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Explore it! Building the Next Generation of Sustainable Energy Researchers

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Principal Investigator: Donahue, Darrell W.
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Organization: University of Maine
Submitted By:
Donahue, Darrell - Principal Investigator
Title:
Explore it! Building the next generation of sustainable energy researchers

Project Participants

Senior Personnel

Name: Donahue, Darrell
Worked for more than 160 Hours: Yes
Contribution to Project:
Principle Investigator

Name: Neivandt, David
Worked for more than 160 Hours: Yes
Contribution to Project:
Co-Principle Investigator

Name: Gardner, Douglas
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Gardner operates as a co-PI assisting with the day-to-day project operations.

Name: Halog, Anthony
Worked for more than 160 Hours: Yes
Contribution to Project:
Mentor

Name: Kravit, Nancy
Worked for more than 160 Hours: Yes
Contribution to Project:
Mentor

Post-doc

Graduate Student

Undergraduate Student

Name: Wolters, Megan
Worked for more than 160 Hours: Yes
Contribution to Project:
First and Second Years of Award: Undergraduate student and later employee of UMaine who helped with communication and planning during the first two years of the REU project. University of Maine - New Media

Name: Hamilton, Abigail
Worked for more than 160 Hours: Yes
Contribution to Project:
First and Second Year of Award: Undergraduate student. University of Maine - Biological Engineering. Assisted with day to day activities of REU program during the first year of the award. Was an REU student the second year of the award, mentored by the PI.

Name: Rush, Kelsey

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award: University of Maine Student hired to assist RET Middle School teachers in development of curricular materials thematically based on sustainable forest bioproducts

Name: MacDonald, Katherine

Worked for more than 160 Hours: Yes

Contribution to Project:

Second Year of Project: Miss Katherine MacDonald is a freshman Psychology major at UMaine who worked with the RET Middle School Teacher, Mrs. Tracy Vassiliev, to develop Middle School Math and Science curricular materials thematically related to sustainable forest bioproducts.

Technician, Programmer

Other Participant

Name: Bousfield, Douglas

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award. Dr. Douglas Bousfield of the Chemical and Biological Engineering Department was a mentor in the first year of the award.

Name: Jellison, Jody

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of the Award. Dr Jellison of the School of Biological Sciences was a mentor in the first year of the award.

Name: Rubin, Jonathan

Worked for more than 160 Hours: Yes

Contribution to Project:

First and Second year of Award. Dr Rubin of the Margaret Chase-Smith Policy Center was a mentor for both the first two years of the award.

Name: Dickerson, Kate

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award. Dr. Kate Dickerson of the Margaret Chase-Smith Policy Center was a mentor in the first year of the award.

Name: Walton, Sara

Worked for more than 160 Hours: Yes

Contribution to Project:

First year of Award. Miss Sara Walton a graduate student in Dr. Adriaan van Heiningen's laboratory in the Chemical and Biological Engineering Department was a mentor during the first year of the award.

Name: Ban, Weipan

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award. Dr. Weipan Ban of Dr Adriaan van Heiningen's laboratory of the Chemical and Biological Engineering Department was a mentor during the first year of the award.

Name: Shaler, Stephen

Worked for more than 160 Hours: Yes

Contribution to Project:

First Two Years of Award. Dr. Stephen Shaler of the Advanced Engineered Wood Composite Center and the School of Forestry was a faculty mentor for both the first two years of the award.

Name: Mason, Michael

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award. Dr. Mason of the Chemical and Biological Engineering Department was a mentor in the first year of the award.

Name: van Heiningen, Adriaan

Worked for more than 160 Hours: Yes

Contribution to Project:

First and Second Years of Award. Dr. Adriaan van Heiningen of the Chemical and Biological Engineering Department was a mentor for both of the first two years of the award.

Name: Frederick, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

First year of Award. Dr. Brian Frederick of the Department of Chemistry was a mentor in the first year of the award.

Name: Wheeler, Marshall

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award. Dr. Marshall 'Clay' Wheeler of the Chemical and Biological Engineering Department was a mentor in the first year of the award.

Name: Fort, Raymond

Worked for more than 160 Hours: Yes

Contribution to Project:

First and Second Years of Award. Dr. Fort of the Chemistry Department was a mentor in both the first and second years of the award.

Name: Cole, Barbara

Worked for more than 160 Hours: Yes

Contribution to Project:

First and Second Year of Award. Dr. Cole of the Chemistry Department was a mentor during both the first and second years of the award.

Name: Leahy, Jessica

Worked for more than 160 Hours: Yes

Contribution to Project:

Second Year of Award: Dr. Jessica Leahy of the School of Forestry participated as a mentor in the second year of the award.

Name: Benjamin, Jeffrey

Worked for more than 160 Hours: Yes

Contribution to Project:

Second Year of Project: Dr. Jeffrey Benjamin of the School of Forestry participated as a mentor in the second year of the award

Name: Jara, Rory

Worked for more than 160 Hours: Yes

Contribution to Project:

Second Year of Award: Mr Rory Jara, a Ph.D student in Dr. Adriaan van Heiningens Laboratory in the Department of Chemical and Biological Engineering served as a mentor in the second year of the award.

Name: van Walsum, Peter

Worked for more than 160 Hours: Yes

Contribution to Project:

Second Year of Project: Dr. Peter van Walsum of the Department of Chemical and Biological Engineering participated as a mentor in the second year of the project.

Research Experience for Undergraduates

Name: Andrews, Gracson

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award. REU participant. From the University of Colorado, Boulder - Chemical & Biological Engineering

Years of schooling completed: Freshman

Home Institution: Other than Research Site

Home Institution if Other: University of Colorado, Boulder

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2008

REU Funding: REU site award

Name: Canney, Alexander

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award: REU participant. Pensacola Christian College - Mechanical Engineering

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Pensacola Christian College

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2007

REU Funding: REU site award

Name: gramlich, Stewart

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award: REU participant. University of Maine - Biological Sciences

Years of schooling completed: Sophomore

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2007

REU Funding: REU site award

Name: Kavkewitz, Jacob

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award: REU participant. University of Tennessee - Resource Economics

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: University of Tennessee

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2007

REU Funding: REU site award

Name: Lena, Ryan

Worked for more than 160 Hours: Yes

Contribution to Project:

First Year of Award: REU participant. Tufts University - Chemical Engineering

Years of schooling completed: Freshman

Home Institution: Other than Research Site

Home Institution if Other: Tufts University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2007
REU Funding: REU site award

Name: Oetter, Brittany
Worked for more than 160 Hours: Yes
Contribution to Project:
First Year of Award: REU participant. University of Colorado, Boulder - Chemical & Biological Engineering

Years of schooling completed: Freshman
Home Institution: Other than Research Site
Home Institution if Other: University of Colorado, Boulder
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2007
REU Funding: REU site award

Name: O'Farrill, Andru
Worked for more than 160 Hours: Yes
Contribution to Project:
First Year of Award: REU participant. University of Colorado, Boulder - Chemical & Biological Engineering

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of Colorado, Boulder
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Patel, Nimesh
Worked for more than 160 Hours: Yes
Contribution to Project:
First Year of Award: REU participant. University of Connecticut - Biomedical Engineering

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: University of Connecticut
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Vacanti, Nathaniel
Worked for more than 160 Hours: Yes
Contribution to Project:
First Year of Award: REU participant. University of Connecticut - Chemical Engineering

Years of schooling completed: Other
Home Institution: Other than Research Site
Home Institution if Other: University of Connecticut
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Jacobson, Peter
Worked for more than 160 Hours: Yes
Contribution to Project:

Second Year of Award: REU Participant, West Virginia Universtiy-Wood Science

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: West Virginia University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009 2008
REU Funding: REU site award

Name: Stone, Ian
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-Louisiana State University-Forestry

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Louisiana State University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009 2008
REU Funding: REU site award

Name: Scofield, Marcianne
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-University of Maine-Ecology and Environmental Sciences

Years of schooling completed: Sophomore
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009 2008
REU Funding: REU site award

Name: Grundy, James
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-Harvard University-Environmental Engineering

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Harvard University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009 2008
REU Funding: REU site award

Name: Andrusyk, Lucas
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-Iowa State University-Sustainable Materials Science and Technology

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Iowa State University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Rhine, Melody
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-Emory University-Chemistry

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Emory University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Khamatnurova, Tatyana
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-Universtiy of Texas at Tyler-Chemistry

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of Texas at Tyler
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Capecelatro, Jesse
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-SUNY Binghamton-Mechanical Engineering

Years of schooling completed: Freshman
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Associate's Degree
Fiscal year(s) REU Participant supported:
REU Funding: REU site award

Name: Knox, Andrew
Worked for more than 160 Hours: Yes
Contribution to Project:
Second Year of Award: REU Participant-Whitman College-Economics

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Wittman College
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2008
REU Funding: REU site award

Name: Dunn, Nicholas
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Union College

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Schual-Berke, Jacob
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Pomona College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Nauert, Anne Marie
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: University of Missouri
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Shaffer, Alexander
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Youngstown State University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Earle, Mathew
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Ramapo College of New Jersey
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Attonito, John
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: CUNY Queens College
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Jonson, Robert
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Kansas State University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Beckvermit, Jacqueline
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Fort Lewis College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Bowman, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Western Kentucky University
Home Institution Highest Degree Granted(in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Polifka, Audrey
Worked for more than 160 Hours: Yes
Contribution to Project:
Student Participant

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Kansas State University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Ochoa, Rose

Worked for more than 160 Hours: Yes

Contribution to Project:

Student Participant

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Sacramento City College

Home Institution Highest Degree Granted(in fields supported by NSF): Associate's Degree

Fiscal year(s) REU Participant supported: 2009

REU Funding: REU site award

Name: Haluska, Alexander

Worked for more than 160 Hours: Yes

Contribution to Project:

Student Participant

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Syracuse University

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2009

REU Funding: REU site award

Name: Urello, Morgan

Worked for more than 160 Hours: Yes

Contribution to Project:

Student Participant

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Columbia University

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2009

REU Funding: REU site award

Name: Rosso, Diego

Worked for more than 160 Hours: Yes

Contribution to Project:

Student Participant

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: University of Puerto Rico Mayagues Campus

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2009

REU Funding: REU site award

Organizational Partners

International Paper Company Foundation

International Paper funded on-going research in this area.

Sylvatica

Margaret Chase Smith Policy Center

Maine State Forest Service

Tethys Research LLC
Tethys personnel acted as REU participant mentors

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities:
Third Year Research and Education Activities:
The third year of the project fourteen undergraduate (all Sophomore and Junior) students representing fourteen different universities, and colleges, and community colleges participated in the REU program. The major research and education activities of the individual studnets are summarized below.

Nicholas Dunn, Union College.
'Characterization of Support Properties as a Factor in the Catalytic Hydrodeoxygenation of Guaiacol'
Comparison of the efficiency and specificity of different catalysts in the hydrodeoxygenation of guaiacol is necessary for the investigation of conversion of lignocellulosic biomass into liquid fuel. This has been accomplished by performing reactions of guaiacol in decalin solvent in a Parr continuous stirred tank batch reactor at hydrogen pressures of 50 bar. Reaction mixture samples were removed from the reactor at regular intervals and chemical composition was determined quantitatively with gas chromatography (GC). The conversion rate of guaiacol into product molecules was measured along with the product distribution of each reaction, looking at the selectivity of the catalysts for hydrodeoxygenation products as opposed to hydrogenation products.

Jacob Schual-Berke, Pomona College.
'Microfibrillated cellulose reinforced polymers:
PVA and latex films with citric acid as cross-linker'
Cellulose is the most abundant biological compound on the planet, with exceptional physical and chemical properties. Microfibrillated cellulose (MFC) possesses even better properties. With its enhanced quality, natural abundance and non-toxicity, MFC may be the key to manufacturing inexpensive, sustainable, durable and environmentally unobtrusive materials. Previous research has suggested that incorporating MFC into polymer matrices may improve the
physical qualities of the material. In this research project, MFC was prepared from two unique processes; one chemical and one mechanical. MFC was combined with polyvinyl alcohol (PVA) and styrene-butadiene latex (SBL), cast into films and tested for mechanical properties. The effects of adding citric acid (CA) was also investigated.

Annemarie Nauert, University of Missouri.
'Separation and Classification of High-Value Chemicals in Pinaceae species'
Polyphenolic compounds are naturally occurring secondary metabolites in plants that represent significant potential for pharmaceutical and nutraceutical use. Polyphenolics have been noted for their role as potent antioxidants and their ability to mimic the effects of calorie restriction; polyphenolics have also been linked with the potential to prevent age-related ailments and regulate anti-cancer mechanisms in the body. This study investigated the prevalence of potentially high value chemicals in the bark of Pinaceae speices.

Alexander Shaffer, Youngstown State University.
'Extraction of Shikimic Acid from the Pinaceae Family'
Foliage from the Pinaceae family was investigated as a potential macro-scale source of shikimic acid. Shikimic acid is an important reagent in the synthesis of oseltamivir phosphate, or Tamiflu, which is used in the treatment of the H5N1 strain (bird flu) and H1N1 strain (swine flu). Specific focus was placed upon white pine needles (Pinus strobus) because of the simplicity, low cost, and industrial practicality of the extraction process. Ultimately, focus will expand to include all species of the Pinaceae family in an effort to simulate a real forest management situation. The overall goal of the project was to utilize unused portions of the tree in a process that maximizes yield of shikimic acid at a low cost while maintaining other industrial operations at their current capacity. Techniques were based on micro-scale methods and research previously conducted at the University of Maine.

M. Alden Earle, Ramapo College.
'Nano-Structred Carbon Materials from Lignin'
Carbon nanomaterials are well known for their characteristic high strength, conductivity, and light weight. Carbon nanofibers in particular have found numerous commercial applications ranging from incorporation into electronic devices and composites, to use as a catalyst support material and as a gas storage medium. Widespread use of carbon nanomaterials is however limited by the expense involved with, and difficulty, of mass production. A great need therefore exists for the creation of carbon nanomaterials from an inexpensive feedstock via a cost effective and scalable process.
Lignin, the second most abundant polymer on Earth, is organic, renewable and harvested in millions of tons per year as part of the Kraft pulping process. Currently, only approximately 2% of lignin sees commercial application, mainly in the form of dispersants and binders. The remainder of the lignin is burnt for fuel to power the pulp mills. As such lignin has great potential as a commercially available, inexpensive and under-exploited feedstock for the production of value added products. To date there exists only one published report of the creation of carbon nanomaterials from lignin. Lignin was electrospun from an organic solvent to create lignin nanofibers, which were subsequently carbonized. While demonstrating that carbon nanomaterials may be produced from lignin, the use of electrospinning limits the work to the bench scale. The current research performed optimization of a proprietary process for the creation of carbon nanomaterials from lignin employing commercially available unit operations in an economically feasible and readily scalable process.

John Attonito, CUNY, Queens College.
'Evaluation of Cellulose Nanofibrils in Sodium Silicate-Wood Flour Composites'
Cellulose nanofibrils are a renewable material expected to improve the properties of polymers as an additive because of their high aspect ratio and relative strength. However, the nano sized fibrils are difficult to analyze due to agglomeration via hydrogen bonding in aqueous solutions. Agglomeration results in different sized clumps of fibrils in a polymer matrix leading to a loss in the enhancing properties of the cellulose nanofibrils, rendering them less effective as polymer additives. Therefore, an inorganic material sodium silicate or 'water glass,' has been evaluated as an alternative matrix for preparing cellulose nanofibril composites. Use of an aqueous-based matrix is expected to keep the fibrils separate at lower concentrations because of strong ionic bonding between the fibrils and the sodium silicate.

Robert Jonson, Kansas State University.
'Utilizing Filtration for the Concentration of Hemicellulose Extracts from the Kraft Pulping Process'
Hemicellulose extracts contain dilute amounts of xylan oligomers and thus must be concentrated before a fermentation process may be carried out. Evaporation is not suitable for concentration because, in addition to the concentrating the xylan, it concentrates fermentation inhibitors such as sodium and acetic acid. Consequently the present work studied the use of tangential flow filtration for the concentration of hemicellulose extracts.

Jacqueline Beckvermit, Fort Lewis College.
'Cellulose Nanofiber Coated Paper'
The increase in public awareness and pressure to discover and use a renewable resource while having an ecologically friendly process is reaching the paper industry. Many publication grade papers are coated with pigments that need petroleum based binders to obtain a high quality print. Other uncoated papers are treated with additional chemicals to help improve print quality. It is known that nanofibers have a unique ability to capture ink pigments at the surface of the paper allowing for little ink penetration. The present research was consequently focused on using natural cellulose nanofibers to coat paper to ascertain if higher quality characteristics resulted.

Rachel Bowman, Western Kentucky University.
'Environmental Assessment of Wood Derived Hemicellulosic Ethanol Using Alternative LCA Models'
A Life Cycle Assessment (LCA) is a commonly accepted method for determining the environmental sustainability of a product or process. The goal of the present work was to complete a cradle to gate LCA of wood based hemicellulosic bio-ethanol coming from a modified Kraft mill that produces pulp and paper using the models of Eco-LCA, Open LCA, and commercial SimaPro software. An LCA of wood based bio-ethanol has already been performed using SimaPro LCA model, but such an LCA technique only accounts for emissions and non-renewable resource consumption. Other LCA models consider land usage in their evaluation, and end-point impact assessments also exist that incorporate multiple factors.

Audrey Polifka, Kansas State University.
'Acid Springing and Extraction Using Trioctylamine'
One avenue to the conversion of cellulosic biomass into ethanol is to extract a by-product stream from the wood chips entering a kraft pulp mill. It has been shown that under optimized conditions, aqueous extraction can yield a dilute stream of fermentable wood-derived sugars while still maintaining the pulp yield and quality. In addition to sugars, the extract also contains furfural and acetic acid, which have been shown to inhibit microbial fermentation and can also be sold as commodity chemicals if separated from the extract at sufficient purity.
The aim of the present work was to remove the acetic acid from a model system consisting of water and acetic acid and eventually aqueous

wood extract. Triocytylphosphine oxide (TOPO) in a water insoluble solvent (undecane) has already been tested to remove the acid via liquid-liquid extraction. In the present work, trioctylamine (TOA) was used with a co-solvent (octanol).

Rose Ochoa, Sacramento City College.
'Bioprospecting for an enzyme that cleaves ether bonds between lignin and hemicellulose in hardwoods'
The goal of the present work was to find microorganisms that can break the ether bond between lignin and xylan, the predominant hemicelluloses of hardwoods. To determine whether a specific microorganisms can break those bonds, a model compound that mimics a specific ether bond between lignin and xylan has been created that liberates a fluorescent molecule when the relevant bond is broken. The fluorogenic model substrate simplifies the detection of microorganisms which make useful enzymes. The project involved collecting soil samples of various decaying hardwoods including: birch, maple, and oak and to assay the microorganisms in the samples using the model compound to see if any of them contain activities that can break the ether bond of the model substrate.

Alexander Haluska, Syracuse University.
'Acid Hydrolysis of Xylo-Oligosaccharide Extracts with Sulfur Dioxide (SO2): Effect of Temperature and SO2 Concentration on Absolute Pressure'
The study focused on the effect of temperature and SO2 concentration on total pressure during the acid hydrolysis process of xylo-oligosaccharide extracts with sulfur dioxide. The study used an oil batch reactor system operation, wireless pressure sensor operation, and bio-refinery concept to study the effect on the total pressure. The study carried out multiple experiments, changing temperature, SO2 concentration and using different extracts. The two techniques used were the hot water extract (HWE) and the near neutral extract (NNE).

Morgan Urello, Columbia University.
'The Isolation and Induction of a Novel Enzyme Capable of Cleaving the Ether bond between Hemicellulose and Lignin'
Wood consists of primarily 3 macromolecules, cellulose, hemicelluloses, and lignin. These three molecules are interlocked in a complex system of bonds. Because each component has their own unique use, utilizing each component to its fullest and hence optimizing woody biomass as a renewable source of energy is strictly dependent on the efficiency of the fractionation method used to separate these macromolecules. It is important they be separated yet not degraded. One particularly troublesome type of bond in this system are the ether bonds between lignin and hemicelluloses. If these bonds were more efficiently cleaved, hemicellulose could be isolated more efficiently and used for purposes such as creating bioethanol or lactic acid. Lignin could also be removed more completely, aiding industries such as the paper industry, requiring fewer bleaching steps in their processing to delignify the paper and reduce the yellowing lignin effect. The University of Maine in conjunction with Tethys Research LLC, is developing an alternative to traditional methods of chemical fractionation through the use of an enzyme pretreatment particularly aiming to cleave one particularly stubborn ether bond between lignin and hemicellulose. The current project aimed to identify a candidate organism for potential bioengineering.

Diego Rosso, University of Puerto Rico, Mayaguez Campus.
'Analysis of Hemicellulose Pre-Extraction from Red Maple'
Aqueous hemicellulose extracts from wood are considered a viable resource for the production of higher value products such as ethanol. The process extracts hemicelluloses mainly as xylan-oligomers from woody biomass. In the present work Red maple (Acer rubrum L.) was employed for the pre-extraction of hemicellulose using hot water to investigate species specific effects. Extractions were performed in both batch and continuous flow reactors.

Second Year Research and Education Activities:
The second year of the project ten undergraduate (mostly Junior) students representing nine different universities participated in the REU program. The major research and education activities of the individual studnets are summarized below.

Ian Stone, Louisiana State University.
'Feasibility of Using Insurance Company Records to Inventory Logging Equipment in the State of Maine'
The purpose of the project was to assess the feasibility of using insurance company records as a source of logging equipment data. The ultimate goal was to determine type and amount of logging equipment used in the state of Maine. The bioproducts industry is becoming increasingly important in Maine, and as such the capacity of equipment supplying this industry should be determined. The project used a phone survey of insurance agents to determine which companies are underwriting logging equipment insurance in Maine.

Peter 'Mike' Jacobson, West Virginia University.
'Moisture Content Detection in OSB Strands With Near Infrared Spectroscopy'
One quality associated with wood composites that increase their market use over lumber in many structural applications, is decreased variation. Variation of both physical (density, appearance, etc.) and mechanical (strength, stiffness, etc.) properties in these materials can be controlled during the manufacturing process. In this project the product investigated was Oriented Strand Board (OSB). OSB is manufactured from strands which are cut, dried, and screen classified. A critical aspect of the production process that must be monitored is the moisture content of

strands, especially during the initial drying cycle and prior to pressing. One method of moisture content detection that is capable of giving on-line, real-time data is Near Infrared spectroscopy (NIR). This project investigated the theories, processes, and operations of Process Sensors Corporation's NIR spectrometers designed for moisture content detection.

Melody Rhine, Emory University.
'Isolation and Quantification of High-value Compounds in Underutilized Components of Trees'
Substantial amounts of forest biomaterials including knotwood, bark, and foliage are underutilized in the forest products industry. The nature and distribution of extractives in waste biomaterials provide us with a potential source of high-value chemicals such as lignans, flavonoids, and stilbenes. This project sought to extract such high value compounds from underutilized forest biomaterials.

Andrew Knox, Whitman College.
'Consumer Biofuel Knowledge and Preferences: Results of Orono Focus Groups'
The goal of this research project was to design and test marketing strategies for the integration of cellulosic ethanol and other potential biofuels into the Northeast's light-duty fuel supply. This information allows future prediction of the potential market penetration that cellulosic ethanol could have in the Northeast - enabling the research team to estimate gasoline displacement, potential job creation, and production costs. This goal was ccomplished by performing an in-depth literary review of possible marketing techniques to employ for cellulosic ethanol, formulating a survey tool to determine consumer awareness and interest in biofuels, and utilizing the survey in a focus group setting.

Jesse Capecelatro, SUNY, Binghamton.
'Production of Ethanol and Acetic Acid by Pichia stipitis, Clostridium phytofermentans and Thermoanaerobacterium thermosaccharolyticum by Fermentation of Northern Hardwood Hot Water and Green Liquor Extracts'
In a joint collaboration to reduce our dependence on petroleum and harvest valuable byproducts in the pulp and paper industry, there is an interest to produce fuels or chemicals from non-food sources. The US pulp and paper industry currently utilizes only about 70% of the wood that it processes. The solid cellulose fraction of wood is saved while the lignin and a fraction of the hemicellulose components are burned for energy. Hemicellulose has can potentially be converted and sold into valuable products such as ethanol and acetic acid without disturbing the amount of paper being produced. A pre-extraction process can be implemented to remove the hemicellulose by a green liquor treatment. This green liquor extract along with a hot water extract contain sugars that can be fermented into valuable products such ethanol, acetic acid and acetone. In this project three organisms were tested in different amounts of extract; Pichia stipitis; Clostridium phytofermentans; Thermoanaerobacterium thermosaccharolyticum ATCC? 31960 to determine their efficiencies at converting hemicellulose to ethanol and acetic acid.

Tatyana Khamathurova-Tomlin, Universtiy of Texas-Tyler.
'Chemistry of nanocellulose (Preliminary Investigation)'
There is growing interest in the use of cellulose fibers as reinforcing agents in composite materials and polymeric matrices. The reason is that the cellulose fibers provide a great potential to become a substitute to conventional glass fibers in a wide range of applications such as packaging, building materials, and the automotive sector. The cellulose fibers are advantageous in terms of lower density, light weight and less wear on the moulding equipment.
The research project studied the chemical modification of cellulosic materials so that functionalized fibers could be produced and effectively incorporated into new polymers and composites.

Abigail Hamilton, University of Maine.
'Identification of forest bio-product process components through near-infrared spectroscopy'
Near-infrared spectroscopy (NIRS) has the potential to advance the productivity of the forest bio-refinery process by rapid identification of material components comprising of liquid extract and woody biomass. The potential exists for composition identification via NIRS to be performed as an in-line process control operation. Before this technology is applied to the forest bio-refinery process, a NIR spectral database of solid wood chips and liquid extract solutions must be developed and analyzed. Model liquid extracts with known compositions were generated in the laboratory while wood chips pre- and post-extraction were acquired from a laboratory-scale bio-refinery process. After developing the database from collected extract and wood chip spectra, partial least squares (PLS) techniques were used in combination with selected pretreatments to develop regression models.

Lucas Andrusyk, Iowa State University.
'Wood Plastic Composite Production from Hot Water Extracted Wood Chips'
The FBRI project has developed a patent pending hot water extraction process for wood to produce a feedstock for chemicals and/or fuels. Currently, the extract from the wood is being investigated as a possible feedstock for acetic acid and ethanol production, the remaining extracted wood can potentially be utilized in traditional product forms. In this project the application of extracted wood flour in extruded wood plastic composites was studied. Extracted wood flour was prepared in quantities required for WPC processing on the pilot scale, and combined with polypropylene and appropriate processing aids (lubricants, coupling agents). Extracted boards were manufactured along with an

unextracted control and evaluated following appropriate ASTM standards for tensile, flexure, impact, flame, specific gravity, and CTE tests.

Marcienne Scofield, University of Maine.
'An analysis of the quantity and framing of articles in New England newspapers relating to forest biomass and bioproducts using content analysis'
As government and industry continue to pursue renewable energy as an alternative to fossil fuels,woody biomass will remain in the news. It is possible to use the news generated to examine public concerns
over the use of woody biomass as a fuel. As such this project sought to examine what frames of reference that are most commonly employed in reporting the use of woody biomass as a fuel source, and to determie the quantity of articles in each frame.

James Grundy, Harvard University.
'Hydrolysis of birch xylan model compounds catalyzed by SO2'
Currently there are two dominant means of hydrolyzing xylan to monosugars for fermentation to ethanol and acetic acid production; sulfuric acid and enyzymatic hydrolysis. Each of the these routes has limitations, specifically gypsum production in the case of sulfuric acid hydrolysis, and the nead for stearile conditions in the case of enzymatic hydrolysis. The present project aimed to evaluate the efficacy of an alternative route, that of sulfur dioxide induced hydrolysis. Solutions modeling water prehydrolysis extract of birch was prepared Sulfur dioxide (SO2) was then dissolved into solution with target concentrations being 3, 8, and 10 wt% SO2. The SO2 containing solutions were subjected to 130, 140, 150 or 160 ?C for 30 or 60 min. The extent and kinetics of hydolysis were subsequently determined, and a sulfur balance performed.

First Year Research and Education Activities:
The numbered projects below had the follow major research & education activities:
1. REU student Ryan Lena helped us learn techniques that are needed to obtain images of nanometer scale cellulose fibers that are released from wood fibers with the new Atomic Force Microscope (AFM). This involved a lot of time just trying various sample preparation methods and machine settings. He helped us characterize the effect of the homogenizer on the average size of these cellulose nanofibers.
2. REU student Stewart Gramlich participated in two primary research projects. The first involved standardization and optimization of a biodegradation/bioconversion assay. The second project involved looking at the effect on cellulose properties associated with fungal and biomimetic treatments.
3. The objective of this research was to examine the potential energy resources available from Maine's forests on a on a sustainable basis. Forest resources available include forest residues, and, if the renewable energy market becomes strong enough, roundwood products (commercial and industrial quality wood). This research reviewed and reconciled (to the extent possible) methodological differences between three existing studies: 'Biomass Feedstock Availability in the United States: 1999 State Level Analysis, The Billion Tons Report , and 'State of Maine Ethanol Pre-Feasibility Study'
4. The REU Project focused on characterizing the inhibition effects of acetic acid on a fully controlled fermentation system, converting pentose and hexose sugars simultaneously into ethanol. The genetically modified organism E. coli K011 was used in fermentation experiments to convert a mixture of glucose and xylose into ethanol when exposed to varying concentrations of sodium acetate.
5. This work is the part of our industrial project. The major novel technology we develop is hemicelluloses pre-extraction before pulping and re-deposition on pulp. Through this new technology, pulp yield would be greatly increased, and pulp qualities would be improved.
6. REU student Nathaniel Vacanti developed a Life Cycle Inventory (LCI) for the production of Oriented Strand Board (OSB). To do this he needed to learn the concepts of LCI, the commercial software package SIMAPro, the OSB manufacturing process, and evaluate provided survey information for inconsistencies.
7. REU student Nimesh Patel worked to synthesize and quantify the catalytic properties of a modified enzyme as part of a biodetection effort in our lab. His work will be used going forward on this project. Both the optical characterization method and the bioconjugation are novel.

Findings:

Third Year Major Findings:
The major findings of each of the fourteen undergraduate research projects are described below.

Nicholas Dunn, Union College.
'Characterization of Support Properties as a Factor in the Catalytic Hydrodeoxygenation of Guaiacol'
The conversion rate of guaiacol into product molecules was measured along with the product distribution of each reaction, looking at the selectivity of the catalysts for hydrodeoxygenation products as opposed to hydrogenation products. Hydrodemethoxylation of guaiacol is the most prevalent visible reaction, with phenol being a major product in each reaction performed. Polymerization reactions with the decalin solvent occurred in all reactions, impeding the quantitation of product distribution by GC analysis.

Jacob Schual-Berke, Pomona College.

'Microfibrillated cellulose reinforced polymers:
PVA and latex films with citric acid as cross-linker'
MFC was combined with polyvinyl alcohol (PVA) and styrene-butadiene latex (SBL), cast into films and tested for mechanical properties. The effects of adding citric acid (CA) was also investigated. Tensile testing showed up to 59% increases in Young's moduli in latex blends and up to 107% increases in PVA blends. The results show that with their increased strength, durability and environmental compatibility, MFC reinforced polymers are excellent low-cost alternatives to traditional materials.

Annemarie Nauert, University of Missouri.
'Separation and Classification of High-Value Chemicals in Pinaceae species'
Bark extract was tested for total phenolics and flavonoids content as well as flavones and condensed tannins; in addition, the extract was subjected to a free radical scavenging assay that measured strength of antioxidant ability. Black Spruce (Picea mariana) was found to have the highest available levels of desired properties across all tests. Samples also underwent liquid-liquid extractions (using hexane, di-ethyl ether, ethyl acetate, and 1-butanol as solvents); extracts were analyzed using the same round of tests as described above. With the 1-butanol extract containing the highest content in twelve of fifteen tests, it was determined to be the best solvent for extraction of polyphenolics.

Alexander Shaffer, Youngstown State University.
'Extraction of Shikimic Acid from the Pinaceae Family'
Samples were collected from various species in the surrounding areas of Orono, Maine and then ground finely for investigation, and then freeze dried. Whole needles also were tested to determine the necessity of the grinding process. Micro-scale extractions were performed via an accelerated solvent extractor (ASE), and quantification was accomplished using liquid chromatography combined with a UV detector at 210nm (HPLC-UV). Additionally, liquid-liquid extractions were used to isolate specific compounds of interest within the samples. Macro-scale techniques first included Soxhlet extraction with water as the solvent. Other solvents were tested to optimize the extraction of shikimic acid. Larger scale experiments were done using a high temperature circulating digester. Results for the circulating digester indicated an optimum operating temperature of 100?C with a yield of 1.62?0.0413% for white pine needles. Polarity of the compounds in each sample played a major role in the choice of extraction solvent.

M. Alden Earle, Ramapo College.
'Nano-Structred Carbon Materials from Lignin'
An alternative processing procedure was developed during the research project that mitigates some of the experimental variation previously observed. The process as a whole is currently undergoing patent protection and scale-up to the pilot level.

John Attonito, CUNY, Queens College.
'Evaluation of Cellulose Nanofibrils in Sodium Silicate-Wood Flour Composites'
In an attempt to prove the positive effects of nanocellulose as an additive and create a structural material using a sodium silicate matrix, samples consisting of sodium silicate, cellulose nanofibrils and wood flour were created and tested for flexural strength. Composite samples containing 2.5% cellulose nanofibril solids content had a superior modulus of rupture (MOR) to that of the control at 4171 psi compared to 3232 psi. The 5% cellulose nanofibril samples had a MOR of 2267 psi. However the 2.5% cellulose nanofibril samples also showed an inferior modulus of elasticity (MOE) compared to that of the control at 636,219 psi compared to 773,448 psi. The 5% cellulose nanofibril samples had a MOE of 479,373 psi.

Robert Jonson, Kansas State University.
'Utilizing Filtration for the Concentration of Hemicellulose Extracts from the Kraft Pulping Process'
Filtration was found to allow the concentration of the xylan without concentrating the smaller inhibitory molecules. Relationships between the cooking conditions of the hemicellulose extracts were seen, however no model was able to be determined. In addition centrifuging was examined and shown to be a possible pretreatment to increase the permeation rate of the filtration process.

Jacqueline Beckvermit, Fort Lewis College.
'Cellulose Nanofiber Coated Paper'
The nanocellulose coating process utilized a draw down coater which evenly distributes the nanofibers. To obtain a high quality print, nanofibers were mixed with other materials that add pigment and/or act as a binder. Kaolin, was investigated as a pigment and nanofiberous cellulose, also referred to as nanocellulose, and polyvinyl alcohol were investigated as binders. Nanofiber coated sheets were examined and compared with industrial grade products for their print resolution, ink distribution, and other product characteristics. Papers were tested and compared based on the inks absorption or penetration rate and the inks density. The latter was performed using a reflection densitometer, a Bristow wheel and a microscopic video camera used to measure the ink dot surface area. The research focused on finding an affordable industrial biofriendly (green) method to upgrade paper thus allowing companies to reduce their use of petroleum based products.

Rachel Bowman, Western Kentucky University.
'Environmental Assessment of Wood Derived Hemicellulosic Ethanol Using Alternative LCA Models'
Eco-LCA and Open LCA are newly developed models that offer a more complete approach to LCA modeling. Eco-LCA, a free LCA model available to the public, considers ecosystem goods and services, referred to as natural capital, which accounts for the environmental impacts of a process on natural goods and services such as water, soil, wood, and grass. Eco-LCA uses an input-output LCA modeling approach to assess a system, resulting in a more comprehensive outlook that requires only simple resource input data, rather than specific information about the emissions from individual processes. The SimaPro model requires setting a boundary for the types of factors that will be included in the LCA and specific emissions data from each individual process, therefore potentially yielding different results than the Eco-LCA evaluation.

Audrey Polifka, Kansas State University.
'Acid Springing and Extraction Using Trioctylamine'
Key investigations included developing extraction equilibrium data for water/acetic acid versus an organic-amine system, and recycling the amine with the intent of using this data in comparing extraction performance on real extracts versus a pure component system and developing distillation equilibrium data for real extracts versus pure components. These characterizations of the extraction and solvent recovery operations lead to the final objective of the project. TOPO costs nearly ten times as much as TOA per gram; therefore, the recyclability and effectiveness of both TOPO and TOA were compared to determine the preferable extraction technology.

Rose Ochoa, Sacramento City College.
'Bioprospecting for an enzyme that cleaves ether bonds between lignin and hemicellulose in hardwoods'
Soil samples were collected and incubated in liquid culture with the potentially fluorescent substrate as the only source of carbon. Cultures that subsequently displayed fluorescence were sampled and re-cultured on a semi-solid medium, again containing the indicating substrate. Colonies that again yielded fluorescence were selected and re-plated until they were pure. Simultaneously, the ATCC culture collection was screened for microorganisms with the ability to generate fluorescence from the test substrate. Microbes were selected from wood decay environments that were not previously known to be white rot or brown rot fungi. Phylogenetic trees were constructed to assess evolutionary diversity among the available microbes. Using these trees and information from the culture collections, 24 microorganisms were selected so as to maximize evolutionary and diversity in the sample. The cultures were tested for their ability to grow on the fluorogenic model compound.

Alexander Haluska, Syracuse University.
'Acid Hydrolysis of Xylo-Oligosaccharide Extracts with Sulfur Dioxide (SO2): Effect of Temperature and SO2 Concentration on Absolute Pressure'
The study carried out multiple experiments, changing temperature, SO2 concentration and using different extracts. The two techniques used were the hot water extract (HWE) and the near neutral extract (NNE). It was concluded that the temperature and the SO2 concentration both have a strong effect on the total pressure and that it is possible to control the SO2 concentration based on absolute pressure and temperature.

Morgan Urello, Columbia University.
'The Isolation and Induction of a Novel Enzyme Capable of Cleaving the Ether bond between Hemicellulose and Lignin'
An extremely promising organism, B603, has proved capable of cleaving the ether bond and through the use of bioengineering, the lab hopes to be able to produce the enzyme(s) allowing for this capability in a commercially viable manner. 11 possible candidates have already been isolated as a result of the present work. These candidates show great promise either as the hemicelluloses-lignin etherase or as simply a fluorescent protein. An NCBI ? BLAST search has shown the sequnces to be unrelated to any known protein.

Diego Rosso, University of Puerto Rico, Mayaguez Campus.
'Analysis of Hemicellulose Pre-Extraction from Red Maple'
The hemicelluloses extraction yields and extraction rates of both the batch and continuous flow processes were compared. Temperature and time of exposure for the batch reactor process were varied over the ranges of 140oC-170oC and 45-90 minutes, respectively. The severity factor Ro, a function of time of exposure and temperature, was used to measure the intensity of the reaction conditions in the batch reactor process. High Performance Liquid Chromatography and High Performance Anion Exchange Chromatography were used to quantify the amount of oligomeric sugars, acetic acid, formic acid, and furfural in the extracted liquor. A UV-VIS detector was used to determine the amount of lignin in the continuous flow reactor process. The sugar analysis focused on the quantification of xylan, arabinan, galactan, glucan, and mannan. The extraction rate of red maple wood strands, wood chips, and wood meal were analyzed and compared.

Second Year Major Findings:
The major findings of each of the ten undergraduate research projects are described below.

Ian Stone, Louisiana State University.
'Feasibility of Using Insurance Company Records to Inventory Logging Equipment in the State of Maine'

The survey found that four entities dominate the market with over 80% of the market share with 11 entities making up the difference. The implications of these findings on this method of inventorying equipment were assessed, and the methods that should be used to generate the inventory determined.

Peter 'Mike' Jacobson, West Virginia University.
'Moisture Content Detection in OSB Strands With Near Infrared Spectroscopy'
Research completed during this project revealed that sample preparation is critical for accurate calibrations and for those with little to no experience using NIR moisture content meters, the calibration process is not an easy task. It was also found that multiple calibrations reduced measurement error and time permitting, should always be completed. With proper calibration these devices are a quick and easy way to measure moisture content in OSB strands, however, their use is more suited for process control where real-time data is needed. For quality control and experimental data, more accurate methods of moisture content detection are preferred (oven-dry method).

Melody Rhine, Emory University.
'Isolation and Quantification of High-value Compounds in Underutilized Components of Trees'
A valuable and potent antioxidant was successfully extracted from the bark waste of Eastern White Pine (Pinus Strobus), Balsam Fir (Abies Balsamae), and from both the bark and needles of White Spruce (Picea Glauca). In addition, the antioxidant properties of various secondary metabolites of bark, including flavonoids, stilbenes, and lignans, were investigated and quantified.

Andrew Knox, Whitman College.
'Consumer Biofuel Knowledge and Preferences: Results of Orono Focus Groups'
The focus group participants overwhelmingly felt that price is the largest factor when deciding between fuels. Many of the participants expressed their pressing economic situations and stated that, despite perhaps viewing one fuel as better for the environment or local area, they would choose the one with the greatest 'bang for their buck' in terms of mileage per dollar. The participants, in general, had little trust of industry or government entities when it came to the source of information. Additionally, it was determiend that it is important for The University of Maine to distance itself from industry in the public eye to maintain credibility as an independent research institution. Concern for the Maine forests stood out as the largest detracting factor for these focus groups' interest in ethanol. It appears that there is a serious lack of consumer knowledge of biofuels in Maine, especially cellulosic ethanol.

Jesse Capecelatro, SUNY, Binghamton.
'Production of Ethanol and Acetic Acid by Pichia stipitis, Clostridium phytofermentans and Thermoanaerobacterium thermosaccharolyticum by Fermentation of Northern Hardwood Hot Water and Green Liquor Extracts'
Of the three organisms that were tested (Pichia stipitis; Clostridium phytofermentans; Thermoanaerobacterium thermosaccharolyticum ATCC? 31960?) Clostridium phytofermentans and Thermoanaerobacterium thermosaccharolyticum ATCC? 31960? were found to have the ability to produce high-value products from hemicellulose extracts without the need of a secondary hydrolysis step.

Tatyana Khamathurova-Tomlin, Universtiy of Texas-Tyler.
'Chemistry of nanocellulose (Preliminary Investigation)'
The silylatiion process was employed to functionalize cellulose fibers. Specifically, alkoxysilanes were bound to cellulose substrates through reaction with surface hydroxyl groups. Reaction conditions were determined that enabled silylated of commerical microcrystalline cellulose with phenyltrimethoxy silane in an water/ethanol solution. ATR FT-IR spectroscopy was used to determine the success of the phenyltrimethoxysilylation of cellulose.

Abigail Hamilton, University of Maine.
'Identification of forest bio-product process components through near-infrared spectroscopy'
The best fit regression models of the NIR data were validated by predicting composition values of actual liquid extracts removed during a laboratory-scale bio-refining process and comparing them to values obtained through chemical analysis. Percent difference values calculated for the acetic acid content in the actual extracts were found to be as low as 25% for weight percents between 0.8 and 2.0 percent. It was found that pre-extracted wood chip spectra had a greater magnitude of reflectance than the post-extracted wood chip spectra. Significant differences were seen when a water spectrum was subtracted from liquid extract spectra. First derivative models based on known woody biomass components indicate positive validation results. These results support the potential for advancement in the identification of extract components via NIRS. With further development of the spectral database, the identification technique could become more practical for use in industry.

Lucas Andrusyk, Iowa State University.
'Wood Plastic Composite Production from Hot Water Extracted Wood Chips'
Testing revealed statistical evidence that the WPC boards produced from extracted wood had greater tensile modulus PSI, tensile strength PSI, and flexural strength PSI. Extracted boards also showed a significant statistical difference in the lineal burn rate and X direction CTE mm/per ?C. The differences in flexural modulus PSI, specific gravity, Y direction CTE mm/per ?C and IZOD J/m were found have no statistical

difference. The results of this study are promising because overall the mechanical properties were not adversely affected by the extraction process. In fact, the only statistically significant differences that were negative were an increase in lineal burn rate of the extracted boards and an increase in the X direction coefficient of thermal expansion. All other mechanical property values were found to have increased or were not statistically different. This is useful information because it confirms the theory the extraction could successfully be added to an existing product lines to create additional products without negatively affecting the original product.

Marcienne Scofield, University of Maine.
'An analysis of the quantity and framing of articles in New England newspapers relating to forest biomass and bioproducts using content analysis'
After examining different news articles from newspapers throughout New England, it appears that the frames that are used the most often in media (and therefore affect the public the most) are Power and Energy, Industry, Economy, and Environmental Impacts. Articles about these four topics are published the most and therefore, the public forms its opinion on woody biomass based on the way in which these articles are presented. An actor interested in manipulating public thoughts on biomass power plants may want to focus on the positive economic and environmental impacts of the power plants in press releases, rather than the technicalities of research or technical terms. Articles about the economy and the environment may be more likely to be reported on which will give the public more time to consider the idea of a biomass power plant. Perhaps if the public has the opportunity to learn about biomass power plants, they will be more likely to accept the construction in their community.

James Grundy, Harvard University.
'Hydrolysis of birch xylan model compounds catalyzed by SO2'
A preliminary sulfur balance revealed that as the concentration of SO2 initially in solution increased, the percentage of SO2 lost during the reaction increased, most likely due to effervescence. A kinetic analysis of the posthydrolysis reaction using the resulting xylose concentrations was carried out by fitting the xylose data to a first order xylose production and first order xylose loss model. This resulted in an activation energy for xylose production, or xylan hydrolysis, of 38.1 kJ/mol and an activation energy of xylose degradation, or furfural production, of 74.2 kJ.mol. The pre-exponential factors and activation energies found in this analysis were then used to produce optimization curves detailing optimum operating conditions in terms of reaction time, temperature, and SO2 concentration in wt%.

First Year Major Findings:
The numbered projects below had the follow major findings:
1. The student found that after two passes through the homogenizer, little change in the average fiber size is observed.
2. The student provided useful information which the lab will be able to use in improving one of our standard assays. His work with laboratory graduate students provided data which can be used in future XRD studies.
3. This research estimates that 2.6 million dry tons of forest residues could potentially contribute annually up to 32% of Maine's light-duty vehicle fuel supply (gasoline gallon equivalent) through its conversion into ethanol. Considering all forest residues and currently commercially used roundwood, Maine's forests could potentially supply 9% of New England's light-duty vehicle fuel supply. Actual levels of fuel supplied, of course will depend on market prices in both the fuel markets, paper and wood product markets.
4. Acetic acid is released from the wood itself during pretreatment, and is known to have an effect on the amount of ethanol that can be produced by fermenting organisms. Similar experiments in the literature had been conducted at smaller scale, with less control over process conditions such as pH, aeration and agitation. We were able to demonstrate a higher tolerance to acetic acid under the fully controlled reactor system that had previously been observed.
5. Hemicelluloses adsorption contributes to significantly increase pulp strength, not only for hardwood pulp, but also for softwood pulp. The adsorption also improves the beatability and reduces refining energy.
6. The project involved the use of survey data and published database information to model the Life Cycle Inventory of the production of Oriented Strand Board. Life cycle inventory is a method used to determine the environmental burdens associated with a process by examining all of the streams that go into and out of the process. While conceptually simple, Nate learned the difficulties in aggregating data, the necessity of making assumptions, and techniques for conducting a sensitivity analysis on models. Within the OSB mill complex itself, the developed model indicated that the adhesive usage was the major contributor to human help effects as quantified by the EcoIndictor 99(I) process.
7. He established a suitable method for determining the time dependent acid generating properties of Lipase (TLL) on a solid wet/dry paper support. Furthermore, Nimesh advanced our Lipase bio-conjugation chemistry, confirming that we can identify by IR spectroscopy positive lipase modification. Furthermore, Nimesh determined that the activity of the enzyme is not decreased from its native state when on paper, AND the modified enzyme also retains its activity in solution and on paper.

Training and Development:

Third Year Training and Development Outcomes:

Nicholas Dunn, Union College.
'Characterization of Support Properties as a Factor in the Catalytic Hydrodeoxygenation of Guaiacol'
Nick gained in-depth knowledge of gas chromatography, in addition to an understanding of the importance of both efficiency and specificity of catalytic conversion of chemical species.

Jacob Schual-Berke, Pomona College.
'Microfibrillated cellulose reinforced polymers: PVA and latex films with citric acid as cross-linker'
Jacob was trained in both the production and utilization of microfibrillated cellulose (MFC). Jacob was able to demonstrate that incorporation of MFC into hydrophilic polymer matrices results in improved physical properties.

Annemarie Nauert, University of Missouri.
'Separation and Classification of High-Value Chemicals in Pinaceae species'
Annemarie gained extensive training in solvent extraction methodologies, in addition to liquid-liquid separtion and purification techniques. The implications of this work are significant and Annemarie developed an appreciation of how applied research can potentially translate into intellecual property.

Alexander Shaffer, Youngstown State University.
'Extraction of Shikimic Acid from the Pinaceae Family'
Alex benefited from experiencing both benchtop and pilot scale accelerated liquid extraction of a value added chemical from a current industrial waste stream.

M. Alden Earle, Ramapo College.
'Nano-Structred Carbon Materials from Lignin'
Alden gained significant experience in product development/engineering. Alden was trained in the physics and chemistry of converting lignin, a waste product of the Kraft pulping process, into value added carbon nanomaterials.

John Attonito, CUNY, Queens College.
'Evaluation of Cellulose Nanofibrils in Sodium Silicate-Wood Flour Composites'
John was trained in early stage product development. Specifically he learnt how to produce composite materials employing celluose nanofibrils and to optimize the products phyiscal properties by varying the composition.

Robert Jonson, Kansas State University.
'Utilizing Filtration for the Concentration of Hemicellulose Extracts from the Kraft Pulping Process'
Rob demonstrated that tangential flow membrane filtration may be employed to concentrate dilute hemicellulose extract solutions without concurrently concentrating fermentation inhibiting species including sodium ions and acetic acid.

Jacqueline Beckvermit, Fort Lewis College.
'Cellulose Nanofiber Coated Paper'
Jackie was trained in techniques of applying aqueous based coatings to paper, and in methodologies of testing the quality of the coatings with regard to printing. Specifically she demonstrated that coating paper with cellulose nanofiber resulted in improved print quality, and that it could also be used a binder for kaolin.

Rachel Bowman, Western Kentucky University.
'Environmental Assessment of Wood Derived Hemicellulosic Ethanol Using Alternative LCA Models'
Rachel gained extensive experience in Life Cycle Assessment. In particular she was trained in three separate LCA software packages and employed them to analyze the economic and environmental impacts of the UMaine near-neutral hemicelluose extraction process.

Audrey Polifka, Kansas State University.
'Acid Springing and Extraction Using Trioctylamine'
Audrey was trained in liquid-liquid extraction techniques. Specifically she compared the traditional extraction technique employed to remove acetic acid from water with a proposed alternative technique.

Rose Ochoa, Sacramento City College.
'Bioprospecting for an enzyme that cleaves ether bonds between lignin and hemicellulose in hardwoods'
Rosie's research was aimed at a very significant issue in the liberation of hemicelluose from woody biomass, specifically removal of covalently bound lignin. As such Rosie was trained in the field of bioprospecting, and gained extensive experience in cell culture and enzymatic assay

development.

Alexander Haluska, Syracuse University.
'Acid Hydrolysis of Xylo-Oligosaccharide Extracts with Sulfur Dioxide (SO2): Effect of Temperature and SO2 Concentration on Absolute Pressure'
Alex (a civil engineer) was trained in experimental chemical engineering. In particular he gained experience in high temperature and pressure hydolysis chemistry employing recyclable acid forming reagents.

Morgan Urello, Columbia University.
'The Isolation and Induction of a Novel Enzyme Capable of Cleaving the Ether bond between Hemicellulose and Lignin'
Morgan gained extensive experience in enzymatic cell culture and bioengineering. Indeed she demonstrated the effictiveness of a particular etherase at cleaving a lignocellulose ether bond. Further, she demonstrated that the enzyme may be unique and previously unreported.

Diego Rosso, University of Puerto Rico, Mayaguez Campus.
'Analysis of Hemicellulose Pre-Extraction from Red Maple'
Diego was trained in the UMaine hemicellulose pre-extraction technology and was able to compare the efficiency of extraction of both batch and continuous flow reactors for a single species (red maple) process.

Second Year Training and Development Outcomes:

Ian Stone, Louisiana State University.
'Feasibility of Using Insurance Company Records to Inventory Logging Equipment in the State of Maine'
Ian developed a previously untrialed method of surveying in order to generate an inventory of logging equipment. He was required to create a phone survey and to effectively apply this tool as well as compile and analyze the results.

Peter 'Mike' Jacobson, West Virginia University.
'Moisture Content Detection in OSB Strands With Near Infrared Spectroscopy'
Mike learned the science behind how near-infrared sensors work, as well as developing an appreciation of the methodologies and limitations associated with employing NIR spectroscopy for the determination of water content.

Melody Rhine, Emory University.
'Isolation and Quantification of High-value Compounds in Underutilized Components of Trees'
Melody developed considerable skills in solvent extraction from solid species, in addition to analyzing samples via gas chromatography-mass spectrometry.

Andrew Knox, Whitman College.
'Consumer Biofuel Knowledge and Preferences: Results of Orono Focus Groups'
Andrew learnt the complexity of the process of creating focus groups, in extracting the participants opinions and feelings, and in compiling the findings into a cohesive and decisive product.

Jesse Capecelatro, SUNY, Binghamton.
'Production of Ethanol and Acetic Acid by Pichia stipitis, Clostridium phytofermentans and Thermoanaerobacterium thermosaccharolyticum by Fermentation of Northern Hardwood Hot Water and Green Liquor Extracts'
As a mechanical engineer Jesse performed a remarkable job in learning and applying the processes of cell growth and fermentation under anaerobic conditions, in addition to quantification of product concentrations.

Tatyana Khamathurova-Tomlin, Universtiy of Texas-Tyler.
'Chemistry of nanocellulose (Preliminary Investigation)'
Tatyana developed an appreciation of the difficulty that can arise in attempting to reproduce experimental procedures from the literature. Through great diligence and initiative in terms of contacting authors, she did successfully silylate cellulose and quantitate it via IR-ATR.

Abigail Hamilton, University of Maine.
'Identification of forest bio-product process components through near-infrared spectroscopy'
Abigail further her existing knowledge in terms of the application of NIR to vastly heterogeneous samples-and the developemnt of regression models that enable predictive capabilites.

Lucas Andrusyk, Iowa State University.
'Wood Plastic Composite Production from Hot Water Extracted Wood Chips'
Lucas gained a great deal of training in ASTM standard testing procedures, signingicant exposure to chemical processing of materials, in addition to extrusion production of WPCs.

Marcienne Scofield, University of Maine.
'An analysis of the quantity and framing of articles in New England newspapers relating to forest biomass and bioproducts using content analysis'
Marcienne was exposed to an area siginificantly outside her previous experience. She gained knowledge and experience in word mining, building databases, and compiling a great deal of information into a cohesive summary.

James Grundy, Harvard University.
'Hydrolysis of birch xylan model compounds catalyzed by SO2'
As and environmental engineer James learnt a great deal regarding wet chemistry techniques and chemical engineering. He gained a great deal of knowledge in terms of chemical equilibria, kinetic analysis and analytical metodologies.

First Year Training and Development Outcomes:

The numbered projects below had the training and development opportunities:
1. Ryan learned about the principles and operation of an Atomic Force Microscope. He learned how to quantify his work with image analysis.
2. Stewart was provided extensive training in sterile techniques and standard laboratory procedures and was also involved in Xray diffraction analyses.
3. Though not a specific technique or methodology, Jacob learned about the level of attention to detail, self-motivation, and responsibility that is required of graduate students. In my view, he is much better prepared for graduate school than when he first arrived.
4. The fermentation project involved training on a variety of instruments and analytical tools, as well as basic laboratory practices. This includes the New Brunswick Scientific Bio-Flo-110 three liter fermentation system and accompanying BioCommand software, the carbon dioxide detector, the optical density monitoring system, the automated reactor sampling system, and a High Performance Liquid Chromatography (HPLC) system.
5. The student learned a wide range of analytical testing for pulp & paper processing.
6. The student was exposed to a completely new field (Life Cycle Analysis) and he learned concepts of and the application to real world data. He also learned about the manufacturing process for Oriented Strand Board (OSB) and spent several days working in a laboratory performing some manual operations (log debarking, stranding) to give a better appreciation of the activities than just 'book learning'.
7. Nimesh learned several laboratory/instrumental techniques including: UV-Vis spectroscopy, IR-microspectroscopy, and went so far as to construct his own simple apparatus for UV-Vis absorption in reflectance geometry.

Outreach Activities:

Third Year Outreach Activities:
As per the previous years, every REU student was interviewed by the RET Middle School Teachers (Ms Tracy Vassiliev and a new teacher from Southern Maine this year, Ms Raye Anne Desoto). The purpose of these interviews was to gain an understanding of the research that each student was performing-and to assess ways in which it could be communicated to the general public. The sound files of the interviews were posted to the REU/RET web log for dissemination to the general public (http://fbri.edublogs.org). Based on the understanding of the research gained by Tracy and Raye Anne, addional curricular modules were created in collaboration with Co-PI Neivandt to teach STEM concepts in Middle Schools using sustainable forest bioproducts as a vehicle. These new modules, in addition to those generated in the first two years of the grant, are undergoing continuous dissemination to middle school teachers through web based procedures, and teacher workshops and conferences. With the participation of Raye Anne the desimination efforts are now targeting Southern Maine Middle Schools, in addition to the Central and Northern Middle Schools targeted in the first two years. The following is a list of workshops held and conferences at which the curricular materials have been presented for the 08-09 year.

Middle School Collaborative Series 2008-09
Workshop #1
Trees, Me and Technology: Using Data to Ignite Critical Thinking
Date: October 29, 2008
Time: 4:30-7:30 PM
Location: Library, Troy A. Howard Middle School, Belfast, Maine

Workshop #2
Microscopic Pie: Experiments students can conduct to predict the medicinal properties of some well known plants. Strategies for Gender Equity in the Classroom: A review of practical strategies to promote gender equity. A self assessment, website reviews, and one shot wonder program ideas.
Date: December 10, 2008
Time: 4:30-7:30 PM
Location: 114 Bennett Hall, University of Maine, Orono

Workshop #3
Middle School Engineers: Mirroring current research being conducting at the University of Maine's Advanced Engineering Wood Composites (AEWC) Center. The Advanced Engineering Wood Composites (AEWC) Center at the University of Maine in Orono, is conducting cutting edge and collaborative research on hybrid wood composites, which are 6 to 7 times stronger than wood alone. We will use inquiry to make and test wood composite planks to determine the most durable recipe.
Date: January 27th
Time: 4:30 -7:30PM
Location: 114 Bennett Hall, University of Maine, Orono

No Question Left Behind: Bringing Guided-Inquiry Curricula into Science and Mathematics Classrooms
Monday, June 22 ? Tuesday, June 23, 2009 at the Schoodic Education and Research Center
'Wood your students use real data'
Workshop Session
Poster Presentation

FBRI REU Presentation
Research Experience for Teachers
August13, 2009
University of Maine, Soderberg Lecture Hall

Maine Association of Middle Level Education Annual Conference
Bringing Cutting Edge Maine Research to the Middle School Classroom
October 22- 23, 2009 at Sugarloaf, Maine

Maine Educators of the Gifted and Talanted 2009 State Conference
Forest Bioproducts Research Initiative
November 13, 2009 at the Ramada Inn, Bangor Maine

National Science Teachers Association National Conference
Bringing Cutting Edge Maine Research to the Middle School Classroom
Philadelphia, PA
March 18?21, 2010
Workshop Approved

Second Year Outreach Activities:
Every REU student was interviewed by the RET Middle School Teacher (Mrs Tracy Vassiliev) and her undergraduate assistant (Miss Katy MacDonald). The purpose of these interviews was to gain an understanding of the research that each student was performing-and to assess ways in which it could be communicated to the general public. Specifically, the RET Team in collaboration with Co-PI Neivandt developed a series of eight curricular modules thematically based on sustainable forest bioproducts. The modules, each of which have a 'hands-on' aspect, teach elements of science and/or mathematics to middle school students. These modules are being disseminated throughout the state of Maine via workshops held throught the Middle School Collaborative program administered via UMaine. Two workshops were held in Fall 2008 (in Belfast and Orono), with a total of 24 middle school teachers being given the modules in electronic form, in addition to instruction and hands on trianing in selected modules. A further two workshops are planned for Spring (in Machias and Orono).

First Year Outreach Activities
All REU students interacted with Middle School Teachers who were in our supplemental RET program. Some REU students interacted with local high school students as part of the NSF-EPSCoR Forest bio-products research initiative (EPS-05-54545). All REU students interacted with other graduate students in the individual laboratories. REU student Brittany Oetter mentored high school students in UMaine's Consider

Engineering High School Outreach program. All REU students attended weekly professional development seminars open to the public.

Journal Publications

Andrusyk, L.; Oporto, G.S.; Gardner, D.J.; Neivandt, D.J., "Wood Plastic Composites Manufactured from Hot Water Extracted Wood. Part 1: Mechanical Evaluation", Proceedings of the Society of Wood Science and Technology, p. , vol. , (2009). Accepted,

Books or Other One-time Publications

Web/Internet Site

URL(s):

http://fbri.edublogs.org

Description:

Second Year of Award:
The website created during the first year of the award was updated with audio interviews of each of the second year REU participants and project abstracts posted. The curricular materials were updated and expanded

First Year of Award:
REU students worked with two middle school teachers who were part of our RET program to create this web site and curriculum materials.

REU students were involved in the update of the forest bio-products research initiative web site.

Other Specific Products

Product Type:

Conference Presentation

Product Description:

Leahy, J., Lilieholm, R., and Porter, T. Media Framing, Agenda-Setting, and Public Discourse of Forest Biomass and Bioproducts in Maine, submitted to the International Symposium on Society and Resource Management. June 2008. Burlington, VT.

Sharing Information:

Disseminated findings to confernece attendees

Product Type:

Conferenece Poster

Product Description:

Stone, I., J.G. Benjamin, and J. Leahy. 2008. Feasibility of Using Insurance Company Records to Inventory Logging Equipment in the State of Maine. Society of American Forester 2008 National Convention ? Forestry in a Climate of Change (Student Poster Session). Reno, NV. November 5-9.

Sharing Information:

Disseminated findings to conference attendees

Product Type:

Confernece Poster

Product Description:

REU Explore it! Building the Next Generation of Bio-Refinery Researchers Neivandt, Donahue, Gardner, Engineering Education NSF Awardees Conference, Arlington, VA, 26-28 Sept 2007.

Sharing Information:

Findings and best practices disseminated to conference attendees

Product Type:

Conference Poster

Product Description:

Hamilton, A, St. Peter, A. L., and D. W. Donahue. Identification of forest bio-product process components through near-infrared spectroscopy. PITTCON 2008, 02-07 Mar, New Orleans, LA.

Sharing Information:

Findings and best practices disseminated to conference attendees

Product Type:

Conference Poster

Product Description:

Oporto, G. and Gardner, D.J. Wood Plastic Composites Manufactured from Hot Water Extracted Wood. 2008 Maine EPSCoR State Conference. Orono, Maine, September 29-30, 2008.

Sharing Information:

Findings and best practices disseminated to confernece attendees.

Product Type:

Conference Poster

Product Description:

Andrusyk,L; Oporto, G.; Gardner, D.; Neivandt, D.J. 'Production and testing of Wood Plastic Composites Manufactured from Hot Water Extracted Wood' Society of Wood Science and Technology (SWST) 51st Annual Convention. Concepcion - Chile, November 10-12, 2008.

Sharing Information:

Findings and best practices disseminated to conference attendees.

Product Type:

Conference Poster

Product Description:

Rory Jara, James Grundy, Sorel Edes and Adriaan van Heiningen. Hydrolysis of hemicellulose extracts catalyzed by sulfur dioxide (SO2). Maine EPSCoR State Conference, University of Maine. September 29-30 (2008).

Sharing Information:

Disseminated findings to conference attendees

Product Type:

Conference Presentation

Product Description:

Jara, R., Grundy J. and van Heiningen, A. Hydrolysis of near neutral hemicellulose extracts catalyzed by sulfur dioxide (SO2). PAPTAC Annual Meeting 2009. Montreal, Canada. February 3-4 (2009).

Sharing Information:

Findings will be desiminated to conference attendees.

Product Type:

Conference Presentation

Product Description:

The production of cellulose nanofibers from wood pulps. Nazia Sidduqui, Ryan Lena, Douglas Bousfield, David Neivandt, Ryan Mills, Douglas J. Gardner, Steve Shaler, Presented at the TAPPI 2008 International Conference on Nanotechnology for the Forest Products Industry, June 2008.

Sharing Information:

Findings disseminated to conference attendees

Product Type:

Conference Presentation

Product Description:

Characterization of mechanically and enzymatically produced nanofibrillated cellulose (NFC) from wood pulp. Nazia Sidduqui, Ryan Lena, Douglas Bousfield, Ryan Mills, Douglas J. Gardner, Raymond Fort, and Barbara Cole, presented at the American Chemical Society Meeting, April, 2008.

Sharing Information:

Findings disseminated to conference attendees

Product Type:

Published Report

Product Description:

Dickeron, K., & Rubin, J., & Kavkewitz, J. (2007). "Biomass and biofuels in Maine: estimating supplies for expanding the forest products industry," Margaret Chase Smith Policy Center, University of Maine, Orono, Maine.

Sharing Information:

Has been posted on the internet for dissemination: http://denali.asap.um.maine.edu/mcs/?q=node/1360

Product Type:

Conference Poster

Product Description:

Poster Presentation
Title: Forest Bio-products Research in Maine: REU & RET experiences
Authors: Darrell W. Donahue, David J. Neivandt, Douglas J. Gardner
Presented at the NSF Engineering Education Awardees Conference, Jan 31 - Feb 02, 2010.

Sharing Information:

Disseminated REU and RET findings to conference participants

Contributions

Contributions within Discipline:

Third Year of Award:
The REU program contributed knowledge development to the following disciplines:
1. Resource Economics
2. Forest Operations
3. Biochemical Engineering
4. Chemical Engineering
5. Composites Engineering
6. Public Policy Development
7. Natural Products Chemistry
8. Interfacial Chemistry of Natural Products
9. Process Optimization
10. Catalytic Chemistry

Second Year of Award:
The REU program contributed knowledge development to the following disciplines:
1. Resource Economics
2. Forest Operations
3. Biochemical Engineering
4. Chemical Engineering
5. Composites Engineering
6. Public Policy Development
7. Natural Products Chemistry
8. Interfacial Chemistry of Natural Products
9. Process Optimization
10.Quantitative Spectroscopy

First Year of Award:
The REU program contributed knowledge development to the following disciplines:
1. Surface science. Surface characterization.
2. biology, chemistry, bioconversion
3. Resource economics
4. Bio-chemical engineering
5. Chemical engineering and pulping technology.
6. Wood science, chemical engineering, industrial ecology
7. Chemistry/Biochemistry

Contributions to Other Disciplines:

Third Year of Award:
As per the second year of the award the, participant cohort was extremely interdisciplinary, as such the projects and resultant findings mirror this breadth.

Second Year of Award:
This years participant cohort was extremely interdisciplinary, as such the projects and resultant findings mirror this breadth.

First Year of Award:
REU contributions were made to the field of forest economics.

Contributions to Human Resource Development:

Third Year of Award:
Perhaps the most significant contribution to human resource development made during the second year of the award was the fact that approximately 50% of the students were deliberately selected from community or four year colleges, and at the completion of the program 92% of the participants indicated that the likelihood that they would go on to graduate school was high or very high (one student indicated medium).

Second Year of Award:
Perhaps the most significant contribution to human resource development made during the second year of the award was the 100% positive participant response to the post-program survey question asking if they intended to seek an advanced degree.

First Year of Award:
The REU experience has cemented their interest in furthering education such as graduate school and/or professional schools.

Contributions to Resources for Research and Education:

Third Year of Award:
As per the second year of the award, the PIs feel that the most significant results of the award relating to resources for research and education stem from the creation and dissemination of Middle School science and match curricular modules.

Second Year of Award:
The PIs believe that one of the most exciting contributions to resource development for research and education stemming from the program to date has been the creation and dissemination of Middle School math and science curricular modules.

First Year of Award:
Several REU projects resulted in technique development which will be crucial for on-going research.

Contributions Beyond Science and Engineering:

Third Year of Award:
As per the second year of the program, the majority of the reserach and findings in the third year of the project were technically related and several have the potential to lead to new products for commercialization. For example the work of Alden Earle on the production of carbon nanomaterial from lignin is the subject of a provisional patent application and is currently being scaled up to the pilot scale. Four of this years research projects focused on aspects of the UMaine hemicellulose pre-extraction from wood process. This process is currently being implemented at the Old Town Fiber and Fuel facility in Old Town, Maine. As such aspects of the student participants work this summer and previous summers are already undergoing industrial implementation.

Second Year of Award:

The majority of the reserach and findings in the second year of the project were technically related and several have the potential to lead to new products for commercialization. For example, WPC from extracted wood, antioxidants from undertutilized woody biomass. In addition, two of the projects investigated public opinion with regard to sustainable forest bioproducts, including bio-fuels. The findings of these projects will guide our broader Forest Bioproducts Reserch Initiative in terms of informing the public and ensuring that we consider not solely technical feasibility but public acceptance with regard to implementation.

First Year of Award:
The individual projects numbered have the following environmental/technological outcomes:
1. The student helped clarify some potential uses of the cellulose nano-fibers.
2. REU student has contributed to assay development. The assay will be used by researchers and others in the development and testing of new environmentally appropriate products from wood biomass.
4. The information gathered in this study is important in the potential commercialization of a process making fuel ethanol from woody biomass.
6. Conducting the LCI falls within the area of environmental impacts.
7. This entire project has great potential for efficient cost-effective field analysis of bio-agents.

Conference Proceedings

Categories for which nothing is reported:

Any Book

Any Conference

2009 REU Student Demographics				
Name	**Gender**	**Race**	**Ethnicity**	**Disability**
Rose Ochoa	Female	White	Hispanic or Latino	None
Diego Rosso	Male	White	Hispanic or Latino	None
Nicholas Dunn	Male	White	Not Hispanic or Latino	None
Jacob Schual-Berke	Male	White	Not Hispanic or Latino	None
Annemarie Nauert	Female	White	Not Hispanic or Latino	None
Alexander Shaffer	Male	White	Not Hispanic or Latino	None
M. Alden Earle	Male	White	Not Hispanic or Latino	None
John Attonito	Male	White	Not Hispanic or Latino	None
Robert Jonson	Male	White	Not Hispanic or Latino	None
Jacqueline Beckvermit	Female	White	Not Hispanic or Latino	None
Rachel Bowman	Female	White	Not Hispanic or Latino	None
Audrey Polifka	Female	White	Not Hispanic or Latino	None
Alexander Haluska	Male	White	Not Hispanic or Latino	None
Morgan Urello	Female	White	Not Hispanic or Latino	None
2008 REU Student Demographics				
Name	**Gender**	**Race**	**Ethnicity**	**Disability**
Jesse Capecelatro	Male	White	Not Hispanic or Latino	None
Tatyana Khamatnurova	Female	White	Not Hispanic or Latino	None
Lucus Andrusyk	Male	White	Not Hispanic or Latino	None
Melody Rhine	Female	White	Not Hispanic or Latino	None
James Grundy	Male	White	Not Hispanic or Latino	None
Marcienne Scofield	Female	White	Not Hispanic or Latino	None
Ian Stone	Male	White	Not Hispanic or Latino	None
Abigail Hamilton	Female	White	Not Hispanic or Latino	None
Peter Jacobson	Male	White	Not Hispanic or Latino	None
Andrew Knox	Male	White	Not Hispanic or Latino	None
2007 REU Student Demographics				
Name	**Gender**	**Race**	**Ethnicity**	**Disability**
Gracson Andrews	Male	White	Not Hispanic or Latino	None
Alexander Canney	Male	White	Not Hispanic or Latino	None
Stewarch Gramlich	Male	White	Not Hispanic or Latino	None
Ryan Lena	Male	White	Not Hispanic or Latino	None
Jacob Kavkewitz	Male	White	Not Hispanic or Latino	None
Andru O'Farrill	Male	White	Hispanic or Latino	None
Brittany Oetter	Female	White	Not Hispanic or Latino	None
Nimesh Patel	Male	Asian	Not Hispanic or Latino	None
Nathaniel Vacanti	Male	White	Not Hispanic or Latino	None