projected onto the landscape in line with CSKT forest management schemes. Transportation assessments will be completed by the GIS team members to mesh well with data developed for the Western Montana Corridor project. High quality road network GIS data (including metrics of road quality) have been shared between the UW and BioIDEX team. CSKT will gain analyzed data, providing for further management capabilities in forestry, fire and fuels management. This collaboration ties in well with the NARA Western Montana Corridor Project, utilizing GIS analysts from both WSU and Salish Kootenai College. The ASPEN simulations are building from prior process simulation carried out by NREL. We are assuming ground wood is delivered. Our initial simulations assume the use of dilute acid pretreatment, followed by enzyme hydrolysis to sugars by-products. The process considers each recovery step as well as drying or concentrating the final sugar products. We are investigating purity, capital, and operating costs.

## Recommendations/Conclusions

Tribal engagement and participation has been excellent, and the project has advanced significantly in the 3 months since the MOA was signed. Timber harvest tables have been established for the next decade, up to the allowable cut of 18 mmbf. A tribal forester has been identified to assist with the prescriptions to be used in FVS. The tribal partnership team has begun to develop plans for the next coordinated project in the Washington/Oregon emphasis area for the 2013-14 academic year. In the initial stages of planning, we have been invited to submit a proposal to the Intertribal Timber Council to host a workshop at their National Indian Timber Symposium, to be held in June 2013 at the Menominee Casino Resort. This workshop would highlight our MOA and partnership with CSKT. This would also identify the opportunities for tribal programs to gain an understanding of the overall NARA goals and objectives, work completed as a part of the Western Montana Corridor project and the resulting information that was produced as a result of our MOA with CSKT. This proposal is pending panel acceptance by ITC, to be decided in early May.

We recommend early identification of the OR/WA region of interest, identify possible tribal partners within the region, then seek a regional agreement (possibly via the Bureau of Indian Affairs (BIA)). This would protect tribally sensitive data from regional partners, while still incorporating tribal numbers into regional assessment. Deliverables for each individual tribe could be identified with the assurance that individual local numbers would not be utilized, however a regional number could reflect all tribes within the region.

## Physical and Intellectual Outputs

### Physical

- *Negotiation of Memorandum of Agreement and data sharing agreement with Confederated Salish and Kootenai Tribes, September, 2012 - January, 2013.*
- *Project Prospectus was negotiated with CSKT, December, 2012-January, 2013.*
- *NARA tribal meeting on Flathead Reservation, January, 2013*
- *High quality GIS tribal road layer data was shared with BioIDEX team, February, 2013.*

### Research Presentations

D.T. Schwartz and L.L. James. 2012. NARA tribal partnership projects. Oral presentation at Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR, Sept 13-14, 2012.

L.L. James and D.T. Schwartz. 2012. NARA tribal partnership projects. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

### Other Publications

Tabish, Dillon. "Confederated Salish and Kootenai Tribes Partner on Biofuel Research. Tribes collaborating on $40 million project studying the ability to create jet fuel using wood debris." Flathead Beacon. 21 February 2013. Online. http://www.flatheadbeacon.com/articles/article/confederated_salish_and_kootenai_tribes_partner_on_biofuel_research/31831/

Miller, Alice. "*Tribal forest biomass could become jet fuel*." 21 March 2013. Page 10. Print. At: http://www.leaderadvertiser.com/news/article_22f2d800-91a1-11e2-98f2-0019bb2963f4.html

Burke, C. 2013. Landscape planning on a large scale: Confederated Salish and Kootenai Tribes partner with NARA. February 2013 NARA newsletter. http://nararenewables.org/feature/newsletter-3

NARA advertisement, provided by Stephen Locker (WSU) included in the 2012-2013, 19th Annual, Special College Issue of the *Winds of Change*, magazine.

James, L. 2012 NARA tribal projects team advertisement in the American Indian Science and Engineering Society, Winds of Change magazine.

James, L. 2012. Northwest Advanced Renewables Alliance Offers Nine-Month Internships. March newsletter of Teru-talk at: http://www.terutalk.com/March-2012.html

### Trainings, Education and Outreach Materials

January 15-16, 2013: NARA Tribal Partnership project kick-off meeting held at the KwaTaqNuk Resort in Polson, MT. Introduction of NARA project personnel and CSKT Forestry personnel with a short field tour of CSKT tribal forest lands and Salish Kootenai College.

February 5, 2013: Formal presentation of NARA and Tribal Partnership Projects to the Confederated Salish and Kootenai Tribes, Tribal Council (at the request of the tribe). Mike Wolcott and Laurel James, presenters.

April 19, 2013: Presentation of the tribal partnership project to the Tribal Summit held on the University of Washington Campus. Laurel James, presenter.

# Task E-2: GreenSTEM K-12 Initiatives

| Key Personnel | Affiliation |
|---|---|
| Tammi Laninga | University of Idaho |
| Steve Hollenhorst | Western Washington University |
| Danica Hendrickson | Facing the Future |
| Karla Eitel | University of Idaho |

## Task Description

The NARA Education Initiative, or ***GreenSTEM***, includes an imaginative suite of programs that seamlessly link an array of educational and training programs with our university and commercial partners in order to meet the region's most compelling energy development needs. The overarching goal of the GreenSTEM is to increase the capacity of the region for a transition to biofuels. This will be accomplished through four interrelated goals:

1. Meet the workforce needs of the bio-energy/bioproducts economy;
2. Develop the next generation of energy leaders for industry, government, and the civic sector;
3. Improve the biofuels literacy of teachers educating our future citizens; and
4. Strengthen the overall science literacy of these same young citizens in areas particular to the biofuels debate.

The program develops energy and biofuel curricula, which are field-tested at UI's award winning *McCall Outdoor Science School (MOSS)*, annually reaching 2,500 K-12 students and 150 teachers. This curricula will then be delivered via the web and social networking approach pioneered by *Facing the Future (FtF*), a Seattle-based non-profit renowned for web-based sustainability curricula. K-12 teacher training will also be achieved through MOSS teacher institutes and FtF webinars and professional development workshops. Teachers and students will be impacted through this work and outcomes-through assessment and evaluation - will show that:

1. K-12 students are becoming more knowledgeable about biofuels, biofuels research, and energy.
2. K-12 students apply knowledge in energy literacy to successfully develop an approach to answering a problem-based energy issue.
3. K-12 teachers are more knowledgeable about biofuels, biofuels research, and energy.
4. K-12 teachers apply knowledge in energy literacy to help their students successfully develop an approach to answering a problem-based energy issue.
5. K-12 teachers participating in professional development programs will integrate problem-based learning and energy content in their home classrooms with increased confidence.

### Task E-2.1. K-12 Students (MOSS)

The McCall Outdoor Science School delivers biofuel education programs to 2,500 middle and high school students annually both during the school year and during the summer. New biofuel lesson plans are created and field-tested in partnership with FtF. Select students will participate in conjunction with their teacher and MOSS graduate students as they prepare a problem-based project to compete in the Washington State University (WSU) Imagine Tomorrow (IT) Competition.

### Task E-2.2. K-12 Teachers (MOSS)

The McCall Outdoor Science School delivers a summer workshop and an annual biofuel Teacher Institute for 12- 14 middle school to high school teachers. Teachers are paired with a MOSS graduate student who serves as a coach and technical resource for a team of students developing a problem-based energy project to compete in the Imagine Tomorrow Competition. An additional 40—50 teachers follow the IT competition preparation process via the web. Fifty teachers that accompany their 6$^{th}$ grade students to MOSS residential school programs participate by observing their students as they participate in biofuel focused education lessons. Teachers are also supported through a web-based "Energy Literacy Principle Matrix" (ELPM), designed to house and effectively organize educational materials covering a broad spectrum of subjects related to biofuels. Its design is flexible and adapts well to NARA activities while providing a single site where teachers or community members can effectively find information about biofuels.

### Task E-2.3: Energy Curriculum Web Delivery (FtF)

Facing the Future creates interdisciplinary K–12 curriculum resources that equip and motivate students to develop critical thinking skills, build global awareness, and engage in positive solutions for a sustainable future. These resources use global sustainability as a framework to present engaging, real-world issues such as energy to K-12 students. Our resources reach 1.5 million students each year and are used in all 50 states and 135 countries through web-based delivery.

Facing the Future provides K-12 educators with high quality, free and low-cost curriculum resources through the web that engage students in learning math, science, language arts and social studies through the context of real-world social, environmental, and economic issues such as energy. Our curriculum resources align with standards in all U.S. states. FtF's professional development services equip school districts, schools and educators with sustainability and global education frameworks and content, instructional strategies, and curriculum resources to help students excel academically. Facing the Future works with 12 peer educators from around the country who provide professional development to other educators based on FtF resources.

## Activities and Results

### Task E-2.1. K-12 Students (MOSS)

*Task 1 activities* are currently ongoing. The McCall Outdoor Science School has trained 34 University of Idaho graduate students from the College of Natural Resources to teach biofuel science to K-12 students. New lessons centered on energy literacy were adapted from FtF's energy curriculum. These lessons were piloted in the summer of 2012 and throughout the 2012-2013 school year. An additional lesson involving the calculation of how much jet fuel can be created from one tree was created at MOSS during

the summer of 2012. Throughout the school year graduate students have refined and further developed these lessons. All K12 students who attend MOSS will do at least four energy literacy lessons while in residence at MOSS. Currently, a MOSS graduate student is developing an entire Energy Literacy themed day that will be taught to new MOSS graduate students in summer 2013.

*Task 1 results:* A random sample of students participating in MOSS residential programs in Fall 2012 and Winter 2013 (n=129) showed a statistically significant increase in energy literacy as measured by a four-item instrument. Mean scores were 2.3 out of 4 for Time 1, and 2.6 out of 4 for Time 2. While this is not a large gain, it is moving in a positive direction. A new instrument is being designed that will include more items and curriculum is being modified to more consistently address content related to energy literacy.

### Task E-2.2. K-12 Teachers (MOSS)

*Task 2 activities* are currently ongoing. One of five major goals for the NARA project is to elevate the level of bioenergy literacy, particularly as it relates to biofuels and the NARA supply chain. Two five-day teacher workshops were conducted during the summer of 2012 focused on problem-based learning about biofuels, water resources and climate change. Each participating teacher was required to recruit teacher "followers' to follow the workshops online via the "adventure learning at MOSS" blog. In addition, MOSS staff held a three-day workshop, "MOSS Imagines Tomorrow" (MIT) in the fall of 2012 with 14 teachers to initiate training for teachers to create teams of high school students to take to the IT competition in May 2013. The training included an in-depth discussion of NARA's goals and achievements. MIT is a teacher professional development effort that aims to integrate multiple pieces of the NARA project by offering curriculum support, content support and coaching for teachers as they develop and coach teams of students who will participate in the IT competition this May. MOSS held a kick-off weekend in November 2012 where teachers were introduced to the NARA project and developed new understandings about the various challenges being undertaken by NARA scientists in developing aviation biofuels. The teachers identified various pieces of the NARA puzzle that their students might address in developing a project for IT. Additionally, IT staff attended the workshop to present on the competition itself to help teachers understand the logistics of bringing a team to the competition. MOSS graduate students are mentoring these high school teams throughout Idaho to participate in the IT competition, and they have been meeting monthly with the teachers to monitor their progress. Currently, 11 teams mentored by MOSS graduate students are registered for the competition. All MOSS graduate students and several staff will attend the competition in May to serve as judges.

In addition to direct teacher contact, MOSS has also created a web-based "Energy Literacy Principle Matrix" (ELPM), designed to house and effectively organize educational materials covering a broad spectrum of subjects related to biofuels. Its design is flexible and adapts well to NARA activities while providing a single site where teachers or community members can effectively find information about biofuels. For K-12 educators, this web-based resource is unique in that it cross-references written, image and video materials to both fundamental science concepts and to the energy literacy concepts outlined by the U.S. Department of Energy. If a teacher requires materials such as lesson plans, data sets, videos, images, activities software and modules to support specific science standards or topics, they can easily discover and retrieve it through the ELPM. Additionally, content can be screened for those tailored to specific grade levels. The matrix has already been a great help to middle and high school teachers developing projects for the upcoming IT competition.

## Task 2 results:

For all teacher workshops:

- All participants showed a statistically significant increase in content knowledge related to biofuels, water resources and climate change.
- In a 9-month follow-up survey, 68% of teachers report being more likely to use a problem-based learning pedagogy after being involved in a MOSS teacher workshop.
- 90% of teachers report that they learned new ways of teaching.
- 66% percent of teachers agree or strongly agree that they have a good understanding of biofuels, that they understand key parts of the supply chain and that they have enough of an understanding to have developed an informed opinion about the feasibility of a woody biomass biofuel program in the Pacific Northwest.
- 45.8% of teachers say that they have been able to incorporate biofuels into their teaching.

### Task E-2.3. Energy Curriculum Web Delivery (FtF)

*Task 3 activities*: Over the last two years, Facing the Future (FtF) has researched and developed a 2-week energy unit for middle school students and a 2-week energy unit for high school students. The purpose of these units is to provide classroom teachers with accessible, interdisciplinary lessons that will expose students to foundational energy concepts and provide students the opportunity to critically think about the sustainability of alternative energy sources such as woody biomass.

FtF has conducted a teacher pilot for the middle and high school lessons. Teachers that participated in the Fall 2012 Energy Unit Pilot viewed an FtF-created webinar, *Fueling the Future*, which provided an overview of the lessons and discussed the importance of fostering energy literacy in our youth.

*Task 3 results:* Staff at MOSS reviewed early drafts of the two-week energy unit for middle school. FtF's Professional Development Manager, Dave Wilton, and Curriculum Developer, Danica Hendrickson, introduced these lessons to MOSS graduate students via an interactive webinar. The MOSS graduate students piloted the lessons during the MOSS 2012 summer programs. MOSS graduate students continue to use these lessons during their 2012-2013 school year programs and **student pre- and post-tests have shown significant growth in student's knowledge of energy concepts after having used these lessons (see MOSS Task 1 results above).**

After the middle and high school lesson pilot, eight middle school teachers (including one special education teacher) and three high school teachers provided FtF with feedback on these lessons. This included the feedback from at least one teacher from Idaho, Washington, and Oregon. Feedback was anecdotal and most teachers found the lessons effective in stating the learning objectives. Feedback also suggests that the lessons were easy to use and helped challenge student misconceptions about energy. For example:

### If you were to tell a colleague or co-worker about this resource, what would you say?

> "Activity 6: This activity helped my students to understand that aviation is not used just for recreational purposes. I had my students do both Baggage Claim and Air Routes online activities which helped them to understand how much the aviation is tied to our daily lives and how much the industry has grown over the years." (Teacher from ID)

"The lesson enables students to see that all sources of energy have positive and negative considerations and to discuss the real world dilemmas that include global concerns, costs, and environmental impacts."

**Did you notice any commonly held misconceptions about energy? What were they? How well did the lessons address these misconceptions?**

"Did not know all the ways we get or use energy."

"They didn't know there were so many alternatives to fossil fuels."

"Students didn't understand that energy just changes from one form to another, and I think these lessons helped with gaining this knowledge."

"Misconceptions: Energy appears and disappears rather than changing forms. They did not have a good concept of what it means to be *stored* energy."

"Lesson 1 really made the students aware that energy is not 'saved' and only transformed. Also, the students realized that they are constant users of energy whether at rest or in motion. Lesson 2 made students aware of how large consumers of oil the United States is. Also, that we do produce quite a great amount of oil, yet still rely on other countries. Great conversations were brought up over this!"

**Were any concepts lacking from the unit that you consider essential for teaching about energy or biofuels?**

"I don't feel there were any concepts about energy that were lacking. As for biofuels, I must say that I was learning about them right along with the students!"

**Would you use this lesson in your classroom in the future? Please explain why or why not.**

"Yes, I will use this unit in the future. I started designing a similar energy unit last year and this lesson was more elegant and all the information was in one place for me."

**General Feedback**

"For all of the lessons I used, I would say they are well planned for the time recommended; they are engaging and give students many opportunities for discussion. The background materials and support is helpful and detailed. The lessons were easy to adapt for IEP [individualized education program] students and gave them many opportunities for success."

Over the last two years, FtF's Educational Technology Manager, Alicia Keefe has also developed, customized, and piloted the digital platform that will be used for the energy units mentioned above.

## Recommendations/Conclusions

### MOSS

Based on measured outcomes, both the K12 student and K12 teacher programs have elevated the level of bioenergy literacy of participants. As a result, we will continue the three-pronged approach of direct K12 student programming, teacher professional development, and development of the web-based Energy Literacy Principle Matrix.

Moving forward, MOSS and FtF will continue to integrate their efforts especially in the areas of K12 and teacher assessment and teacher professional development. The current integration of MOSS teacher professional development with the IT competition is a positive one for both programs in terms of teacher recruitment. As NARA scientific discoveries are made and communicated to the K12 education team in years 3-5, MOSS will integrate this new science into new and existing lesson plans for K12 students and teachers and graduate students. Additionally, MOSS teacher professional development will focus on and occur in NARA communities in years 3-5. Finally, a cohesive and comprehensive set of energy literacy assessment tools will be developed for K12 students, K12 teachers and MOSS graduate students. A new K12 assessment instrument is being designed that will include more items and curriculum is being modified to more consistently address content related to energy literacy.

### FtF

FtF plans to develop a Moodle version and Smart Board lessons by the end of July. A print version of both the middle and high school energy units will be available on their website. The digital versions of the energy units will be updated with NARA-based science information as it is made available. FtF will also conduct Professional Development webinars for teachers that involve NARA scientists and regional stakeholders (e.g., private timber landowners, federal and state land management agencies, economic development specialists).

## Physical and Intellectual Outputs

### Biofuel Lesson Plans

1. *Value of a Tree* – how much biojet is in one tree?
2. *Hydroboxes Demonstration* - Students will see the impact of surface types on surface and ground water.
3. *Wind and Solar Audit* - Students will investigate the feasibility and practicality of installing wind and/or solar panels on MOSS campus as a viable source of energy.
4. *Toil for Oil* (adapted from FtF) - Students will explore the difficulties and limitations of extracting oil from the ground. Students will learn about the limitations of non-renewable resources and various renewable resources.
5. *Energy Audit* (adapted from FtF) - Students will investigate the energy needed to power various electronics on MOSS's campus which will include a discussion of energy sources within the state of Idaho.
6. *Renewable Energy* (adapted from FtF) – Pro and Con exploration.
7. *Biofuel* (adapted from FtF) - students learn about various sources of biofuel and evaluate their sustainability.
8. *Planes In Flight* (adapted from FtF) - students evaluate the sustainability of jet fuel from the perspective of various government agencies.

9. *Lifecycle of a Fuel* (adapted from FtF) - students use a lifecycle assessment framework to evaluate the impacts of producing various types of fuel.
10. *Fuel Debate* (adapted from FtF) - students debate about the more sustainable fuel option for our region.

### Refereed Publications (accepted or completed)

Hougham, R. J., Eitel, K. B., & Miller, B. G. (2013). *AL@: Combining the strengths of adventure learning and place based education*. 2012 CLEARING Compendium.

Eitel, K.B., Hougham, R.J., Miller, B.G., Schon, J. & LaPaglia, K. (2013). *Upload/download: Empowering students through technology-enabled problem-based learning*. Science Scope, Vol. 36, No. 7.

Hougham, R. J., Bradley Eitel, K., & Miller, B. G. (2013). *Technology-enriched STEM Investigations of Place: Using Technology to Extend the Senses and Build Connections to and between Places in Science Education.* Manuscript in review at the Journal of Geoscience Education.

Eitel, K.B., R.J. Hougham, B.G. Miller, and J.S. Schon. A technology-enabled problem-based learning approach to connect teachers online and face-to-face to content and experiences in water resources, climate change and biofuels (in preparation for the Journal of Digital Learning in Teacher Education).

Schon, J., R.J. Hougham, and K.B. Eitel. The Value of a Tree. (in preparation for The Science Teacher).

### Conference Proceedings and Abstracts from Professional Meetings

Hougham, R.J. (2013). *Education at the Speed of Adventure: Global and Local Student Inquiry in Climate Science Education.* Northern Rockies URISA -Intermountain GIS Users Conference, Invited Keynote.

Hougham, R.J., Miller, B.G., Cox, C., & Walden, V. (2012). *Communicating Science Research to High School Students in the Arctic: Adventure Learning @ Greenland*. Poster presentation accepted, American Geophysical Union (AGU) Annual Meeting, San Francisco, CA.

Hougham, R.J. (2012). *Endangered Futures, Voices for Change: Global and Local Student Inquiry of our Changing World Through Adventure Learning.* National Council for Geographic Education (NCGE), San Marcos, TX.

Hougham, R.J., J.A. Schon, K.B. Eitel, and S.A. Hollenhorst. 2012. *Education at the Speed of Research: Communicating the Science of Biofuels.* In Proceedings of the Sun Grant Initiative. New Orleans, LA.

Veletsianos, G., B. Miller, K.B. Eitel, J.U.H. Eitel, and R.J. Hougham. 2012. *Localizing Adventure Learning: Teachers and Students as Expedition Leaders and Members.* In Proceedings of Society for Information Technology & Teacher Education International Conference 2012 (pp. 2164-2169). Chesapeake, VA.

## Research Presentations

Veletsianos, G., B.G. Miller, K. Eitel, J. Eitel, and R.J. Hougham. 2012. Localizing adventure learning: Teachers and students as expedition leaders and members. Presented at: *Society for Information Technology & Teacher Education (SITE) Annual International Conference*, Austin, TX. March 5, 2012.

Miller, B.G., R.J. Hougham, and K.B. Eitel. 2012. AL@UI: Connecting people to places for meaningful learning. Presented at: *Society for Information Technology & Teacher Education (SITE) Annual International Conference*, Austin, TX. March 5, 2012

Eitel, K.B., and R.J. Hougham. 2012. Adventures in learning the MOSS way: A new PD model using problem-based learning. Presented at: *Tri-State EPSCoR Consortium Annual Meeting*, Sun Valley, ID. April 4, 2012.

Hougham, R.J., J.A. Schon, K.C.B. Eitel, D. Hendrickson and S.A. Hollenhorst. 2012. *Education at the Speed of Research: Communicating the Science of Biofuels*. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

Hougham, R.J., J.A. Schon, B. Schroeder, K.C.B. Eitel, and S.A. Hollenhorst. 2012. NARA energy literacy matrix: http://energyliteracyprinciples.org. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

Hendrickson, D. 2012. Facing the Future: Energy unit overview. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

Hendrickson, D. 2012. Life cycle assessment lesson: Feedback on a working draft. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

Schon, J., R.J. Hougham, K. Eitel and S. Hollenhorst. 2012. Value of a Tree. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

## Other Publications

MOSS Blog. *Teaching Adventure Learning @ MOSS*. http://www.teachingadventurelearningatmoss.wordpress.com - Blog site we used for the teacher workshops.

Hougham, R.J. *Energy Literacy Principl*es. http://energyliteracyprinciples.org/ - the Energy Literacy Principles Matrix

CSS 566. *Biofuels*. http://ecosensing.org/teaching/css-566/group-products/biofuels/ - graduate student products from CSS 566

One-page K12 Education Team marketing piece for both internal and external constituents.

Two-page Energy Literacy Principles Matrix promotional piece for both internal and external constituents

## Videos and Webinars

The University of Idaho McCall Outdoor Science School was featured September 19, 2012 in a KTVB (Boise NBC) news story < http://www.ktvb.com/news/slideshows/Outdoor-school-helps-students-experience-science-170502646.html>

Combined efforts with the NARA Outreach Team to build first draft of project feedstock video.

Wilton, Dave. *Fueling the Future: Energy Explorations Webinar*, recorded in Fall 2012 for teachers piloting Facing the Future's energy curriculum. http://www.youtube.com/watch?v=SGWTh_irMVU&feature=youtu.be

## Trainings, Education and Outreach Materials

MOSS Summer Teacher Workshop**,** June 18 – 22, 2012 (14 teachers plus 47 online followers) engaged in problem-based learning about biofuels, water resources and climate change.

ISTEM Summer Teacher Workshop**,** June 25 – 29, 2012 (14 teachers plus 47 online followers) engaged in problem-based learning about biofuels, water resources and climate change

MOSS Imagines Tomorrow, November 9 – 11, 2012 (12 teachers) plus Spring 2013 follow-up in helping teachers to coach Imagine Tomorrow teams.

CSS 566, Spring 2013**,** 16 MOSS Graduate Students learning about biofuels, climate change and water resources; developing curricular material to support MOSS K12 programming. Sixteen lesson plans have been developed in support of teaching energy literacy, climate change and water resources concepts.

# Task E-4: Imagine Tomorrow with BioFuels


| Key Personnel | Affiliation |
|---|---|
| Liv Haselbach | Washington State University |
| David Bahr* | Washington State University |

*Dr. Bahr has moved and is no longer affiliated with the NARA project.


## Task Description

The NARA Imagine Tomorrow program is designed to engage high school students in developing creative solutions to society's energy challenges. This project builds on the Imagine Tomorrow high school science competition at Washington State University. Now in its sixth year, the goal of Imagine Tomorrow is to unite educators, scholars, and industry leaders to teach students of all backgrounds and high school grade levels how to translate ideas into results. This energy-based competition program has been expanded to include a biofuel track, with the following objectives:

1. Engage future energy innovators. Students find ways to shift the public mindset, reshape governance and policy, reengineer technologies, and redesign communities toward a new energy future.
2. Foster collaboration. The competition shows students how collaborative actions make a difference in meeting the challenge of energy production and use in the 21st century.
3. Support educators. High school teachers inspire students to think bigger, gather information from diverse resources, and jointly develop new ideas.
4. Strengthen our community. Imagine Tomorrow creates connections among students, research faculty, and industry leaders. Students build confidence in their ability to make a positive difference in their communities.
5. Raise energy literacy. Imagine Tomorrow builds awareness of energy issues among students, educators, and the general population.

## Activities and Results

This project has provided support of Tasks 1 and 2, engagement of future energy innovators and fostering collaboration, in its first and second years of involvement (2012 and 2013) extending the reach of the competition from one state (Washington) to three additional states (Idaho, Montana and Oregon). In 2012 433 students participated as compared to 363 students in 2011. High registration numbers to date point to an even higher level of student participation in 2013, and with the addition of the biofuels category in 2012, the number of biofuels projects increased that year from 3 to 14 teams. An assessment team has been set-up to evaluate the effects of Imagine Tomorrow on students' STEM career choices and energy literacy. In 2012, this team conducted a very preliminary student survey with a 35% response rate which suggests that participation is having positive effects on students' STEM career related attitudes and interests.Results for attitude for engagement and STEM interest are encouraging and summarized in Figures 1 and 2. The project has also supported Task 3, supporting educators, with the involvement of more schools and the collaborative work with the NARA researchers from MOSS to

mentor teachers involved in the competition. In both 2011 and 2012 there were 46 schools. However the current registration indicates more schools will participate in the May 2013 event. The competition is also strengthening connections among students, faculty and industry (Task 4) with the vast number of judges volunteering for the competition (117 in 2011, 119 in 2012 and 120 to date in 2013). Results from the 2012 survey also indicate positive comments as listed in Table 1. An energy literacy assessment process began in early 2013. The goal is to use the competency rubrics in Tables 2 and 3 to rate the level of energy literacy demonstrated through two available deliverables, the *abstract* and the *poster*. Final abstracts are available for the 2009, 2010, 2011 and 2012 competitions and using this rubric as a guide, each abstract has been rated on a scale from Absent to Mastering for both general energy literacy and also biofuel literacy (some projects dealt with biofuels even before the *biofuels* category was implemented). The expectation is that most of the abstracts will not exceed "emerging" in quality. This is not considered to be a weak point as the expectation is that after the project is done the students will have learned more and that their poster score will show improvement. In a similar manner, when the posters are ranked after the competition in May, it is not expected that the grading rubric will exceed the *competent* level, as beyond this would entail additional dedicated energy curricula that students would not be exposed to at this level. Figure 3 provides a comparison of how the abstracts show improvement in energy literacy competency in 2012. Figure 4 provides some insight into the initial influence of the addition of the biofuels category. Note that in 2009, the beginning of the recession and high fuel prices may also have influenced the outcomes. Future assessment activities will provide additional information.

Figure 1: Attitudes: Pursing careers where I could work on Imagine Tomorrow like projects would be:

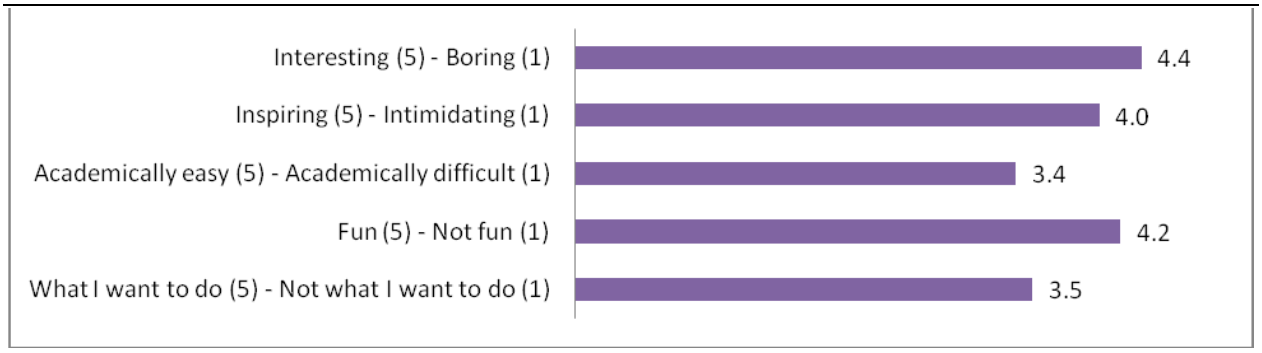

Figure 2. Degree of Interest in STEM Careers after Participating in Imagine Tomorrow

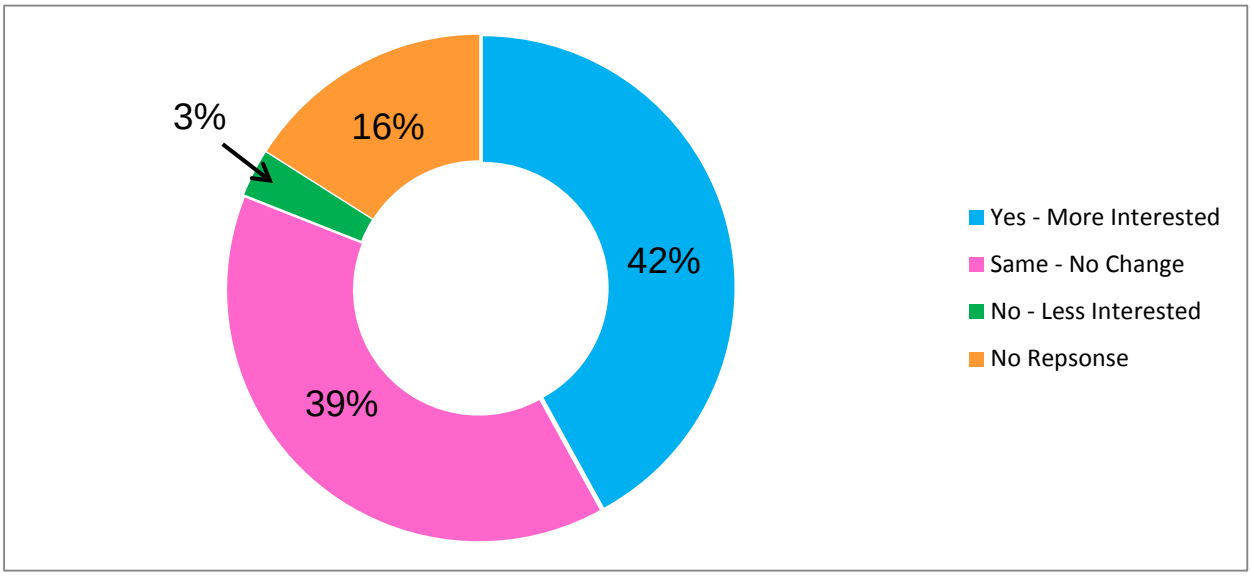


**Table 1.** Students' Revelatory Comments – Sample Quotes 2012

(*Research Team's Assessment)

| |
|---|
| *"I will want to be a cardiovascular surgeon but I might change my mind before I graduate and become something having to work with biofuel"* **[Reveals that IT competition can help change career interest]*** |
| *"I'm more interested in helping the environment and making people more aware of what is going on around the world and what we can do to stop it."* **[Reveals that IT competition can help enhance interest]** |
| *"I realized what it took and that I can do it."* **[Reveals that IT competition can help cultivate more confidence]** |
| *"After seeing all the designs of the others I am more interested in coming up with designs of my own."* **[Reveals that IT competition can help uncover interest which they never knew they had]** |
| *My project exposed me to the process required to obtain materials such as nitrogen cylinders and provided me with opportunities to meet scientists.* **[Reveals that IT competition provides exposure that students may not get at their schools]** |
| *Engineering is a very interesting subject. It involves a lot of thinking and creativity. This project really helped me to understand what it would be working in that field.* **[Reveals that IT competition can enhance learning]** |
| *I've always wanted to be an engineer and this made me more sure of that"* **[Reveals that IT competition can help reinforce student choices]** |
| *I've always wanted to go into science and this has reaffirmed that"* **[ Reveals that IT competition can help reinforce student choices]** |
| *This competition had me realize that we need to help make a difference for our future.* **[Reveals that IT competition can enhance students' social responsibility]** |

**Table 2:** Energy Literacy Rubric (Version April 2013)

| Energy Literacy | | | | | | |
|---|---|---|---|---|---|---|
| Absent | Pre-Emerging | Emerging | Developing | Competent | Effective | Mastering |
| Students:<br>- Do not identify issue<br>- Do not summarize the issue<br>- Do not consider stakeholders<br>- Focus on their own perspective<br>- Do not consider impact or context<br>-Do not consider current information available on the issue | | | Students:<br>- Begin to frame the issue, but gloss over key details<br>- Discuss approaches to resolve issue<br>- Discuss the impact in one or two contexts<br>- May consider perspectives of some stakeholders<br>-Mention available information | | Students:<br>-Frame professional challenge<br>-Develop appropriate approaches to resolve the issue<br>-Deeply examine impact<br>-Seek and evaluate outside sources<br>-Examine current information as it relates to their research | |

**Table 3:** Biofuel Energy Literacy Rubric (Version April 2013)

| Biofuel Energy Literacy | | | | | | |
|---|---|---|---|---|---|---|
| Absent | Pre-Emerging | Emerging | Developing | Competent | Effective | Mastering |
| Students:<br>-Do not address biofuels<br>-Do not explain why alternative fuels are needed<br>-Do not mention potential impacts of biofuels<br>-Do not consider challenges associated with biofuels | | | Students:<br>-Address a specific biofuel<br>-Briefly state why they are needed<br>-Discuss one or two possible impacts<br>-Mention possible technology or market challenges | | Students:<br>-Address feedstock, processing, etc. of a particular biofuel<br>-Explain with specific facts why they are needed<br>-Explain specific future impacts associated with particular fuels<br>-Explain potential challenges in terms of technology and market | |

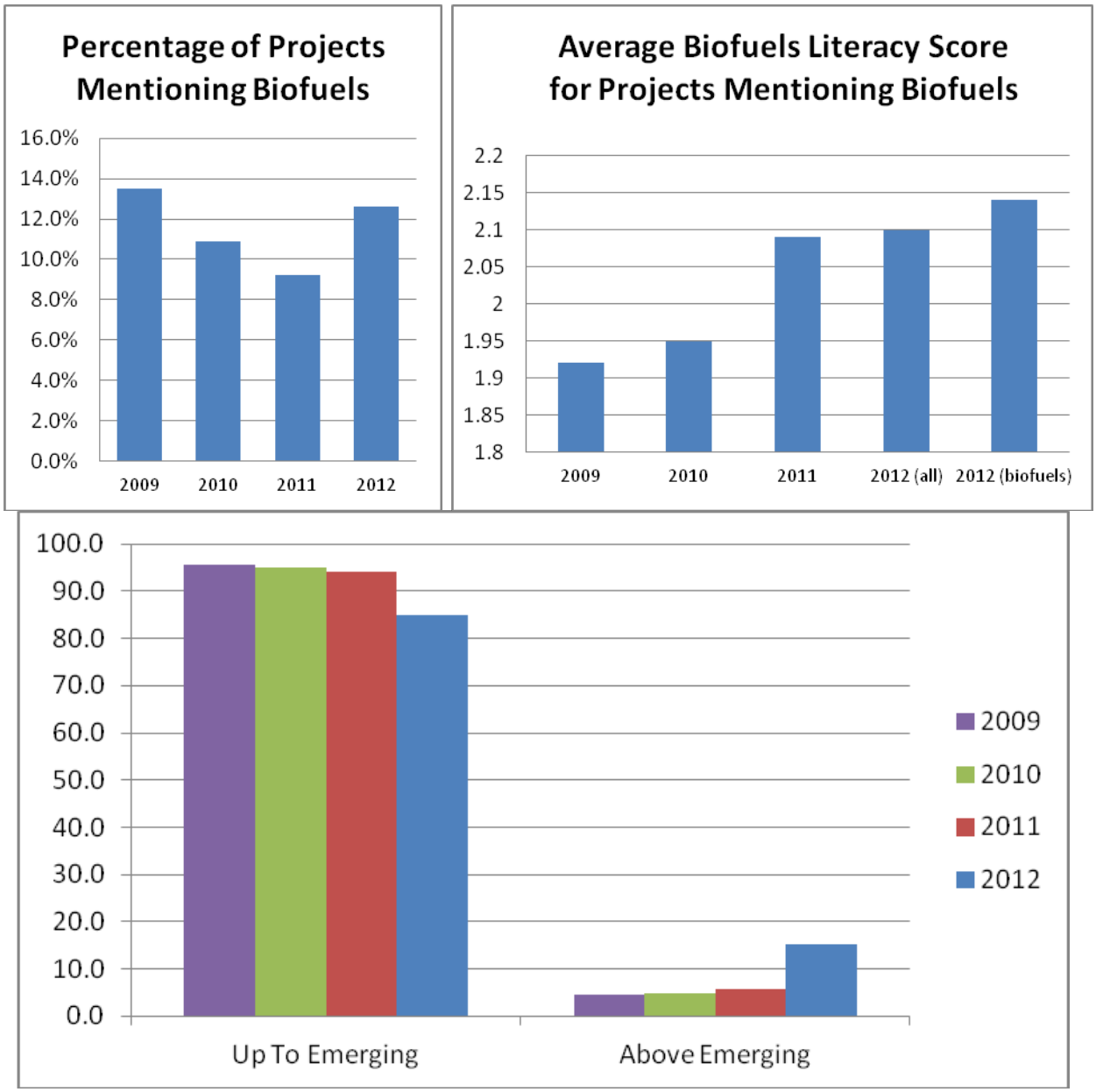


**Figure 3:** Results of the general energy literacy assessment for 2009 through 2012 relative to emerging.

**Figure 4**: Preliminary biofuels ranking on the abstracts: Percentage mentioning biofuels and score

## Recommendations/Conclusions

Support for the Imagine Tomorrow Competition has not only seen expansion in the numbers of participants and states involved, but is also apparently impacting energy literacy and STEM interest in positive ways. Addition of the biofuels category is also providing a larger platform for promoting alternative fuel knowledge and growth in the region. Additional assessment of these outcomes is growing with the leveraging of additional funds from other sources for the assessment research activities, and will be applied in additional ways during the May 2013 and future competitions. The STEM surveys will be expanded and compiled into databases and the energy literacy rubric will be piloted on the main competition deliverable; the *poster,* in addition to collection of supporting information from other competition outputs such as PowerPoint files and demonstrations. The collaborative work among other NARA education team members with the Imagine Tomorrow is making the potential for positive outcomes even more possible, particularly with the investment by the MOSS team in teacher mentoring and education in energy literacy and student team support. The marketing campaign for 2013 also included distribution of energy-based literature in new media that is expected to enhance the interest in the competition and also increase energy knowledge in those who are not able to directly participate. It is recommended that the level of support for the competition increase with the prediction of higher rates of participation, additional assessment and a more widespread reach. Continued participation by high profile executives such as the Washington State Superintendent Randy Dorn and 2013 keynote speaker Bob Peters, Washington State President of the Bank of Americapoint towards even greater success and engagement in collaboration and strengthening our communities for the future.

## Physical and Intellectual Outputs

### Research Presentations

Haselbach, L. 2012. Imagine Tomorrow – 6th annual problem-solving competition for grades 9-12. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

### Other Publications

About a dozen regional newspapers have highlighted the NARA supported Imagine Tomorrow program. Please see http://imagine.wsu.edu/news/default.aspx for an up to date list.

- Imagine Tomorrow: How to deliver a memorable presentation (pdf), ***The Seattle Times***, November 27, 2012
- Imagine Tomorrow: A better world through technology (pdf), ***The Seattle Times***, November 20, 2012
- Imagine Tomorrow: A better world through design (pdf), ***The Seattle Times***, November 13, 2012
- Imagine Tomorrow: A better world by changing behavior (pdf), ***The Seattle Times***, November 6, 2012
- Imagine Tomorrow: A better world through biofuels (pdf), ***The Seattle Times***, October 30, 2012
- Green Washington Awards 2012: Government/Academia, ***Seattle Business***, November 7, 2012

- EHS students take home prizes on Imagine Tomorrow competition, ***The Daily Record***, June 22, 2012
- CHS aims for a healthier world, Camas School District, June 8, 2012
- Yelm students earn honors at 'Imagine Tomorrow' contest, Yelm KOMO News, June 7, 2012
- Todd Beamer Students Win Imagine Tomorrow Regional Science Fair, Federal Way Public Schools, May 25, 2012
- Missoula students take first place in science competition, KPAX.com, Missoula, MT, May 24, 2012
- Students Work With DEA To Grow Sustainable Garden, NBCMontana.com, May 24, 2012
- Students propose energy solutions, compete for $100k, WSU News, May 22, 2012
- Sentinel High team gets win at problem-solving competition, Missoulian, May 21, 2012
- Toward a sustainable future: MHS students win second place in biofuels category at 'Imagine Tomorrow' event, ***Moscow-Pullman Daily News***, May 21, 2012

Award winners and event programming at http://imagine.wsu.edu/past/2012/default.aspx

**Videos and Webinars**

Missoula Students Take First Place in Science Competition. KPAX.com, Missoula, MT, May 24, 2012. http://www.kpax.com/videos/missoula-students-take-first-place-in-science-competition/

YouTube video thanking the USDA is at http://www.youtube.com/watch?v=6Lr0mLrTwbk

**Trainings, Education and Outreach Materials**

Imagine Tomorrow Competition. 2012. Washington State University, Pullman, WA. May 18-20, 2012.

# Task E-5: Summer Undergraduate Research Experiences (BF-SURE)

| Key Personnel | Affiliation |
|---|---|
| Shelley Pressley | Washington State University |
| David Bahr* | Washington State University |

*Dr. Bahr has moved and is no longer affiliated with the NARA project.

## Task Description

BF-SURE is a summer immersion research experience for undergraduates aimed at giving them hands on skills in biofuels and bioproducts research, feeding the pipeline into energy research careers.

SURE participants participate in full time research experiences for a summer (10 week) program that provides laboratory, fieldwork, and research skills in the broad area of biofuels and bioproducts research. The SURE program goals are:

1. To excite undergraduate students about cutting edge research in the area of biofuels and bioproducts.
2. To develop skills needed for future biofuels and bioproducts research careers
3. To increase the number of students participating in biofuels and bioproducts research in the Northwest, including those from schools that do not have strong research efforts.
4. To integrate mentoring experiences for graduate students and post docs into a formalized training program.

## Activities and Results

Recruit and Select SURE Students

The second group of SURE students is currently being recruited and accepted for the summer 2013 program. The first year (summer of 2012) there were a total of 11 applicants resulting in 8 students that were selected for participation. Primary recruitment efforts included development of a NARA SURE website (http://www.nararenewables.org/ed) and individual faculty members in NARA contacted students at their schools. Although the number of applications was low the first year, we were able to reach a very diverse group of applicants. Demographics of 2012 applicants were 36% women, 64% men; and 18% Hispanic, 9% Native American, 9% Asian, and 64% Caucasian.

Additional recruiting efforts were implemented in the Fall 2012/Spring 2013. An informational flyer advertising NARA SURE was developed and distributed at the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), the American Meteorological Society (AMS) Annual Meeting and the 2013 Small Log Conference. In addition, a notice was posted on the Institute for Broadening Participation: Pathways to Science website (http://www.pathwaystoscience.org/). To date, a total of 38 applicants have been received and offers are currently being made to selected students (3 to

date). Demographics of 2013 applicants are 61% women, 39% men; and 11% Hispanic, 3% Native American, 8% African American, 34% Asian/Pacific, and 39% Caucasian.

## Recruitment of Faculty Mentors

For the first year individual faculty in NARA (as well as industrial partners) were solicited for their interest to host a summer student project. During the annual NARA meeting in Missoula, MT (Sept 13-14, 2012), a poster was presented on the SURE experience and multiple contacts were made with NARA members (both faculty and industrial partners) for the NARA:BF-SURE 2013 program. Currently 6 projects have been identified for 2013 including projects at Penn State, WSU tri-cities, WSU Pullman, US Forest Service in Madison, WI, and two projects at Weyerhaeuser (Federal Way, WA).

## SURE Experience

The students are paid a stipend of $5000 for the full summer of working full time, with additional costs for housing or tuition added for students depending on location and on–site needs. In 2012, students were placed at 4 different NARA locations: WSU Pullman (3), WSU-TC (1), Oregon State (2), and UW (1). In Pullman students are co-located in housing with other summer researchers. All students participated in the poster session on August 3, 2012 in Pullman. The final 7 student participants, their home schools, and their SURE appointment schools are listed here and shown in Figure 1.

1. Margaret Buffum (OSU/OSU)
2. Lucy Cheadle (Washington University / UW)
3. Brady Do (OSU/OSU)
4. Madeline Fuchs (Montana State / WSU-P)
5. Pedro Guajardo (WSU-TC / WSU-TC)
6. Anthony Lathrop (WSU-P / WSU-P)
7. Ellen Simonsen(WSU-P / WSU-P)
8. Burdette Birdinground* (Salish Kootenai College / UW)

SURE participants traveled to Pullman to present posters at the culminating poster symposium (Table 1), sponsored by the WSU Office of Undergraduate Research. Over 70 undergraduate researchers from various WSU sponsored programs participated along with the SURE students.

Figure 1: SURE participants on Aug 3, 2012 during the poster symposium. Front row, l to r: B. Birdinground, M. Buffum, Middle row, l to r: L. Cheadle, B. Do. Back row, l to r: P. Guajardo, Jr., M. Fuchs, E. Simonsen, A. Lathrop

Table 1: 2012 NARA SURE participants, poster title, and research advisor.

| Northwest Advanced Renewables Alliance; USDA-Funded | | | |
|---|---|---|---|
| **Sec.** | **Poster Title** | **Author** | **Advisor** |
| 1.1 | Scale up of an ultra-low cost in-forest thermal processing of biomass | Burdette Birdinground* | Daniel Schwartz |
| 1.2 | Moisture Content in Biomass Piles | Maggie Buffum | Glen Murphy |
| 1.3 | Analysis of Bioproducts from Ultra-Low Cost Biomass Processing | Lucy Cheadle | Daniel Schwartz |
| 1.4 | Assessing Risks of Arson in Biomass Piles | Brady Do | Glen Murphy |
| 1.5 | NARA Biofuels Production Emissions | Madeline Fuchs | Michael Wolcott |
| 1.6 | Diluted acid and peroxide pretreatments of Douglas fir biomass | Pedro Guajardo Jr. | Xiao Zhang |
| 1.7 | Effect of Hot Water Extraction on Mechanical Properties of Ponderosa Pine Chips | Anthony Lathrop | Vikram Yadama |
| 1.8 | Biobased Curing Agent for Epoxy | Ellen Simonsen | Jinwen Zhang |

*Burdette Birdinground worked under Dr. Daniel Schwartz, a UW NARA mentor; however he was not funded by the NARA SURE program.

## Recommendations/Conclusions

For We are headed into the second summer and everything appears to be on track. The next steps are to refine the projects with individual faculty members to ensure a successful summer experience for the students and mentors. In the future, students need to be notified sooner (ideally in March instead of April), as many of the students have already accepted other positions and are no longer available. In order to accomplish this, faculty need to submit project descriptions much sooner as well.

## Physical and Intellectual Outputs

### Physical

- Pre and post surveys were developed and administered to NARA SURE participants. The goal of the survey is to identify gains (from the student perspective) of the research experience, determine if career goals (i.e. decision to attend graduate school) change after a summer research experience, and establish how satisfied the students were with the program.

## Research Presentations

Bahr, D., S. Pressley and M. Wolcott. 2012. NARA SURE Summer Undergraduate Research Experiences. Poster presentation at NARA 2012 Annual Meeting, Missoula, MT, Sept 13-14, 2012.

## Other Publications

Sorensen, E. 2012. A Summer of Science, Washington State Magazine, Winter 2012/13, v12 n1, page 31-36. http://wsm.wsu.edu/s/index.php?id=998#.UVnCZqt36aI

Burke, C. 2012. Summer undergraduates = hot research. December 2012 NARA newsletter. http://nararenewables.org/feature/newsletter-2#story3

Makhani, B. 2012. WSU Hosts Summer 2012 Undergraduate Research Poster Symposium. University College News website, Aug. 9, 2012: http://universitycollege.wsu.edu/units/undergraduateresearch/News-Events/headlines/2012reupostersession/

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One-page NARA SURE marketing piece for both internal and external constituents.

# Task E-6: Summer Undergraduate Research Experiences (SURE-SKC)

| Key Personnel | Affiliation |
|---|---|
| Adrian Leighton | Salish Kootenai College |

## Task Description

Biofuels and bioproducts offer a high value use for woody biomass. Tribal forestry operations generate substantial quantities of woody biomass during fuels reduction aimed at forest health, timber harvest, and other activities. These forestry operations are keen to realize the environmental, economic, and social benefits of developing high value products from the forest. In order to help accelerate the development of high value-added uses of woody biomass among Northwest tribal communities, NARA is partnering with the forestry program at Salish Kootenai College (SKC), a tribal university, to provide research opportunities tied to biofuels and bioproducts from woody biomass. Annual summer internship awards will be made to SKC Forestry students so they can join a NARA research university for a summer research experience.

SURE participants participate in full time research experiences for a summer (10 week) program that provides laboratory, fieldwork, and research skills in the broad area of biofuels and bioproducts research. The SURE program goals are:

1. To excite undergraduate students about cutting edge research in the area of biofuels and bioproducts.
2. To develop skills needed for future biofuels and bioproducts research careers.
3. To increase the number of students participating in biofuels and bioproducts research in the northwest, including those from schools that do not have strong research efforts.
4. To integrate mentoring experiences for graduate students and post docs into a formalized training program.

## Activities and Results

Three SKC students have interned in NARA related biomass research projects. All three have since leveraged this position in various ways at NARA related institutions. Two interns have been accepted to graduate school at the University of Washington with Dr. Ivan Eastin, who is involved in NARA's sister project. In the case of both students, the NARA internship proved to be a valuable asset in their applications and also their exposure to UW partners increased their interest in UW natural resource grad programs.

The third student successfully completed an internship in New Zealand studying fire ecology through a Montana State University PIRE grant. Again, NARA internship experience in biomass helped her leverage an internship (she had been unsuccessful in her previous application for the PIRE program) and she will be working with MSU researchers this summer in Yellowstone National Park on invasives and fire ecology.

Three internships will be set up this summer, including one that is with the Confederated Salish and Kootenai Tribes forestry department, building on biomass work that was done for them last summer.

## Recommendations/Conclusions

NARA has provided excellent opportunities for Native American undergraduates to conduct meaningful research. This has led to all three students to date pursuing other research internships and graduate school opportunities. This is creating a "ripple effect" at SKC that is leading to increased interest in NARA, in research and in graduate school.

## Physical and Intellectual Outputs

### Physical

- Two NARA interns have been accepted to Graduate School at the University of Washington. NARA related internship experience was an important factor in their acceptance (and the internships promoted interest in UW to start with).

### Research Presentations

None to date – though two NARA related student posters accepted for June 2013 Intertribal Timber Council Indian Timber Symposium

### Other Publications

**Tribal forest biomass could become jet fuel.** Lake County Leader, March 20, 2013. http://leaderadvertiser.com/news/article_22f2d800-91a1-11e2-98f2-0019bb2963f4.html

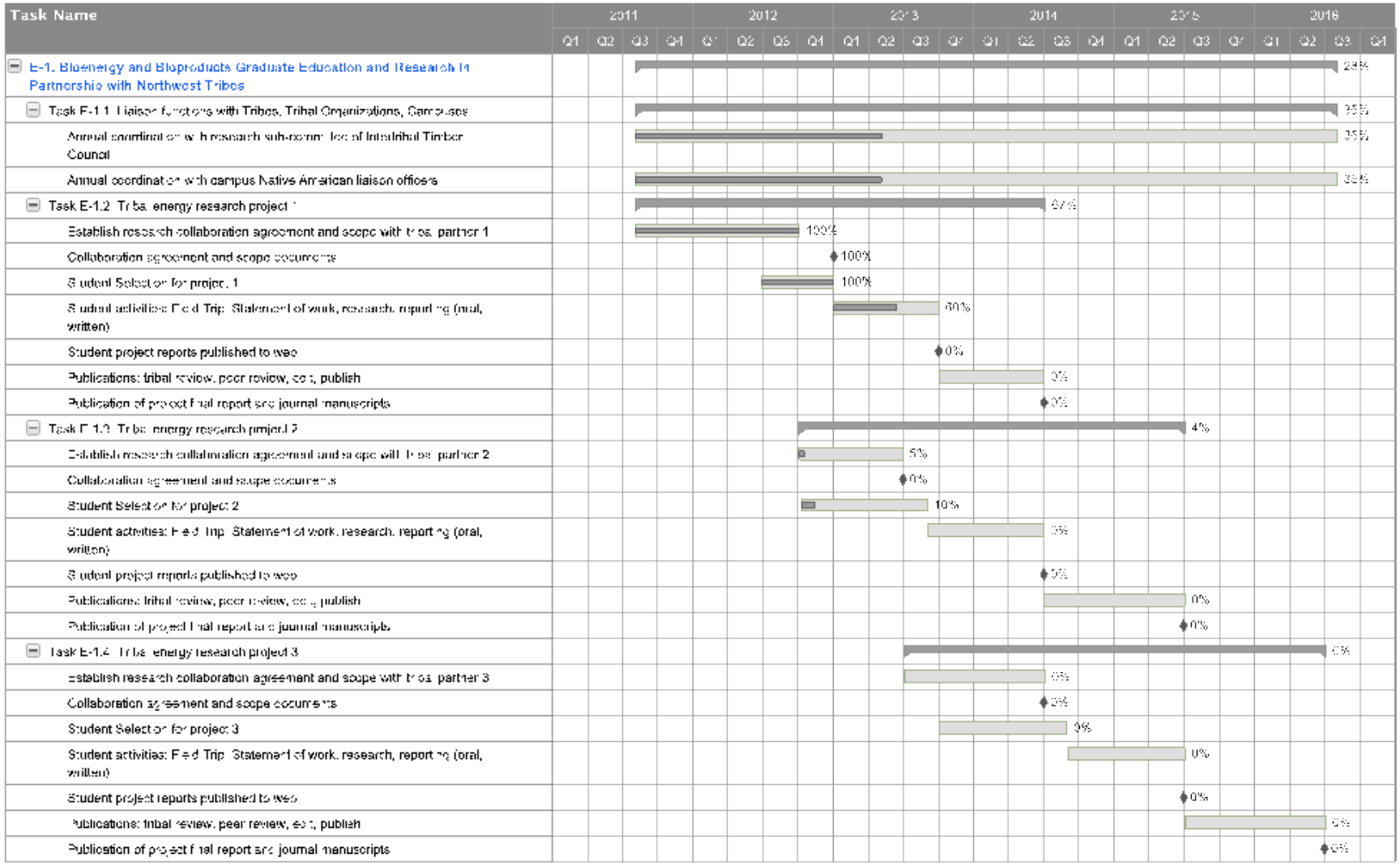
### Trainings, Education and Outreach Materials

Presentation on NARA project to student session of Traditional Knowledge and Fire Workshop, held at SKC on November 3-5, 2012

# Education_Schwartz

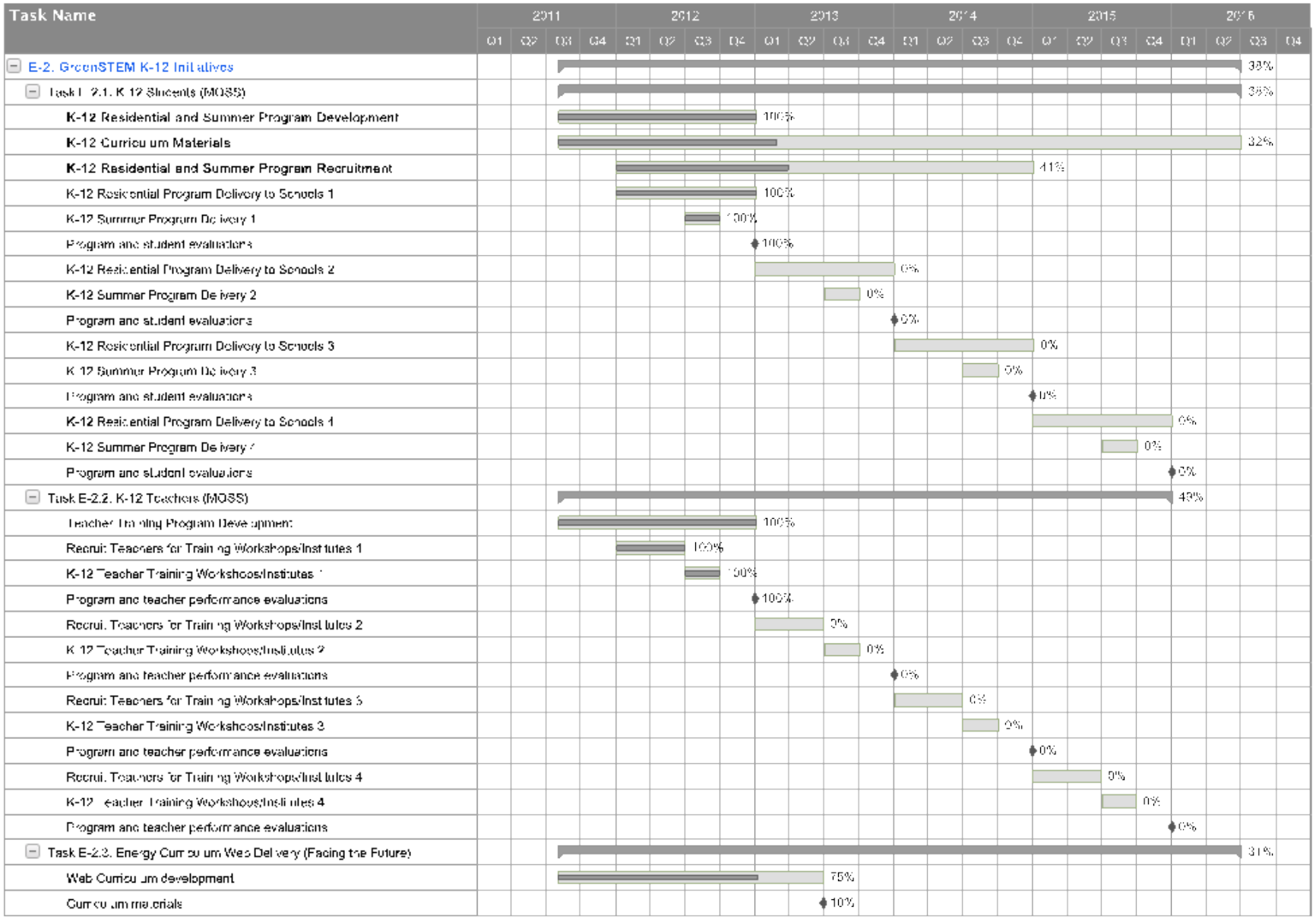
NARA

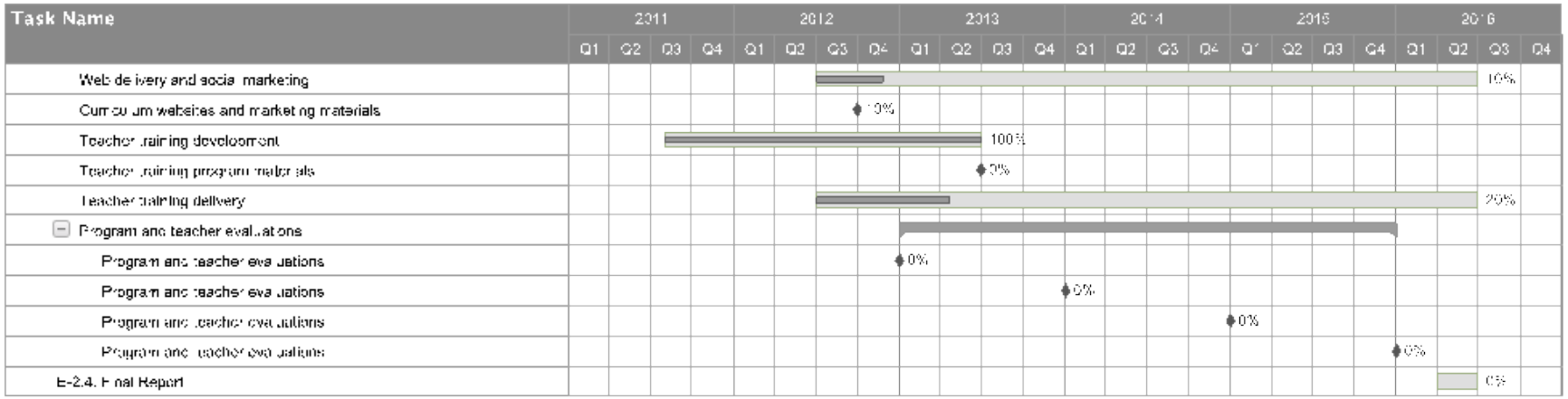




# Education_Laninga



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35 Web delivery and social marketing
36 Curriculum websites and marketing materials
37 Teacher training development
38 Teacher training program materials
39 Teacher training delivery
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# Education_Haselbach

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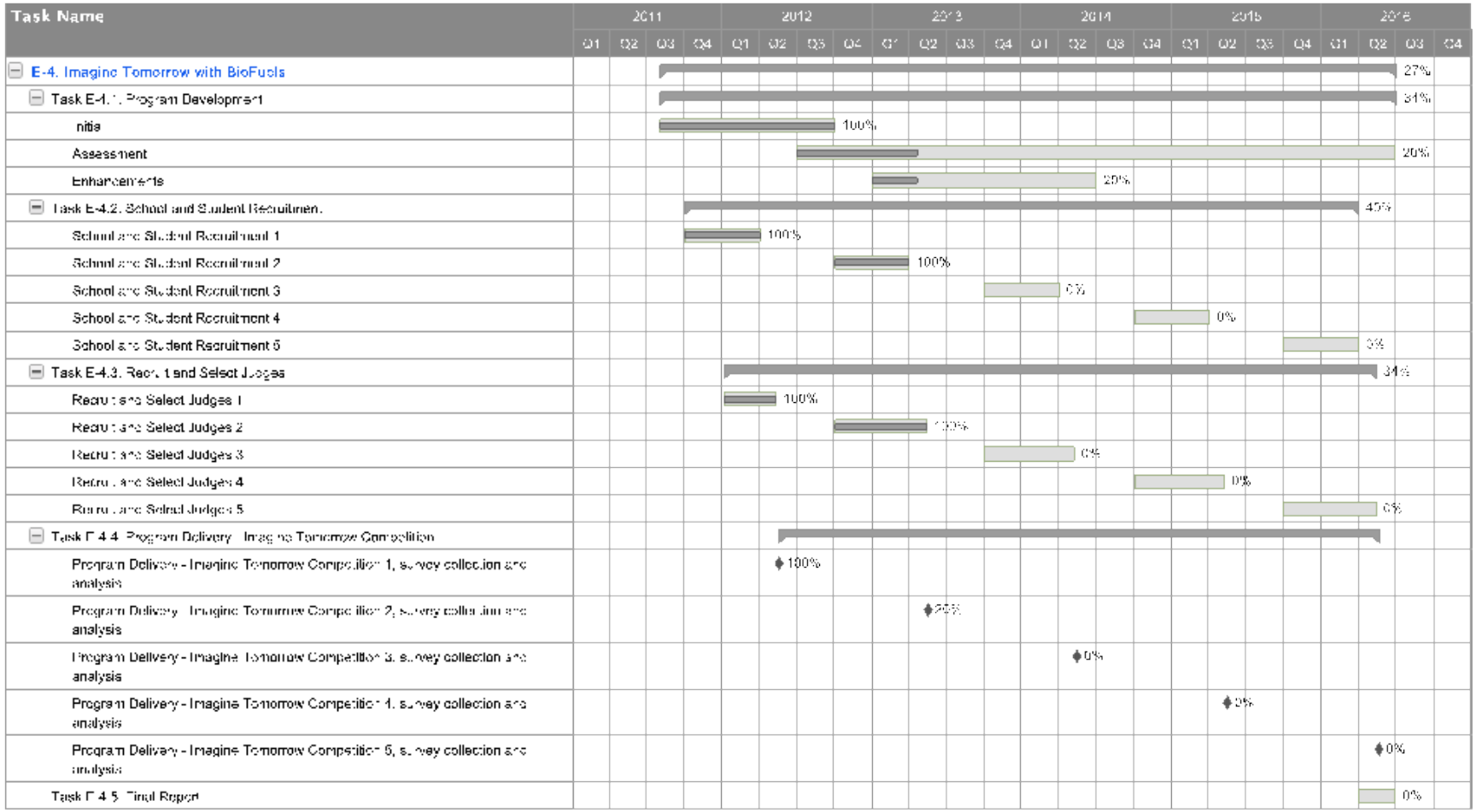

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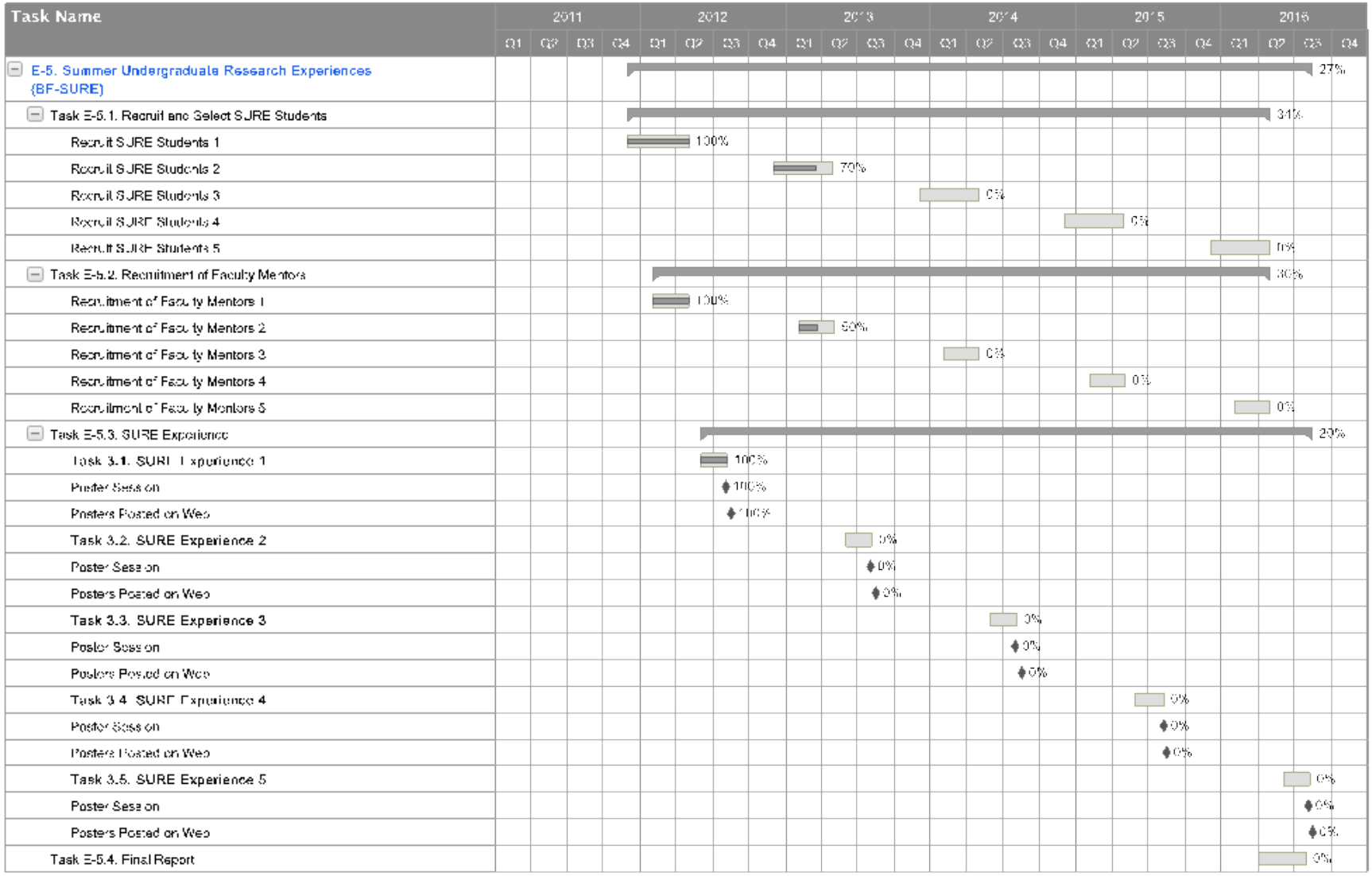

# Education_Leighton

NARA