

Posters

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P-1

PHOTOCHEMICAL TRANSFORMATIONS OF ATMOSPHERIC ORGANIC NITROGEN: IMPLICATIONS FOR THE BIOAVAILABILITY OF N IN ATMOSPHERIC DEPOSITION

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Atmospheric deposition is an important source of exogenous nitrogen to coastal waters, oligotrophic lakes (including Lake Tahoe), and remote oceanic regions and it therefore plays an important role in nitrogen loading and phytoplankton growth. Although organic compounds are a major component of the nitrogen in atmospheric deposition, little is known about the importance of this organic nitrogen (ON) as a source of nutrient nitrogen. Similarly, very little is known about the chemical reactions of organic nitrogen in atmospheric particles and drops even though these reactions may significantly alter the bioavailability of ON. Our research has focused on the photochemical transformations of organic nitrogen compounds in aerosol particles and fog waters from the Central Valley of California. One reason for studying these transformations is that the long-range transport of aerosol particles from the Central Valley appears to be an important source of atmospheric nitrogen deposited to Lake Tahoe. Our experiments indicate that a number of organic nitrogen compounds are rapidly transformed during illumination in Central Valley fog waters to form products that include ammonia. These results suggest that atmospheric reactions likely increase the bioavailability of atmospheric organic nitrogen and, therefore, the impacts of this material after it is deposited.

P-2

THE PRAIRIE ECOSYSTEM STUDY: HEALTH OF THE LAND

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The prairie ecosystem study (PECOS) is a major interdisciplinary study of sustainability and ecosystem health in the semi-arid prairie ecoregion of the Canadian part of the Great Plains. Research on the land and the biota was the focus of twelve graduate research projects, all cross-disciplinary to some degree, and at various scales or levels of detail. The present state of small parts of the ecosystem, such as soil aggregation and the nature of the pore space between aggregates are a function of both the nature of the minerals and organic materials making up aggregates, and land use, particularly practices that influence soil organic matter. Agriculture has direct effects on land, and influences adjacent ecosystems such as wetlands, and the diversity of

species that live there. Far-ranging species such as ferruginous and Swainson's hawks, despite reduced populations and fragmentation of habitats, have a high degree of genetic diversity; their future is likely to be influenced mainly by social and economic decisions that influence land use. Rare plants, some of them endangered, benefit from the great spatial heterogeneity of the landscape, and are likely to be threatened by a variety of direct and indirect human activities that destroy or modify habitats. The trace element composition of soil and water shows the influence of human activities such as atmospheric deposition of pollutants from metal smelting, from distant places far removed in time.

P-3

THE CENTER FOR CONSERVATION MEDICINE: A MULTI-DISCIPLINARY APPROACH TO MANAGING FOR ECOSYSTEM HEALTH

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The Center for Conservation Medicine at the Tufts University School of Veterinary Medicine is a relatively new collaborative of veterinarians, wildlife ecologists and physicians who are working together to increase knowledge and understanding of the connections between ecosystem health and the health of humans and animals, and to promote conservation of biodiversity as a critical component of ecosystem health. The Center's partners include the Tufts University School of Veterinary Medicine, Wildlife Preservation Trust International, and the Center for Health and the Global Environment at Harvard Medical School. CCM conducts field research projects around the world involving conservation professionals and veterinary and medical students. This poster will provide background on the Center for Conservation Medicine and brief highlights of field initiatives.

P-4

US ENVIRONMENTAL PROTECTION AGENCY'S ECOLOGICAL RESEARCH STRATEGY

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EPA's Office of Research and Development (ORD) has recently released a research strategy to guide its program to improve ecosystem risk assessment and risk management, which is one of the Agencies highest priority research areas (<http://www.epa.gov/ORD/WebPubs/final/eco.pdf>). It is ORD's vision that, in the next decade, EPA researchers will have developed the next generation of measurements, models and technologies

necessary to protect both the present and probable future sustainability of ecosystems at local, watershed, and regional scales. The general direction of EPA's research program is to larger scales, a more holistic systems view, assessment of cumulative stress, determination of relative vulnerability to multiple stressors, and development of alternative management strategies for flexible decision-making. The strategy supports EPA's changing regulatory perspective towards less centralized, more flexible decision making and to more accountability to achieve results.

P-5

MULTIVARIATE CHARACTERIZATION OF DISTURBANCE BY FERAL HORSES USING FOUR CLASSES OF ECOSYSTEM INDICES

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According to the most recent agency estimates, feral ('wild') horses in the western United States number greater than 37,000 animals, and occupy over 18.6 million ha of land in ten states. Although other species of horses roamed the North American continent before their ultimate demise at the end of the Pleistocene, most scientists consider contemporary horses to be an evolutionarily novel grazer in western arid ecosystems. Because feral horses possess a suite of behavioral, morphological, and physiological traits distinct from both other feral grazers (i.e., cattle) and native herbivores, it may not be appropriate to assume that consequences of horse grazing will be similar in nature or in magnitude to effects of grazing observed for other species. To assess the null hypothesis that areas used by horses do not differ from sites at which horses have been recently removed, we surveyed vegetation, small mammals, aboveground ant mounds, and levels of soil surface compaction at 19 relatively cattle-free sites from nine mountain ranges during 1997 and 1998. While we found significant ($p < 0.05$) differences in each of our four ecosystem indices between horse-occupied sites and horse-excluded sites, these differences could largely not be ascribed to any of ten environmental variables in multiple linear regressions. Because very few of our response variables exhibited statistically significant single-factor correlations after Bonferroni corrections were employed, we instead used multivariate techniques to characterize disturbance. Using reciprocal averaging and TWINSpan analysis techniques, we analyzed sites using three data sets: site-by-species percent plant cover matrices; environmental variables, and a matrix of the twelve (of our 25) response variables predicted to most likely reflect disturbance. In both the percent cover and disturbance data sets, we observed notable discrimination of horse-occupied and horse-excluded sites at both levels of our stratification factor, elevation. In

light of the intense socio-political debate engendered by issues of wild horse management, we recommend an expanded monitoring strategy based on established ecological techniques. This strategy would both provide a mechanism for early detection of adverse effects, and would provide the managing agency with defensible data in an arena that has been embroiled in conflict for several decades.

P-6

GENETIC EFFECTS OF CONTAMINANT EXPOSURE IN THE RED SWAMP CRAYFISH IN THE SACRAMENTO-SAN JOAQUIN DELTA OF CALIFORNIA

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The goal of this study is to expand the understanding of toxicity in aquatic systems, especially in the Delta, by incorporating population-level responses, namely, a combination of biomarkers of exposure and effect, with an assay of population genetic patterns. Three specific aims are proposed: 1) validate the use of biomarkers in conjunction with tissue chemistry as indicators of exposure, sublethal effects and disposition of a variety of contaminants; 2) investigate the use of nuclear genetic markers (microsatellite loci) as correlates or indicators of exposure to and damage from contaminants; and 3) assess, using multivariate statistical models whether biomarker effects are related to contaminant distribution and patterns of genetic variation. The project will test the hypotheses that 1) populations living within contaminated sites will show greater biomarker responses and more genotoxic damage than uncontaminated animals, and 2) genetic analysis will reveal altered genetic patterns in these stressed populations. An understanding will also emerge of the importance of the crayfish as an indicator organism for short term and long term effects and as an intermediate reservoir of bioaccumulated contaminants and biotransformed metabolites capable of trophic transfer to wildlife species and humans. The red swamp crayfish, *Procambarus clarkii*, (Girard, 1852) is an introduced benthic macro-invertebrate that provides a variety of advantages for this study, including its widespread distribution in the Sacramento valley and its relatively omnivorous feeding habits thus its exposure to a wide variety of contaminants. Crayfish are also an extremely important food source at many higher trophic levels in the Delta and support commercial and sport fisheries.

P-7

BEHAVIORAL RESPONSE TO CLIMATE CHANGE AND THE DECLINE OF STRIPED BASS IN THE SAN FRANCISCO ESTUARY

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Understanding biotic responses to climate change is an urgent ecological challenge. Prediction and identification of biotic effects, however, are complicated by human interventions. Here we report on an unexpected relationship between atmospheric-oceanic climate change and sharp decline in the striped bass, *Morone saxatilis*, population in the San Francisco estuary (SFE) beginning in 1976-1977. The decline was previously attributed to impacts on young fish related to withdrawal of freshwater inflow from the estuary for human use. We analyzed annual (1969-1994) abundance statistics with ocean temperature and upwelling records using regression accounting for serial autocorrelation. In addition, we analyzed quarterly (1960-1994) records from the recreational fishery with the oceanic variables using autoregressive integrated moving average models (ARIMA). Our results support the hypothesis that shifting ocean climate played a significant role in the decline. Warmer ocean temperatures and periods of relaxed upwelling stimulate migration of older fish to the ocean, presumably to capitalize on near-shore schooling bait fishes. Greater utilization of the ocean since 1977 affects older adult and egg abundance in the SFE, which may in turn affect recruitment to the fishery. These results suggest that the decline of the striped bass population was caused by the dual effect of climate change, influencing adult migration and survival, as well as on factors regulating recruitment in the estuary. This constitutes a unique example of a behavioral response to climate change affecting the population dynamics of an important fishery. Moreover, this highlights the vulnerability of estuarine systems to climate change and the importance of linkages with the watershed and oceanic environments.

P-8

MERCURY FLOW THROUGH THE AQUATIC ECOSYSTEM OF CLEAR LAKE, CALIFORNIA USING STABLE ISOTOPE ANALYSES

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Clear Lake is the site of a USEPA Superfund Site (the Sulfur Bank Mercury Mine) which was mined intermittently from ca. 1872-1957. Physical and biological processes have distributed approximately 100 metric tons of inorganic mercury throughout the aquatic ecosystem of Clear Lake. We utilized stable isotopes of carbon (d13C) and nitrogen (d15N) in conjunction with Hg analyses to evaluate contaminant flow through various trophic pathways. Included in our analysis of lake biota were aquatic detritus, primary producers, benthic invertebrates, zooplankton, and several representative trophic levels of fishes (silversides = planktivore, carp = benthic detritivore/scavenger, catfish = benthic omnivore, largemouth bass = top predator). Carbon pathways were evaluated separately for each arm of the lake. Since organisms fractionate 15N in a predictable way as a function of trophic level, this isotope has been especially effective in elucidating pathways of mercury bioaccumulation. Largemouth bass had the highest d15N values as well as the highest levels of total mercury, consistent with studies showing that top predators experience the highest degree of contaminant biomagnification. Current data suggest that carbon flows in the lake are derived from the benthic (as opposed to the planktonic) pathway. This study suggests that d15N values can be useful in predicting bioaccumulation of mercury in the biota of aquatic systems.

P-9

FISH CONSUMPTION, FISH LORE AND MERCURY POLLUTION - RISK COMMUNICATION FOR THE MADEIRA RIVER PEOPLE

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Fish is an important food resource in the Amazonian aquatic ecosystems. There is a strong cultural background regard-

ing fish consumption (fish lore) among indigenous people in the Amazon. Mercury (Hg) ingestion through fish consumption has been a major route of Hg exposure among the riverside people along the Upper Madeira river. In this paper a diet investigation has been used to identify the pattern of fish consumption. The amount and frequency of fish species consumed were combined with fish Hg levels in order to estimate the Hg ingestion. We also compared the pattern of fish consumption with fish Hg levels as related to the fish lore. We suggest that risk communication must be addressed for this exposed population in the context of health in general and fish advisory in particular. For the fish advisory it is necessary to pictorially recommend fish eaters, fishermen and fish business people the number of fish meals to be consumed according to the fish species, differently addressed by the target exposure: to protect reproductive stage of life and life in general.

P-10

A SIMPLE, INEXPENSIVE AND RAPID METHOD TO MEASURE TOXICITY WITH BACTERIA

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A simple assay for toxic chemicals using bacteria as the indicator organisms has been developed. More than 170 chemicals have been assayed. The method has been compared with 20 other assays from the literature. The assay could be used by any laboratory able to grow bacterial cells.

P-11

PROMOTING ENVIRONMENTAL HEALTH THROUGH BIOLOGICALLY INTEGRATED FARMING SYSTEMS

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Adverse effects of agriculture have included loss of wildlands and danger to associated sensitive species; soil erosion and downstream sedimentation; agrichemical and livestock-related pollution of ground and surface waters and threats to humans and other organisms; depletion of stratospheric ozone caused by methyl bromide use; and air pollution caused by burning

agricultural wastes, agrichemical applications, and dust. For many years, regulatory address of these concerns has included prohibition or graded phase-out of some practices and pesticides and restrictions on development of wildlands and on agricultural burning. The early 1990s marked the emergence of voluntary agrichemical use reduction projects that combine research-based information with practical farmer-to-farmer experience. The first such project was Biologically Integrated Orchard Systems (BIOS) for almonds, begun in 1993 and aimed at crafting, adapting, and implementing alternatives to organophosphate insecticides, pre-emergence herbicides, and at generally reducing agrichemical reliance. The BIOS approach has proven successful enough to inspire several grants programs providing state and federal monies to analogous projects in grapes, cotton and row crops, purnes, walnuts, rice, citrus, and strawberries. Here we present data on several of these funded projects, documenting their structural similarities and differences and their accomplishments in reducing use of targeted agrichemicals and other pollutive practices, both through input substitution and through systematic changes in cultural practices. We also present data from the Biological Prune Systems project on the restoration of native plants to riparian zones and other sites, and use of the restored sites by various native birds.

P-12

EFFECTS OF DITHANE-M-45 ON THE AQUATIC LIFE-CYCLE OF MICROPTERUS SALMOIDES: ECOTOXICITY EFFECTS

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Dithane-M-45, a widely known EBDC-(ethylene bis-dithiocarbamate) fungicide used for the control of rust and mold of apples and pears, is a teratogenic chemical in the aquatic areas. Dithane-M-45 is a chemical fungicide known as mancozeb. This chemical is used in conjunction with Lindane and maneb, another toxic EBDC, is controlling the growth and development of apple scab, pear rust, and apple rot on green, gold, and red apples and green pears. When aquatic animals such as *Procambarus clarkii*-(the adult Red crawfish) and *Micropterus salmoides*-(Largemouth Bass) are exposed to this fungicide severe toxicity is usually the result. In our study the effects of varying concentrations (0.20, 0.4, 0.6, and 0.80 ppms) of Dithane-M-45 were analyzed with respect to the ecotoxicity effects on members of *Micropterus salmoides*. It was shown that as the concentration levels of this fungicide increased so did the ecotoxicity effects in group of *Micropterus salmoides* analyzed. For example, males exposed to concentrations greater than 0.2 ppm-(parts per million) were shown to exhibit hepatic and intestinal damage. Additionally, the male members were shown to have severely damaged stomach regions that were distorted and misfigured from increasing concentrations of exposure. For

the female members it was shown that they tended to absorb high concentrations of this fungicide ($p > 0.2$ ppms) and store the excessive amounts in their fillet and lower gut regions. Unlike the males, the females were basically not effected by the increases in concentration levels of this compound. Out the 20 females samples for the four concentration groups, only 1/10 showed any type of eco-toxicity poisoning as a result of exposure to varying concentrations of this compound.

P-13

THE IMPACT OF POLLUTION ON CETACEANS: IMPLICATIONS FOR THEIR SURVIVAL IN THE 21ST CENTURY

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While many cetacean species were driven to the point of biological extinction in the past two centuries by exploitation, the ultimate long-term threat to both large and small species of cetaceans may be environmental change, including chemical pollution in marine and freshwater environments, climate change, ozone depletion, and noise. This presentation will focus on the growing threat of chemical pollution on cetacean species and current initiatives to ensure the health of their ecosystems throughout the world. The paper will also include a prescriptive component—focusing on the role of international pollution prevention regimes.

P-14

PROPOSED INDICATORS OF ECOLOGICAL INTEGRITY FOR THE CALFED BAY-DELTA ECOSYSTEM RESTORATION PROGRAM.

CALFED Ecosystem Restoration Program Indicators Work Group

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The CALFED Bay-Delta Ecosystem Restoration Program (ERP) proposes to restore and/or rehabilitate various ecological processes, habitats, and species and biotic assemblages in the San Francisco Bay - Sacramento/San Joaquin Delta estuary and its watersheds. Ecological indicators have an essential role in any ecosystem restoration program employing adaptive management. Ecological indicators are measurable ecosystem attributes or surrogates that provide information on environmental conditions, trends, and their significance. The ERP Ecological Indicators Group, composed of environmental scientists from

CALFED agencies and stakeholder organizations, developed indicators of ecological integrity or health for the ERP. The group devised a process or framework for indicator development. The group adopted an ecological hierarchical approach for subdividing the CALFED program area and developing indicators. This hierarchy has landscape, ecosystem, habitat, and species/ ecological process levels. The group focused on the ecosystem and landscape levels. The ecosystems are greater San Francisco Bay, the Sacramento/San Joaquin Delta, alluvial river-floodplain, and mountain river-riparian. Key ecosystem level attributes or characteristics for each of these ecosystems were described. These attributes are arrayed in the following categories: hydrologic and hydrodynamic, geomorphic, natural habitat, native biological community, and energetics and nutrient dynamics. Additional steps in the process include delineating human stressors on the ecosystem, developing conceptual ecological models, and establishing indicator selection criteria. These tools, plus program objectives and additional scientific information, were used to develop a broad suite of potential ecosystem level indicators of ecological integrity for each ecosystem. The indicators are organized into the same categories as the attributes. The group then developed potential landscape level indicators of ecological integrity. We will present the proposed ecosystem level and landscape level indicators of ecological integrity.

P-15

AN APPROACH TO MONITORING AND ASSESSING ECOSYSTEM HEALTH: SOCIOECONOMIC SITUATION, WATER QUALITY AND HUMAN HEALTH IN KHUMBU VALLEY (NEPAL)

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The Khumbu is part of district of Solukhumbu which includes the most outstanding peak in the world, the mount Everest and many other peaks superior to 7000 m. In this area, is the Sagarmatha National Park, one of the main tourist attractions in Nepal. A dramatic increase in tourist trekking in the Himalayas produced positive effects including an increase in income of the population, but unfortunately causing profound social, environmental and cultural modifications: migration, deforestation, loss of biodiversity, pollution, cultural contamination. In order to give a clear view of the environmental conditions in the Khumbu Valley, an evolution has been made of the socio-economic reality, sanitary conditions and qualitative aspect of the water using a combination of biophysical parameters, demographic parameters and human health consideration. The first indicator chosen is composed of population, settlement and tourism. The second indicator is water quality comprized river water quality and drinkable water quality because they are excellent gauges of man's use of the ecosystem. The third indicator is human health comprizing the health of the local and

tourist populations. The problems existing in Kumbu Valley are serious: superficial waters showed a certain degree of alteration in the quality of fecal origin, above all in correspondence with greater anthropic pressure; local population presents many infections referable to living conditions; a profound socio-economic transformation connected with the ever greater abandoning of the traditional economy (agroforestral, mercantile) totally to mass tourism and commerce. Therefore, management of natural resources in the area is urgently needed to check further degradation and to meet the growing demands of the population. Policies for sustainable tourist development of Valley have been proposed. In conclusion Khumbu Valley has all the potential to promote a sustainable tourism if it can overcome a limited economic approach, as has not happened in many industrialized as well as developing countries.

P-16

WATER QUALITY STUDY OF THE NEW RIVER INTO THE SALTON SEA

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The 82 miles of the New River is essentially a drainage channel originating in Mexicali Valley, Mexico, flowing to the Imperial Valley in California where it discharges into the Salton Sea, California's largest inland water body. The river conveys mainly discharges of return flows from agriculture and wastewaters from municipalities and industries on both sides of the border. The water quality in the New River is of concern due to potentially adverse impacts to both public health and the ecosystem of the Mexicali-Imperial valleys. United States accounts for about two thirds of the total flow in the New River, Mexico contributes with the rest. This study has the objective to describe the New River system from its headwaters to the end.

P-17

A COMPARATIVE STUDY OF THE SALTON SEA, CA AND THE DEAD SEA, ISRAEL AND JORDAN

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Salty bodies of water in desert zones are known all over the world. The Salton Sea, California, USA and the Dead Sea, Israel/Jordan, are located in arid areas on the same approximate latitude, a fact that might explain some similarities. The Salton Sea, the largest inland water body in California, is a saline lake in the Coachella and Imperial Valley. The Imperial Valley is one of the ten top agriculture areas in the United States. Several thermoelectric plants exploiting geothermal wells operate

around the Salton Sea, and some of its areas are National Wildlife Refuge. The Dead Sea (Salt Sea in biblical Hebrew) located in Israel and Jordan, contains high concentrations of salts and is the lowest saline lake in the world. It is a reservoir of minerals with a unique evaporation regime. The Dead Sea's salts are raw material for the production of several products. Magnesium salts and sulfur containing mud are utilized to treat human skin, allergic and respiratory diseases. The Salton Sea and the Dead Sea constitute ecosystems with a singular saline sea/hot desert interface. The similarities and differences of both areas were recorded, analyzed and compared following visits to both zones. Some of them are geographic, orographic, hydraulic and climatic proprieties but the main difference is in economic-industrial aspects. These characteristics and aspects will be described and their implications discussed.

P-18

COUPLING WATER EVAPORATION AND DIAZINON VOLATILIZATION IN UNSATURATED SOILS

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This study focused on how water status and water transport in the soil near the soil-air interface affects volatilization of pesticides. Volatilization of soil-incorporated diazinon [O,O diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate] was measured under various water status and water transport conditions. These conditions were varied by using soil of different initial water content and by passing wet air and dry N₂ alternately across the soil surface. When dry sweep N₂ was used, diazinon volatilization was accelerated due to the appreciable upward water flow. When upward water flow was insufficient, soil-water content at the soil surface was quickly reduced below a threshold, and diazinon volatilization started to decrease exponentially. When the sweep gas was switched to humidified air, the soil surface absorbed water and diazinon volatilization increased dramatically. Depending on flux of the upward water flow, water content at the soil surface may or may not be increased above the threshold water content. Therefore, diazinon volatilization can or can not be increased as high as the volatilization rate before the soil was dried. Water vapor adsorption alone may be insufficient to raise the soil-water content above the threshold water content. A numerical model was developed to simulate water evaporation and pesticide volatilization. Extra efforts were made to address both pesticide and water transport in dry soils, therefore, the model is applicable in both wet and dry soils. Water transport in the gas phase was included in our numerical model. The calculated and measured results agree well. The dramatic change of pesticide volatilization occurs in the low soil-water content range, where water transport in gas and liquid phases may be comparable.

P-19

CHANGES IN PLANT MERCURY AND ARSENIC UPTAKE CAUSED BY SOIL AMENDMENTS FOR REVEGETATION OF THE SULPHUR BANK MERCURY MINE

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Plant uptake of mercury (Hg) and arsenic (As) is mediated by soil pH and metal concentration, but also by root membrane integrity, root density, soil organic matter, and specific sorption by competing ions. In the quest of ameliorating soils for revegetation, the potential exists for increased metal uptake resulting from increased root growth and surface area, from displacement of As by P added as fertilizer, by changes in pH and by chelation by amended soil organic matter. Greenhouse studies suggest that relatively minor changes in metal uptake occur as a result of soil amendments in preparation for revegetation of barren areas at the Sulphur Bank Mercury Mine. The displacement of As by fertilizer P and subsequent uptake by plants was observed, but did not increase plant tissue As to critical tissue toxicity levels. Plant tissue Hg levels were modulated by pH increases and organic matter (compost) addition, but plant tissue levels for Hg were also below critical levels. In field plots, Hg and As tissue levels were low for all plants except a viscid leafed *Mimulus* species. These data suggest that the barren substrates of the mine can be amended and that revegetation species can be established without mobilization of the high levels of As and Hg that exist in the substrate materials.

P-20

REGENERATION OF DECOMPOSTED GRANITE SOILS FOR SUSTAINABLE REVEGETATION OF ERODING HIGHWAY CUTSLOPES

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Eroding decomposed granite slopes in the Lake Tahoe Basin are a major source of non-point source pollution. These slopes are difficult to revegetate in a sustainable manner and can commonly remain poorly vegetated for decades, contributing sediments and nutrients to Lake Tahoe. Recent studies have compared nutrient levels in soils that are

adequately vegetated with those that are not. These data are used to design nutrient amendments for barren soils for the purpose of regenerating soil nutrient pools and sustaining an erosion resistant plant community. Using USEPA 319(h) funds with match funding from California Department of Transportation, the University of California, Davis and the Lahontan Regional Water Quality Control Board have developed a methodical approach for amendment and monitoring of eroding decomposed granite slopes. Target slopes are being treated along State Highway 89 in the Luther Pass area of the Upper Truckee Watershed. Treatments focus on provision of organically stabilized, slowly available nitrogen sources, site adapted mycorrhizal fungi, long lasting mulch covers, and native, regionally adapted plant species.

P-21

EFFECTS OF ACID MINE DRAINAGE ON MERCURY METHYLATION IN CLEAR LAKE, CA: THE POTENTIAL ROLE OF AN ALUMINO-SILICATE PRECIPITATE

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The abandoned Sulphur Bank Mercury Mine (SBMM), adjacent to Clear Lake, CA, has been indicated as the primary source of inorganic mercury (Hg) to Clear Lake, an alkaline, shallow, and eutrophic lake with elevated Hg levels (>1 ppm) in fish. The major input of inorganic Hg to the lake was believed to be erosion of mining waste rock and overburden piles into Clear Lake, but the discovery of an alumino-silicate precipitate (floc) produced from acid mine drainage (AMD) in April, 1995 indicated aqueous inputs from the SBMM. The AMD measured in monitoring wells has high sulfate, extremely low pH and yet relatively high inorganic Hg concentrations. Long-term monitoring data indicate that floc in Clear Lake has significantly lower total Hg concentrations and higher methyl mercury (meHg) concentrations than adjacent sediments. These conditions in the presence of sulfate reducing bacteria, are known to stimulate the conversion of inorganic Hg to meHg. Acid Volatile Sulfide (AVS) and Simultaneously Extractable Metals (SEM) analyses indicate that floc has no detectable sulfides and significantly more SEM-Hg than typical Clear Lake sediments. Other published reports of similar materials indicate the potential for strong effects on the composition of the bacterial community, and may favor either methylating or demethylating bacteria. The chemical composition of floc could allow for weakly bound dissolved organic and inorganic Hg species on its surface, increasing its ability to stimulate methylation and enhance Hg bioavailability.

P-22

ECOSYSTEM HEALTH MANAGEMENT IN INDUSTRY INDUCED BY REGIONAL ENVIRONMENTAL POLICIES: APPLICATION TO THE WALLOON HYDROECOSYSTEMS

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Business behavior motivated by environmental pressure, coming mainly from environmental protection agencies, is under study. The paper defines Ecosystem Health Management in Industry (EHMI) and describes the methodology to assess EHMI which is specifically induced by environmental policies. Since not for all sectors of industry and sizes of firms the data is available in sufficiency, a qualitative approach is chosen. The so-called Enterprise-Environment Connections Diagram is proposed, which provides a contingency table with classes of business environmental actions in rows and environment pressures (among which are environmental instruments) in columns. Various factor analyses can be performed on such a contingency table. To assess EHMI, three kind of variables are taken into account: (1) ecosystem health quality parameters, (2) ecosystem boundaries, and (3) ecosystem resources used. A case study describes the hydrological ecosystems, water protection policy, and industries of Wallonia (the French speaking region of Belgium). The results of five factor analyses are detailed, from which practical recommendations to improve the Walloon water protection policy are drawn.

P-23

EFFECTS OF MULTIPLE STRESSORS (MERCURY AND COPPER) ON ZOOPLANKTON: STUDIES ON CERIODAPHNIA AND DAPHNIA

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The acute toxic nature of Cu-methyl mercury (MeHg) mixtures and the bioconcentration of MeHg in the presence of Cu was evaluated using freshwater cladocerans in 48 hr laboratory exposures. Toxicity tests were conducted on *Ceriodaphnia dubia* from laboratory culture and on *Daphnia pulex* cultured in the lab from an individual collected from Hg-rich Clear Lake, CA. Bioconcentration trials were conducted on the Clear Lake *D. pulex*. The 48 hr Cu, MeHg, and Cu-MeHg mixture LC50s were respectively 13.0, 10.2, and 18.0 ug metal/L for *C. dubia* and 13.0, 22.8, and 18.3 ug metal/L for *D. pulex*. Using Toxic Unit methodology, Cu-MeHg mixture toxicity was characterized as additive to slightly less than additive. The possibility of a slight adaptation in Clear Lake *D. pulex* for tolerating MeHg stress is discussed. Approximately 4% of MeHg in

bioconcentration tests partitioned into test organisms with an average bioconcentration factor of 26,000 across MeHg treatments of 5 and 10 ug Hg/L. Two-way ANOVA analysis revealed no measurable effect of Cu on MeHg bioconcentration ($p < 0.39$).

P-24

CONNECTING RESEARCH TO THE PRE-COLLEGE CLASSROOM: NOAA'S TEACHER-AT-SEA PROGRAM

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Due to national concerns over the quality of pre-college science education, numerous programs have been established to improve teacher preparation and to involve teachers directly in the research process. One such program is the Teacher-at-Sea Program run by the National Oceanic and Atmospheric Administration (NOAA). Teachers are assigned to fisheries and/or oceanographic research projects and spend one to several weeks aboard a NOAA research vessel as active participants in a research team. Data and materials from this experience are then used as the basis for curriculum and activities for the pre-college science classroom. Through this program, teachers have participated in the annual shrimp/groundfish survey of the Southeast Area Monitoring and Assessment Program (SEAMAP). This survey provides a rich source of information concerning relevant environmental parameters and the abundance, distribution, and diversity of species in the northwest portion of the Gulf of Mexico. Results of this and other SEAMAP surveys are disseminated in an annual environmental and biological atlas. Slides, data, activities and fish samples from teacher participation in this survey have enriched science class for seventh grade students in Delmar, Delaware.

P-25

REMOTE SENSING APPROACHES TO MONITORING AGROECOSYSTEM HEALTH

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Remote sensing offers numerous ways to aid in the assessment of agricultural ecosystems. We present techniques to assess agroecosystems at the watershed scale and at the regional scale using remotely sensed data. One approach used combines temporal and spatial land cover data to explore the relationship of landscape variables to stream

condition/health in the heavily agricultural states of Nebraska, Kansas and Missouri. The landscape pattern metrics software FRAGSTATS 2.0 was used to quantify land cover pattern. In addition, AVHRR NDVI phenological metrics were used to capture temporal aspect. We associated these metrics with biological, physical, and chemical values from over 300 randomly selected watershed. Preliminary results showed significant correlations of contagion, interspersion and Shannon diversity to levels of total phosphorus and metolachlor. Mean and standard deviation values of the maximum NDVI were significant in regressions to NO_2 - NO_3 levels. In another set of analyses at the regional scale, a ten-year data set was derived from AVHRR NDVI imagery that characterizes phenological development states for agricultural vegetation in the U.S. Great Plains. From this data set, various metrics including onset of greenness, maximum greenness, rate of green-up, and duration of growing season are used to identify and quantify year-to-year changes in phenological development states in this highly dynamic area. Long-term trends in phenological events are used to evaluate the condition, progress and productivity of agricultural vegetation in near-real time. For a single metric (onset of greenness), preliminary research shows that variability can range from zero to ten percent in areas dominated by warm season grasses, while areas dominated by cool season grasses and agricultural crops can vary from zero to forty percent.

P-26

PECOS*: AN EXPLORATION OF ASSOCIATIONS BETWEEN EXPOSURE TO PESTICIDES AND INJURY IN A RURAL POPULATION

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The objectives of this study were to describe non-fatal, unintentional injury in a rural population and to examine the association between exposure to pesticides and injury outcome. A cross-sectional survey design was utilized to gather detailed information about injury and selected host and environmental characteristics in a sample of rural dwellers who participated in a test-retest study of pesticide exposure and human health conducted in rural Saskatchewan. Measurements were obtained using standardized questionnaires. The study population comprised 214 persons, ages 12 to 84 years, both sexes, farm and non-farm dwellers. The cumulative proportion of injury causing disability from regular activities for > 4 hours or resulting in a visit to a health care professional was 32.7%. The association between measurements of pesticide exposure and injury was examined in a logistic regression model which contained the other covariates of importance in the study population (age

category, sex, alcohol use, handedness, stomach trouble, use of suspect medication, insomnia and exposure to farm work). Injury was significantly associated with lifetime occupational exposure to insecticides (ORadj 3.22, 95% CI 1.23,8.30). No statistically significant association with injuries was observed for lifetime occupational exposure to herbicides, fungicides or occupational exposure to any pesticide.

**Prairie Ecosystem Study, Eco-research Program, Tri-council Secretariat of Canada.*

P-27

HISTORICAL BIOCHEMICAL MARKERS OF AIR POLLUTION IN PINE TREE RINGS

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Air pollutants (e.g. O₃) induce biochemical compensatory responses in vegetation under natural, multiple-stress settings. Chamber fumigation studies have revealed the potential value of biochemical markers in tree seedlings and annuals, but application to adult trees in their natural setting is untested. A problem with such settings is that a large number of markers are needed to resolve the multiple effects of pollutants and natural stresses. Thus, field-practical markers must: (a) represent the effect of multiple biochemical pathways; (b) be cumulative; (c) yield sufficiently complex information to resolve (a); (d) be amenable to long-term monitoring; (e) support practical sampling at remote locations. For example, growth measurements cannot meet condition (c). Analysis of wood chemical structures from annual tree rings appear to satisfy ALL of these conditions. Tree ring cores were sampled, freeze-dried, ground, and analyzed by pyrolysis-GCMS, which has the resolution to analyze complex macromolecular structures. Our current study involved ponderosa pine stands east (downwind) of the Los Angeles basin. Ratios of ignin substructures (H:G lignins) at ozone-impacted sites showed declines in the period from 1950-96, as compared with 1900-40. The opposite relationship was seen for the low-ozone site. Also there were corresponding trends seen for a styrene-substructure marker, which we believe originates from stilbene-class phytoalexins in the wood. Efforts are underway at sites designed to distinguish water, nitrogen, and pathogen status from air pollution effects, using pyrolysis -GCMS and other wood chemistry tools such as FTIR. Supported by EPA-funded (#R819658) Center for Ecological Health Research at UC-Davis.

P-28

REMEDICATION OF THE GOWANUS BASIN ECOSYSTEM

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In July of 1998, biologists, chemists, and physicists at Baruch College initiated a comprehensive, multidisciplinary study of the Gowanus Canal, a dead-end waterway extending over a mile inland from the Gowanus Bay. The goals of the study include (1) providing research experience for undergraduate science majors, (2) evaluating health hazards associated with the Canal for community groups on an ongoing basis, (3) creating a data base of biotic and abiotic environmental variables for monitoring the response of this ecosystem to the remediation efforts presently underway, and (4) developing specific bioremediation strategies for the restoration of this ecosystem. The study will provide information useful in the formulation of public policy with respect to the future development of the Gowanus Basin. The Canal is located between two Brooklyn residential neighborhoods. Its waters are polluted with industrial wastes and sewage overflow following heavy rainstorms. Because tidal movements are not sufficient to flush the Canal, the city built an underground tunnel connecting the Canal to the Buttermilk Channel and in 1911 activated a pump capable of moving 300 million gallons of water through the Canal each day. In 1967 the pump broke. Pumping resumed in February, 1999. At present, undergraduate science majors at Baruch College have established 18 sampling sites along the Canal and are measuring temperature, salinity, dissolved oxygen, turbidity, microbial biomass (both total and viable), and total organic carbon on a regular basis. Samples are collected for subsequent analysis for metals. Microbial ecology is the major focus at present. Students are determining concentrations of heterotrophic bacteria, including total heterotrophs, coliforms., thermotolerant coliforms (fecal), and enterococci. Starting in June, students will be determining numbers and activity of microbial autotrophs. In the Fall of 1999. The projects will expand to include students in chemistry and physics who will measure specific organic pollutants (using gas chromatography mass spectrometry) and model dissolved oxygen as a function of the distance from sources of pollution using the Streeter-Phelps equation.

P-29

THE PHYSIOLOGICAL EFFECTS OF DIETARY METHYLMERCURY ON SACRAMENTO BLACKFISH, *ORTHODON MICROLEPIDOTUS*

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The health of the Clear Lake (California) ecosystem is affected by multiple stresses, including the presence of mercury. The

mercury loading problem associated with an important point source, the Sulphur Bank Mine (a USEPA Superfund site) may adversely affect fish populations and their well being. The Sacramento blackfish (*Orthodon microlepidotus*) is a planktivorous cyprinid native to Clear Lake that may be exposed to methylmercury (MeHg) through both trans-gill and dietary pathways. Previous and ongoing studies emphasize MeHg uptake rates, but MeHg effects on blackfish functioning are unknown. To better understand these effects, we exposed juvenile blackfish to four levels of dietary MeHg and measured their growth and routine respiratory metabolic (oxygen consumption) rates. After the 36-d growth experiment, blackfish fed the "high" MeHg dose (50 mg/kg) grew at 0.24 ± 0.17 % body weight/d (mean \pm SD specific growth rate, SGR), significantly slower ($p < 0.05$, ANOVA) than the "low" (0.45 mg/kg) MeHg treatment group (SGR: 0.44 ± 0.13) or the control fish (0 mg/kg MeHg; SGR: 0.48 ± 0.12). None of these SGRs differed from the "medium" (20 mg/kg) MeHg treatment group's SGR (0.42 ± 0.11). Routine respiratory metabolic rates were statistically indistinguishable across all MeHg dosage levels. Ongoing determinations of these blackfishes' food consumption rates, swimming performance, optomotor reactions, and disease challenge responses will further describe important sublethal effects of dietary MeHg exposure. Research was supported by the UC Ecotoxicology Program and the USEPA-sponsored UC Davis Center for Ecological Health Research.

P-30

INFLUENCE OF KOMEEN® TO CONTROL BRAZILIAN ELODEA ON COPPER CONCENTRATIONS AND TOXICITY IN SACRAMENTO-SAN JOAQUIN DELTA ECOSYSTEM.

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In 1998, the California Department of Boating and Waterways began pilot treatments in several areas of the Delta with the copper-based aquatic herbicide, Komeen® to control the exotic aquatic weed Brazilian elodea *Egeria densa*. Copper concentrations in water samples from Komeen®-treated areas were highest at 3 hours posttreatment. Copper concentrations generally declined to levels at, or near, the minimum detection limit within 24 hours. Water samples collected from treated sites 3 hours posttreatment produced significant mortality of cladocerans in toxicity tests which appeared related to copper conditions. Water from Komeen®-treated sites produced variable mortality to fathead minnows. Komeen® toxicity dissipated partially within 24 hours after treatment. Komeen®-treated sites did not have higher sediment copper concentrations than did the control sites. Komeen® applications should have minimal impact to fish, but may have transient impacts on aquatic invertebrates, especially zooplankton.

P-31

INFORMATION CENTER FOR THE ENVIRONMENT:
MANAGING AND INTEGRATING INFORMATION FOR
ECOSYSTEM HEALTH**Information Center for the Environment***

University of California, Davis, CA • USA

**presented by Cynthia Moore*

The Information Center for the Environment (ICE) is a cooperative research facility at UC Davis, housed within the College of Agriculture and Environmental Sciences. Funding from dozens of agencies and programs enables ICE to support faculty projects, develop public-friendly access to environmental information, and supply data critical to decision-making. The expert staff provides geographic information systems (GIS) and database development services. The ICE web page (URL <http://ice.ucdavis.edu>) hosts a vast array of data, maps, models, and reports, all available to the public. These featured projects are examples.

California Rivers Assessment (CARA)

CARA evaluates the environmental conditions of California's rivers, compiling the best existing data from many contributors. By making this information available to decision makers and the public, CARA improves river management and conservation. Users can query the CARA database online to get statewide watershed information, linked to local and regional data. Watershed projects, special status species, number of dams, Total Maximum Daily Load data, precipitation data, and much more information is available for each watershed. This internet system includes the ability to map environmental data through ICEMAPS2 (see below).

GeoSpatial Waterbody System (GeoWBS)

ICE has been collaborating for several years with the U.S. Environmental Protection Agency (EPA) and the State Water Resources Control Board (SWRCB) to improve reporting and management of California's water-quality data. The EPA has funded ICE to georeference the water-quality assessment data stored in the Waterbody System (WBS) at a higher degree of spatial refinement. WBS stores all water-quality information used for Clean Water Act Section 305(b) and 303(d) Total Maximum Daily Load reporting requirements. After georeferencing and linking the existing WBS database for 1994 and 1996 reporting years, ICE developed the GeoSpatial Waterbody System (GeoWBS) ArcView interface. GeoWBS allows Regional Water Quality Control Board staff to spatially record new waterbody entries into the system as they are entering assessment information; they can also refine the existing, (often very coarse) spatial data. The result is a much clearer geographical indication of where water-quality impairment is occurring throughout the state

ICEMAPS2

ICEMAPS2 allows anyone with access to the World Wide Web to make custom maps pertaining to conservation and watershed management in California. The maps are created in real time, and the user can save them locally to print out. Users choose from a wide variety of layers, including watershed basins, rivers, lakes, river project locations, dams, jurisdictional boundaries, State Assembly and Senate Districts, highways, quadrangle boundaries, and cities. Some biological information is also available, such as unique NDDB species and biological oxygen demand. Map legends may be added at any point. Users can zoom and pan to a custom-defined area or view predefined regions (counties, CERES bioregions, etc.). Information about individual features may be listed in a new window.

Natural Resource Projects Inventory (NRPI)

The online NRPI database brings together information about resource-management projects throughout California, gathered from agencies and organizations working to restore, protect, manage, and study California's vast natural landscape. Agencies contributing data include the members of the California Biodiversity Council, CALFED, the State Water Resource Control Board, the California Interagency Noxious Weed Coordinating Committee, and the Central Valley Habitat Joint Venture. The database now holds over 1500 projects, with more projects coming in. Project data can be queried interactively on the World Wide Web, and location data is linked to CARA's watershed data. Mapping is also possible, using ICEMAPS2.

Navarro River Watershed Project

On October 31, 1997, the United States Environmental Protection Agency entered into a consent decree which listed several watersheds in northwest California for the development of Total Maximum Daily Loads (TMDL), per Section 303(d) of the Clean Water Act. This decree includes the Navarro River, a forested watershed in Mendocino County, California, where water quality is limited due to sedimentation and temperature. Stressors from land use practices are impacting the migration, spawning, reproduction, and early development of cold water anadromous fish, namely coho salmon and steelhead trout. To measure progress toward the TMDL goals, ICE has initiated an inventory of existing salmonid habit conditions and implemented a geographic information system (GIS) to aid in analysis and derive a salmonoid habitat suitability model. For further information about these and other ICE projects, please visit our web site at <http://ice.ucdavis.edu>, or contact Jim Mullins at (530) 752-0532.

P-32

AN ECOTOXICITY ANALYSIS OF SEMPRA-(HALOSULFURON) IN ASSESSMENT EXPOSURE TO *PROCAMBARUS CLARKII* IN SOUTHEAST LOUISIANA SWAMP-WATERS

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Halosulfuron (methyl 5-[(dimethoxy-2-pyrimidinyl) amino]carbonylamino-sulfonyl]-3-chloro-1-methyl-1-H-pyrazole-4-carboxylate) is a selective preemergence and postemergence herbicide registered for use on field corn, sorghum, and turf. Proposed new use sites are fallow ground, rice, cotton, sweetcorn, popcorn, tree nuts, and sugarcane. According to the 1992 USDA Agricultural Census (see plots), the geographical areas corresponding to these crops include areas in the midwest (especially in Illinois, Wisconsin, and Minnesota), the northeast, Pacific northwest, and the southeast (especially in southern Louisiana and southern Florida). Exposure to certain swamp-water animals in the southeast Louisiana and Mississippi areas has proven to be very lethal. One particular species of aquatic animals which have been found to be extremely sensitive to this chemical herbicide are the Red Louisiana crawfishes, *Procambarus clarkii*. At varying concentrations and varying seasons for which this chemical herbicide is applied, these aquatic animals are known to show bioaccumulation of Semptra in their intestinal tract and lower tail regions. In our study three groups of *Procambarus clarkii*-(each containing twenty-five males and females mixed together) were used and labeled as C1 and EX1 and EX2. In groups EX1 and EX2, the aquatic animals were further divided into smaller and exposed to varying concentration levels of Semptra. The concentration levels were for the experimental groups were as follows: 0.1ppms, 0.20 ppms, and 0.8 ppm. The time of exposure for all groups was 7 wks. After the exposure period was concluded, noticeable changes in the weight and physiological development of each of the animals on EX1 and EX2 could be documented clearly. Males in each experimental exposure group were shown to have a high tissue and muscle accumulation in their intestinal tracts and lower abdominal regions while the females demonstrated an increase in eye development and a change in antennae development. In both cases the males and females demonstrated an increase in eating and weight gain.

P-33

BIOCHEMICAL PROFILES FOR ECOTOXIC ASSESSMENT AND MITIGATION EVALUATION

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The Sacramento/San Joaquin River and North San Francisco Bay represents a highly disturbed ecosystem through water diversions, proliferation of introduced species, and pollutant inputs. Point and non-point sources of pollution include agricultural and mine drainage, industry, and urbanization, along with salinity fluctuations which results in a multi-stressed ecosystem. We are currently working on characterizing how multiple stressors affect the metabolic biochemistry of indigenous biota in North San Francisco Bay. We are also developing biomarkers specific for metal and selenium contamination. This research is being conducted as part of a collaboration with researchers at UC Davis and the US Geologic Survey in Menlo Park, Ca. The principle species under investigation is the Asian Clam, *Potamocorbula amurensis*. We conducted a broad screening of biochemical compounds for their profiles in response to natural and pollutant stressors in both field and laboratory samples. Whole clam homogenates were analyzed by GC-FID/GC-MS, HPLC, H-NMR, P-NMR, and PAGE for primary metabolites, amino acids, nucleotides, sugar phosphates, glutathione, and metal binding proteins to establish adaptive and stress related responses, energy status, and oxidative stress. Metallothionein-like, i.e. low molecular weight-sulfhydryl-rich proteins and peptides, were analyzed by PAGE after derivatizing with a fluorescent label utilizing methods developed in our lab. The stressors being investigated include salinity, diazinon, ziram, cadmium, which were administered singly and in combination to elicit biochemical changes detectable as patterns in the biochemical profile. Thus, the approach can give insight to the mechanisms underlying changes observed in the biochemical profile from field and laboratory exposures.

P-34

ABOUT THE METHOD OF CONTROL ON ECOSYSTEM

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The analysis of ecosystem development dynamics in a territory is necessary for determining its reaction as organism to various changes, which take place on the concerned territory. It is important from consumer point of view as the health of people and all living things depends considerably on the health of ecosystem they function inside. That is why it is important to define the state and development dynamics of ecosystem and reveal reasonably-consequent links of undesirable deviations from the standard. We suggest to use the method of parameters assessment of its control system. At present, we do not have sufficient and authentic information, reflecting the entire parameters of the control system of a territory ecological system. That is why consequent and purposeful search of the control system parameters on the basis of the information, accumulated in various science

branches, is a necessary and well grounded stage. We suppose that the control system of a territory ecosystem is responsible for fulfilling a number of functions. In particular:

1. To maintain inside the body of a territory ecosystem the dynamic balance, required for the life activity of all living things of the given landscape. Climate, accustomed for the given territory, will be formed if ecosystem state is normal. With aggravation of ecosystem state, the weather deviation from the accustomed standard will take place. The cyclity of natural processes will be broken that influence negatively the life activity of living things. The morbidity of living things will increase, food quality and nutrition will worsen. Although the index of the "weather deviation from the accustomed standard" is the visual reflection of ecosystem state, it is difficult to use it in comparison calculations. There could be a great number of such components of the control system of ecological system, connected with the parameters of microorganisms, vegetable and animal kingdoms, people and inanimate substances, that change as well as ecosystem state on the whole. A specific possibility is 2. To maintain "Right-handed - Left-handed" signs of new-born children. On the basis of numerous information the component of the control system of territory ecosystem, responsible for the balance of the "Right-handed - Left-handed" parameter, has formed. The "Right-handed - Left-handed" parameter of children is slightly connected with that of one of parents (health, "right-handed-left-handed" parameter), but it depends considerably upon the ecosystem state of a territory. While assessing the development dynamics of a territory ecosystem, the range of time in 10-15 years is of great interest. For numerical ecosystem state assessment of a territory within a concrete year the correlation of right-handed-left-handed boys or girls, born in the same year, is determined. If the ecosystem state of a territory is normal, the correlation of right-handed and left-handed is equal to 1. An example of the ecosystem state assessment of a territory is given by this parameter over the 10-year period, 1980 to 1988. It can be seen that the aggravation of the ecological state has led to the abrupt increase of left-handed people.

P-35

SEDIMENTATION RATE CHANGES IN MONTANE MARSHES IN NORTHERN SIERRA NEVADA, CALIFORNIA: WHAT ARE THEY TELLING US?

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Sediments keep a longer history of watershed and aquatic change than human records. To trace the effect of anthropogenic impacts on sedimentation and sediment accumulation rates, sediment cores were collected in 11 montane marshes in northern Sierra Nevada, California, which have various watershed characteristics and anthropogenic impacts. Cores were ²¹⁰Pb dated by CRS and CIC models.

Sedimentation rates and sediment accumulation rates were calculated and compared with environmental variables. Age-depth profiles indicated that sedimentation rates changed at different times in different marshes, and we separated sediment cores into two parts to show sedimentation and sediment accumulation rate change. The ranges of dry mass accumulation rates and sedimentation rates were 0.081 - 1.356 kg m⁻² yr⁻¹ and 0.94 - 4.64 mm yr⁻¹ in the upper core, and 0.094 - 0.563 kg m⁻² yr⁻¹ and 0.57 - 1.75 mm yr⁻¹ in the lower core. In general, the cores showed recent increase of sedimentation and sediment accumulation rates. Meyers Grade Marsh was impacted by road improvement in the 1930s and it continues to be impacted by road maintenance using road salt. Miller Meadow has been impacted by a nearby timber road. Snow Creek and Lake Van Norden data showed that human residence and recreation were the most effective factors increasing sedimentation and sediment accumulation rates. In contrast, Upper Grass Lake results indicated that this marsh recovered from anthropogenic impacts such as logging and dust from a nearby. Many marshes in northern Sierra Nevada, California are in pristine condition, while others have been heavily impacted. Montane marshes are very vulnerable ecosystems. This study suggests that impacted marshes can be restored to pristine condition.

P-36

INSTALLATION OF "INSECTARY" HEDGEROWS ON FARMS: MANAGEMENT PRACTICES AND COSTS

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Four "insectary" type hedgerows were planted in Yolo County in 1996 on large-scale rotational field crop farms. Establishment practices and costs were documented at each site for two years, resulting in the first "model guidelines" for hedgerow installation and maintenance on farms in California. Although hedgerows take time and money to establish, their numerous benefits (wildlife habitat, increased biodiversity, beneficial insect habitat, weed control/pesticide reduction, erosion control, nutrient leaching, dust/chemical buffer) can potentially offset these costs.

P-37

CALIFORNIA DEPARTMENT OF FISH AND GAME SPATIAL DATA INTEGRATION APPLICATION FOR CONSERVATION AND PROTECTION OF NATURAL RESOURCES

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Applications for use in conservation and protection of natural resources have been developed to assist DFG field staff in environmental review, analysis and identification of habitat.

- IBIS (Integrated Biological Information System) application is a simple spatial data viewer and query application. IBIS provides DFG staff the capability to access a variety of biological spatial and tabular data. The application and data are produced on one CDROM allowing for wide use of the product.
- An application developed for use by county planners that flags areas rich in species and/or specific habitats, thus reducing the workload to DFG biologists doing environmental review and coordination.

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INTEGRATION OF TRADITIONAL ECOLOGICAL KNOWLEDGE, ENVIRONMENTAL TOXICOLOGY, AND HUMAN/ANIMAL HEALTH—A COUNTRY FOOD CONTAMINANT STUDY IN COLLABORATION WITH THE INNU NATION OF LABRADOR, CANADA

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Aboriginal peoples, living for centuries in close harmony with their environment, have accumulated extensive knowledge about their natural ecosystem and its resources. During the past several decades, elders and hunters of the Innu Nation of Labrador (Canada), have observed physiological and behavioural changes in many wildlife populations intrinsically tied to their country diet and culture. These observations include changes in behavioural patterns, lack of reproductive success, declining fat reserves, increased parasite loads and variations in normal activities. Also, there are perceived differences in carcass quality based on alterations in the colour, odour and taste of the meat. The Innu people believe that regional industrial activities including military low-level flight training, hydroelectric development and mining, as well as airborne pollutants from distant sources may be responsible for these changes. A preliminary contaminant study of Innu country food was performed at a total of four locations during the spring and fall of 1997 by collecting samples of various bird, mammal and fish species considered relevant to Innu diet.

Samples were analysed to determine tissue concentrations of heavy metals, organochlorines (OCs), polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Samples were taken from animals of 8 species including caribou, muskrat, northern pike, surf scoters and Canada geese. The levels of contaminants in the tissues of several species were found to exceed health guidelines both on a tissue wet weight and a tolerable daily intake (TDI) basis. The Tolerable Daily Intake (TDI) threshold is 20 ug/kg of body weight per day for DDT, 0.2 ug/kg×bw⁻¹×d⁻¹ for toxaphene, 1.0 ug/kg×bw⁻¹×d⁻¹ for PCBs, and 10 pg/kg×bw⁻¹×d⁻¹ of TEQ for PCDD/PCDF. In relation to the TDI and wet weight guideline (1.00 ug/g), high levels of DDT and metabolites were found in the adipose tissue of a Canada goose (1.25 ug/g). Levels of toxaphene in several tissues from five species were found to be higher than the wet weight guideline for both short term (0.18 ug/g) and long term (.002 ug/g) consumption. PCB levels were also found to be high in samples of surf scoter and black scoter adipose tissues (1.193-2.368 ug/g). Surf scoters also had high concentrations of PCDD/PCDF (53.00 pg/g adipose tissue). Cadmium concentrations in 6 caribou kidneys (10.9 - 28.6 ug/g) were found to be higher than environmental quality guidelines (10 ug/g wet weight) and the mercury content of a pike liver (0.25 ug/g) exceeded the guideline for subsistence fisheries consumption (0.2 ug/g). The results of this preliminary sampling program support Innu concerns that organic contaminants and heavy metals may occur at concentrations significantly higher than Total Daily Intake threshold levels in country foods that comprise a substantial proportion of their diet. A more detailed study is planned that will quantify and correlate various health parameters of individual animals and humans with their contaminant burdens. Results should help aboriginal hunters in selecting appropriate game for safe consumption and assist Innu organizations in their efforts to reduce the effects of industrial activities on the Innu way of life.

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ECOSYSTEM MANAGEMENT - CURRICULUM AND TECHNOLOGY

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Fleming's Ecosystem Management (EM) Programs highlight an integrated approach to sustainable resources management. The focus is ecosystem health, connections and interactions. Small class sizes facilitate hands-on learning and access to state-of-the-art technology. The aim is to prepare students for an exciting career in a variety of fields such as restoration, conservation, habitat assessment, environmental protection, and stewardship. Students acquire a broad range of technical skills and the flexibility to adapt to changing job requirements. They learn the principles of experimental design and applied research. They participate in the assessment of habitats, wild life, soil, and water,

and develop plans for the management of private and public landscapes. Students acquire skills in Geographic Information Systems (GIS) data manipulation and analysis. Not only do they learn important skills in sustainable resource management, but also in communications, human relations, facilitation, problem-solving and cultural awareness. These skills are transferable on a global scale. Small classes encourage individual attention and student camaraderie. When the EM Technology option is selected students participate in the Program's unique Credit for Product Placement in which they spend one day a week working on a project designed by the student and an agency of their choice. It's a wonderful opportunity to expand their network of employment contacts and gain valuable job experience. "Ecosystem Management students produce accurate, innovative work in land planning, analysis and management. Their research and proposal writing skills measure up to professional industry standards. They deserve the highest recommendations for assisting the cause of land stewardship by helping to plan a remedial strategy towards improving the Holland River Valley."

P-40

ECOSYSTEM HEALTH AND SENIOR MEDICAL STUDENTS: CHANGING PERSPECTIVES

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The University of Western Ontario has recently integrated a course on Ecosystem Health into the final year of the medical school curriculum. This course is a selective, given with the intent of focusing on the wider mechanisms of disease and the environmental, political, social and economic aspects of health. This poster discusses the changing perspectives of medical students as a result of selecting this course. The course format utilized case studies with two sessions devoted to each topic (the first session to explore areas of knowledge deficit and determine areas to be researched, the second to share the fruits of the research and discuss implications of the information). Topics included antibiotic resistance, asthma, natural disasters such as Hurricane Mitch, changing disease patterns, and ozone depletion. Student participants were surveyed to assess their degree of understanding of each topic, their perceived role of physicians in ecosystem health, and if and how the course had altered their attitudes toward health within the ecosystem framework.

P-41

LINKS BETWEEN ECOSYSTEM, SOIL, PLANT, AND HUMAN HEALTH: A CASE IN VINEYARD SOIL MANAGEMENT

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A two year study of phylloxera infested northern California vineyards showed that organically managed vineyards had significantly reduced phylloxera related fungal pathogen damage relative to vineyards using insecticides, herbicides, and soluble fertilizers. Evidence is presented showing that this reduction is a result of soil management mediated development of soil suppressiveness and plant systemic acquired resistance (SAR) to disease. Data is presented showing that vineyard soil management using organic methods reduces or in most cases eliminates common agricultural pollutants into the ecosystem as well pesticide residues in food. Additionally, it is shown that the products of induction of SAR in plants can be important health and food quality factors in the human diet. For example, resveratrol, a SAR induced plant defense phytoalexin, has been shown to be the major compound responsible for the reduction of heart disease in red wine drinkers. The soil ecosystem is focused on as a central link between reduced ecosystem pollution, increased local biodiversity, and improved crop and human health.

P-42

SEDIMENT MICROBIAL COMMUNITY STRUCTURE AND MERCURY METHYLATION IN CLEAR LAKE, CA

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Clear Lake is an alkaline, eutrophic lake polluted with mercury as a result of mining operations (total sediment Hg 1-160 ppm). Previous work at Clear Lake suggested that both sulfate-reducing bacteria and other, unidentified bacterial groups are important for methylmercury production in Clear Lake sediments and in a flocculent material (floc) that forms when acid mine drainage contacts lake water. The current study was designed to identify potential relationships between mercury methylation potential and sediment and floc microbial community structure. Phospholipid fatty acid (PLFA) analyses of sediment and floc cores indicate that microbial community structure is significantly different among lake locations, and that community structure is only weakly influenced by seasonal changes. Total PLFA content of the sediments increases with increasing organic carbon content, suggesting that microbial biomass is at least partially limited by carbon availability. Based

on information contained in a database of over 100 published PLFA analyses for sulfate-reducing pure cultures, Clear Lake sediments are dominated by organisms with PLFA compositions characteristic of *Desulfobacter*. PLFA biomarkers characteristic of *Desulfovibrio* were also detected. Sediment samples analyzed for PLFA composition were collected in parallel with sediment used for mercury methylation potential analyses. Relationships between mercury methylation potential and PLFA composition will be used to generate hypotheses about bacterial groups and sediment physical characteristics leading to high methyl mercury production in Clear Lake.

P-43

SULFATE REDUCTION AND MERCURY METHYLATION POTENTIAL IN THE SEDIMENTS OF CLEAR LAKE, CALIFORNIA

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Rates of sulfate reduction and potential for methylation of inorganic mercury were measured over an annual cycle in sediments of Clear Lake, California. These processes were found to be highly seasonal and site specific. Because increases in measured mercury methylation potentials correlated well with increases in methyl mercury in Lake biota collected at the same time, it is likely that measurements of mercury methylation potential are representative of *in situ* conditions. High mercury methylation potentials measured at sites low in total mercury indicate that these sites may be important to the integrated methyl mercury production in Clear Lake and should not be neglected when choosing remediation strategies. Additionally, the observation that mercury methylation is stimulated by small amounts of exogenous inorganic mercury indicates that much of the mercury and methyl mercury in Clear Lake sediments is not bioavailable. An important aspect of controlling the mercury contamination at Clear Lake is to minimize further inputs of fresh inorganic mercury. Methyl mercury efflux from vertically stratified, unsupplemented, sediment cores was stimulated by anoxia and by the presence of a precipitate formed when acidic mine site water seeps into and mixes with Clear Lake water. The mechanism for this stimulation of methyl mercury efflux is not clear, but the observation is important as it represents a possible source of fresh mercury and methyl mercury to the Clear Lake system. The processes of sulfate reduction and mercury methylation were not coupled in these sediments. Furthermore, in contrast to published observations, experiments with molybdate (a specific inhibitor of sulfate reduction) indicated that sulfate reducing bacteria were directly responsible for one-third or less of the methyl mercury produced in this freshwater system.

P-44

FOREST STRUCTURE AND MORTALITY IN THE LAKE TAHOE BASIN AND THE SIERRA SAN PEDRO MARTIR: THE ROLE OF FIRE EXCLUSION AND LOGGING

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Fire exclusion and the selective cutting have modified forest species composition and structure in the western U.S. In the Sierra Nevada of California many forested areas now have very high understory and overstory stem densities. These conditions have potentially resulted in increased susceptibility of forests to a number of disease and insect epidemics. This study compares the mixed-conifer forests of the Sierra San Pedro Martir (SSPM) of northern Baja, Mexico, which has had no history of logging or fire suppression, to the altered forest ecosystems of the Lake Tahoe basin in the Sierra Nevada of California. In the Lake Tahoe Basin we sampled both seral (previously, logged, fire excluded) and late-seral (unlogged, fire excluded) sites. What we have found is that Lake Tahoe seral sites had the highest understory tree densities (351 trees/ha) followed by Lake Tahoe late-seral sites (258 trees/ha). The lowest stem densities (80/ha) were found in late-seral SSPM sites. With this increase in stem.

P-45

REPLICATOR NETWORKS: A NEW TOOL FOR AUTOMATED DATA CLASSIFICATION

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We are developing new informatic tools to automate the classification and analysis of large complex datasets that today require the attention of skilled human analysts. Typically, the method requires access to human-validated categorized reference datasets. These reference datasets are presented to informatic components known as basis vector extractors, which extract custom sets of basis vectors for each individual data category. The resulting sets of basis vectors are then used to construct associated replicator networks, which we have dubbed 'Adaptive Focused Replicator Networks' or AFRNs. Once extracted, the sets of basis vectors are 'frozen,' so that each AFRN has its own custom-tailored basis vector set. In production use, the AFRNs are presented, in parallel, with new data exemplars. Each AFRN attempts to reconstruct a faithful copy of the new exemplar using only its own associated basis set. A 'higher-level

informatic critic' reviews the replication fidelity of all the AFRNs and decides which AFRN has most faithfully reproduced the novel exemplar. If none of the AFRNs has performed adequately or if multiple AFRNs have inappropriately performed well, the exemplar is tagged for human interpretation and possible inclusion into an auxiliary reference database that itself can be used to build additional AFRNs in future. We demonstrate the method with two applications. The first uses Fisher's classic 'Iris' dataset and compares AFRN performance with Fisher linear and quadratic discriminant classifiers; the second uses exemplars from our laboratory's short-tandem-repeat (STR) DNA genotyping electropherogram database. With high quality reference training datasets, our pilot STR studies indicate that greater than 90% of new STR electropherogram exemplars can be scored accurately – completely bypassing the manual double-checking step required by other scoring methods in current use.

P-46

PRAIRIE ECOSYSTEM STUDY*(PECOS): DERMAL AND INHALATION EXPOSURE TO PESTICIDES

McDuffie, H.H., K.M. Semchuk, A.J. Cessna, D.G. Irvine, D.L. Ledingham, P. Hanke, M.F.O. Crossley, A. Senthilselvan, J.A. Dosman, and A.M. Rosenberg
University of Saskatchewan, Saskatoon, SK • CANADA

Our objective was to characterize various types of exposure to pesticides among rural farming and nonfarming men, women and children residing within a defined geographical area of the Prairies. Individuals (n=367) completed baseline questionnaires characterizing lifetime exposure to pesticides. Dermal exposure was defined as a reported pesticide spill on skin or clothing. Inhalation of a pesticide directly into the lungs was the second focus. Conditional questions after a "yes" response assessed the pesticide involved and the year. Details of acute post-exposure illnesses were obtained. We found that (a) 108 (29.4%) people had experienced at least one pesticide spill on skin or clothing (herbicides: n = 62, 16.9%, insecticides: n = 34, 9.3%), fungicides: n = 4, 1.1%, class unknown: n = 21, 5.7%); (b) 64 (17.4%) had accidental inhalation exposures, (herbicides: n = 22, 6.0%), insecticides: n = 41, 11.2%, fungicides: n = 2, 0.5%, class unknown: n = 10, 2.7%). Given the variety of potential toxic, teratogenic and carcinogenic effects of specific pesticides, accidental dermal and inhalation exposures may be important to assess. (*Eco-Research Program, Tricouncil Secretariat of Canada).

Poster presented: Canadian Society of Epidemiology and Biostatistics, Vancouver, May 1999.

P-47

THE PRAIRIE ECOSYSTEM STUDY (PECOS): DRINKING WATER QUALITY

McDuffie, H.H., K.M. Semchuk, R. Kerrich, A.J. Cessna, D.G. Irvine, A. Senthilselvan, D.L. Ledingham, V. Juorio, P. Hanke, L.M. Hagel, M.L. Masley, J.A. Dosman, and M. Crossley

University of Saskatchewan, Saskatoon, SK • CANADA

As part of an integrated, multidisciplinary study of the land, the biota, the communities, and the people in a semi-arid region of the Canadian Prairie, participants provided 181 samples of drinking water from their homes. The water sources were community based (ground and surface waters) and private wells. Potential contamination of water sources is a concern in some communities. We conducted chemical elemental analyses using inductively coupled plasma mass spectrometry (ICP-MS). Quantification of the concentration of forty-four chemical elements in parts per billion was included in the assay. We grouped the elements into (a) those nine tested for which there are municipal drinking water objectives (boron, chromium, arsenic, selenium, cadmium, barium, mercury, lead, uranium), (b) those with known or suspected human toxicity, teratogenicity or carcinogenicity in sufficient concentration (chromium, nickel, copper, zinc, arsenic, selenium, strontium, molybdenum, cadmium, antimony, barium, mercury, lead, thorium, uranium) and (c) those present in high concentration in samples of herbicides supplied by area farmers. We found large variations in concentrations defined by the range within the 90th percentile of log transformed values for nickel, copper, zinc, selenium, strontium, molybdenum, antimony, barium and lead. The municipal objectives were exceeded in a proportion of samples for selenium and lead. Each family will receive individualized reports on their water quality, and a summary including explanations of the findings. Eco-Research Program, Tri-Council Secretariat of Canada.

Poster presented: The Canadian Society for Epidemiology and Biostatistics, Boston, 1998 and The Fourth International Symposium: "Rural Health and Safety in a Changing World", Saskatoon, October 1998.

P-48

THE PRAIRIE ECOSYSTEM STUDY (PECOS): ENVIRONMENTAL PESTICIDE EXPOSURE AND HUMAN HEALTH: CHARACTERIZATION OF EXPOSURE BY QUESTIONNAIRES

McDuffie, H.H., K.M. Semchuk, A. Cessna, D.G. Irvine, A. Senthilselvan, A.M. Rosenberg, M. Crossley, J.A. Dosman, P. Hanke, V.A. Laxdal, Holfeld L. Ledingham, L. Hagel, and M. Masley

University of Saskatchewan, Saskatoon, SK • CANADA

Our aim was to characterize the short term health effects of environmental and occupational pesticide exposure using multidisciplinary, community-based methodology. Residents of three rural communities were invited to participate in neuropsychological and pulmonary function tests, to donate blood samples to permit evaluation of immune function and pesticide levels, and to complete extensive questionnaires. On the basis of questionnaire responses at baseline, individuals were defined by their occupational pesticide exposure history as **A:** pesticide applicators, (n=177) **B:** family members of applicators (n=130) and **C:** others (n=69). Members of any group may have mixed or applied pesticides for use in their home or garden. Among applicators, lifetime use of herbicides (86%) was more frequent than insecticides (78%) or fungicides (59%). The most commonly used chemical classes of herbicides were phenoxyacetic acids, carbamates, organochlorines, trifluralins, glyphosate and organophosphorus compounds and among insecticides: carbamates, organochlorines and organophosphates. Accidental spills on skin and/or clothing (50% of applicators) and accidental inhalation into the lung (30%) were frequent. Characterization of exposure to pesticides by questionnaire is the conceptual link between baseline and repeat measurements of neuropsychological, pulmonary and immune function and of pesticide levels in blood. The Ecoresearch Program, Tri-Council Secretariat of Canada.

Poster presented: The Canadian Society for Epidemiology and Biostatistics, London, Ontario, 1997 and The Fourth International Symposium: "Rural health and Safety in a Changing World".

P-49

PRAIRIE ECOSYSTEM STUDY (PECOS)*: ACCIDENTAL OCCUPATIONAL DERMAL AND INHALATION EXPOSURES TO PESTICIDES BETWEEN BASELINE (FEBRUARY 1996) AND RETEST (JUNE 1996)

McDuffie, H.H., K.M. Semchuk, A.J. Cessna, D.G. Irvine, D.L. Ledingham, P. Hanke, M.F.O. Crossley, A. Senthilselvan, J.A. Dosman, and A.M. Rosenberg
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In February 1996, we obtained self-report information by questionnaire that characterized lifetime pesticide exposure for men, women, and children living in a defined geographical region of the Prairies. In June, we conducted in-person interviews with 250 individuals using a structured questionnaire. Ninety-eight people had applied at least one pesticide at work during the interval; 74 were family members of applicators and 78 were neither pesticide applicators or family members of applicators. Among the pesticide applicators, 49 (50.0%) had experienced at least one accidental spill on their skin or clothing and 58 (59.2%) had inhaled a pesticide directly into the lung during the interval. There were 57 spill and 85 inhalation incidents. Fourteen applicators (14.3%) reported feeling ill within 24 hours of using pesticides. Herbicides and

fungicides were the most frequently reported pesticide classes involved in spill, inhalation and illness incidents reflecting the pattern of seasonal use. Between the baseline and retest dates, 80.6% of the applicators used herbicides, 30.6% insecticides and 66.3% fungicides at work. Reports of accidental dermal and inhalation exposures to pesticides were common in those applicators who were exposed to a variety of pesticides, some of which have known potential health risks. (*Ecosystem research Program Tricouncil Secretariat of Canada).

P-50

HISTORIC AND PRE-HISTORIC MERCURY CONTAMINATION IN CLEAR LAKE (CA) AS DEDUCED FROM SEDIMENT CORES

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Total (primarily inorganic) mercury (totHg) and methyl mercury (meHg) were measured in sediment cores (ca. 250 cm long), spanning a temporal sequence of ca. 150-250 years, from Clear Lake, California. Dates for the first 100 years were estimated using ²¹⁰Pb. A small increase in totHg (about 0.1 ppm) above background occurs in most cores at 100-150 cm depth, which approximates the onset of cinnabar mining in 1872 at the Sulphur Bank Mercury Mine, located along the shoreline of Clear Lake. Shaft mining, prevalent till around the 1920s, did not appear to cause significant elevated totHg or meHg in Clear Lake sediments. However, open pit mining, initiated in the 1920s, with the use of mechanized earth moving equipment, increased both totHg and meHg by a factor of 30 above pre-mining levels, yet these sediment concentrations have dropped only slightly since the mine closed in 1957. Interestingly, there was also a pre-1872 increase in totHg (but not in meHg) in two cores retrieved in the Oaks arm (close to the minesite) and in the Lower Arm. We hypothesize that inorganic Hg deposited prior to mining was either mostly unavailable for methylation or was deposited from below after the sediments were buried too deeply to allow significant microbial methylation to occur. We believe that most biologically available Hg was introduced into the Clear Lake aquatic ecosystem only after the initiation of open pit mining, possibly by geothermal fluids pumped out of the open pit for logistical purposes, or inadvertently through acid mine drainage from the mine site into the lake. For the post-1872 strata in any given core, we found that meHg maxima roughly coincided with totHg maxima.

P-51

ANTHROPOGENIC IMPACTS ON ECOSYSTEMS—
METHODOLOGICAL APPROACH FOR AN ASSESS-
MENT STARTING AT ECOSYSTEM FUNCTIONING

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Ecosystems are influenced by agricultural production which releases material and non-material emissions into the surrounding environment. In order to relate emissions from agricultural production and affected ecosystems we have presented a methodological approach earlier. This paper aims at testing this approach by means of a case study. In a first step ecosystemic effect indicators shall be developed for the agroecosystem itself. Later these indicators shall be transformed into decision criteria for farmers to enable ecologically sustainable production. The ecosystemic effect indicator approach relates an emission and an ecosystem by combining top-down and bottom-up approaches. This allows to identify specific indicators for different production systems. At the same time the indicators depict relations between cause and effect regardless of the hierarchical level of the ecosystem on which they are identified. The approach starts top-down at ecosystem functioning to guarantee the health of the system encompassing the so called utility functions, represented by the equation $EF = f(RF + HF + IF = PF)$ and their determining characteristics. RF is the regulation function, HF is the habitat function, IF the information function and PF the production function. The functions are described by different characteristics located on different hierarchical levels. Bottom-up different receptors for the effects of an emission are identified. These are potential effect indicators. By connecting the characteristics of each function with the potential effect indicators intersections are searched and ecosystemic effect indicators are identified. Decisive is thereby to look at intersections between the frequency of a disturbing input and the temporal sensitivity of a potential effect indicator. Ecosystemic effect indicators for functions of an agroecosystem have been developed being indicative at different hierarchical levels of the ecosystem. The data used in the case study was measured in an area of South-western Germany. The poster submitted will demonstrate the approach by the example of nitrogen. Our results suggest that ecosystemic effect indicators appear to be an aid for assessing anthropogenic impacts, especially agricultural inputs on ecosystems. Moreover they provide information to assess loading capacities of ecosystems.

The work is part of the project "Sustainable Production and Utilization of Energy Crops", funded by the German Environmental Foundation (Deutsche Bundesstiftung Umwelt).

P-52

INDEXING SOIL QUALITY IN CALIFORNIA'S
CENTRAL VALLEY

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Various conceptual frameworks for assessing management impacts on soil health have been proposed, but they have not been tested under a wide range of soil quality indicators is an approach developed by Karlen and Andrews at the USDA National Soil Tilth Lab that is being used to analyze and interpret data sets of soil quality indicators from two established comparisons of different soil management practices in California: the Sustainable Agriculture Farming Systems Project in the Sacramento Valley and the Biologically Integrated Farming Systems Project in the San Joaquin Valley. The index, developed with indicator data from each project, is being compared to farmers' experience-based descriptive knowledge and to assessments of soil quality using additional analytical measurements of key soil quality indicators. The soil quality index may serve as a tool to guide soil and crop management practices, thus helping to improve soil quality while sustaining or enhancing productivity in these regions.

P-53

IN SEARCH FOR AN INTERDISCIPLINARY SPATIAL UNIT
FOR AGRICULTURAL LAND USE PLANNING AND
POLICY ANALYSIS: CONCEPTUALIZATION AND
OPERATIONALIZATION

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While natural resource problems are rooted in physical and biological sciences, they are driven by human behavior. Typically, agricultural planning requires understanding interactions among socio-economic and bio-physical processes. These interactions suggest some of the utility of integrated, interdisciplinary framework for understanding natural resource problems. The theoretical importance of this "integrated interdisciplinary" approach in agricultural planning is now well recognized but applications are still hampered by major obstacles which render difficult the integration process. Currently, it is not clear how to facilitate such an integrated approach, but it is perceived that an initial step is to create an integrated interdisciplinary unit of analysis. In the realm of agricultural planning, many conceptual and methodological constraints make creating an integrated unit a difficult task. In this paper an attempt is made to develop and operationalize a conceptual and

methodological framework that remove these constraints in search for finding an integrated interdisciplinary unit. The paper can be divided into four main parts. The first part analyses and explores the challenges that stand in the way of defining an integrated unit. In the second part, the concept of the “integrated unit” is developed. Methods and procedures for operationalizing this concept are described and presented in the third part. And finally, in the fourth part, the concept of the integrated unit is compared with the concepts of disciplinary units.

P-54

EFFECTS ON TROPICAL FISH OF SOIL SEDIMENTS FROM KAFUE RIVER ZAMBIA

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The Kafue river, an important tributary of the Zambezi river is located in a highly exploited area in the Copperbelt region of Northern Zambia. Mining and other industrial activities are highly concentrated in this part of the river. Copper and Cobalt production is important especially at the city of Kitwe and the surrounding areas. Other minerals mined are Zinc, Lead and Gold, although in smaller quantities. River sediments may serve as a trap for various anthropogenic pollutants including metals, and some metals e.g. Copper and Cobalt is present in high concentrations in fish caught in the Copperbelt area (Mwase et al master thesis 1994). In reproduction, early life stages are very sensitive steps in the animal life circle. Many studies examining sensitivities of early life stages have revealed that larval stages are the most sensitive to Copper. In the present study, sediments from environmentally different localities of the Kafue river were toxicologically evaluated by microtoxicity bioassay and by different test systems of three species of tropical fish.

P-55

ENVIRONMENTAL CYCLING OF CHROMIUM

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Seven soil samples were taken from the Yolo Bypass and characterized in order to determine whether the Yolo Bypass is potentially a significant non-point source of Cr(VI). Samples were taken from two locations and partitioned by depth, 0-15cm, 16-30cm, 31-45cm, 76-90cm, 91-107cm. Chromium(VI) concentrations of the soils ranged from 50 to 209ng/g with concentration tending to increase with depth. All samples showed significant pools of easily oxidizable Cr(III), 33-47mg/g. When analyzed for their ability to oxidize added solutions of Cr(III), all seven samples showed significant oxidizing capacity, 5.3-17.2mg/g.

P-56

INDICATOR DEVELOPMENT FOR NATURE POLICY ASSESSMENT IN THE NETHERLANDS

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Nature Policy Assessment Office, RIVM/DLO,
Bilthoven • THE NETHERLANDS

Holding an independent and scientific position, the Nature Policy Assessment Office points out actual state of landscape and biodiversity, assesses the impact of current national policies, and strategically surveys both the opportunities for and the threats to nature in the short and the long term. A limited core set of key indicators should summarise information on national and lower scales in a transparent and significant way and are as such, together with additional information sources, applied in the analysis performed by the office. Indicators are defined from four different perspectives: conservation, man-use of ecosystems, pressures, and societal basis and policy processes. Argumentation of the indicators selected for each of these perspectives is briefly discussed. Within the context of nature conservation biodiversity indicators for natural and man-made areas are distinguished. This is in agreement with the different existing policies and with important differences in human interference's in these two types of areas. In the indicator for biodiversity of natural areas (nature reserves) both the quantity of remaining habitats and their quality is taken into account. The quality of natural ecosystems is being assessed by species abundance's in comparison with baseline situations and policy targets. The discussions about this indicator are now focused on species selection and baseline reconstruction for the different habitat types in the Netherlands. Moreover, we assess landscape diversity by analysing landscape integrity and the geomorphologic and cultural identity. The current man-use of ecosystems will be evaluated by assessing its impact on the sustainable use for future generations and societal needs. Furthermore, pressures on ecosystems are analysed by estimating the reduction of actual natural values compared to potential values. Next to this, an important consideration is the availability and development of models for species abundance in relation to abiotic conditions. Such models make the indicator also useful for scenario analysis.

Finally, we study the public concern to biodiversity and nature protection and the way in which nature and other policies are effective.

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BIO-ECONOMIC MODELING OF WATERSHED RESOURCES

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A major challenge facing agricultural economists working on sustainable agricultural intensification strategies in the developing world is the ability to integrate biophysical and socio-economic information into a coherent analytical framework for analyzing the best development option. This challenge stems from the observation that technological solutions to many problems of unsustainable and stagnant agriculture abound yet they are often not acceptable to most farmers. Bio-economic models offer much promise as the kind of integrative tool required for such analysis. A bio-economic model has been developed for a pilot watershed in the Ethiopian highlands. Both static and dynamic versions of this model are generated to evaluate the interrelationships between poverty, low productivity, land degradation and changes in human welfare indicators. A watershed framework of analysis is employed and interactions and inter linkages among various parts of the landscape are tracked and investigated. In each part of the watershed, specific land use pattern affects the partition of water between run-off and infiltration, evapo-transpiration and recharge and soil and nutrient losses. This makes it possible to compare the consequences of utilizing a finite amount of water and land in different ways e.g. for crops, livestock, trees or other purposes, in terms of soil and nutrient losses, level of agricultural productivity in various parts of the watershed, the income levels of the households and, generally, the change in human welfare over time. In order to operationalise the model, socio-economic and biophysical data from Ginchi watershed were collected at both household and community levels and were supplemented with on farm and on station experimental data. The static model simultaneously optimizes both environmental and economic goals of the watershed for the short run. The dynamic model optimizes an aggregate watershed income function that is indirectly linked to the biophysical aspects of the watershed through a soil erosion-yield decline loop. Both versions of the model employ mathematical programming techniques, taking into account seasonality in input and output supplies, labour substitutability, the various roles of gender, crop and livestock constraints, minimum household food requirements, forestry activities as well as the biophysical aspects of soil erosion arising from these activities. In the dynamic model, a modified Universal Soil Loss Equation (USLE) is used to estimate annual soil erosion from four categories of land found in the watershed. An exponential soil loss-yield model with single year time lags is then employed to link soil losses in one year to yields of various crops in the following year. Costs and the ameliorative effects on yields of organic and inorganic fertilizer application and soil management

techniques employed by farmers are taken into account. The model uses a planning horizon of ten years and enables evaluation of the impact of technology, policy and institutional interventions on the watershed's ecological and economic sustainability.

P-58

FOREST TREE DISEASES AND INSECTS—INDICATORS OF EXOTIC ECOSYSTEMS.

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Man has caused changes in established forest ecosystems such that neither host nor pathogen have had sufficient time to adapt. Anthropogenically caused "exotic ecosystems" may have consequences similar to exotic pest introductions. Both include loss in productivity and greatly increased mortality, except the "exotic ecosystem" occurs with co-evolved host-pathogen relationships. For example, our research indicates *Heterobasidion annosum* biological species in North America (P and S group) have co-evolved with their pine and fir hosts, respectively, and are host specific. Isozyme data and DNA studies also suggest that historically, the P group was not widely distributed. Recent creation of fresh stump surfaces (past 100 years) probably resulted in increased incidence of the P group and current mortality patterns observed in pine at the present time. These events have changed the dynamics of fungus-host interactions yielding a set of pathological consequences that did not occur in the past. In the southern United States, longleaf pine (*Pinus palustris* Mill) is a species that co-evolved with fire. Increased mortality in this species has been associated with relatively low intensity prescribed fires. Also correlated with this fire-associated mortality are *H. annosum* and various *Leptographium* species. Why, in this tree species that co-evolved with fire, is mortality increasing and what are the roles of these pathogens in this ecosystem? Could recent changes in forest management or land use history on certain sites have resulted in exotic ecosystems in which this tree species is maladapted? Answers to these questions have implications with respect to ecosystem restoration and future forest management practices in the context of forest health.

P-59

PRELIMINARY DESIGN OF A REGIONAL SCALE ASSESSMENT OF ECOSYSTEM VULNERABILITY TO PESTICIDES

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The toxicity that makes pesticides useful in agriculture, silviculture, and disease vector and nuisance control also poses potential risks for humans and the environment under certain exposure conditions. The mission of EPA includes the responsibility for solving this policy and regulatory dilemma, and balancing society's short term needs with short and long term environmental and health risks particularly through a process of registering pesticides. Current pesticide risk assessments have focused on the scale of individual agricultural fields, farm ponds, and shelter belts with aggregation by individual crop type and selected communities. However, recent improvements in availability of highly detailed satellite imagery and derivative land use data, combined with the Geographic Information System technology and ancillary data on soils, human population, topography, roads, and streams, make regional scale assessments of environmental vulnerability possible. EPA began exploring the applicability of the principles of landscape ecology to the issue of ecosystem vulnerability in the mid Atlantic Region in 1995, and to assessing vulnerability to pesticides in 1997. The design of a study currently in the planning stages which will evaluate landscape indicators for estimating watershed vulnerability to pesticides will be described.

P-60

HYDROCARBONS TO PROTECT SALT-WATER AQUATIC LIFE AT NAVAL FACILITIES IN SAN FRANCISCO BAY

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Soils and groundwater affected by petroleum hydrocarbons are common at U.S. Navy facilities in San Francisco Bay. These facilities are undergoing site investigations and feasibility studies for cleanup prior to transfer for civilian reuse. Strategies for setting cleanup criteria include literature standards, regulatory standards, ecotoxicity testing, aliphatic and aromatic risk assessment, and negotiations. These criteria may accepted "as is" or may modified by accounting for location such as soil depth and processes such as dilution attenuation processes for groundwater. Several case studies will be presented.

P-61

CONSERVATION OF FOREST GENE RESOURCES IN RUSSIA

Prokazin, Andrey, and Iliodor Rukovsky

Russian Tree Breeding Centre,
Moscow, Russian Federation • RUSSIA

State policy • National programme • *in situ* and *ex situ* activities • Problematical regions and species • Research priorities • database • participation in all-European programme perspective.

P-62

WATERSHED RESTORATION AND COASTAL TIMBERLANDS

Rae, Stephen P.

California Dept. of Fish and Game, Watershed Restoration Branch, Sacramento, CA • USA

The California Department of Fish and Game has reorganized its program for watershed restoration and monitoring of timer harvest operations within private coastal timberlands.

P-63

A HIERARCHICAL APPROACH TO THE STUDY AND MONITORING OF ECOSYSTEM HEALTH

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Accelerating human activities have profoundly influenced the integrity of ecosystems throughout the world, and ecosystem health is becoming a central issue in ecology and environmental science. Ecosystem health refers to the level of an ecosystem being active, maintaining its organization and integrity, performing its functionality, and exhibiting temporal stability. Several disciplines in ecology provide the scientific basis for understanding ecosystem health, including molecular ecology, physiological ecology, population ecology, community ecology, ecosystem ecology, landscape ecology. However, the concept, ecosystem health, has often been regarded as being too broad and vague for real-world evaluation and management purposes. Of recent concern is the need to integrate the insights that are offered from the different fields of ecology and related disciplines. Apparently, a comprehensive and practical concept of ecosystem

health may serve as a step toward this goal. We propose a hierarchical concept of ecosystem health which explicitly recognizes that ecosystem health can be and should be studied or monitored at multiple organizational levels and across spatial and temporal scales. We define ecosystem health in terms of four primary ecosystem attributes: structure (composition and arrangement), function (energy flow and material cycling), dynamics (temporal change in structure and function), and services (benefits supplied to human societies). The four attributes can be placed into a nested hierarchy that incorporates elements of each at four levels of organization: genetic, species-population, community-ecosystem, and regional landscape-globe. Indicators for each attribute at the four levels of organization are identified for evaluating and monitoring ecosystem health. Considering the nature of the nested hierarchy, we advocate a top-down approach which allows more holistic and comprehensive evaluation of the health status of ecosystems.

P-64

THE ASSOCIATION OF LAND USE/LAND COVER AND NUTRIENT LEVELS IN MARYLAND STREAMS

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¹PAI-SAIC

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To investigate the relationships between stream chemistry, habitat, and land use maps for the state of Maryland.

Anthropogenic nonpoint sources of nutrients are known to cause accelerated eutrophication of estuaries. The Chesapeake Bay is one of the world's largest estuaries exhibiting eutrophication problems caused by pollution from various land use activities. The sources contributing to this include streams, atmospheric deposition and direct loading to the bay. This study was focused on the sources to the stream. Spatial and statistical analyses were conducted to investigate the relationships between field measurements of stream chemistry (nitrate, sulfate, dissolved organic carbon, etc.) habitat, and satellite-derived land use maps for the state of Maryland. Hydrologic Unit Code (HUC) watershed boundaries (8-digit) were used as the basis for grouping stream chemistry data. Arc/Info was used to compute percent land cover area (forest land, crop land, pastureland, etc.) within a HUC. The percent-agricultural lands (crop, pasture etc.) were significantly and positively correlated with nitrate (NO_3) and dissolved organic carbon (DOC) while percent-forest cover was significantly and negatively correlated with NO_3 and DOC. These results were in agreement with other reports and with the fundamental understanding of the role of the land cover types in chemical loadings to the streams. The percent-forest and percent agriculture land use displayed opposite signs in the correlation matrix with stream chemistry

data, including sulfate and pH variables. Although there was a negative correlation between percent-forest and NO_3 in the streams, this was likely due to a reduction in the area occupied by agricultural lands, a predominant source of NO_3 , not the amount of forest area. This was further supported by the presence of a negative correlation between percent-forest area and percent-agricultural area. These analyses indicated that agriculture was the main source of NO_3 pollution in Maryland streams. The next step in this study should lead into investigation of the point sources leading to the chemical loadings to the streams.

P-65

DEVELOPMENT OF IMMUNOASSAYS FOR THE DETECTION OF PYRETHROID INSECTICIDES ESFENVALERATE AND PERMETHRIN IN WATER SAMPLES

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Two competitive enzyme-linked immunosorbent assays (ELISA) were developed for the detection of the pyrethroid insecticide esfenvalerate and permethrin. Through careful hapten design and preparation, extensive studies with various antibody-antigen combinations, assays for esfenvalerate or permethrin were optimized and characterized. The I_{50} for esfenvalerate and permethrin were 25 ± 5.2 ppb and 5.0 ± 0.85 ppb, respectively. Tested with water samples after a solid phase extraction step, the lower detection limits for esfenvalerate and permethrin were 0.01 and 0.005 ppb, respectively. A GC-MS method, which could detect cis-permethrin, trans-permethrin, esfenvalerate and R,S-fenvalerate at the same time, was developed for assay validation. A good correlation between concentrations measured by GC-MS and ELISA was observed for both esfenvalerate and permethrin assays. These assays could play an important role in environmental monitoring and toxicological studies.

P-66

FISH CONSUMPTION PRACTICES OF ONTARIO ANGLERS IN POLLUTED AREAS OF THE GREAT LAKES

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It is estimated that over 4.7 million people in the United States and Canada consume fish caught from the Great Lakes. Great Lakes' biota contains toxic substances such as PCBs, dioxins, and mercury. Pollution in the Great Lakes has been linked to birth defects, decreased reproductive success and death in wildlife. Consumption of Great Lakes sport caught fish by area residents has been associated with neurobehavioral effects and shortened menstrual cycle length. To protect those who eat sport caught fish provincial and state governments issue fish consumption advisories. Our understanding of the behavior of those who eat these fish is limited. This poster will report on a study conducted in Ontario to better understand anglers who fish in 5 polluted areas on the Great Lakes (Toronto, Hamilton, Niagara, Detroit River, and St. Clair River). From 1995 to 1997 trained interviewers approached people fishing along the shore in the above 5 locations. The interviewers administered a standardized questionnaire to over 6,400 anglers. Information was obtained including: the amount of fish consumed by species by season; fish consumption practices; fishing experience; knowledge and use of the provincial fish consumption advisories; perception of fish as a hazard; consumption of other aquatic wildlife; and basic demographic information. The results of our ongoing analysis will contain information on what distinguishes anglers who eat fish from those who do not, characteristics associated with quantitative fish consumption and compliance with fish advisories.

P-67

WATERSHED-SCALE ANALYSIS AND LAND-USE PLANNING IN THE SIERRA NEVADA

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Sierra Nevada Network for Education and Research, University of California, Davis, CA • USA

There has been an increasing emphasis in land-use planning on the watershed as a regional unit on which to focus. Inter-agency cooperative agreements and ad hoc watershed groups

have defined the decision-making landscape at this scale. Funding has been sought and received for a variety of planning and restoration activities and less often for comprehensive monitoring of conditions. We have used geo-spatial analysis to map various conditions in the Sierra Nevada at the watershed scale on public and private lands. CALWATER boundaries (The Resources Agency) were used to delineate boundaries at various scales ("river basin units" to "planning watersheds"). The density of roads was mapped per planning watersheds for the entire Sierra Nevada. A single watershed (Yuba River) was also chosen for more detailed analysis of road occurrences in relation to natural features (streams) and within the various vegetation community types. This type of assessment provides a "first cut" for evaluating landscape conditions within watersheds and can inform transportation and development planning, and decision-making regarding land set-asides and acquisition. Monitoring of ecological and socio-economic conditions can be used to "ground-truth" and give a temporal dimension to these spatial analyses.

P-68

AQUATIC BIOMARKER RESEARCH: WHERE WE VE BEEN AND WHAT IS NEEDED TO INCREASE AQUATIC/MARINE ENVIRONMENTAL MONITORING

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Worldwide aquatic/marine environments, especially those surrounding large urban centers, are increasingly impacted by human activities (stressors such as pollutants). Traditional approaches to monitor species level effects of environmental stressors have focused most heavily on bioconcentration and overall lethality measures. Recent years have brought new emphases on defining the potential significance of stressors such as anthropogenic chemicals on ecological and biological scales. Many methods have concentrated on the examination of one or more measures of organismal physiological/biochemical response, commonly referred to as biomarkers. Among the biomarkers receiving increased attention are enzymes such as cytochrome P450 and glutathione S-transferase, membrane transporters such as the multi-xenobiotic resistance protein, and heat shock or stress proteins. These proteins are grouped into two major categories: Those involved in protecting from the effects of a stressor and those involved in repairing damaged intracellular proteins that result from the exposure. Much effort is required to delineate the relationships between the severity of various biomarker effects and their subsequent relationships to an individual's ability to survive and reproduce. Ultimately, these measures of individual responsiveness will provide clearer pictures of higher level effects on populations, communities, and whole ecosystems. In this presentation, these emerging methodologies in molecular and cellular techniques will be discussed in light of what we hope is the future of organismal monitoring approaches in the aquatic environment.

P-69

TISSUE SPECIFIC AND DEVELOPMENTAL EFFECTS OF *IN VIVO* TCDD EXPOSURE IN FEMALE CHICKENS

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Twenty-one week old Rhode Island Red hens were treated with 100 mg/kg body weight TCDD or equal volume of the corn oil vehicle for 24 hours to determine the effect of exposure on cellular function and signal transduction pathways. Liver, adipose, and ovarian tissues were collected and analyzed for glucose transporter, lipoprotein lipase, and cellular signaling protein kinases that are well-characterized as targets for TCDD in mammals. Specifically we focused on two important components of signaling protein pathways: 1) tyrosine kinase, an upstream signaling protein that mediates cytosolic signals in response to changes in epidermal growth factor receptor (EGFR) and 2) ERK2, one of the MAPK family members that can transduce from cytosolic to nuclear signal, activates the transcriptional activity of several transcription factors including early response genes and their protein complex AP-1, and phosphorylates and activates the estrogen receptor. Birds treated with TCDD *in vivo* exhibited decreased ³H-cytochalasin B binding in both liver and ovarian tissue and decreased lipoprotein lipase activity in adipose tissue but not ovarian tissue. Ovarian tissue from treated birds also showed decreased amounts of the ERK2 enzyme. TCDD exposure also altered profiles of tyrosine phosphorylation and binding to DNA response elements for glucocorticoid receptor, AP-1, and cyclic AMP.

P-70

RESEARCH ON SEDIMENT DELIVERY DYNAMICS FOR THE PRIORITIZATION OF RESTORATION EFFORTS AT LAKE TAHOE

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University of California, Davis, CA • USA

Several hundred million dollars will be spent on restoration efforts in Lake Tahoe watersheds over the next few decades to preserve the famous clarity of the Lake. This poster presents research on sediment source areas and sediment delivery dynamics undertaken to prioritizing these restoration efforts.

P-71

EFFECTS OF ACID MINE DRAINAGE DERIVED FLOC ON NET METHYL-MERCURY PRODUCTION FROM CLEAR LAKE SEDIMENTS

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Chemical and biotic interactions at the sediment-water interface are known to regulate the production of bio-accumulating methylmercury in aquatic ecosystems. In Lake County, California, the Sulphur Bank Mercury Mine (SBMM), an EPA Superfund site, is presumed to be a source of mercury, sulfate, and acidic water input into Clear Lake and may therefore affect sediment biogeochemistry and methylmercury production. In a microcosm experiment, we assessed the effects of a laboratory-made flocculent precipitate (“floc”), derived from acid mine drainage from the SBMM, on sediment collected from three sites in Clear Lake which vary in physical properties (i.e. mercury concentration, organic carbon concentration, grain size). The overlying water in each core was sampled with replacement for methylmercury analysis after 7 and 21 days of incubation. Addition of floc to sediment cores had strong effects on net methylmercury production (repeated-measures ANOVA: $F = 8.79$, $d.f. = 14$, $p = 0.0103$), producing 4 to 80 times more methyl-mercury (0.80–8.12 pptr) in cores from all sites than in untreated control cores (0.04–0.15 pptr) at day 21 of the experiment. Net methylmercury production in cores from a site which receives re-occurring mine inputs exceed that of treated cores. These cores containing natural floc exhibited highest concentrations at day 7 (16 pptr), suggesting exhaustion of a limiting factor (e.g. sulfate). Cores with no sediment had uniformly low methylmercury concentrations (0.035 pptr) throughout the experiment, and exhibited no response to floc addition. Variation in the total amount of methylmercury produced in the presence of floc is largely explained by the organic carbon content of the underlying sediments ($R^2 = 0.94$). Our results demonstrate that acid mine drainage from the Sulphur Bank Mercury Mine may potentially have strong effects where floc interacts with Clear Lake sediments.

P-72

TEACHING ECOSYSTEM HEALTH

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This poster will represent the Canada European Community Programme For Cooperation In Higher Education and Training, led by Donald E. Buckingham from the University of Saskatchewan. The consortium will comprise six institutions specializing in agricultural science, law and international trade and will jointly develop and deliver a curriculum exploring the interdisciplinary aspects of sustainable agriculture practices. The curriculum will be delivered via distance learning and faculty/student exchanges. Academic staff will provide instruction to mobil and non-mobile students through the development of ten teaching modules. Dr. David Rapport and two graduate students were responsible for the first module "Agroecosystems and Sustainable Agriculture" at the University of Guelph. This module will focus on the sustainability issues in agriculture and agro-ecosystem health. The poster will display our teaching module.

P-73

A CONCEPTUAL MODEL OF PATTERNS AND PROCESSES OF RIPARIAN WOODLANDS FOR LANDSCAPE INDICATOR DEVELOPMENT

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NV • USA

Models are fundamental tools of ecosystem research and analysis. A comprehensive ecosystem model should delineate all known biotic and abiotic components and processes, both natural and anthropogenic, and identify the interactions between these components. Even though conceptual models, in themselves, are lacking in rigor, they do provide the setting for subsequent mathematical models and computer simulations. The conceptual model is central to understanding integral biogeochemical, ecophysiological and micrometeorological components, processes and patterns and should organize a system such that the components, processes and patterns can be translated into computer programs, equations and algorithms. In addition, the conceptual model is the first step towards identifying and selecting riparian landscape indicators. This poster describes a conceptual model of low-elevation, arid, riparian indicators. Developing a set of landscape indicators from measurements of riparian patch patterns and geometry verified against associated aquatic systems will provide information about the overall ecological condition of the watershed and improve understanding of

environmental risk. These indicators will be derived from the spatial patterns and geometry of riparian patches. Foremost is the hypothesis that emerging patterns in the riparian landscape are produced by natural (flooding) and anthropogenic (e.g., livestock grazing, soil compaction, hydrological modifications) disturbances and by delineating the patterns we can identify and quantify the condition of the ecosystem. Ultimately these landscape indicators may enable detection and assessment of southwestern woodlands with limited ground truthing.

P-74

THE ASSESSMENT OF BREAD AS PART OF ASSESSING THE ECOLOGICAL IMPACT OF DIFFERENT DIETARY HABITS

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About one fifth or 260 million metric tons of the yearly CO₂-emission in Germany is contributed by the sector nutrition (Kjer et al. 1994). In the scope of the sustainability debate Germany committed to reduce its CO₂-output by 25% (basis 1990) until the year 2005 (Enquete-Kommission 1998). To achieve this goal, reduction of man-made CO₂-production is necessary in all areas of life, also in the section nutrition. Therefore an evaluation showing to which extent specific dietary habits contribute to the nutrition related CO₂-production is of importance. A prerequisite for this is to investigate the ecological impact of staple foods such as bread. It is one of the basic foods in Germany with an average consumption of 45 kg per person and year according to the German National Consumption Study (Adolf et al. 1995). The objective of this paper is to show the contribution of a single food item to the overall CO₂-production and other environmental indicators to the sector nutrition when its complete life cycle is assessed from cradle to grave. By choosing a modular approach, inventories of the processes are calculated per kilogram bread. Besides the CO₂-equivalents, the ecological impact is evaluated with indicators such as nitrogen, phosphorus and pesticides. The agricultural production (organical as well as conventional), food processing (milling to different degrees of refining, bakery), trade and transportation are taken into account. This method enables to make statements about the ecological impact of an important staple food. The same method can be used for further foodstuffs, the whole nutrition system and finally the comparison of the ecological impact of different dietary habits.

P-75

CHRONIC TOXICITY OF CHROMIUM VI IN ASIAN CLAM (*POTAMOCORBULA AMURENSIS*): A BIOCHEMICAL, IMMUNOHISTOCHEMICAL AND HISTOPATHOLOGICAL APPROACH

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Three replicates of Asian clam (*Potamocorbular amurensis*) were bath-exposed to 0.00-, 0.92-, 8.40-, and 25.6-ppm of chromium-VI at 150 Western blot analyses revealed significantly elevated stress protein HSP70 levels in 8.40-ppm group. Histopathologic analyses revealed mild digestive gland (DG) atrophy in 0.00-ppm group. In 0.92-ppm treatment, lesions observed were moderate DG atrophy, moderate granulomatous inflammation and necrosis in DG, ovary and testis. In 8.40-ppm treatment, lesions observed were severe DG atrophy, severe granulomatous inflammation and necrosis in byssal gland, DG, gill, kidney, ovary and testis. Gills and testes of treated groups showed greater apoptoses than mitoses. Gills of 8.40-ppm treatment showed enhanced HSP70 staining. No staining differences in metallothionein between control and treatment groups. These results indicate cause-effect relationship and that the digestive gland, gill and reproductive organs are the principal targets of chromium-VI toxicity at sublethal concentration.

P-76

INTEGRATED METHODOLOGY TO PREDICT THE POTENTIAL IMPACT OF RECYCLED AND WASTE MATERIALS ON ECOSYSTEM AND HUMAN HEALTH

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A variety of recycled and waste materials (RWMs) are being proposed as construction and repair materials in transportation industry. There are concerns about their effects on ecosystem and human health due to constituents that migrate from the roadbed through surface and groundwater. The objective of this study was to develop a novel methodology integrating both biological and chemical assessment of RWMs and to develop a predictive model. This methodology will be of use to transportation agencies, consultants, contractors, waste material suppliers and health officials to properly assess the suitability of using RWMs transportation applications. The methodology development was planned in three phases. Phase I, resulted in screening a spectrum of RWMs including crushed concrete, MSW

incinerator ash, asphalt binders, fly ash, ACZA pressure treated wood, industrial waste slags, mine tailings, deck sealers and scrap tires for ecological risk and human health assessment. Phase II, evaluation of leaching characteristics of RWMs and ameliorating effects of sorption and other environmental factors were accomplished. A predictive model was also developed in this phase. Phase III (in progress), focuses on the validation of the methodology and further modeling enhancements and testing.

P-77

GEOGRAPHIC VARIATION OF NOTIFIED ROSS RIVER VIRUS INFECTIONS IN QUEENSLAND, 1985-1996

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The objective is to assess the geographic variation of notified Ross River virus infections in Queensland between 1985 and 1996. The notified cases of the Ross River virus infection came from 489 localities between 1985 and 1988, 805 between 1989 and 1992, and 1,157 between 1993 and 1996 ($T = 10.3$; $p < 0.01$). There was a marked increase in the number of localities where the cases were reported by 65 percent for the period of 1989-1992 and 137 percent for 1993-1996, compared with that for 1985-1988. The geographic distribution of the notified Ross River virus cases has been expanded in Queensland over recent years. As Ross River virus disease has impacted considerably on tourism and industry, as well as on residents of affected areas, more research is required to explore the causes of the geographic expansion of the notified Ross River virus infections.

P-78

HYDROGEOLOGIC PROCESSES RELATED TO ECOSYSTEM FUNCTION IN THE TAHOE BASIN

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Knowledge of the magnitude of groundwater flow is essential in determination of the significance of groundwater flow to the

water budget of an ecosystem, and of the magnitude of ground-water-delivered pollutant and nutrient fluxes to and from an ecosystem. A water budget was estimated for Pope Marsh, located off the south shore of Lake Tahoe. Lake water and marsh water were found to communicate via groundwater. Thus the level of Lake Tahoe was found to be a key factor in the water balance of the marsh, and consequently in the health of the marsh ecosystem. Additionally, low levels of MTBE were detected in two shallow monitoring wells. The evidence strongly indicates that Lake Tahoe surface waters have been a source of MTBE in Pope Marsh. An improved estimate of the water budget for Lake Tahoe would better constrain the magnitude of the groundwater component, and thus the importance of groundwater in delivering nutrients and other dissolved substances to the lake. In evaluating the water budget of Lake Tahoe, perhaps the largest source of systematic uncertainty has been in estimates of evaporation from the lake surface. Data pertaining to evaporation from Lake Tahoe is evaluated and assessed. A revised estimate of the evaporative component is used in an updated water budget estimate for Lake Tahoe. Results suggest that Lake Tahoe may be a net groundwater losing lake. Possible routes and conditions necessary for such groundwater loss are investigated, in conjunction with flow modeling. Groundwater flow patterns are of particularly urgent public concern in the southern portion of the Lake Tahoe Basin, where many point sources of MTBE contamination of groundwater have been documented. The consequences of this contamination on area ecology may result primarily from altered pumping patterns and new pumping sites, driven by public demand for MTBE-free drinking water. Future work will be directed toward geostatistical modeling of the aquifer in the southern portion of the Lake Tahoe Basin. Such geostatistical modeling should result in improved delineation of ground water flow and contaminant transport in the area, and the impact of pumping on flow and transport.

P-79

MANGROVES OF VIETNAM: REHABILITATION, CONSERVATION AND RESTORATION

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Large areas of mangroves have been converted to agriculture and, in particular, to shrimp aquaculture, causing ecological disturbance and enhancing instability in the coastal physical environment. The total mangrove area of Vietnam has been in decline in the second half of this century. One aspect of ecosystem management widely practiced in coastal Vietnam, namely mangrove restoration, undertaken to enhance and restore local environments as well as to benefit local populations. Mangrove restoration enhances the resilience of ecosystems at the landscape scale through enhancing species and functional diversity of suitable coastal regions. In addition, such practices enhance social resilience of the coastal

population. Photos illustrate the economic benefits to local populations. This poster is used to demonstrate the reinstating mangroves can be a desirable activity both from the local perspective and in buffering coastal regions from the impacts of coastal flooding. Thus the direct economic benefits and the environmental benefits of enhanced coastal protection, also enhance the adaptability and resilience of these coastal populations. It would appear that mangrove planting is an example of a 'win-win' activity in the case of present day coastal landscapes and communities in improving the livelihood of local resource users as well as enhancing sea defense. In the context of climate extremes, adaptation must involve identifying such 'win-win' situations in which action to reduce future risk also minimizes vulnerability in the present-day.

P-80

THE ECOSYSTEM APPROACH TO BIODIVERSITY CONSERVATION IN A UK RIVER SYSTEM

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Recent research suggests that regional land use is the primary determinant of stream conditions. The conservation benefits of ecological restoration at a local scale may therefore be negated by management activities in larger areas of the catchment. As yet, no study has investigated whether management at the local scale (stream-riparian) impacts on the biodiversity of the stream, and whether the magnitude of the impacts are affected by changes within a larger area of the catchment. The question still remains as to whether local or landscape management is more important for biodiversity conservation in river systems. The poster will explore the following:

- The effects on biodiversity of restoration management at a local scale.
- The importance of wider land use to local stream riparian restoration efforts.

P-81

ANIMAL POPULATION DENSITY AS AN INDICATOR OF PUBLIC AND ECOSYSTEM HEALTH

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In Southwestern Ontario overall livestock production has decreased, but the per farm animal density has increased. One major environmental impact of increased livestock density is increased manure load, which results in nutrient and bacterial contamination of the ecosystem. Cattle manure used as fertilizer on crops or deposited on pastures, has the potential to contaminate stream, ground, and recreational waters, as well as crops used for human consumption. The potential for bacterial infection also exists with close contact of workers with host animals. Michel (1997) found that cattle density is a significant predictor of vero-cytotoxigenic *Escherichia coli* (VTEC) incidence in Ontario. Sources of bias include dilution or amplification of association by urban or uninhabited areas. To investigate the impact of animal density on the ecosystem and public health, various measures of animal density were developed. Ecological regression analysis was used to test the ability of animal population density indicators (APDI) to predict VTEC incidence.

P-82

A SURVEY OF DRINKING WATER QUALITY AND GROUNDWATER NITRATE LEVELS ON PRINCE EDWARD ISLAND DAIRY FARMS

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Drinking water was sampled from the milkhouses of one hundred and forty-six PEI dairy farms. The purpose of the survey was to describe the mineral content of the drinking water, and therefore the samples were submitted for a "complete mineral test package" which included: pH, nitrate-nitrogen, total hardness, phosphorus, potassium, calcium, magnesium, bicarbonate, chloride, sulphates, total solids, sodium, zinc, manganese, copper, iron, boron, silicon and total salts. Latitude and longitude co-ordinates for each of the dairy farms were obtained in order to perform geographical statistics and create distributional maps. On average, drinking water contained significantly less sodium, chloride and calcium, and significantly more magnesium in the eastern parts of the Island ($p < 0.05$). Iron levels were below detection limits for most of the samples, contrary to belief that water exposed to the red, iron-dense, PEI soil must have high iron levels.

P-83

NITROGEN DYNAMICS AND SOIL-ATMOSPHERE EXCHANGE OF NITRIC AND NITROUS OXIDE FROM INTENSIVELY-FERTILIZED AGROECOSYSTEMS

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Emissions of the trace gases, nitric and nitrous oxide (NO and N₂O), from fertilized soils may have several ecological consequences including impacts on tropospheric and stratospheric chemistry. NO is a precursor to nitric acid formation, and also plays a central role in photochemical reactions which regulate tropospheric ozone (O₃) levels. With the recent promulgation by the U.S. Environmental Protection Agency (EPA) of new National Ambient Air Quality Standards for O₃ based on 8-h average concentrations, there is increasing concern regarding air quality violations in rural areas of the U.S. Because tropospheric NO tends to limit rates of O₃-forming reactions in rural areas, soil emissions have the potential to significantly impact local O₃ levels. N₂O accounts for an estimated 5% of the total anthropogenic greenhouse effect, and is increasing in the atmosphere at a rate of ~0.25% yr⁻¹. The eventual oxidation of N₂O to NO in the stratosphere also contributes to stratospheric O₃ destruction. A series of field and laboratory experiments were conducted to examine the processes responsible for elevated NO and N₂O emissions following fertilizer applications to a Sacramento Valley agricultural soils. Under acidic soil conditions, which are promoted by intensive and repeated nitrogen (N) fertilizer applications, the driving process was the generation of nitrite (NO₂⁻) from microbial oxidation of ammonium (NH₄⁺) and inhibition of NO₂⁻ oxidation due to the presence of high concentrations of ammonia (NH₃), nitrate (NO₃⁻) and/or nitrous acid (HNO₂). The chemical decomposition of HNO₂ was responsible for elevated rates of NO production in sterile and non-sterile soils. N₂O was produced directly from HNO₂ decomposition, from the microbial transformation of NO, and from denitrification of soil NO₂⁻ and/ NO₃⁻. While N₂O production was promoted by increased water-filled pore space (WFPS), bulk anaerobic conditions were not necessary in order to generate high emissions from intact cores. Regression and mechanistic models were developed to describe the underlying processes. The control of soil acidity may be an important consideration in the development of strategies for minimizing gaseous N losses from intensively-fertilized soils, and possibly for improving air quality in rural areas.

P-84

A COMPARATIVE STUDY ON CHLOROPHYLL A CONTENT AND PRODUCTION OF PLANKTONIC ALGAE IN LARGE RIVER-CONNECTED LAKE AND NEIGHBOURING SECTIONS OF CHANGJIANG RIVER IN CHINA

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Changjiang (yangtze) River is the third largest river in the world and the biggest one in China. Lying at the junction of middle and lower reaches of Changjiang, Poyang Lake is the largest freshwater shallow lake and still interconnected with the river's mainstream. It covers an area of 3283 km². After receiving the outflows of 5 river-systems, viz. Rivers Ganjiang, Fuhe, Xinjiang, Xiushui and Raohe, the lake discharges water into Changjiang through its north outlet. The annual outflow of the lake is 1457×10^8 m³, amounting to 15.6% of the average runoff of Changjiang River. In order to evaluate the effects of the lakes on the water ecosystem of Changjiang River, hydrobiological studies were made both in Poyang lake and in upstream and downstream sections of the river near the outlet during March-April, 1989, October, 1997 and April 1998. Chl a contents and phytoplankton production were major subjects of the investigations. The chl a contents of planktonic algae in Poyang lake were 1.63 ± 0.71 ug.L⁻¹ in April, 1989, 1.98 ± 1.30 ug.L⁻¹ in October, 1997 and 1.33 ± 1.11 ug.L⁻¹ in April, 1998. Hence, the content in autumn was slightly higher. The average chl a content in Jiujiang river section, 30 km upper lake mouth, was 0.52 ± 0.21

ug.L⁻¹ in surface water. The average chl a contents in Balijiang and Pengze river sections, 10 and 50 km lower the mouth, were 1.30 ± 1.02 ug.L⁻¹ and 1.36 ± 1.04 ug.L respectively. Longitudinal investigation of the river-course from Jiujiang to Nanjing indicated that chl a content in 200 km lower the lake increased by 1-2 times, probably due to lake discharge. The difference of chl a contents in any transect of the river was indistinct. It seemed that chl a contents in midstream and deeper water, 10-20 m below surface, as well as in backwater area, were slightly higher. The average production of phytoplankton in Poyang Lake were 0.373 ± 0.175 mgO₂.L⁻¹.d⁻¹ in April, 1989, 2.55 ± 0.225 mgO₂.L⁻¹.d⁻¹ in October, 1997 and 0.365 ± 0.423 mgO₂.L⁻¹.d⁻¹ in April, 1998. the average community metabolisms were 1.417, 0.861 and 0.812 in respective periods, showing that community metabolisms were closely related to hydrological phenomena. As a rule, autotrophic metabolism appeared during low water period and heterotrophic occurred during higher water. In terms of the production in the river, there were 0.363 ± 0.163 mgO₂.L⁻¹.d⁻¹ in Jiujiang, 0.334 ± 0.121 mgO₂.L⁻¹.d⁻¹ in Balijiang and 0.329 ± 0.094 mgO₂.L⁻¹.d⁻¹ in Pengze. The average community metabolism rates are 0.824, 0.813 and 0.929 respectively. Thus, river-water is heterotrophic metabolic in general.

P-85

A MERCURY BUDGET FOR CLEAR LAKE, CA

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We are evaluating the fate, transport and cycling of mercury (Hg) within the Clear Lake aquatic ecosystem. The Sulphur Bank Mercury Mine (SBMM), active intermittently from 1872-1957, became an EPA Superfund site since 1991 and is thought to be an ongoing source of Hg contamination to Clear Lake through erosion and acid mine drainage. Lakebed sediments have Hg concentrations up to 450 mg/kg (ppm) in areas adjacent to the mine. This budget is attempting to quantify (1) inputs (e.g. streams, atmospheric deposition, erosion and acid mine drainage from the mine), (2) outputs (e.g. flow downstream into Cache Creek, efflux to the atmosphere), (3) storage (in sediments) and (4) biogeochemical cycling of Hg within Clear Lake. Over the past 7 years we have collected data on Hg concentrations in water, biota and sediments in the lake and its surrounding watershed. This Hg budget for Clear Lake will help determine the relative contribution of Hg from the SBMM (as compared to other sources to the lake) and will help guide remedial options at the mine site. We will compare our Hg budget to that of other aquatic systems from a range of sites that are relatively uncontaminated to highly impacted.

P-86

TOXICITY OF METHYL-TERT-BUTYL ETHER (MTBE) TO FRESHWATER ORGANISMS

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Increased input of the fuel oxygenate MTBE into aquatic systems has led to concerns about its effect(s) on aquatic life. As part of a study conducted by University of California scientists for the State of California, the Aquatic Toxicology Laboratory, UC Davis, reviewed existing literature on toxicity of MTBE to freshwater organisms. Then, we derived information on potential toxicity of MTBE to California resident species, and conducted chronic, developmental toxicity assays in fish. Depending on time of exposure and endpoint measured, MTBE was found to be acutely toxic to various aquatic organisms at concentrations of 44 - >1000 mg/L in invertebrates, and 388 - >3000 mg/L in vertebrates. Developmental effects in medaka (*Oryzias latipes*) were not observed at concentrations up to 480 mg/L, and all fish hatched and performed feeding and swimming in a normal manner.

Bacterial assays proved most sensitive with toxicity to *Salmonella typhimurium* measured at 7.4 mg/L within 48 hours. In microalgae, decreased growth was observed at 2,400 mg/L and 4,800 mg/L within 5 days. MTBE does not appear to bio-concentrate in fish and is rapidly excreted or metabolized. Collectively, the available bioassay data suggests that at the commonly observed environmental MTBE exposure levels found in surface waters (<100 parts per billion) the compound is likely not toxic to aquatic life.

P-87

SPATIAL AND TEMPORAL PROFILES OF STRESS PROTEIN (HSP70) IN ASIAN CLAM (*POTAMOCORBULA AMURENSIS*) IN NORTHERN SAN FRANCISCO BAY

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Multiyear investigations by United States Geological survey have revealed populations of Asian clam with reduced condition indices along a well established metal contamination gradient in Northern San Francisco Bay. Our study seeks to determine whether biomarker responses such as stress protein hsp70 levels in *P. amurensis* can be correlated with exposure to anthropogenic stressor(s), and/or are related to histopathologic markers, concentrations of metallothionein and the individual's condition. Here we present our results on stress proteins (hsp70). Stress proteins are induced by a variety of stressors, which either damage cellular proteins directly or cause cells to synthesize aberrant proteins. Clams were sampled monthly from 4 stations in Northern San Francisco Bay over the period of 19 months (July '96 - January '98). Stress proteins were analyzed by western blotting using monoclonal antibodies. Results show that levels of Hsp70 were significantly higher at stations 12.5 and 8.1 than at stations 6.1 and 4.1, and appear to be positively correlated with salinity and/or cellular energy levels in *P. amurensis*.

P-88

PESTICIDE-INDUCED CHANGE IN GENE POOLS OF AT-RISK POPULATIONS: EXAMINING THE LONG-TERM POPULATION-LEVEL CONSEQUENCES OF CONTAMINANT EXPOSURE

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Historically, the majority of projects studying the environmental toxicology of contaminants have focused on effects on short-lived, low mobility, sensitive species in the laboratory as acute indicators of toxicity. However, long-term effects on resident species at the population level have not been well characterized. Populations are ecological structures that consist of a collection of interbreeding individuals, each of which owes its existence to the survival and success of its ancestors. The cumulative impact of stressors may result in the loss of individuals, and thus the loss of their genetic contribution to descendants, to the population. Populations, therefore, are integrators of multigenerational information. Modern DNA fingerprinting technologies have been useful, in fields such as conservation biology, as tools to examine the consequences of historical events on populations. This project is being approached and developed as a proof of principle to test whether novel sophisticated DNA fingerprinting tools can be used to reveal contaminant-induced population-level impacts, by examining the genetic structure of field-collected populations. Specifically, I will develop amplified fragment length polymorphism (AFLP, a novel DNA fingerprinting technique) as a tool to generate population-genetic patterns from resident fish populations collected from rivers of California's Central Valley that receive agricultural chemical contamination. My rationale is that multigenerational impacts may be manifest as change in gene pools of exposed populations. I will examine AFLP patterns in combination with laboratory studies to test for the influence of different mechanisms that may drive multigenerational genetic change.

P-89

BIOMARKERS AND ECOSYSTEM HEALTH

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Although living systems are organized on multiple levels, from the molecular to the ecosystem, traditional ecological approaches for assessing ecosystem health often rely heavily on population and community level measurements. Typical endpoints include such parameters as population density and indices of reproduction. Events at the sub-organismal level are often considered topics for researchers in other fields, and are not investigated. The ever increasing concern for the impact of multichemical pollution on ecosystems has altered this situation, leading to recognition that a need exists to develop a suite of sub-organismal biomarkers that can assess and predict population and community level effects. This paper (poster) draws upon research done in our laboratory and also by our colleagues to develop subcellular biomarkers of exposure to environmental chemicals that can be used to assess effects on higher organizational levels. These include cholinesterases (neural), fecal testosterone (reproduction), creatine kinase (general tissue damage), and liver P450 (chemical exposures). Organisms studied include fish, rodents, birds and humans. Chemicals studied include pesticides (organophosphates and chlorinated hydrocar-

bons), industrial chemicals (fuel additives) and heavy metals. A paradigm for the development of biomarkers and criteria for their application to population level problems will be discussed. Supported by the Centers for Ecological Health Research (EPA), Environmental Health Science (NIH) and Agriculture Health and Safety (NIOSH).

P-90

PHYSICALLY-BASED MODELING OF WATERSHED PROCESSES AS A DRIVING MECHANISM FOR SEDIMENT/NUTRIENT TRANSPORT

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One of the major concerns in the Lake Tahoe region is the nutrient transport to the lake from its surrounding tributary watersheds as it deteriorates the clarity of the lake by boosting

the algal growth. To model nutrient transport properly, it is necessary to model sediment transport as it is the effective carrier of nutrients in an attached form. Most of all complete description of the flow field needs to be attained before modeling any of the above transport processes. As a first building block in modeling nutrient transport, hydrology has an important role of driving all the other processes occurring in it. In this poster are presented some of the results from the application of physically-based hydrology model to the Ward Creek watershed. Being a physically-based model, it does not require rigorous calibration efforts and parameter estimation is based upon actual data rather than the use of fitting. Another strength of the model is the capability to perform what-if scenarios such as land use changes and fires and it is made possible through the physically-based parameter estimation. The comparison of the simulated result to the observed one was quite encouraging and the developed hydrology model is expected to serve as a solid foundation for the upcoming transport modeling.



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