Connecticut Conference on Natural Resources 2014 Abstract Listing

Oral Presentations (alphabetical by first author)

A Well-Seasoned Case Study: Investigation and Modeling of Road Salt in Groundwat

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Oral

Groundwater Pollution Fate and Transport

A water-supply aquifer near state and local roads was affected by an increase in dissolved sodium levels after a period of heavy snow. An investigation of potential sources of sodium was conducted and indicated likelihood that the sodium originated from road de-icing activities. Further investigation was performed to 1) identify the portion of road from which the salt originated so as to advocate for changes in salt usage, and 2) to assess whether the sodium could be flushed out by pumping over a short period. History of sodium and magnesium chloride usage on state and local roads was examined. Samples collected from a monitoring well network and nearby stream showed that the sodium likely originated upgradient from the supply well. Geochemical analysis supported the hypothesis that the sodium was related to road salt. Groundwater modeling indicated a stretch of road that most likely would contribute salt runoff. Additional modeling was performed to assess whether the well could be pumped to efficiently reduce sodium concentrations. The well was pumped at a rate determined by modeling. It was concluded that the presence of elevated sodium was relatively widespread throughout the aquifer and likely attributable to road salt application over many years and not a single localized event. The supply well was taken off-line. Discussions with local and state road operators are ongoing.Connecticut

When the water gets hot, the sculpins get going!

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Oral

Fish and Wildlife Management

Stream temperature is an important environmental variable for aquatic ectotherms. Thermal tolerances have been studied for individual fish species but few have investigated how stream fish assemblages respond along a temperature gradient and which thermal ranges act as a threshold, triggering discernible community change. The purpose of this study was to define summer temperature thresholds of fish community transitions in Connecticut streams. Threshold Indicator Taxa Analysis suggested that the cold water class had a June-August mean water temperature <18.29 ºC, the coolwater class 18.29-21.70 ºC, and a warm water class > 21.70 ºC. Significant indicator species of cold water streams were Slimy Sculpin Cottus cognatus and Brook Trout Salvelinus fontinalis. Significant indicator species of warm water streams were Cutlips Minnow Exoglossum maxillingua, Smallmouth Bass Micropterus dolomieu, Rock Bass Ambloplites rupestris, Brown Bullhead Ameiurus nebulosus, and Yellow Bullhead Ameiurus natalis. The narrow 3.41 ºC temperature range between the cold water and warm water thresholds was designated as a cool water transition zone, with potential for the presence of both coldwater and warmwater species and lack of species uniquely associated with this thermal range. These thresholds developed from a robust set of water temperature and fish community data will be useful for informing development of thermal criteria, application of multi-metric indices, planning for future effects of changes in temperature regimes, and for understanding variability of fish communities in Connecticut.

Brownfields to Greenfields: Three Case Studies In Progress on the Willimantic River

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Oral

Turning Brown Fields Into Green Fields

During the industrial revolution many textile mills were built along river systems in eastern Connecticut, but by the middle of the 20th Century many were abandoned or underutilized and falling into disrepair. The complexes were often too large and ill-designed for more modern reuse and were challenged by environmental contamination from former operations and building contaminants. These architecturally and environmentally challenging facilities were typically located in economically depressed areas which further reduced the likelihood of successful redevelopment options. The facilities met the definition of "Brownfields" in that the environmental conditions contributed to the barriers that inhibited or prohibited redevelopment. State and Federal Brownfields programs provided, and still provide, funds to address many of the challenges facing these properties. However, in the current economy with its built space glut, and in consideration of the physical challenges these facilities present, removal or "selective building demolition" provides alternative opportunities to enhance urban areas, especially those areas that lack public spaces and recreation. Those sites on rivers further provide a unique and accentuated opportunity to become "Greenfields". Three sites along the Willimantic River provide unique examples of Brownfields to Greenfields transformation along a continuum of redevelopment stages including a

completed riverfront park, a whitewater park in progress, and a still untapped forested parcel containing an ash landfill along a beautiful waterway and connected to other park and trail opportunities. The completed park is located in the footprint of a portion of the former Windham Mills complex remediated under a state program. The whitewater park was previously occupied by a large textile mill and then a gasoline station. It was purchased by a non-profit commanding site investigation and remediation funds from the State and EPA and resulting in considerable progress toward park development. The third site remains dormant, but is rich with opportunities.

Major and Trace Element Geochemistry and Background Concentrations of Soils

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Oral

Soil Health

Soil samples were collected throughout Connecticut (CT) to determine the relationship of soil chemistry with the underlying geology and to better understand background concentrations of inorganic constituents in soils. Soil samples were collected from the C horizon at 79 sites, from the A horizon at 86 sites, and from surficial soils at 100 sites. The samples were analyzed for 44 major and trace constituents by methods that yield the total or near-total elemental content. Sample sites were characterized by glacial setting, underlying bedrock geology, and soil type. These spatial data were used with element concentrations in the C horizon to relate geologic factors to soil chemistry. Concentrations of elements in C-horizon soils varied with grain size and with underlying rock types, as determined using nonparametric statistical procedures. Element concentrations generally were highest overlying carbonate rocks of the Grenville Belt and (or) the Grenville Shelf Sequence Provinces in western CT. Concentrations of most major elements were highest in C-horizon soil samples, including aluminum, calcium, iron, potassium, sodium, and titanium, but maintained a similar pattern of distribution in A-horizon and surficial soil samples. Trace elements including barium, tungsten, gallium, nickel, cesium, rubidium, strontium, thorium, scandium, and uranium also had higher concentrations in C-horizon soil samples than in overlying soil samples. Concentrations of magnesium and several trace elements, including manganese, phosphorus, arsenic, niobium, tin, beryllium, bismuth, mercury, selenium, antimony, lanthanum, cobalt, chromium, lead, vanadium, yttrium, copper, lead, and zinc, were highest in some A-horizon or surficial soils, and indicate possible contribution by anthropogenic sources. Since element concentrations in soils above the C horizon are more likely to be affected by anthropogenic factors, concentration ranges in C-horizon soils and their geologic associations should be considered when estimating background concentrations of elements in CT soils.

CREATING Custom Online Maps with CT ECO and ArcGIS Online

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Oral

GIS Applications in Natural Resources

It's safe to say that web GIS is here to stay. Once dubbed the "tool of the future," online mapping is now easier than ever, thanks to plethora of available resources including Connecticut Environmental Conditions Online (CT ECO) and Esri's ArcGIS Online. This talk will include a tour of the CT ECO website and highlight new features as well as demonstrate methods for combining the comprehensive natural resource information of CT ECO with ArcGIS Online.

Included in CT ECO are web mapping services which allow a user to combine CT ECO data with their own desktop GIS data or with web GIS data in ArcGIS Online. This talk will demonstrate this process and will show the audience ways to customize online maps to include informational pop-up windows, graphic layers, GPS data and more.

CT ECO is a collaboration between the University of Connecticut Center for Land Use Education and Research (CLEAR), and the CT Dept. of Energy and Environmental Protection (CT DEEP). The website is designed to provide easy access to the most up-to-date spatial information for the state, including high resolution aerial imagery and soon to include, seamless Lidar (detailed elevation) data for the state. The site is tailored to every kind of user, from the novice to the expert, and includes multiple ways to access geographic information.

Surveying the Potential for High Output Production of Portable Band Sawmills

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Oral

Urban Environmental Issues

A significant rise in power outages across the state of Connecticut due to recent severe weather events has prompted utility companies to begin the controversial elimination of roadside trees that pose a threat to the power lines. However, little to no research has been conducted to determine what is being done with the trees that are removed. One option that has been proposed is to encourage the use of portable band sawmills in these locations, rather than simply chipping branches and allowing the larger pieces to be scavenged for firewood. There is potential for portable band sawmill owners/operators (PBSOs) to create a local market for resulting wood products. Rising popularity of regional farmers' markets in the Northeast indicates that local-grown labels could be successfully converted from foodstuffs to locally sourced forest products. Promotion of the homegrown attributes of timber has the potential to increase demand for wood harvested from Connecticut's suburban and urban areas, which are often underutilized due to accessibility and possible inferior wood quality. Access problems are often attributable to lack of large-scale property owners; Connecticut's land ownership is comprised of countless property owners who own small amounts of land, with parcels continually decreasing in size. This survey will explore the potential role of Connecticut PBSOs in wood reclamation from utility company initiatives. The survey accounted for where and how PBSOs might be willing to source their

forest products, as well as where they would sell such products. Problems to be examined include scale-wise production costs, economic impact, and property owners' attitudes towards this alternative to the procedures currently in place. Preceding results pertaining to Connecticut Grown labeling of wood products, as well as hypotheses concerning PBSOs and local forest products, will be addressed.

Angling-Induced Evolution in Connecticut Largemouth Bass Populations

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Oral

Fish and Wildlife Management

Examples of evolutionary change in exploited fish populations, a phenomenon commonly referred to as "fisheries-induced evolution" (FIE), are now myriad and have led to a growing call for the development of "evolutionarily-enlightened" fisheries management practices. The foundational discoveries elucidating FIE were made in commercially exploited fish stocks, but relatively little effort has been devoted to assessing whether recreational angling might also act as a strong selective agent. Recent research on largemouth bass, a popular and widely distributed freshwater gamefish, has shown that individual largemouth bass vary in their vulnerability to angling, and that physiological and behavioral traits relevant to vulnerability are heritable. In Connecticut, we have a unique opportunity to test the hypothesis that FIE has altered largemouth bass populations because a) we have small bass populations that experience high fishing pressure (i.e. there is potential for strong selection), and b) we have numerous drinking water reservoirs that are closed to fishing and support unexploited bass populations. Previous research by the DEEP Inland Fisheries Division (IFD) demonstrated that largemouth bass in unexploited drinking water reservoirs were much more vulnerable to angling than bass from public lakes, a dynamic that we now believe may be partially attributable to evolutionary selection against high vulnerability in public lakes. IFD, in cooperation with the UConn Department of Natural Resources and the Environment, has embarked on a multi-faceted research project to investigate the potential for angling-induced evolution in Connecticut largemouth bass populations, and to assess the potential for remediation of undesirable evolutionary change via re-introduction of desirable genes from unexploited reservoir bass populations.

Eagleville Brook: stormwater reductions and water quality monitoring

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Stormwater Management and Infiltration

Eagleville Brook is an impaired stream that drains part of the UConn campus. Many green infrastructure (GI) practices have been installed on campus with the goal of reducing stormwater discharges to the brook. A unique tracking system using real precipitation data was developed to quantify the reductions in stormwater volume due to GI implementation on campus. Water quantity and quality measurements have also been taken downstream of campus: specific conductance and temperature have been measured continuously since 2011, and weekly grab sampling for copper, chloride, and suspended sediment occurred from 2012-2013. To date, more than 39,000,000 gallons of stormwater have been

treated by the GI practices on campus. Suspended sediment concentrations were low (mean 11.1 mg/L), but chloride concentrations were high (mean 514.3 mg/L). Copper concentrations were moderately high as well (18.1 mg/L). Chronic aquatic life criteria were exceeded on 80% and 95% of samples for chloride and copper, respectively.

Emerald Ash Borer and Potential Municipal Responses: Tools for Tree Managers
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Invasive Species
In July of 2012, the invasive, exotic insect, the emerald ash borer was found for the first time in Connecticut. Within a year, the number of municipalities known to have EAB had climbed to 15. White and green ash are important street trees throughout the state, although the percentage of trees that are ash in any community averages around 3%. Nonetheless, as the insect spreads, this could require a community to remove, in a narrow time frame, hundreds of trees more than it may have otherwise planned to remove. Tools both to help community understand the spread of EAB and also control the costs associated with its presence do exist. These include the iTree tools, that allow the user to quantify the environmental and economic benefits that would be lost to a community through the loss of ash trees, and the Emerald Ash Borer Cost Calculator, which allows the user to compare the costs and effectiveness of various EAB management strategies. This talk will explore these tools along with providing suggestions for municipalities to consider in connection with managing EAB.

Warming and phenology effects on invasive plant success in forest understories
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Oral
Invasive Species
Invasive exotic species (IES) pose a serious threat to ecosystem structure and function worldwide, but the causes for IES success in introduced environments are often unclear. In temperate forests of eastern North America, the ability of IES to colonize understories is notable given the intense competition for light and other resources. In these ecosystems, one of several widely cited mechanisms facilitating invasion is an extended duration of annual photosynthetic activity in IES foliage, due to early leaf flush in the spring and/or delayed autumnal senescence. In many cases, IES appear to exploit a broader niche than most native species (NS), where the niche can be defined as integrated photon flux during conditions that are favorable for photosynthesis. However, the amount of “extra” light harvested by IES foliage is determined in large part by overstory canopy phenology, which varies considerably among deciduous tree species. This aligns with recent research indicating that deciduous forests canopies with late leaf flush and comparatively short leaf duration are, on average, more extensively colonized by IES. In the same vein, given the sensitivity of plant phenology to variation in climate, and the inevitability of further climate warming, pronounced phenological responses to future climate change will likely have important implications for the susceptibility of temperate forest understories to IES. To help elucidate the possible roles of altered resource availability in IES vs. NS responses to overstory and climate, a set

of common gardens have been established in the UConn Forest. In subsequent years, comparative understory growth and ecophysiology of several IES and NS in four phenology treatments (early leaf expansion, late leaf abscission, both, or ambient phenology) and two climate warming scenarios (ambient temperature and ambient + 1.5oC) will be assessed. Previous findings and current hypotheses will be discussed.

Fine-Scale Selection of Early Successional Habitat by Mesopredators

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Oral

Fish and Wildlife Management

The New England cottontail (NEC) Slyvilagus transitionalis, is a focal species of wildlife management having been designated a candidate for listing as an endangered species by the U.S. Fish and Wildlife Service. NEC are highly reliant on early-successional, 'thicket' habitats which are thought to serve as refuge from predation. Early-successional habitat has disappeared rapidly due to development and reforestation, making habitat restoration the primary conservation action for NEC. The success of thickets as refuge may be determined by mesopredator communities surrounding patches. Predation could affect NEC abundance within managed units, and population connectivity between units if mesopredators utilize early successional patches and patch edges. We used remote cameras to assess mesopredator habitat selection in and around early successional patches at Kollar Wildlife Management Area in Tolland, CT. Species of interest were Red Fox (Vulpes vulpes), Bobcat (Lynx rufus), Coyote (Canis latrans), and Fisher (Martes pennanti). Cameras were distributed along game trails in a systematic grid to sample a representative range of habitats. Detections were measured for six months from September 2013 to March 2014, including the fall and winter seasons and the pheasant and deer hunting seasons. We used a mixed-effects Poisson regression to quantify the relationship between frequency of mesopredator detection with proximity to early-successional patches, proximity to roads, forest type, frequency of hunters, and season. Preliminary results indicate that Canid species utilized areas closer to early successional patches, whereas Fisher selected for coniferous forest cover. We did not find a significant relationship between frequency of hunters and detection of any mesopredator species. These results suggest that potential predators of NEC utilize early-successional patches, emphasizing the need to account for community composition on NEC population recovery. This finding indicates the need to consider landscape context in selection of areas for targeted habitat restoration, as fragmented and diverse landscapes can create more abundant mesopredator communities.

The Battle for Candlewood Lake:Can the Invaders be Stopped?

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Oral

Invasive Species

Candlewood Lake is Connecticut's largest lake. It offers excellent recreational opportunities and produces hydroelectric power. Candlewood Lake's Rocky River generating station pumps water into the lake from the Housatonic River during periods of low electricity demand and then releases it when

electricity demand is high. This “pump-storage” process offers the advantage of allowing the water level of Candlewood Lake to be lowered for weed control and the disadvantage of potential transfer of invasive species from the Housatonic River. In the 1980’s the non-native invasive plant Eurasian watermilfoil (Myriophyllum spicatum) became a problem in Candlewood Lake and control was needed. By lowering the lake during the winter months to expose the milfoil to freezing and desiccation varying degrees of control have been achieved. These drawdowns alternate between shallow (1 m) and deep (3 m) on a yearly basis. Beginning in 2007, The Connecticut Agricultural Experiment Station’s (CAES) Invasive Aquatic Plant Program began annual invasive aquatic plant surveys of Candlewood Lake, Lake Lillinonah and Lake Zoar. The latter two lakes are impoundments of the Housatonic River and thus contain invasive species that are threats to Candlewood Lake. The CAES surveys find the invasive plants, Eurasian watermilfoil, curlyleaf pondweed (Potamogeton crispus) and minor naiad (Najas minor) in all the lakes as well as water chestnut (Trapa natans) in Lake Lillinonah and European waterclover (Marsilea quadrifolia) in Lake Zoar. Eurasian watermilfoil is the most severe problem in all lakes. Deep drawdowns on Candlewood Lake reduce Eurasian watermilfoil coverage and abundance but regrowth after the following year’s shallow drawdown result in little long term control. Other Eurasian watermilfoil control options that have been tested or proposed are harvesting, milfoil weevils, herbicides, and grass carp. This presentation will detail the results of the CAES surveys and examine control options.Connecticut

Managing Recreational Fisheries in the Catch-and-Release Era

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Fish and Wildlife Management

Recreational fisheries are increasingly dominated by catch-and-release (CR) practices. Recent research indicates that when fishing pressure is high, CR-related mortality may comprise a large portion of overall fishing-related mortalities. Mortality from CR is a challenge to managers because it is unlikely to be altered by actions such as changing length or creel limits. We conducted a population survey in 2012 and 2013 of three popular Connecticut lakes featuring a recreational fishery for Largemouth bass Micropterus salmoides. Assessments included population estimates, creel surveys, and tournament monitoring to characterize the contribution of CR to overall annual mortality vs. purposeful harvest and natural mortality. We simulated the outcomes of management actions such as length limits, decreased and increased fishing pressure and a range of CR mortality rates on population size and age structure. Tournament monitoring and creel surveys indicated that the total number of catch events was up to 3.5 times higher than the estimated population size, indicating that most individuals are captured more than once. However, overall harvest rates for all studied lakes were low (< 1%). As a result, CR mortality accounted for the majority of fishing related mortalities. Given observed catch-to-population size ratios and low harvest rates, our model did not predict that length limits would significantly affect size or age structure. Further, given observed levels of angling, relatively low levels (~5%) of CR mortality can cause a significant depression in age and size structure. Consequentially, in populations characterized by high angling effort, low harvest, and high CR rates, management actions other than length based harvest limits must be considered if size and age structure are not satisfactory. Additionally, the management of

populations in the CR era would benefit from improved precision in the estimation of population size, and angler catch rates.

Photochemical Reactive Species Formation Above and Below Riverine Wastewater Tre

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Oral

Water Quality and Conservation

Treated wastewater effluent organic matter (EfOM) is an important component of the dissolved organic matter (DOM) pool in receiving waters below wastewater treatment plant (WWTP) discharges. EfOM's composition differs from natural OM and its presence may alter the generation of photochemical reactive species in rivers that receive large contributions of municipal wastewater. Quantum yields of triplet-state dissolved OM (3DOM*) and singlet oxygen (1O2) formation were measured for both whole water samples and DOM isolates from above and below WWTP discharges in three rivers receiving varied effluent contributions: Hockanum R., CT (22 % effluent flow), E. Fork Little Miami R., OH - (11 %), and Pomperaug R., CT - (6 %). The presence of EfOM in whole water samples resulted in only small differences in the photochemical production of these reactive intermediates, relative to whole water samples from above the WWTPs. Isolated EfOM showed higher quantum yields than for corresponding natural organic matter isolates. All isolated organic materials had 3DOM* and 1O2 quantum yields that were correlated with E2/E3 absorbance ratios following trends for reference DOM isolates. Seasonal variations in quantum yields between DOM isolates from 2012 and 2013 were only observed for one river. These findings indicate that, while the extractable DOM from wastewater effluent and natural river waters differ with respect to 3DOM* and 1O2 quantum yields, whole water effluent contributions to rivers do not alter photochemical yields of these species.

The impact of effluent and stormwater on metal lability and bioavailability

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Urban Environmental Issues

This work examined differences in metal and organic matter size and characteristics from effluent, storm runoff and upstream samples from several representative systems. Both WWTP effluents and stormwater runoff contributed high concentrations of DOC (10-30 mg/L) to streams, relative to the 5 mg/L background. The organic matters (OM) in effluents were less aromatic, more microbial-derived and more protein-like than those in storm runoffs. Metal distribution results in different source waters showed great variation. Generally, most Cu and Zn were found in colloidal and truly dissolved phases, especially in effluents, while Fe and Pb were dominant in the particulate fraction. The asymmetric flow field flow fractionation (AF4) results showed the majority of colloidal associated metals were found in the 0.5-3 nm range for both upstream and effluent samples except Fe which had a large size distribution (3-80 nm) in most upstream samples. Moreover, the metal colloidal size distribution in runoff gradually changed during a storm event and a larger size distribution appeared. In terms of stream conditions, metal concentrations were elevated during baseflow (about 2-5 times higher) at all

sites downstream from the WWTP. The labile and bioavailable metal measured by diffusive gradient in thin-film technique (DGT) and periphyton samples in streams increased approximately 50%, and 300%, respectively downstream of the effluent release. Labile metals represented 30 to 70% of total dissolved metal concentrations, and that percentage always decreased in the days following a storm. On the contrary, the metal concentrations in periphyton samples covaried with metal concentrations in streams during storm events, suggesting metal exchange between periphyton and streamwater is a fast process and periphyton is good indicator of biovailability. This study provides a better understanding of metal speciation and lability in urban streams as a guide to improve metal loading regulations.

Early Detection-Rapid Response: Draft Protocol For Aquatic Invasive Species Resp

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Invasive Species

Aquatic invasive species (AIS) pose a significant environmental and economic threat to the ecosystems and communities in Connecticut and beyond. While preventing invasive species introductions from occurring is the top priority, managers must be prepared to take action when prevention measures fail. The Connecticut Department of Energy and Environmental Protection (DEEP) and Connecticut Sea Grant (CTSG) collaborated with the Connecticut Aquatic Nuisance Species Workgroup and the Connecticut Institute of Water Resources to develop a draft protocol for responding to new reports of AIS. Modeled after a template developed by the Mid-Atlantic Panel on Aquatic Invasive Species, the protocol is based on the Incident Command System, a standardized, on-scene, all-hazards incident management approach that integrates facilities, equipment, personnel, procedures and communications within a common organizational structure, and facilitates a coordinated response among the various jurisdictions and public / private agencies involved. Once adopted and implemented, this protocol will guide institutional response to newly-reported AIS incidents quickly and effectively. Major components of the plan include 1) an overview of the Early Detection and Rapid Response Framework; 2) the Operational Planning “P”; 3) Rapid Response considerations; and 4) an AIS Sighting Report Form. Components of the EDRR protocol using a hypothetical case study, and the resource needs to facilitate the implementation of the rapid response part of EDRR, will be highlighted.

Effect of Silt Input on Larval Wood Frog Growth and Development

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Oral

Fish and Wildlife Management

Urban development and agricultural activity increase sediment input and water turbidity in aquatic systems. These water quality changes are known to affect fish and invertebrate communities but effects on amphibians are poorly understood. We manipulated silt addition and predator presence in cattle tank mesocosms to determine if water turbidity or the interaction between turbidity and predator presence affect survival, growth, or development of larval Wood Frogs. We found no effect of silt

addition or predator presence on survival. Addition of a large amount of silt during the early larval period resulted in earlier metamorphosis ($F_{1,30} = 5.111$, $p = 0.031$) at a larger size ($F_{1,30} = 36.244$, $p < 0.001$). Non-lethal predator presence did not affect either mass at or time to metamorphosis. Results suggest that suspended sediment is not directly harmful to Wood Frogs and may potentially serve as an additional food resource. Although silt is not directly harmful to Wood Frogs, urban and agricultural runoff typically contains other pollutants in addition to sediment which are potentially harmful to amphibians. Manipulating turbidity in mesocosms has advantages over studying turbidity in natural systems because treatments can controlled and replicated sufficiently, however selecting the most appropriate method to induce turbidity deserves special consideration. Future research should investigate the relationship between sediment organic content and tadpole growth and survival and the interaction between water turbidity and other wetland stressors.

A Statewide Survey for the Presence of Ranavirus in Connecticut Wetlands

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Oral

Threats/Ecosystem Health

Ranaviruses cause 40 to 60% of reported local amphibian die-offs in the United States. However, the spatial distribution and frequency of these events are not well understood. Following an amphibian die-off reported by a private citizen in CT that was later confirmed as ranavirus-driven in 2010, as well as anecdotal reports of mass mortality events in northeastern CT, we sought to determine threats posed to local amphibian populations due to ranavirus in CT. We sampled larval wood frogs (Lithobates sylvatica) and where possible green frogs (Lithobates clamitans) from 8 wetlands in northeastern CT in 2012, and 35 wetlands distributed throughout the state in 2013 to document additional mass-mortality events due to ranaviruses, and to assess prevalence of ranavirus statewide. We sent 10 tadpoles from sampled wetlands to the Amphibian Disease Diagnostic Laboratory at Washington State University to test for the presence or absence of ranavirus using qPCR. We detected ranavirus in all wetlands sampled in 2012, and 24 of 28 wetlands submitted for testing in 2013. We observed suspected mortality events in one wetland in 2012, and a different wetland in 2013. Prevalence rates within wetlands varied from 10-100%. We provide evidence of widespread presence of ranavirus in small wetlands throughout Connecticut, suggesting that the pathogen persists at apparently sub-lethal levels, or die-off events are not being detected. Further research would benefit from incorporating multiple sampling events within seasons, the study of local population dynamics with the pathogen present, and the potential impacts of ranavirus relating to metapopulation dynamics.

Fish assemblage response to a small dam removal in the Eightmile River System

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Oral

Fish and Wildlife Management

We examined the effects of the Zemko Dam removal on the Eightmile River system in Salem, Connecticut, USA to gain insights about how small New England streams respond to sudden hydrological

change. The objective of this research was to quantify spatiotemporal variation in fish community composition in response to small dam removal. We sampled fish abundance over a six-year period (2005-2010) to quantify changes in fish assemblages prior to dam removal, during drawdown, and for three years following dam removal. Fish population dynamics were examined above the dam, below the dam, and at two reference sites using indicator species analysis, mixed models, non-metric multidimensional scaling, and analysis of similarity. We observed significant shifts in fish relative abundance over time after dam removal. Changes in fish community composition were variable and they occurred within one year of drawdown. A complete shift from lentic to lotic fish specialists failed to occur within three years after the dam was removed. However, we did observe increases in fluvial and transition (i.e. pool head, pool tail, or run) specialist fishes both upstream and downstream from the former dam site. Our results demonstrate the importance of dam removal for restoring river connectivity for fish movement. While the long-term effects of dam removal remain uncertain, we conclude that dam removals can have positive benefits on fish assemblages by enhancing river connectivity and fluvial habitat availability.

Landscape correlates of extirpation in Bridle Shiner (Notropis bifrenatus)

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Oral

Fish and Wildlife Management

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Bridle shiner (Notropis bifrenatus) is apparently declining over most of its range and is currently listed as a species of concern in Connecticut. Recent research indicates the apparent decline of bridle shiner in this state is in part due to changes in sampling gear used for statewide surveys. Seining used 50 years ago is demonstrably more effective at capturing bridle shiner than the currently favored and more frequently used electrofishing gear. The present study is a reevaluation of the distribution of this species in light of this recent finding. We seined at all known historic sites in Connecticut and found some populations once thought to be extirpated are extant, but an overall alarming range reduction is evident where the number of site occurrences has declined 60% over 50 years. Using a GIS approach we identified site- and landscape-scale habitat measures and land use changes that are most predictive of extirpation, which will provide needed context on declines in this species and potential avenues for conservation actions.

Sturgeon in CT waters

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Fish and Wildlife Management

A natal population of shortnose sturgeon and non-natal Atlantic sturgeon were found to co-occur in the

lower estuarine portion of the Connecticut River on a seasonal basis. Shortnose sturgeon typically move to the lower river (rkm 0 - 12) during the Spring freshet in April and May which displaces the salt wedge from the river out into Long Island Sound. Shortnose sturgeon reside in this area for 60 to 90 days before slowly moving northward to utilize other upriver areas. This northward movement can coincide with return of salt water into the river but shortnose sturgeon routinely experience 0 to 10 ppt and up to 25 ppt while in this area. Immigration of non-natal Atlantic sturgeon typically takes place during this same time period (June July) of increasing salinities but Atlantic sturgeon have moved into the area and co-occur with shortnose sturgeon as early as April. Atlantic sturgeon remain in the river through September in most years but some have been known to linger until October or November when some shortnose sturgeon move back into this estuarine area. Telemetry observations of tagged fish and collections of both species in single gill nets and trawl hauls indicate both species are sharing selected habitats and not that one species displaces the other. Both species are selecting for the deeper areas within the lower 15 kilometers of river, although there is foraging at shallower depths. Upriver movements and residence of Atlantic sturgeon to river kilometer 89, well above the salt wedge, have been documented.

Living Shorelines: Implementation Strategies and Case Studies

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Oral

LIS and Coastal Connecticut

Living Shorelines are created or enhanced wetland systems that serve as a shoreline management practice that provides: erosion control benefits; protects, restores or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural organic materials (e.g., biologs, oyster reefs, etc.). They have been increasingly utilized as a natural alternative to shoreline hardening practices, and incorporated into coastal engineering designs to address more frequent and severe coastal storms. Shorelines have been traditionally stabilized with hardened structures, such as bulkheads and concrete seawalls. Ironically, these structures often increase the rate of coastal erosion, remove the ability of the shoreline to carry out natural processes, and provide little habitat for estuarine species. This presentation describes various implementation options, their relative complexity and cost implications. It also reviews conventional shoreline stabilization strategies as a comparison. The presentation describes the guiding principles for design considerations and treatment selection processes to successfully implement Living Shorelines. It also provides details regarding specific planting strategies, slope modifications, erosion control fabrics, and bioengineering materials including live stakes, fascines, and wattles. Also covered is the need for providing site controls, and follow-up monitoring and maintenance to ensure project success. The presentation provides the practices and strategies for living shoreline design and implementation, and provides various Long Island Sound Living Shorelines case studies that demonstrate the viability of the practice. Case studies examine project successes, as well as damages from coastal storms, remedial actions and strategic responses to ensure practice longevity.

Managing Human Health Risk through a Comprehensive Air Monitoring Plan at a Form

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Oral

Managing Human and Ecological Risk at Contamination Sites

Monitoring for potential emissions from an MGP remediation site is implemented to reduce or prevent a potential inhalation pathway for VOCs such as benzene, toluene, ethylbenzene, and xylenes; and contaminated particulates acting as a conduit PAHs and heavy metals. This risk management case study presents a USEPA-approved air monitoring program implemented to manage human health risks at a former MGP site located in the southeast U.S. Risk-based Acceptable Air Concentrations (AACs) were developed and a sampling regime established to monitor potential emissions to maintain contaminant concentrations below the AACs. The AAC for benzene was based on carcinogenic effects using the current IUR from the USEPA's IRIS database. The AACs for toluene, ethyl benzene, and xylenes were based on non-carcinogenic effects using the current inhalation reference concentration (RfC) from the IRIS database. The AACs for the carcinogenic PAHs were based on carcinogenic effects using the current IUR from California EPA. The AAC for respirable particulate matter (PM10) was the National Ambient Air Quality Standard (NAAQS) for PM10 and was used as a surrogate for both PAHs and heavy metals. Site-specific AACs were calculated using target cancer risk (TR) value of 1X10-4 for carcinogens and a target hazard quotient (THQ) of 1 for non-carcinogens. The exposure duration used was based on a twelve-month project duration and an exposure time of 24-hours per day; equations, toxicity values and sources were based on USEPA's Regional Screening Levels website (2009). A total 535 twenty-four hour time weighted samples (269 VOC samples and 266 PAH samples) were collected over the project duration. Only minor levels of VOCs and PAHs were detected and no results were above the AACs. These time-weighted averages demonstrate that the real-time air monitoring and control measures implemented at the Site effectively maintained concentrations below the AACs and were protective of human health.

Forest Health and Conservation in the Hands of Connecticut Families

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Oral

Threats/Ecosystem Health

Half of Connecticut's forestland is owned by families and individuals – and these are the lands most at risk of fragmentation, poor management, neglect, and being overrun with invasive plants and insects. Results from landowner focus groups and a survey conducted in 2010 and 2011 show that most have done very little management or stewardship planning on their land, seek no professional advice, and are ill-informed about how to manage for forest health. Almost a third, who own about 300,000 acres of forest, say they would sell their land if the price was right. Together, these factors could be interpreted as a significant threat to Connecticut's forests, particularly as disturbances such as invasive plants, insects, and wind storms become more frequent and forest health deteriorates on unmanaged land. On the positive side, over 80% have a strong conservation ethic - they want to do the right thing by their land. The vast majority own their land primarily for lifestyle values, followed by conservation values.

Awareness of available landowner assistance programs for things like wildlife habitat improvement and riparian buffer protection is very low, and may not meet the needs of landowners who don't have much time or resources to invest. State and federal policies and well-publicized programs that are designed to enhance conservation and lifestyle values that the landowners care about (such as wildlife and recreation) could achieve the dual goals of meeting landowner needs and reducing threats to forest health at the landscape scale.

Loss of anadromous migration results in reduced swimming performance and poor se

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Oral

LIS and Coastal Connecticut

Examining populations in which differential habitat use is correlated with functional trait divergence can yield insights into the processes of adaptive evolution. In coastal Connecticut, migratory anadromous Alewives (Alosa pseudoharengus) repeatedly gave rise to landlocked (freshwater only) populations that do not migrate. Our previous work indicates that landlocked and anadromous Alewives are physiologically diverged with respect to salinity tolerance, osmoregulatory function, and gill ion exchange. In addition, work by Jones et al (2013, Evolutionary Ecology) has shown that landlocked and anadromous Alewives differ in body shape; landlocked forms are more streamlined and fusiform, a shape that should reduce friction and improve sustained swimming ability. The consequences of divergence in osmoregulatory function and body shape on whole organism performance among Alewives are unclear. To address this issue, we measured sustained swimming speed and growth of an anadromous and two independently derived landlocked Alewife populations. We predicted that, relative to anadromous Alewives, landlocked Alewives would: 1) swim and grow better in freshwater due to their streamlined shape and adaptation to year-round freshwater; and 2) swim and grow less well in seawater due to differences in osmoregulatory function and ion exchange. Despite being more streamlined, we show that landlocked Alewives have reduced swimming performance in both salinities. In agreement with our predictions, we found that landlocked Alewives grow little or not at all in seawater, whereas anadromous Alewives grow rapidly. Reduced growth among landlocked Alewives is correlated with a near cessation of feeding, may be do to reductions in the drive or the capacity to feed. Loss of the migration among anadromous fishes, therefore, appears to lead to substantial reductions in whole organism performance in freshwater and seawater. These results suggest that landlocked fish have evolved a lower intrinsic growth rate, perhaps as an adaptation to less productive freshwater environments.

CONNECTICUT'S Lidar (Elevation) Data and CT ECO

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Oral

GIS Applications in Natural Resources

In case you haven't noticed, 3-D is "in" these days, and not just at the movies. One of latest trends in mapping is 2-D and 3-D map layers generated from Lidar data, a detection system that uses light from a

laser on an airplane to collect very accurate and dense elevation values. This data has many different applications including flood mapping, determining watershed boundaries and shorelines, seeing rugged and remote terrain and managing natural resources among others.

Connecticut is (partially) covered by a patchwork of nine Lidar datasets captured at different times by different companies with different specs. Those data sets are now available on the Connecticut Environmental Conditions Online (CT ECO) website (http://cteco.uconn.edu). This talk will highlight what is available, how to access, and what Lidar-based services will be available soon, including elevation, hillshade, slope and aspect. These data are being created using Esri's mosaic dataset capabilities with ArcGIS Server to create a seamless map service for use in map viewers, ArcGIS Online and in GIS software.

CT ECO is a website that was designed to provide access to the most up-to-date natural resource information available. It is a partnership between the University of Connecticut Center for Land Use Education and Research (CLEAR) and the Connecticut Department of Energy and Environmental Protection (CT DEEP).

Lobsters and mosquitocides: restricting methoprene and resmethrin in CT

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Oral

LIS and Coastal Connecticut

In 1998 and 1999, the lobster population in Long Island Sound saw a catastrophic decline. Research concluded that increased temperature, hypoxia and the presence of a paramoeba likely weakened the population making them susceptible to disease and mortality. The mosquito control pesticides malathion, resmethrin and methoprene, used to combat West Nile virus in early September of 1999, were alleged to have significantly contributed to the die off although the data did not support this. To compound this, Tropical Storm Floyd produced gale force winds and heavy rainfall in mid-September, causing turnover and further contributing to poor water quality conditions. Many in the lobster industry and anti-pesticide activists attributed the lobster die off to mosquito control efforts, despite the chronology of events and lack of scientific evidence. Since then the lobster stocks in LIS have not rebounded. In 2011, the CT DEEP and the UConn tested lobsters from western LIS and purportedly detected methoprene and resmethrin in organ tissue. However, the results and sampling protocol were disputable with regard to the methodology used. Still convinced that pesticides were the primary cause of the crash, lobstermen were successful in lobbying the CT legislature to pass PA13-197 which restricts the use of methoprene and resmethrin in the CT coastal zone and mandates additional conditions. Additional testing in 2013 of lobsters from LIS, MA and ME produced inconclusive results and suggested that detection protocols were not specific enough for these pesticides. Using new protocols and more specific analytical methods, further testing of LIS lobsters will continue in 2014 to look at possible impacts from water quality stressors as well as methoprene and several common synthetic pyrethroid pesticides.

Dormancy Response Patterns in Deciduous Forest Communities of New England

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Oral

Extreme Weather and Climate Change

Observed phenological changes in recent decades across temperate forest regions, such as earlier leafing in the spring out or later leaf senescence in the fall, provide a dramatic indication of biological response to climate change. While mechanisms of spring phenology (bud burst, leafing out, and flowering) has been well studied and have been integrated into predictive models of future responses to climate change, it is still unclear how fall phenology in plants (leaf senescence and dormancy) responds to environmental variation. Although delayed leaf coloration and abscission in deciduous forest trees have been observed in Europe and North America in recent decades, the role of different environmental triggers and how the interact in different species to produce observed fall phenological patterns remains unknown. There is a long list of environmental changes or stressors during growing season that may affect phenological change in fall. Using remotely sensed phenology data, this study reveals multiple significant effects from temperature, precipitation, and other weather stressors on the timing of dormancy of deciduous forests communities in New England during 2001 and 2010. The inter-annual timing of dormancy responds not only to decreasing temperature in fall, but also to precipitation, drought, frost, heat and other extreme weather event during the growing season. Moreover, interactions among these variables also contribute to fall phenological timing. Deciduous forests in northeastern highlands dominated by maples and birches have higher sensitivity to weather condition changes than forests in coastal area dominated by oaks. These regions also showed different responses to precipitation in summer and fall. This study helps with a mechanistic understanding of fall phenological responses in temperate forest communities to variation in weather patterns as well as a way to build predictive models of future responses to climate change.

Influence of nitrogen and silicon on Spartina alterniflora and its possible role

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Oral

LIS and Coastal Connecticut

The disappearance of smooth cordgrass (Spartina alterniflora) along intertidal creeks in salt marshes of Connecticut is referred to as Sudden Vegetation Dieback (SVD). The cause(s) of SVD remain(s) unclear. However, the influence of plant pathogens in the genus Fusarium and herbivorous marsh crabs, Sesarma reticulatum, have been strongly associated with dieback sites. The role of plant nutrition in these estuaries has not been examined with respect to SVD. Poor nutrition may predispose plants to be more susceptible to disease and herbivory. Silicon is one nutrient that has been implicated in plant health. Recent evidence suggests that Si levels in estuaries are heavily influenced by urbanization and damming of rivers. Our objectives were to determine if N and Si applied alone and in combination to S. alterniflora would affect disease severity by the Fusarium pathogens and/or susceptibility to herbivory by the marsh crab. Transplants of S. alterniflora were grown in the greenhouse and exposed to low or high levels of N combined with and without Si applied as a Silica slag. Half of the plants in each of the

four treatments were inoculated with Fusarium. After three months, plants were rated for disease. Plants were washed, weighed and then paired with their respective control plants and placed in mecocosms with one adult marsh crab. Plants were monitored for one week for active consumption then reweighed to determine percent loss due to herbivory. Application of Si made plants less susceptible to disease and herbivory, but only when fertilized at the high N rate. Management of estuary health may require a re-examination of dissolved silica levels.

POSTERS (alphabetical by first author)

Triclosan-- an Emerging Contaminant in Thames River Effluent

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Water Quality and Conservation

Emerging contaminants in surface waters and effluent from wastewater treatment plants have been a growing concern among scientists and environmental policy experts for more than a decade. More and more evidence is mounting of the potentially harmful effects of these unregulated residues of pharmaceuticals, personal care and cleaning products on wildlife and humans. To add to the understanding of how widespread these chemicals are in the environment, samples were collected in August 2013 from two locations in the Thames River, a tidal estuary of Long Island Sound, and the fully treated effluent from four wastewater plants that empty into the river. The samples were tested for 11 emerging contaminants using ultra-high performance liquid chromatography-mass spectrometry in the Center for Environmental Sciences & Engineering at the University of Connecticut. The contaminants included nine over-the-counter and prescription medications, plus caffeine and triclosan, an antimicrobial used in antibacterial hand soap, some toothpastes, dish detergents and a wide variety of other consumer products. No detectable quantities of any of the 11 compounds were found in the river samples. Three of the four effluent samples, however, had levels of triclosan ranging from 493 nanograms per liter to 102 nanograms per liter. One of the samples also contained 3,100 nanograms per liter of ibuprofen and 566 nanograms per liter of gemfibrozil, a blood pressure regulator. After the sampling and testing aspect of the project, research and interviews focused on the high frequency that triclosan and its close cousin, triclocarban, have been found both in surface waters, effluent and sediments. Research on the health effects of these compounds was also reviewed. Action in December 2013 by the Food and Drug Administration towards stricter controls on the use of triclosan and triclocarban responds to a growing chorus of scientists, environmental policy advocates and officials in the state of Minnesota calling for a ban on its use in consumer products. This project adds to momentum building for the FDA to take the first regulatory actions on the emerging contaminants issue by curtailing or banning triclosan and triclocarban from all non-medical uses.

Trophic Cascade Effects of Deer Overabundance on the Northeast

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Poster

Fish and Wildlife Management

Trophic cascade theory is described as the destabilization of one trophic level resulting in the direct and/or indirect disruption of others. One of the most notable impacts on trophic cascades is the top-down effects of apex predators, which can result in increased herbivore abundance and herbivory impacts. The reduction of grass and shrub layers can diminish small mammal habitat, thus reducing populations. Conversely when an apex predator is reintroduced, herbivore populations often decrease, reducing consumption of the shrub layer, resulting in an increase in small mammal populations. However, results indicate that disturbed portions of Northeast ecosystems harbor invasive plant species, which disrupt the trophic cascade. White-tailed deer have become overabundant in Connecticut. Species such as Japanese barberry are flourishing due to the lack of competition with overbrowsed native species. This study attempted to determine the effects of invasives on trophic cascades by determining small mammal population sizes and survival rates. White-footed mice were trapped in three different locations. At each location, three plots were established; an unmanipulated intact barberry stand, an area where barberry was minimal or absent, and an area where barberry was managed. Trapping occurred from May to August, 2007-2013. In program MARK, population size and survival rates were estimated using POPAN and Cormack Jolly-Seber models, respectively. No significant differences were detected between the three plots at any of the three locations. Therefore, the cascade occurring in the Northeast ecosystem was impeded and had no effect on the small mammal trophic level. This study concluded that there is a distinctive trophic cascade, which could assist in wildlife management development.

Tuning an activated carbon nanofiber membrane material for specific sorption

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Poster

Water Quality and Conservation

Sorption is a proven and reliable technology, but existing materials, e.g. granular activated carbon (GAC) are not well suited to remove low level contaminants from high background conditions of organic matter or cations. Our novel sorbent, activated carbon nanofiber nonwoven (ACNFN), takes advantage of nanoscale fabrication to reduce mass transfer limitations while functionalizing the surface through chemical means enhances the specificity of the sorption interaction. Mass transfer limitations were observed to decrease as the kinetic rate constant (μg g-1 h-1) for sorption of pyrene on ACNFN was up to 10-fold higher than that of GAC. In addition, the equilibrium capacity was at least double that of GAC. In our efforts to find more effective ways of functionalizing ACNFN, we have focuses on novel reactions that limit material degradation. We have added carboxylic acid groups on powdered activated carbon (PAC) with either traditional HNO3 surface oxidation or osmylation reactions. Osmylation is a novel pathway, less aggressive than HNO3, and results in a dicarboxylic acid that may enhance metal binding stability. Subsequently, ethylenediamine (EDA) was attached using coupling agents familiar to protein

chemistry, which can form much stronger ligand interactions with metals. Both pathways generated the same diagnostic □C=O in the 1600-1700 cm-1 IR spectra range that indicates carboxylic acid functionality. However, later experiments that applied the two pathways to ACNFN showed that while HNO3 destroyed the nanofiber structure, the osmylation pathway kept the inherent structure of the nonwoven. In addition, after EDA modification, the IR spectrum showed a shift to the right from AC with carboxyl group, titrations showed increased basic functionality indicative of EDA attachment, and the overall sorption capacity for Ni was much higher than the unmodified AC. The results show promise that target functional groups can be added to the surface of activated carbons via this novel mechanism.

Organic Cation Structure: Effects on Adsorption to Montmorillonite

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Poster

Water Quality and Conservation

An increase in human and veterinary pharmaceutical use has lead to the release of positively charged organic compounds into the environmental systems. An organic cation contains a positively charged amine group that adsorbs to negative charges on alumino-silicates through cation exchange. A set of compounds was chosen to evaluate how organic cation structural differences affect sorption to montmorillonite. These differences included size, order of the amine group, and the presence of electron donating or withdrawing groups. Experimental sorption coefficients generally increased with increased molecular volume and the more focused amine charge of higher order amines. An increase in affinity towards the surface was observed as compound concentration on montmorillonite increased and was attributed to cation-π compound-to-compound interactions. The influence of exchange ion species on adsorption was also assessed by comparing both calcium- and sodium-saturated montmorillonite.

Northern Long-eared Bats Endangered? Implications for Natural Resource Managers

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Poster

Fish and Wildlife Management

The northern long-eared bat (Myotis septentrionalis), once common in Connecticut and the northeast, has suffered steep population declines due to the nascent and fatal fungal infection known as white-nose syndrome (WNS). In October 2013 the US Fish and Wildlife Service issued a proposed rule, based on a 12-month petition review, to list the northern long-eared bat as endangered under the US Endangered Species Act. A final rule is expected in October 2014. What this potential listing will mean to natural resource managers is a matter of active discussion in the community of bat biologists. The potential listing of the northern long-eared bat as an endangered species has implications for forestry practices, wind energy development, habitat management and protection, as well as nuisance wildlife control practices.

The Rise of Connecticut River Academy

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Poster

Turning Brown Fields Into Green Fields

Poster will display photos with brief explanations showing the conversion, over time, of a former oil terminal on the banks of the Connecticut River into into the Connecticut River Academy magnet high school which opened January 7, 2014.

Iron oxide – organic matter copreciptates and controls on copper availability

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Poster

Stormwater Management and Infiltration

Copper is considered a high-profile pollutant in aquatic environments causing acute and chronic toxicity at very low levels. However, copper is also a vital element for living organisms and some biological processes. The mobility, behavior, and availability of trace metals are considerably influenced by processes like coprecipitation and adsorption. Copper availability in aquatic systems is controlled by strong interactions with organic matter (OM) and highly sorptive mineral precipitates, such as iron oxides. Cu can precipitate within the structure of ferrihydrite, which often forms in the presence of OM, and produce Fe-OM-Cu coprecipitate, Cu bound to the surface of iron oxides, or Cu chelated by coprecipitated OM. The purpose of this research is to examine copper sorption and availability by using bench scale experiments to mimic more complex geochemical systems involving iron oxide precipitates and organic matter. In this study, copper and iron oxide-OM coprecipitation solids were prepared by varying the ratio of Fe:OM from 1:0 to 1:10 with a fixed Cu concentration of 1 mg/L Cu, background of 10 mM NaNO3, and a pH range of 4 to 7. Precipitate mass and Cu sorption per mass were calculated based on a mass balance. We found that as the ratio of Fe:OM decreased, less coprecipitation of Cu occurred per gram of material; while increasing pH showed an increase of coprecipitated Cu for all Fe:OM ratios. Additional samples were prepared with Cu added after precipitation to compare the in-situ conditions to conditions typically studied in laboratories. Preliminary results have shown that iron oxide-OM coprecipitates exposed to Cu after precipitation produce an increase in coprecipitated material when compared to those formed in the presence of Cu. Future experiments will focus on distinguishing the form of Cu in the solid phase, i.e. within the oxide structure, sorbed to the surface, or chelated by OM.

Business Planning for New England Cottontail Recovery, a Parcel-by-Parcel Analysis

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Poster

Fish and Wildlife Management

The term “Business Plan” may seem incongruous with natural resource management, but this is the model used to plan and implement New England cottontail (NEC) recovery. The US Fish & Wildlife

Service will make the decision whether to list this Candidate species under the federal Endangered Species Act in 2015. The decision will depend on how well managers demonstrate that conservation efforts will be implemented and effective. Each State where NECs occur has developed a detailed design to achieve specific objectives outlined in this Regional Conservation Strategy. Although there are many aspects to the Strategy including research, monitoring, captive breeding and introductions, successful recovery depends largely on insuring adequate habitat. Initial work done in New Hampshire identified property parcels throughout the NEC's range that had excellent potential for supporting the species. CT's business plan for meeting habitat goals involves prioritizing the most highly-ranked parcels for habitat management, while taking into consideration distance to existing habitat and the nearest documented NEC population.

Workshops (alphabetical by first author)

Utilizing the Sun, Wind, Earth and Water as Natural Energy Resources for a Sustainable Modern Societ
Raman, K., Ph.D., Solar Energy Association of Connecticut, Inc.
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Workshop

Nature has vast renewable energy resources available from the Sun, Wind, Water and Earth. It is slowly being realized that it is important to replace our use of fossil fuels -- coal, petroleum, natural gas -- as much as possible by these renewable resources -- both to conserve fossil fuels and to reduce the increasing Carbon footprint which can lead to adverse climate change and the consequent risks. In this workshop we will discuss how we can use (and have been using) energy from the Sun, Wind and moving water, and the stored thermal energy in the Earth and large bodies of water. We will describe what technologies are needed and are available for doing this. The role of biomass will be briefly pointed out. Particular attention will be paid to the generation and use of electricity on which modern industrial society depends in essential ways, and new developments in these. We shall point out that long-term sustainability requires us to supply society's needs with resources that are renewable within the time scales of human activity, rather than to look for newer ways of finding and rapidly depleting non-renewable fossil-fuel-based resources. We shall outline relevant economic, policy and security issues, and discuss the problems being faced in moving toward a large-scale sustainable utilization of energy resources.

Modeling Dynamic Natural Systems with STELLA®
Warner, Glenn, University of Connecticut/Dept. of Natural Resources and the Environment
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Workshop

Mathematical models are powerful tools in the analysis of systems, and can be used to make predictions, to learn how systems function, and to design better sampling schemes. The workshop will provide participants the basics of building dynamic models of natural systems using STELLA®. The

software is an icon-based computer program that permits the user to build dynamic models by connecting components in a diagram based on the user's concepts and ideas of how the components are interrelated. Differential equations for conservation of mass, energy or momentum are automatically developed and solved as the icons for fluxes and storages are connected on the desktop. Multi-sector (physical, chemical, biological, economic) models are easily constructed using connections among different components, providing an ability to understand the linkages, processes and feedback mechanisms, and to assess the influence of varied inputs and initial conditions. Numerous example models in different disciplines are presented, and a technique to incorporate human attitudes and knowledge into models is explored.