## Transportation-Related Presentations and Posters at the 2013 UVM Student Research Conference

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Tuesday, April 23, Davis Center

### ORAL PRESENTATIONS

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter</th>
<th>Location</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:15a –</td>
<td>Dan Sithole (CESS)</td>
<td>Jost Foundation Room 422</td>
<td>The Effects Of The Carl D. Perkins Act Policies On Gender Equity In Vermont High School Career Technical Education: A Hierarchical Linear Model</td>
</tr>
<tr>
<td>10:30a</td>
<td>Geoffrey Battista</td>
<td>Frank Livak Ballroom 417</td>
<td>Estimating the Effect of Mobility and Food Choice on Obesity</td>
</tr>
</tbody>
</table>

### POSTER PRESENTATIONS 10 – 11:30a

<table>
<thead>
<tr>
<th>Presenter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ben Carlson (MPA)</td>
<td>Best Practices in Transportation Communications and Applications for UVM’s Transportation Research Ctr</td>
</tr>
<tr>
<td>Nicholas Leggett (MPA)</td>
<td>Transportation Workforce Development in Vermont &amp; Northern New England</td>
</tr>
<tr>
<td>Nathan Tirk (CEMS)</td>
<td>Statistical Analysis of Weigh-in-Motion Data: Application to Bridge Reliability Analysis</td>
</tr>
<tr>
<td>Robert Fish (MPA)</td>
<td>Reducing Vehicle Idling in Vermont: A Community-based Strategic Communication and Intervention Plan</td>
</tr>
<tr>
<td>Nathan Reigner (RSENR)</td>
<td>Modeling of recreation dynamics and capacity at multiple spatial scales</td>
</tr>
<tr>
<td>Jessica Lindle (CEMS)</td>
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</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
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<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebastian Downs (CEMS)</td>
<td>Scour Monitoring Research</td>
</tr>
<tr>
<td>Kristine Harootunian (CEMS)</td>
<td>Drive Like a Local! Findings from the Vermont State Crash Database</td>
</tr>
<tr>
<td>Ben Schilling (CEMS)</td>
<td>Automated Counting of Bicyclists and Pedestrians</td>
</tr>
<tr>
<td>Isaac Lawrence (RSENR)</td>
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</tr>
<tr>
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</tr>
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</table>

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</table>
ABSTRACTS: Oral Presentations

10:15a – Dan Sithole (CESS) Jost Foundation Room 422
The Effects Of The Carl D. Perkins Act Policies On Gender Equity In Vermont High School Career Technical Education: A Hierarchical Linear Model

The purpose of this study was to examine the effects of Carl D. Perkins Act policies on gender equity in nontraditional career pathways in Vermont High School Career Technical Centers using Hierarchical Linear Modeling. Data was collected concerning the members of the Vermont high school graduating class of 2011 (N= 7214), with a focus on those who attended technical courses at one of the 18 regional career technical centers (N = 2504) to find out what the effects of gender equity coordinators, dual enrollment, career technical student organizations, and cooperative education were on female students completing nontraditional career pathways. The data revealed that students’ participation in and completion of technical courses in the technical centers of Vermont were reminiscent of the situation of the decades from 1980-2000, when girls and boys disproportionately concentrated in traditional career pathways based on their gender. The findings showed that although girls have been completing the Agriculture and Natural Resources and Information and Communication career pathways in slightly greater numbers, the Carl D. Perkins Act policies have had no effect on the completion of nontraditional career pathways for either boys or girls. Although the study was limited to the number of career-technical centers in Vermont, it nevertheless contributes an understanding of the context of gender equity in Vermont’s high school career technical centers, the dialogue on narrowing the gender achievement gap, and the use of Hierarchical Linear Modeling as a research methodology in Career Technical Education.

10:30a Geoffrey Battista (CDAE) Frank Livak Ballroom 417
Estimating the Effect of Mobility and Food Choice on Obesity

A majority of Americans are overweight, with nearly one-third of the total population classified as clinically obese (BMI > 30). The prevalence of obesity and its related health consequences has evoked a considerable response by policymakers, but the condition has been difficult to address due to its various causes. Previous studies have indicated that the topographical features of the built environment affect individual mobility and food choice, which in turn impact caloric energy balance. This current research contributes to deeper understanding of this relationship by considering northern New England, a region with a unique rural and seasonal environment. The analysis will estimate the size and significance of individual mobility and food pattern choices on caloric energy balance while accounting for both seasonality and individual perceptions of navigability of the built environment in northern rural climates.

Panel data from 654 individuals residing in Vermont, New Hampshire, and Maine were gathered through the “Transportation in Your Life” survey from 2008 through 2009. The panel data set contains individual level data, including both time constant and time (seasonal) variant variables. The geospatial characteristics of the built environment – grocery stores, convenience stores, fast food and full-service restaurants, recreational amenities, and trails – were incorporated into the model using geographic information systems. Panel participant accessibility to features of the built environment was assessed through as-the-crow-flies buffering and real-distance network analysis from geocoded participant addresses. While the final models have not yet been estimated, previous results suggest rural residents are both more car-reliant and more likely to rate their travel time to various amenities as “too long,” a combination of factors that discourages active commuting and inhibits caloric energy balance.
ABSTRACTS: Posters 10-11:30am

Ben Carlson (MPA)
Best Practices in Transportation Communications and Applications for UVM’s Transportation Research Center

This research examines best practices in communication and outreach efforts among transportation organizations to effectively inform stakeholders and transfer information and research results. Starting with an examination of organizational goals and strategies that define how and what communications tools will be employed, this research reviews the communications efforts of departments of transportation, university transportation centers (UTCs), and other transportation industry organizations.

Specifically this involves assessment of (1) website design, (2) social media strategies, (3) newsletters, and (4) media promotion. These areas are assessed qualitatively through observation and analysis of online practices and relevant literature. Interviews with communications professionals in the transportation field inform the results of the observed practices and reveal the underlying strategies, how they are aligned with organizational mission and what metrics are established to measure success and direct future action. This research is applied to incorporate relevant practices in these four areas into the development of the UVM Transportation Research Center’s communication strategy and plan.

Robert Fish (MPA)
Reducing Vehicle Idling in Vermont: A Community-based Strategic Communication and Intervention Plan

Decreasing idling has important human health, environmental and economic benefits. But regulatory approaches designed to reduce idling haven't changed individual behavior. This presentation describes an alternative approach to automobile idling reduction: using community-based social marketing to achieve a community-wide sustainability goal. It revolves around the idea that initiatives promoting behavioral changes are most effective when they involve direct contact with people. Promoters identify the activity to be promoted and the barriers to this activity, and then design a strategy to overcome these barriers applying psychological knowledge about behavioral change. For the purposes of this report, we chose Richmond, Vermont as our example town. In each community chosen, overall strategies would remain consistent but be individually tailored based on community direction and collaborations. These cannot be top-down campaigns but will require extensive community buy in and collaboration to be successful. The plan is based on a review of successful efforts in northern communities, existing efforts in Vermont, the experience of other Vermont organizations in promoting energy efficiency, and discussions with community leaders and Vermont citizens. The proposed intervention campaign involves a multifaceted approach that seeks to reach potential idlers through a variety of mediums, at different points in their lives, and through several official and unofficial power brokers in the community. Unlike many information-intensive campaigns, community-based social marketing has been shown to have a much greater probability of promoting sustainable behavior.

Nicholas Leggett (MPA)
Transportation Workforce Development in Vermont & Northern New England

Transportation is a multi-disciplinary sector that depends on a wide array of professionals to design, build, operate and maintain systems at the local, state and national levels. The transportation workforce faces many obstacles, most notably that roughly 40-50% of the transportation workforce is slated to retire in the next 5-10 years. There are opportunities to retain and retrain this mature workforce, as well as attract workers from other fields that have been displaced but have cross-over skills. Challenges to be overcome include the rapid change in technology and skills required to remain relevant. At the opposite end of the workforce spectrum students and young persons are not replenishing the ranks of those who are leaving and are aggressively competed for by other industries. Through a series of outreach educational initiatives, the UVM Transportation Research Center, through a FHWA funded Transportation Education Development Pilot Program, has explored four strategic interventions to help attract, retain, and retrain the transportation workforce in Vermont and northern New England. These initiatives include the Transportation Systems Academy (TSA) for graduating high school seniors and targeted transitional populations (e.g., Veterans), the Transportation Systems Institute (TSI) for incumbent
transportation department workers, Second Careers in Transportation Program for mature workers, and an assessment of the role of community colleges with the American Association of Community Colleges (AACC) and support of a new associate's degree program in business operations in transportation at the Community College of Vermont. The expected results from the implementation of these programs include slowing of the projected retirement rate, the attraction of professionals from other fields into second careers in transportation, and the funneling of youths and adults through career & technical centers and into entry-level positions at transportation employers.

Nathan Reigner (RSENR)
**Modeling of recreation dynamics and capacity at multiple spatial scales**
(Authors: Nathan Reigner, Jeremy Wimpey, Jillian Spies, Robert Manning)

Recreational behaviors are complex and dynamic. This is particularly true when recreation areas are large, experiential opportunities are diverse, and demands for access are high. Freedom of movement and from the interference of others are key elements of high quality recreation. Influenced as much by site design and management as by the magnitude of use, these freedoms often underlie quality objectives for parks and protected areas. When seeking to manage large, complex and diverse areas in a holistic and systematic way, area-wide use patterns must be linked with site-specific crowding related impacts. This research presents an integrated approach to visitor use modeling at multiple spatial scales. Spatial models of recreation sites, including trails, roads, camps and attractions, provide a common basis for analysis and integration. GIS based network models identify locations within recreation areas where use concentrates, while microsimulation models estimate individual and aggregated recreational freedom and crowding-related impacts.

Nathan Tirk (CEMS)
**Statistical Analysis of Weigh-in-Motion Data: Application to Bridge Reliability Analysis**

Multiple types of loads need to be considered when designing a bridge. From the point of view of functionality, the most important one is the live load, i.e. gravity loads induced by traffic. Live loads vary randomly as a function of space and time. Using data gathered from weigh-in-motion stations located across the state of Vermont during the last 13 years, we conducted a statistical analysis of the live loads experienced by existing bridges. The data includes time of events, truck axle weight and spacing. This data, combined with structural analysis algorithms, provides an estimate of the maximum stress demands that would have been produced by each truck if passed over a bridge of a given length and type. These results were compared to the values recommended by current bridge design specifications. The goals of this project are: (i) to verify that the live loads used in current bridge design specifications are consistent with low-probability events as reflected by the statistical analysis of the weigh-in-motion stations and (ii) to propose a new stochastic model consistent with the observed live loads. This new model can be used to perform explicit reliability calculations for complex bridge structures.

Jessica Lindle (CEMS)
**Using a biosensor-controlled synthetic feedback loop to improve microbial biofuel tolerance**

Advanced biofuels offer a promising alternative fuel source to gasoline and diesel because they are renewable sources of energy that are compatible with existing fuel infrastructures. Engineered microbes can synthesize these biofuels, but can only tolerate limited concentrations in their environment. To increase biofuel yield, and to make biofuels an economically competitive fuel source, microbial biofuel tolerance must be increased. Previous research has shown that efflux pumps are an effective tolerance mechanism for cell growth in biofuels. These pumps are complexes of proteins that identify harmful compounds and remove them from the cell. However, overexpression of these pumps can also inhibit cell growth and, therefore, decrease biofuel production. Biofuel and pump expression toxicity must be balanced with each other in order to maximize cell growth. Our research goal is to design a synthetic feedback loop that will be able to detect biofuel using a sensor protein, which will then trigger the expression of the efflux pump in the host *E. coli*. The protein MexR, native to *Pseudomonas aeruginosa*, was chosen as the biosensor because it detects oxidative stress, such as that caused by certain biofuels, in cells. The gene *mexR* has been codon optimized for *E. coli* in order to limit the strain on the cell. In the feedback loop, MexR represses the expression of the efflux pump by binding to synthetic promoter regions. Our initial
studies, which use rfp for biosensor characterization, show that the sensor responds to biofuel. These results lay the groundwork for the synthetic feedback loop design where the biosensor will regulate efflux pump expression.

ABSTRACTS: Posters 12:30 – 2p

Sebastian Downs (CEMS)
Scour Monitoring Research

Scour refers to the erosion of streambed sediments by moving water. By some estimates, bridge scour is responsible for as much as 60% of all bridge failures. There are three main types of scour. Contraction scour is caused by the narrowing of the river channel as it passes under a bridge. Degradational scour is the riverbed sediment loss due to typical flow conditions. Local scour is created by water flowing around the piers and abutments. All of these can undermine structural supports, and are most severe during flooding. Many systems for scour monitoring are only useful at a predetermined point location at what is predicted will be the lowest spot, typically the front center of the pier or abutment. These systems are also often expensive to buy and install, or are of limited use, in that they will only trigger at one set depth. Consequently, these systems do not track the formation of scour holes, and so do not allow preparation for future scour events. Although scour is deepest in front of a structure, this depth often extends around the corner. Additionally, the deepest point is often ahead of the structure, not touching it. This would indicate that not all of the areas of concern can be accounted for in a single point. As of now, there are no systems in use that are capable of monitoring the full extent of riverbed scour in real time at an affordable cost. What we intend to develop is a scour monitoring system that is affordable to build and easy to install. With a less expensive procurement and installation costs these systems can not only be installed on more bridges, but could feasibly be installed in an array around a single bridge so as to track the scour hole development over time.

Tyler Feralio (CEMS)
Biodiesel vs. Petro-diesel: a comparison of particle number emissions at 80% load

Diesel on-road vehicles are main contributors to particulate matter pollution in urban areas. Subsets of the diesel vehicle fleet are currently utilizing blends of petro-diesel and biodiesel for fuel. As time goes on, the number of these vehicles is projected to grow.

The amount of particles emitted from a diesel engine running on biodiesel is different than that of the same engine running on petro-diesel. It has been shown that ultra-fine particles (UFP, diameter < 100nm) cause adverse health effects in humans which include aggravated asthma, decreased lung function, irregular heartbeat, and even nonfatal heart attacks. Because of their small size, these particles do not contribute substantially to the standard measurement of particulate matter, Particle Mass (PM). For this reason, the Particle Number (PN) metric, which counts the number of particles in different diameter ranges, presents a clearer picture of the particles that likely cause the most harm.

The objective of this research was to determine whether an engine running on neat biodiesel emits more or less UFP than the same engine running petro-diesel. Here, PN distributions were measured from a 1.9L Volkswagen diesel engine in real-time for neat petro-diesel (B0) and neat soybean oil based biodiesel (B100) with an Engine Exhaust Particle Sizer (EEPS, 32 channels, 5.6 – 560nm range). For these experiments the engine was run at a constant 80% load (2200 RPM, 67% throttle, producing ~104Nm of torque). The results show that operation with B100 tends to emit more nanoparticles in the 10nm diameter range than for petro-diesel, however, there also seems to be a decrease in the number of nanoparticles with diameters centered at 45nm.

Future research will continue to explore PN emissions of petro-diesel and biodiesel as the engine is subjected to a transient drive cycle. The results will more accurately represent real-world, on-road emissions.

Kristine Harootunian (CEMS)
Drive Like a Local! Findings from the Vermont State Crash Database

This study examined single- and two-vehicle police-reported crashes in Vermont between 2003 and 2008. It evaluated the likelihood of being at fault for out-of-state drivers versus in-state drivers. Analysis using nominal logistic regression
estimated that out-of-state drivers are over twice as likely to be at-fault for a single-vehicle crash and 6.5% more likely to be at-fault for a two-vehicle crash. Season and road type were statistically different interactions between in-state and out-of-state drivers for single-vehicle crashes. Driving during the winter months had more pronounced effects of increasing single-vehicle crash fault for out-of-state drivers than for in-state drivers, while driving during the summer decreased the odds of being at-fault for out-of-state drivers. In-state drivers, on the other hand, were more apt to cause a crash on unpaved roads. The interactions were less pronounced for two-vehicle crashes as none of the variables tested were significant for either group. The crash evaluation of fault for “foreign” drivers’ crashes has been understudied in the United States. Previous research, conducted mostly in other countries, has been limited but has shown that foreign drivers are more likely to be involved in a crash. This study in Vermont strongly suggests the need for further study of this factor as well as identification of associated interventions.

John Kasumba (CEMS)

**Is Biodiesel Really Better? Effects of Biodiesel on Particulate Matter Emissions**

Biodiesel use and production has significantly increased in the United States and in other parts of the world in the past decade. This is mainly because of the reduction in production of petroleum-based diesel. Also, recent research has shown that emission of some pollutants such as CO, particulate matter (PM), SO2, hydrocarbons, and polycyclic aromatic hydrocarbons (PAHs) is greatly reduced with biodiesel. However, some research findings have shown that some unregulated emissions such as carbonyls in the gas-phase are increased with biodiesel. Very limited research has been done to investigate the carbonyl emissions in the particle-phase.

In this study, an Armfield CM-12 automotive diesel engine was used to generate particulate matter from two biodiesel feedstocks (soybean and waste vegetable oil biodiesel). The PM emissions were sampled by a variety of instruments: - engine exhaust particle sizer, EEPS (TSI Inc, Model 3090) for measuring particle size distributions between 5.6 and 560 nm in real-time; scanning mobility particle sizer, SMPS (TSI Inc, Model 3936) also for particle size distributions between 2 nm and 1000 nm; Teflon filters for gravimetric mass, and quartz fiber filters (QFF) for chemical analysis of the exhaust PM using gas chromatography mass spectrometry (GCMS). PAHs, carbonyls, and alkanes have been measured in the biodiesel and diesel exhaust PM. Preliminary results show that the total PAHs emissions are reduced between 2 – 10 times with B20 soybean biodiesel, while the total carbonyl emissions seem to increase with biodiesel. Alkanes have also been found to be in higher concentrations in petrodiesel exhaust PM than in biodiesel exhaust PM.

Ben Schilling (CEMS)

**Automated Counting of Bicyclists and Pedestrians**

Traffic monitoring through video has been an area of research for years and though methods have continued to improve, especially in terms of automobiles, detecting and counting pedestrians and bicyclists continues to be a problem. Automobile characteristics and behaviors on roadways are very predictable while bicyclists and specifically pedestrians are highly unpredictable. The most accurate method of counting pedestrians would be to manually watch every video; however this is a slow and tedious process.

Our program aims to automate as much of the process as possible and provide the user with quick, accurate estimates with efficient error checking. This is accomplished by analyzing every video, detecting any moving objects, and saving features for these objects including size, shape, and speed. The detected objects are then classified by comparing the saved object features against trained feature values for the different object types. As the videos are real world situations with countless sources for noise, the program does have errors. In a video folder containing 8 bicyclists and 28 pedestrians, the program found 9 bicyclists and 35 pedestrians. In another folder with 38 bicyclists and 3 pedestrians, the program found 38 bicyclists and 7 pedestrians. The results vary on other folders, with bicyclists and pedestrians both generally being slightly over counted. After classification the user can do a quick manual check on the bicyclists and pedestrians by viewing captured images of the objects sequentially. By providing this manual check the user not only gets an automated estimate, but a function to check that estimate in minutes. Though the program is far from perfect, the automated video analyzing and classification followed by quick manual checking significantly reduces the man hours required to get accurate counts.
Chester Harvey (RSENR)
The relationship between multimodal transportation infrastructure and housing prices in Baltimore

Accessibility to transportation infrastructure is an important factor of property values. As cities develop increasingly multimodal transportation networks to provide alternatives to car travel, access to these networks is likely to be an important consideration for homebuyers. This study aims to reveal how overlapping access to vehicular, bus, rail, and bicycle networks are related to the sale price of residential properties, and whether access to particular combinations of network access may yield advantages to neighborhood economic development. To investigate this we use a statistical method called hedonic regression, which assesses thousands of individual properties according to a bundle of attributes that include property-based measures, such as improvement value and quality of construction, as well as place-based measures, such as access to transportation networks. Parameters of the model reveal the portion of a sale price that can be associated with each attribute. The study is based in the city of Baltimore, which is home to a handful of small transit systems as well as a burgeoning on-street bicycle network. While these networks are limited in scope compared with some cities, Baltimore provides useful insight on the early-stage development of alternative modes that is representative of many mid-sized American cities."

Isaac Lawrence
A Model to Predict Impervious Surface Impacts of Land Use and Transportation System Change with UrbanSim

The importance of impervious surface area (ISA) as an indicator of human impact on ecosystems and a driver of increases in flooding has been well established. In order to predict impervious surface outcomes for municipal and regional Master Planning processes, Reilly et al. (2002) developed and tested a model of ISA based on commonly available planning data. Since publication, adoption of agent-based land use and transportation models by planning authorities and researchers has increased. UrbanSim, one increasingly popular model, provides a powerful, flexible environment for predicting land use and transportation system change. In order to leverage UrbanSim towards the management of flooding and stream health with impervious surface as a proxy, I propose and test a model to predict ISA within a Chittenden County, Vermont implementation of UrbanSim. In addition, I compare the model developed to Reilly et al. as well as a simple factor model commonly utilized in hydrologic modeling.

Timothy Pede
Assessing the use of UrbanSim for energy consumption estimates: A Chittenden County case study

UrbanSim is an agent-based model that simulates the development of a given geographic area (ie. city, town, or state), including land use, transportation, and environmental impacts over 20 years or more. Although the combustion of fossil fuels is closely linked to land use and transportation, there has been little use of UrbanSim for the prediction of energy consumption. I present my progress on the development of such an indicator for the UVM Transportation Research Center’s Chittenden County 2005 Baseyear Model of UrbanSim, and summarize similar past applications and their utility. Predictions for annual energy consumption can be grouped in three main sectors: 1.) residential 2.) commercial/industrial and 3.) transportation. Estimates are essentially based off the variables/indicators associated with residential units (household income, year built, number of residents), employment locations (sq. ft. per sector), and road segments (VMT, fuel economy). Although data for the residential and transportation portion of the energy consumption indicator is readily available, developing the commercial/industrial portion will be significantly more difficult and has yet to be accomplished.

Phoebe Spencer (CDAE)
Bicycle Transportation and Quality of Life: Qualitative Connections between Mobility and Wellbeing

Transportation and mobility are considered key components of quality of life because they mediate and shape the ways individuals interact with the built and natural environments around them. In this project, we contribute to the developing field of quality of life studies that focuses on the importance of the experience of transportation, specifically the effects of
bicycle use on wellbeing. Previous scholarship demonstrates that bicycle use provides numerous benefits for riders by enhancing mobility through healthy and relatively inexpensive transportation. These factors are major components shaping the quality of life for individuals worldwide. Bicycle use has clear and measureable impacts on health and environment, yet the specific effects of utilitarian bicycling on subjective perceptions and objective measures of quality of life are largely unknown.

Through this research, we examine the relationship between quality of life, transportation sustainability, and bicycle transportation by asking: How do everyday cyclists and transportation professionals think about the relationship between quality of life and bicycling? Do cycling transportation and culture impact aspects of quality of life beyond transportation and mobility, and what are these extensions? By examining these questions, we provide a critical analysis of the concept of quality of life within the framework of mobility and bicycle studies. In-depth interviews were conducted among everyday transportation cyclists and bicycle transportation professionals in Burlington, Vermont in order to gain understanding of connections between bicycle transportation and quality of life. Support for our critique of current quality of life paradigms is provided through qualitative interview analysis, identifying personal histories and perspectives on cyclist experience, practice, and perceptions of wellbeing.

**ABSTRACTS: Posters 2:30-4p**

Timothy Tomko (CEMS)

**Bioprospecting for genes that confer biofuel tolerance using a genomic library approach**

Microorganisms are capable of producing advanced biofuels that can be used as ‘drop in’ alternatives to conventional liquid fuels. However, the cell machinery of these microorganisms often becomes overwhelmed by the toxic effects of the biofuel product. In order to make microbial biofuels a competitive fuel source, mechanisms of improving resistance to the toxic effects of biofuel production is vital. Our investigation aims to identify resistance mechanisms from microorganisms that have evolved to withstand extreme environmental pressures. Using a plasmid based transgenic library approach; genes believed to impart resistance can be inserted and studied in a different microorganism. Adapts such as increased efflux pump efficiency and less permeable cell membranes could improve biofuel tolerance in the host organism, *Escherichia coli*. *Pseudomonas aeruginosa* was studied because the bacterium has evolved mechanisms to survive attacks from many damaging compounds. A plasmid library from *P. aeruginosa* was created and transformed into *E. coli*. The resulting cells were then stressed with biofuel to determine if any of the genetically altered *E. coli* displayed improved tolerance. Our studies identified specific genes from *P. aeruginosa* that significantly improve tolerance to limonene when expressed constitutively in *E. coli*. Using the transgenic library approach, other microorganisms with interesting tolerance mechanisms can also be studied.