

UNIVERSITY OF PENNSYLVANIA

SCHOOL OF ARTS AND SCIENCES

**Department of Earth & Environmental Science
Senior Research Conference**

**April 29, 2010
358 Hayden Hall
8:30 AM – 6:00 PM**

Individual abstracts, arranged alphabetically by author, follow the schedule

ACKNOWLEDGMENTS

We extend a special vote of thanks to all the Academic Advisors who worked with the seniors on their research projects.

We thank Rebecca Caldwell, who worked with the seniors in the design and production of their posters.

We thank Joan Buccilli, who has ensured the attention of all participants by keeping them very well fed.

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Edward Doheny

Jane Dmochowski

Robert Giegengack

SENIOR RESEARCH CONFERENCE, APRIL 29, 2010

8:30-8:55: Registration, continental breakfast, and transfer of PowerPoint presentations to the computer in room 358 Hayden Hall.

8:55: **Welcome and Introduction** (*Robert Giegengack*)

Session I: ENVIRONMENTAL HEALTH (*Robert Giegengack*)

9:00: Kellee Hand: **Metropolitan Nature: Examining the Tidal Schuylkill River in Philadelphia**

9:20: Jana Hirsch: **Heavy Metals in Urban Community Gardens: Analysis of Risks in West Philadelphia**

9:40: David Hilbert: **Post-1990 change in Heavy-Metal Deposition in the Estuaries of the Gdansk Bay, Poland**

10:00: Grace An: **Implications of Climate Change on Incidence of Malaria in China**

10:20: Valerie Frankel: **Environmental and Health Consequences of the Chernobyl Nuclear Disaster in Belarus.**

COFFEE BREAK (10:40-11:00)

Session II: ENVIRONMENTAL SCIENCE I (*Fred Scatena*)

11:00: Dan Brickley: **Climate Change on the Northern Mongolian Steppe**

11:20: Rebecca Caldwell: **A Cathaysian Calamite and its Paleobiogeographic Implications**

11:40: Patrick Kneeland: **Coastal Erosion on the Baldwin Peninsula in Arctic Alaska**

12:00: Stephanie Scott: **Waste Not, Want Not: The Stability of Organic Wastes**

12:20: Sarah Brody: **Using Stable-Isotope Geochemistry to Examine a Geologic Record of Cascadia Subduction-Zone Earthquakes**

LUNCH BREAK, 360 HAYDEN HALL: 12:40 – 1:20

Session III: ENVIRONMENTAL SCIENCE II (*Jane Dmochowski*)

- 1:20: Margaux Howard: **Surface Macroplastic Concentrations in the Caribbean Sea: 1987-2009**
- 1:40: Dani Olexa: **Suitability of Carbon Capture and Sequestration for Emissions Reduction**
- 2:00: Madison Kramer: **The Application of Geophysical Techniques to the Field of Paleontology**

COFFEE BREAK: 2:20 – 2:40

Session IV: ENVIRONMENTAL POLICY AND MANAGEMENT (*Ed Doheny*)

- 2:40: Chris Ward: **Policies Addressing Sea-Level Rise in Mid-Atlantic States**
- 3:00: Meg Gilley: **Examination of the Challenges facing the National Flood Insurance Program**
- 3:20: Meg O'Donnell: **Preventive Measures to Protect Urban Forests from the Emerald Ash Borer**
- 3:40: Mordechai Treiger: **Identification of Nitrogen-containing organic compounds in the biomass-burning aerosol of beetle-infested Ponderosa pines (*Pinus ponderosa*)**
- 4:00 Leah Yudin: **Institutional Approaches to Sustainability in the Urban Environment**
- 4:20: Shauna O'Donnell: **Land Use Management and Recreation in the Paria River Valley, Utah**

RECEPTION: 4:40 – 6:00

All participants, guests, and members of the audience are invited.

THE IMPLICATIONS OF CLIMATE CHANGE ON MALARIA IN CHINA

Grace An

ABSTRACT

Malaria, a mosquito-borne infectious disease caused by the parasite *Plasmodium*, is the fifth leading cause of death from infectious diseases worldwide, after respiratory infections, HIV/AIDS, diarrheal diseases, and tuberculosis. With 3.3 billion people, or half the world's population, living in areas at risk of malaria transmission, malaria remains a public-health issue in many countries, including China.

Many studies show relationships and correlations between climatic factors and malaria incidence. The malaria life cycle can only be complete with the presence of the transmitting mosquito (at least 4 species), humans, and malaria parasites. Because mosquito development and breeding is affected by temperature, humidity, precipitation, altitude, and fog, malaria incidence can also change with changes in climatic factors.

Concern is growing about the expansion of infectious diseases such as malaria in non-endemic areas due to climate change, which affects the minimum and maximum temperatures, precipitation, and other factors that control the life cycles of the mosquito vectors. However, historical malaria-distribution maps show that malaria has affected human societies in extremely cold areas as well as in areas of high altitudes. Thus, to predict future expansion of malaria distribution, public-health professionals should address factors such as urbanization, land-use change, population density, pollution, public-health protocol and infrastructure, education and awareness, and malaria control and prevention methods, as well as the consequences of climate change.

CLIMATE CHANGE ON THE NORTHERN MONGOLIAN STEPPE: ECOLOGICAL CONSEQUENCES AND HUMAN ADAPTATION

Dan Brickley

ABSTRACT

The consequences of climate change affect even some of the most remote areas of the planet, like the large, landlocked country of Mongolia. With rising temperatures and a climate already arid, Mongolia faces significant pasture depletion, a serious development for a country in which one-third of its populace works as pastoral nomads. The influx of new pastoralists into rural areas following the 1990 democratic transition and increased Chinese demand for cashmere wool have led to extreme overgrazing. The loss of plant biomass has led to deeper permafrost thawing and increased soil erosion, as well. While western development agencies have often tried to rectify this problem, their lack of understanding about Mongolian pastoral and cultural history has led to failure. I propose a return to seasonal migration patterns and herder collectives.

Without action to educate herders about best-management practices of the steppe grassland and improvement of their economic situation through investments in infrastructure and the pooling of resources, northern Mongolia's pastoral populations seem doomed to a bleak economic and environmental future.

USING STABLE-ISOTOPE GEOCHEMISTRY TO EXAMINE A GEOLOGIC RECORD OF CASCADIA SUBDUCTION-ZONE EARTHQUAKES

Sarah Brody

ABSTRACT

While great (magnitude larger than 9) earthquakes have not occurred on the Cascadia subduction zone in recorded history, the geologic record suggests that such earthquakes have occurred in this region in the past. Great earthquakes cause land levels to subside at distance from the plate boundary; this coseismic subsidence is proportional to the magnitude of the earthquake, and can be seen from evidence of sudden relative rise of sea level in coastal marshes (peat horizons buried by tidal mud) in Cascadia. Earthquake models can use estimates of coseismic subsidence to determine past earthquake magnitudes.

I examined whether stable carbon isotopes can be used to estimate coseismic subsidence quantitatively in Cascadia. The ratio of $^{13}\text{C}:^{12}\text{C}$ (δC) differs in plants by photosynthetic pathway: plants using the C_3 pathway have lower δC values than C_4 plants, and tend to colonize upland/high-marsh environments, while C_4 plants colonize the low marsh. I compared the δC values of modern marsh samples of varying elevations relative to mean tide level with other environmental variables (total organic carbon, clay-silt grain-size fraction) that vary with elevation, and performed the same analysis on two peat-mud contacts in a core from the same marsh. I found that δC values for the modern marsh increased with lower elevation and lower organic content; however, differences between the average δC values for each marsh zone (upland, high marsh, mid marsh, low marsh, tidal flat) were obscured by the uncertainty of each average measurement. Furthermore, the two peat-mud contacts did not show the increase in δC values expected with rapid sea-level rise. Therefore I conclude that stable carbon isotopes are not an effective means of quantifying coseismic subsidence for past great earthquakes on the Cascadia subduction zone.

A CATHAYSIAN CALAMITE AND ITS PALEOBIOGEOGRAPHIC IMPLICATIONS

Rebecca Caldwell

ABSTRACT

Pangaea formed ~300 million years ago, creating a supercontinent including all of the land then on Earth. Cathaysia is the term used for one region of Pangaea that included the terrain that is now North China. This region's biology, similar to many regions of Pangaea during the Carboniferous Period, contained a vast flora that contributed to the formation of peat.

A well preserved example of this flora was found at a site in the Wuda Coal District of the Inner Mongolia Autonomous Region of North China, and is currently being studied to reconstruct the paleobiology of the region surrounding the site. Preservation at the site is the consequence of deposition of a thick, extensive layer of volcanic tuff that was ejected at the time of the Carboniferous-Permian boundary, and has essentially "frozen" the landscape in fossil form.

My project focuses on the identification of a number of specimens from the Calamitaceae family that include well-preserved cones as well as some foliage and stems. When I have completed a full identification and description of these Cathaysian Calamite specimens, my work will be published to contribute to the growing floral database of Cathaysia. That database will enable paleoecologists to describe aspects of the biology, climate, and geography of that place and time. This reconstruction is important because the end of the Paleozoic most directly resembles modern conditions, in terms of vegetation cover and climate change. Therefore, by studying the changes that occurred 300 million years ago, we may be able to predict more accurately the natural changes we will experience in coming years.

ENVIRONMENTAL AND HUMAN-HEALTH CONSEQUENCES OF THE CHERNOBYL NUCLEAR DISASTER IN BELARUS

Valerie Frankel

ABSTRACT

On April 26, 1986, Unit 4 of the Chernobyl Nuclear Power Plant exploded, causing the most severe disaster ever to occur in the history of domestic nuclear-power production. The event was not a nuclear explosion, but a steam explosion triggered by burning graphite moderator. That explosion spread both fission products of the normal operation of the reactor and unexpended uranium fuel across a large area. Studies have shown that Belarus, Ukraine, and Russia suffered from the highest levels of radionuclide contamination. In total, ~14 EBq⁵ of radioactive substances were released from the burning reactor, some of the most harmful being 1.8 EBq of ¹³¹I, 0.085 EBq of ¹³⁷Cs, 0.01 EBq of ⁹⁰Sr, and 0.003 EBq of Pu radioisotopes. More than 200,000 km² of Europe received levels of ¹³⁷Cs in excess of 37 kBq/m²; and ~70% of this area lies in the Ukraine, Belarus, and Russia. A full accounting of the environmental consequences of the disaster has not been released. And, although Belarus was severely affected, the consequences of this event in Belarus have not been well studied.

Of the three most affected countries, Belarus suffered the greatest level of ¹³⁷Cs contamination, absorbing ~33.5% of the total amount emitted. This disproportional level was a result of the wind and precipitation patterns initially following the reactor accident. Soil accumulation of ¹³⁷Cs and ⁹⁰Sr was mainly restricted to the first 15 cm of the soil layers. Soil contamination led to removal of 256,700 ha of agricultural land from production between 1986 and 1990. Other studies have asserted that 1,434,300 ha of land are contaminated, but still remain in production. Small-scale farms suffered greater losses than state-owned collectivized farms. Runoff from agriculture, along with other forms of radionuclide deposition, contaminated bodies of water near the reactor. ¹³¹I levels in the Pripyat and Dneiper rivers have shown signs of decline. ¹³⁷Cs and ⁹⁰Sr levels in the Kiev and Kahovka reservoirs, into which the Pripyat and Dneiper flow, are also declining. ~1.7 million ha of Belarusian forests, or ~25% of the forested area of Belarus, were contaminated; of that area, 188,000 ha are contaminated at a level of 555-1480 kBq/m². As a result, forest resources were taken out of production.

Belarus experienced a high level of radionuclide contamination following the Chernobyl disaster. Efforts to manage the consequences of the Chernobyl event in Belarus continue, and will lead to better management practices in the future.

AN EXAMINATION OF THE CHALLENGES FACING THE NATIONAL FLOOD INSURANCE PROGRAM

Meg Gilley

ABSTRACT

The National Flood Insurance Program (NFIP) was enacted in 1968 to provide government-subsidized flood insurance for residents of floodplains and coastal properties. Before the creation of the NFIP, these residents were unable to insure their properties via the private sector because the flood risk was considered uninsurable. The federal government spent a substantial amount in disaster relief for flood victims who had no other form of relief, and decided to establish this program to prevent some of these losses. Although the program was well intentioned, it has many fundamental flaws that affect its future viability.

The NFIP is made up of three components: floodplain mapping, flood mitigation, and flood insurance. The first involves creating Flood Insurance Rate Maps (FIRMs), which delineate floodplains and indicate which communities are eligible to participate in the program. The second charges communities to mitigate the flood risk on individual properties and to ensure that new construction is flood resistant. The largest component is the insurance itself, which is provided at very reasonable rates to individuals in communities who join the NFIP. These three components are intended to reduce damages and government expenditures on flood disasters.

There are many fundamental challenges facing the NFIP. The program is over \$19 billion in debt to the US Treasury, largely because of funds borrowed to pay for claims in the 2005 hurricane season. Loans from the Treasury must be paid back with interest, but since the NFIP has no financing mechanism to provide for catastrophic losses, it is unlikely that the loans will ever be repaid. Policyholders consistently pay very low premiums that in aggregate are only enough to cover an average year's losses. Perhaps the largest drain on the program comes from properties built before FIRMs were created. These properties receive significant discounts on their already subsidized insurance, and represent ninety percent of properties experiencing repetitive losses. It is estimated that a mere one percent of properties, most of which are pre-FIRM, represent one third of paid losses. FIRMs themselves are also often out of date and inaccurate. The NFIP has not kept up to date with changes in floodplains, and as a result the flood risk is unclear in many areas. These problems represent foundational issues with the administration of the program that offer the potential for reform.

More fundamentally, the premise of the NFIP is flawed. The reason that floodplain residents could not purchase flood insurance before 1968 is because the risk is truly uninsurable. People should not build homes on floodplains. The risk of destruction is extremely high, and as a result of the NFIP, many people are less aware of the threat. The NFIP creates an misleading sense of security that encourages development in areas at risk of predictable flooding.

METROPOLITAN NATURE: EXAMINING THE TIDAL SCHUYLKILL RIVER IN PHILADELPHIA

Kellee Hand

ABSTRACT

For many years, the lower section of the Schuylkill River was feared and forgotten, due to more than a century of industrialization, sewage dumping, and petrochemical manufacturing. The July 9th, 1949, issue of the Saturday Evening Post featured an article about the Schuylkill by Bill Wolf, who boldly stated: “ ‘Too thick to navigate, too thin to cultivate’ best describes its semiliquid state, and only hardened Philadelphians can breathe its odors without shuddering.” Efforts to revitalize Philadelphia’s “Hidden River” have been pursued by various public and private organizations over the past several decades, and there is now a vibrant, highly-utilized trail that connects the Schuylkill Banks to the greater greenway system of Fairmount Park and Valley Forge. However, the trail now ends at Locust Street, and the lower Schuylkill remains an afterthought in the minds of most Philadelphians, despite the valuable resources present, like Historic Bartram’s Garden.

I use E.O. Wilson’s idea of biophilia, or a human affinity to nature, as a framework to emphasize the value of reconnecting people to the riverfront. The Schuylkill River represents an opportunity for the residents of Philadelphia to bond with nature in the city.

The tidal portion of the Schuylkill River runs from the Fairmount Dam at the Philadelphia Museum of Art to the mouth of the river at Tinicum/Fort Mifflin and the Delaware Bay. Since 1924, when John Frederick Lewis wrote his Redemption of the Lower Schuylkill, ideas have been offered to renew the river’s post-industrial banks. In the 1960’s these efforts consisted of planning exercises and early renewal of the east bank of the river, and finally, in the 1990’s, extensive efforts to revitalize the river’s east bank to Locust Street. The trail, as it is known today, was completed in the early part of the new millennium, a result of decades of collaborative work from a diverse group of players and beneficiaries, including architectural firms, designers, illustrators, non-profit organizations, landscape architects, planners, ecologists, civil engineers, and volunteers.

The greenway corridor along the Schuylkill River offers numerous benefits, including human-health and recreational amenities, pollution reduction, efficiencies in transportation and traffic flow, gains in real-estate and property values, connections to underserved neighborhoods, highlighted cultural and historical aspects of the city, and habitat improvements. The extension of the trail from Locust Street southward to Bartram’s Garden will reconnect the city to a valuable piece of historical land.

Overall, the Schuylkill River is essential to the prosperity and vitality of Philadelphia. The first steps in extending the trail are set to begin in the summer of 2011, with construction of a 15-foot-wide boardwalk from Locust Street to the South Street Bridge. The Schuylkill River Development Corporation’s master plan outlines several other projects that will follow completion of the trail in the summer of 2012. These projects include remediation of the Dupont Crescent and a pedestrian bridge crossing the Schuylkill at Gray’s Ferry, which will eventually link this trail to Bartram’s Garden.

POST-1990 CHANGE IN HEAVY-METAL DEPOSITION IN THE ESTUARIES OF THE GDANSK BAY, POLAND

David Hilbert

ABSTRACT

The Vistula River that flows into the Gdansk Bay drains a watershed that encompasses more than half of Poland, causing the river to be used for a wide variety of agricultural, industrial, and municipal uses. The Vistula Delta divides into several outlets near its mouth, some of which have been dredged and controlled, and others dammed, in order to facilitate shipping.

Each of the four outlets has a theoretically different contaminant profile as a result of different upstream land uses. The main channel, the Przekop Wisly, passes through an agricultural area on its way to its outlet, and is thus likely to carry the lowest burden of industrial contaminants. The Smiala Wisla passes through the legendary Gdansk shipyard, and the Martwa Wisla passes through that shipyard as well as the city of Gdansk. There is another outlet on the eastern side, the Elblag River, that passes through the heavily industrialized city of Elblag.

Each of the outlets produces a lobe of sediment that grows continuously toward the ocean. I have collected sediment samples from each of the lobes in order to determine the rate of heavy-metal deposition, which can be seen as a proxy for industrial contamination. A comparison of sediment stratigraphy with aerial photos and historical maps allows for approximate reconstruction of former shorelines, thus allowing an estimate for the date of deposition of each sedimentary unit.

In this thesis I have attempted to answer two questions: 1) how does the influx of contaminants from local sources control the inventory of contaminants in the Vistula's main channel, and 2) how has the contamination profile of the delta changed over time? In addition to my own data, I will use information from published papers that document analysis of contaminant levels in the Bay, and I will address the possibility that re-suspension may have moved the sediment out of its original depositional environment.

I will use the data obtained in this study to assess whether or not Poland's attempts to curtail industrial contamination since the fall of Communism have been successful, and I will assess the effect of economic restructuring on the operation of industries that previously acted as point sources of heavy metals.

HEAVY METALS IN URBAN COMMUNITY GARDENS: ANALYSIS OF RISKS IN WEST PHILADELPHIA

Jana Hirsch

ABSTRACT

With urban agriculture expanding rapidly nationwide, ensuring the safety of both the gardeners and the food they produce is crucial. Urban gardens build community, reclaim and beautify urban space, and help give people access to fresh, locally produced food. However, pursuit of these positive goals may entail serious health hazards for urban populations unless we explore the extent to which urban gardeners may be exposed to toxic metals. Elevated heavy-metal levels in urban soils are a potential source for elevated levels of heavy metals in blood of residents, a consequence of hand-to-mouth ingestion, skin absorption, and dust inhalation.

To evaluate an inexpensive and effective way to measure the risk to community members of coming in contact with soil contaminated with heavy metals, I collected 225 samples of garden soil from 7 of the Urban Tree Connection's gardens following EPA and PA DEP collection protocols. I used X-Ray Fluorescence analysis to determine total heavy-metal concentrations. I sent selected samples to the Penn State Agricultural Analytical Services Lab for verification. Screening data from XRF indicated a potential threat from mercury (Hg). However, the laboratory at Penn State Agricultural Analytical Services reported no threat from heavy metals. Despite the appeal of its low cost, XRF screening did not provide an accurate assessment of the levels of heavy metals in soils in the community gardens I studied.

SURFACE MACROPLASTIC CONCENTRATIONS IN THE CARIBBEAN SEA: 1987-2009

Margaux Howard

ABSTRACT

Plastic pollution is threatening marine ecosystems all over the coastal and offshore waters of Earth. Eventually, such massive and constant pollution will impact the human condition in ways that we have not anticipated. While the plastic waste we dump in the ocean is diluted by the great mass of ocean water and thus seems negligible, plastic pollution is in fact growing exponentially. Yet scant research has addressed this emerging environmental issue, which profoundly impacts the world's most precious ecosystem.

Successive classes of the Sea Education Association (SEA) have assessed the magnitude of this problem. An analysis of the data collected from SEA semester cruise tracks, including over 900 plastic-sampling exercises in the Caribbean Sea over the past 16 years, provides an opportune research model to examine the changes in levels of plastic pollution. Although concentrations of macro pellets are somewhat inconsistent, those concentrations show an overall upward trend. However, this is not the case for pre-consumer plastics, concentrations of which have been on the decline in recent years. To understand better the distribution and concentration of plastic pollution in the Caribbean Sea, it is essential to continue the program of systematic sampling.

COASTAL EROSION ON THE BALDWIN PENINSULA IN ARCTIC ALASKA

Patrick Kneeland

ABSTRACT

Climate change is one of the most widely discussed issues in society today, and for good reason: if current trends continue, the results could change many aspects of our lives that we take for granted every day. Nowhere is climate change more evident across the globe than in the Arctic, which serves as a “canary in the coal mine” for the rest of the world on issues related to climate change.

One Arctic area which has shown significant effects of rising temperatures is the Alaskan coastline, which has seen vastly increasing rates of erosion, slumping, mass failure events, and thermokarst collapse in conjunction with rising average temperatures. As this area is dominated by sub-surface permafrost, rising temperatures result in accelerated melting, which directly results in increased erosion.

My study focuses on the Baldwin Peninsula, which lies almost directly on the Arctic Circle and is experiencing a high frequency of coastal slump failures. This erosion poses a serious threat to the current landscape, but the threat is more immediate to the people who call this region home. These people depend on coastal areas of Alaska for subsistence hunting and fishing, and the majority live along the coastline. Any acceleration of processes of erosion could be drastic for the lives of many native Alaskans, and could hint at what is to come for areas that are less vulnerable, should climate change continue on its current path.

The main sources of data for my study of this area are topographic surveys taken in the summer of 2009, which I used to examine slump morphology in comparison to aerial photographs from the 1950's through the past decade. Using these data, I have developed a hypothesis that associates failure erosion in the area primarily with seepage erosion, due to thawing permafrost as a result of increased average local and global temperatures.

THE APPLICATION OF GEOPHYSICAL TECHNIQUES TO PALEONTOLOGY

Madison Kramer

ABSTRACT

The application of remote methods to determine the location and depth of large fossilized bones and similar material without the need to excavate could improve field methodology in paleontology and yield valuable information. Recently, advances in geophysical equipment, data collection, and analytical methods suggest that geophysics could provide these techniques. As gravitational, magnetic, electrical, E and M, and GPR methods increase in sensitivity and reduction of time needed for data collection, paleontologists may choose to identify fossils in the field by performing geophysical mapping of the fossil localities before embarking on expensive excavation.

I am using the paleontological and geological setting of the Bahariya Oasis dinosaur fossil discovery as a test case to determine whether geophysical methods could have been helpful in determining the depth and location of the most important bone discovered at the site, the humerus of *Paralatican stromeri*. I am using the measured densities and dimensions of the bone and matrix, and I am modeling the measured length, diameter and overall structure of the humerus to determine if it would have been detectable directly, or after using a “stacking” procedure.

PREVENTIVE MEASURES TO PROTECT URBAN FORESTS FROM THE EMERALD ASH BORER

Meg O'Donnell

ABSTRACT

I studied the invasive species Emerald Ash Borer (EAB) to learn more about its risks and management, to understand the process of infestation of ash trees by EAB in urban areas, and to develop management strategies to deal with this risk.

The Emerald Ash Borer is an invasive species that was introduced into the United States in 2002. An invasive species is an organism that is not native to a particular region, and whose introduction will likely damage the environment, the economy, or human health. The larvae of the EAB exclusively attack ash trees beneath the bark, excavating damaging tunneling systems, called serpentine galleries. This destruction creates significant nutrient and water-transport problems within the tree, initiating its ultimate decline. Detection is difficult, leaving those in forestry departments with limited tactics to protect the ash trees.

While working with Fairmount Park in Philadelphia, a region not yet affected by EAB, urban foresters decided to produce a map indicating the location of ash trees to quickly locate "high-risk regions" as a pre-emptive measure, allowing the foresters to monitor prioritized locations. High-risk regions are areas covered by ash trees that are located near roads, homes, or paths frequented by humans, where a destroyed tree could fall and harm or kill someone. Once a map is available, these zones can be identified, and authorities can determine what future steps are appropriate to protect human health and the environment in the Park.

LAND-USE MANAGEMENT AND RECREATION IN THE PARIA RIVER VALLEY, UTAH

Shauna O'Donnell

ABSTRACT

The Paria River of South-Central Utah is a mostly dry desert wash that runs approximately 75 miles through southern Utah and drains a large section of south-central Utah. For most of its length, the river flows through primitive public land, much of which is part of *Grand Staircase Escalante National Monument*, a unit of public land under the management of the Bureau of Land Management (BLM). Though much of the Paria River runs dry for most of the year, it is considered to be a major tributary of the Colorado, as it is the only major tributary to meet the Colorado between the Glen Canyon Dam and the head of the Grand Canyon. The deep canyons of the Paria have prevented human settlement; as a result, the Valley has remained very primitive. In recent years, the main use of the Paria River Valley has been to transport cattle and for recreation.

For a long time the Paria River Valley was simply part of a large tract of public land with no special designation, until 1996 when President William Clinton suddenly declared it to be part of the newly formed *Grand Staircase Escalante National Monument*. In 2000, the BLM released its first official management plan for the Monument, which declared the Paria River Valley a part of the *Paria-Hackberry Wilderness Study Area (WSA)*. Since WSAs are required to be managed as wilderness areas, they come under the protection of the Wilderness Act, and are therefore closed to all motorized traffic. Excluding the Paria Valley from the transportation plan and protecting it as a wilderness was considered to be a controversial move by local officials, who have continuously claimed rights-of-way through the river corridor as part of an outdated provision called Revised Statue 2477. This statute is invoked to support the claim that, because the people of Kane County have been using the Paria River as an access road (via wagons and horses) before any of the laws that now govern the land were even in place, they are grandfathered that right and have jurisdiction over the Paria Valley as a right-of-way.

The fight over jurisdiction in the Paria River Valley is not a new or unique issue in Utah. There is a long history of anti-federal sentiment in the American West, and in Utah that sentiment is apparent in the thousands of county right-of-way claims that have been made all across the state. Even after Kane County, Utah (which part of the Paria runs through) lost two court battles and was told that the BLM did indeed have the right to close the Paria Valley as a road, local residents still ride off-road vehicles (ORVs) down the canyons just as often as they please. Though all environmental laws clearly support the BLM position, the situation on the ground is a very different story. Conflict over land use in the Paria Valley provides an instructive case study of the conflict between local and federal authorities that often occurs in states with high proportions of public land.

SUITABILITY OF CARBON CAPTURE AND SEQUESTRATION FOR EMISSIONS REDUCTION

Dani Olexa

ABSTRACT

Since the industrial revolution began in the late 18th Century, levels of carbon dioxide in the Earth's atmosphere have been rising steadily, making global warming one of today's most pressing issues. Various technologies exist to capture carbon dioxide from industrial sources before it can be released into the atmosphere; however, storing this carbon presents a problem on the basis of available markets, means of transportation, and storage capacity. Ultimately, while carbon capture and sequestration has shown success in reducing emissions, the current scale of use is too limited to have a measurable impact on total emissions.

WASTE NOT WANT NOT: THE STABILITY OF ORGANIC WASTES

Stephanie Scott

ABSTRACT

The application of organic amendments to soil, in particular, the application of different types of organic waste, is being studied to understand the impacts of these materials on soil organic matter and soil nutrient content. By researching organic-waste addition to soils and analyzing the organic-waste mixtures using a range of characterization techniques, we can determine the effects of these wastes on soil chemistry, biology, and biochemistry, with the ultimate goal of quantifying which type of amendment is most beneficial for increasing soil organic carbon. The important questions I have asked in this project are: 1) how do additions of organic waste influence the chemical and biochemical properties of soil organic matter, and 2) how can these effects be measured?

I studied three types of organic wastes: thermally dried sewage sludge, composted sewage sludge, and composted municipal wastes. I applied 4 tests to each type to assess the value of adding these wastes to soils to increase the soil organic matter. My tests allowed me to determine important properties of the organic wastes. I found that the composted materials are better than thermally dried sewage sludge to amend soils deficient in organic matter.

IDENTIFICATION OF NITROGEN-CONTAINING ORGANIC COMPOUNDS IN THE BIOMASS-BURNING AEROSOL OF BEETLE-INFESTED PONDEROSA PINES (*Pinus ponderosa*)

Mordechai Treiger

ABSTRACT

Bark beetles depend on specific tree species for reproduction and sustenance. In the battle between beetles and a tree, the outcome is generally 'all or nothing': trees either successfully repel beetle invasion, or succumb to attack and die. A number of methods have been developed to combat pine-beetle outbreaks, including controlled burning of affected areas in an attempt to eradicate the insect. Furthermore, the trees killed by bark beetles increase a forest's fuel load, increasing the likelihood that a natural forest fire will occur.

Fire, of course, produces smoke. My pilot study compared the chemical composition of smoke produced by burning infested trees with smoke produced by burning healthy trees. My study used methodologies developed by scientists from the Pacific Northwest National Laboratory (Drs. Julia and Alexander Laskin), who documented the presence of potentially toxic nitrogen-containing organic compounds (NOCs) in typical forest-fire smoke. The levels of most abundant NOCs in our sample of healthy trees are consistent with the results from their experiments, though the data were obtained under different conditions and with somewhat different biofuels. This result indicates a remarkable analytical reproducibility, and offers the potential for predicting the types of NOCs that will be produced in biomass burning.

I found differences in NOC content between smoke generated by burning beetle-infested trees and smoke produced by burning healthy trees. Infested trees showed an elevated terpene signal, which is consistent with the role of terpenes in repelling insects. In addition, two of our findings were consistent with pine beetles' well-known propensity to polymerize their hosts' chemicals as a signaling mechanism: low-molecular-weight NOCs were depleted in infested trees and replaced with less abundant high-molecular-weight NOC species. Similarly, CH₂ series of non-NOCs in infested trees were generally longer than corresponding series in healthy trees, indicative of elongation activity.

POLICIES ADDRESSING SEA-LEVEL RISE IN THE MID-ATLANTIC STATES: A CASE STUDY OF NORTH WILDWOOD, NEW JERSEY

Christopher Ward

ABSTRACT

Global sea-level has risen at a rate of 1.7 mm/year during the 20th Century, and is projected to accelerate from 1.9 to 5.9 mm/year during the 21st Century. This trend will exacerbate flooding events and permanently inundate low-lying coastal areas. Rates of relative sea-level rise along the New Jersey coast exceeded global trends, with rates for the 20th Century of 3.3 to 4.0 mm per year, and for the 21st Century projected within the range of 6.1-12.2 mm/year. Relative sea-level rise is believed to be higher due to local land subsidence from the extraction of water from underground wells. Such rates will likely increase the susceptibility of New Jersey's coasts to flooding from the 100-year storm, and will permanently inundate some low-lying areas.

To counter the potential consequences of future sea-level rise, the State of New Jersey has enacted programs which primarily address the effects of increased rates of erosion, such as beach replenishment, restrictions on wetland development, and the construction of features like seawalls, bulkheads, and dunes. By using a Coastal Vulnerability Index applied to the City of North Wildwood NJ, I ascertained that the city is at "very high" risk for the effects of sea-level rise. In addition, North Wildwood relies upon a combination sea-wall and sand-dune system to mitigate flooding and inundation; this system, in addition to being limited by the municipality's budgetary constraints, has incited opposition from homeowners on the island. My analysis illustrates both the State's aversion to retreat strategies, and North Wildwood's ongoing efforts—and subsequent complications—regarding the implementation of their primary policies addressing sea-level rise.

INSTITUTIONAL APPROACHES TO SUSTAINABILITY IN THE URBAN ENVIRONMENT

Leah Yudin

ABSTRACT

Environmental phenomena occur on a regional scale; for example, problems of air and water pollution do not conform to the borders set by state and city boundaries. It is common practice, however, for governments to struggle to deal with environmental issues as they occur on the municipal level, a strategy that forces adjacent towns to attempt to solve similar or overlapping problems without collaboration or shared responsibility. This division of effort ultimately leads to a fragmented and less effective response, which benefits no one and fails to solve the initial environmental problem.

Regional—versus city-specific—thinking can be used to amend the cycle described above. The area surrounding Portland OR has implemented such thinking in the form of a regional government structure known as Metro. This regional governance body oversees the work being done by individual municipalities, and adjusts these efforts to present a unified regional plan for growth. Unique aspects of the land-use systems in place in Portland make this type of regional oversight possible.

A distinctly different land-use system governs planning efforts in the Philadelphia area. Here, the traditional practice of ‘home rule’ makes it much more difficult for individual municipalities to cooperate. Despite this challenge, the work of the Mayor’s Office of Sustainability (MOS) in Philadelphia has met with some promising success. As a new governmental department, it is yet to be seen how much the MOS will achieve in terms of creating a comprehensive plan for regional governance.