Envirovet Baltic: Workshop on Ecosystem Health

Proceedings from a workshop in Saaremaa, Estonia, August 15-19, 2002

Börje K. Gustafsson and Ulf Magnusson *(editors)*

Uppsala 2002

CRU Report 15

CRU CENTRE FOR REPRODUCTIVE BIOLOGY IN UPPSALA

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F O R E W O R D

In June of 2001, scientists of the Centre for Reproductive Biology, Uppsala (CRU), Envirovet USA, an ecosystem health educational program at the College of Veterinary Medicine, University of Illinois, Urbana- Champaign, and the Estonian Veterinary Association met in Uppsala to discuss a possible cooperation between Europe and the United States on ecosystem health education, research, and application. The meeting resulted in the formation of a Steering Committee to further develop Envirovet Baltic, a network involving scientists from all nine countries bordering the Baltic Sea and the United States. The CRU became the headquarter of the cooperative venture.

The overall purpose of the Envirovet Baltic Network is to strengthen education, research, and application in ecosystem health. A sizeable portion of that function will be to teach ecosystem health to veterinarians, other health professionals, and environmentally oriented scientists using intensive courses, symposia, workshops, and field exercises. Forming a sustainable cooperation between Europe and North America, the network will promote transatlantic harmonization of environmental health standards.

The further develop and consolidate the Envirovet Baltic Network, the Steering Committee decided to gather scientists from all member countries to a workshop on ecosystem health. The workshop was held in Saaremaa, Estonia, August 15- 19, 2002. All three Baltic States, Denmark, Finland, Sweden, and the United States were represented. Totally, twenty-three papers were presented and discussed.

We are pleased to present the abstracts of the workshop presentations. Also, included are summary reports of a fact-finding project, *Environmental Programs, Policies, and Problems in the Baltic Sea Region,* conducted by scientists from Envirovet USA prior to the workshop.

Financial support for the workshop was provided by the *Nordic Council of Ministers* and the *University of Illinois International Programs. The Wallace Genetic Foundation, Inc.*, USA, supported the fact-finding project including the reporting at the workshop. We are truly grateful for the generous support of these organizations without which the workshop could not have been conducted.

We would also like to acknowledge Dr. Toomas Tiirats, Estonian Veterinary Association and key member of the Envirovet Baltic Steering Committee for his outstanding work on the arrangements in Estonia.

Uppsala and Champaign, November, 2002

Ulf Magnusson and *Börje K. Gustafsson*, Organizers and Editors

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Introduction

A key question to consider is whether there is a need for an Envirovet or a similar program that focuses on the Baltic Sea region. Thus, a major focus of this conference is to discuss the status of the ecosystems of the Baltic Sea and it's watershed, as well as the potential future opportunities for veterinary medicine to be of benefit. If a regional Envirovet would likely be of value, then it will be important to discuss the feasibility and likely character of a such a program. A number of questions arise including: What will be the principal focus of the program?, What will be the main goals and principal products?, Who will be the organizers?, Who will comprise the faculty members?, Who will be the target audience?, What will be the specific content?, How long will the program last?, Where will it take place?, What will be the total budget?, and From where will the needed financial resources be derived? Reflections on current regional and global environmental problems as well as the philosophy and roles of previous Envirovet programs may be of value in answering some of these questions.

Problems, Trends, and Challenges

Existing environmental problems and challenges illustrate weaknesses of current disciplinary approaches to complex transdisciplinary challenges. Despite the evolution of modern environmental sciences and policy, a great deal has "fallen between the disciplinary cracks" and many problems have grown. It can be argued that among the greatest shortcomings of modern societies are the failure to learn from resource mismanagement, failure to discern how multiple stressors interact together to harm health and ecological function, and failure in our educational mission, which has given rise to insufficient public environmental literacy. These shortcomings have had immense negative impacts on the ecological resources on which current societies and other species depend for the well-being and survival. Accordingly, there is a need for a much more integrative approach to environmental sciences to support adaptive management based on shared short and long term goals.
Marked stress on modern ecosystems is apparent in the following trends: since 1900, the world's human population has roughly tripled, fossil fuel consumption has increased more than 30-fold, and industrial production has increased more than 50-fold; since 1950, the demand for grain, beef, and mutton has roughly tripled and presently cattle, sheep,

goats, and other livestock often over-graze and erode land, and increase the percentage of toxic plants; since 1950, water use has roughly tripled, and because of water abstraction and leaching of salts from soil related to irrigation, parts of Rio Grande have become so saline, that fish sometimes die, and large rivers such as the Colorado River in the US and the Yellow River in China often dry before reaching the sea; and since 1950, human consumption of seafood has increased more than four fold and, of the 15 major ocean fisheries, 13 are in decline. These declines have given rise to several international conflicts over fishing rights. In addition, persistent contaminants that biomagnify in food webs have threatened the sustainability of some fish populations as well as the health of fish-eating wildlife and human populations, especially the young.

North America offers valuable illustrations of the effects of environmental mis-management. On that continent, there is a reported “biodiversity deficit,” which infers that far more species are becoming extinct than are arising. Extinction rates have been said to be 100 to 1,000 times faster than before humans existed, and they are accelerating. For each of the following species groups, the percentage of North American species that are currently threatened or already extinct is given in parentheses: mussels (67%), crayfish (64%), fishes (36%), amphibians (35%), mammals (17%), and birds (11%). Because of shared sensitivity to environmental stressors, including chemical contaminants, climate change, increased ultraviolet exposure, soil erosion, and water depletion, these species are important sentinels for potential threats to human health and well-being. Thus, if societies consistently protected wildlife and livestock that have direct contact with the environment from environmental stressors, we would not have to worry so much about the health and well-being of human populations.

In an edition of Scientific American entitled "Managing the Earth," William Ruckelshaus, a former Director of the US Environmental Protection Agency, stated, "If 80% of (people) are poor, we cannot hope to live...at peace. If the poor nations attempt to improve their lot by the methods we have employed, the result will be world ecological damage. Can we move nations and people in the direction of sustainability? Such a move would be a modification of society in scale to only two other changes: the Agricultural Revolution of the late Neolithic [Period] and the Industrial Revolution of the past two centuries. Those revolutions were gradual, spontaneous, and largely unconscious. This one will have to be a fully conscious operation, guided by the best foresight that science can provide–foresight pushed to the limit. If we actually do it, the undertaking will be absolutely unique in humanity's stay on Earth."

Underlying Causes and “Ecosystem Disease”

A first question that should be asked is, How did societies get into this troubling situation? It can be argued that the current dilemma has arisen largely due to good faith efforts to solve problems that have faced human populations for millennia. Specifically, environmental degradation has come about because of the manner by which we derive our foods, clothing, shelter, energy, transport, security, and status. In much of the world, we have effectively pursued control of diseases, an abundant food supply, and limits on warfare. However, these successes have spurred vast growth in human populations and this, combined with business growth and the marketing revolution, has catalyzed massive increases in resource consumption per individual culminating in resource depletion and environmental pollution. Moreover, through development, we have isolated ourselves from outdoor environments such that we do not often witness what is going on in the ecosystems around us. Although our aim was and is to increase safety and comfort for human populations, as generally practiced, our means to these ends have decimated other organisms in nearby as well as distant environments.

• Predator Elimination

Although wildlife managers can be quite effective in supporting enhanced ecological services, inappropriate wildlife management approaches can create immense problems. In the past, in North America, extirpation by killing of native predator populations was a common management strategy to deal with "problem wildlife" that had the potential to prey on livestock. Unfortunately, this resulted in the overpopulation of other wild species that formed their primary prey base. For example, removal of wolves and cougars set the stage for an unprecedented increase in the numbers of whitetail deer in the US, which now contributes to malnutrition in deer herds and the spread of Lyme disease. High numbers of deer are also a likely factor in the spread of chronic wasting disease, a form of spongiform encephalopathy. Similarly, without large predators, the US has witnessed a marked increase in meso-predators, such as the raccoon. Unfortunately, raccoons are a reservoir of both *Baylisascaris* and rabies, and thus the risks of these zoonotic diseases to human beings are increased. Another form of inappropriate wildlife management is overharvest, and it has occurred often with fish and fur-bearers. This has resulted in depletions of stocks of marine, lake, and river fishes as well as marked sporadic declines in otters, mink, beavers, and other species.

• Transportation

Another example of how modern society has attempted to solve one problem, yet inadvertently created multiple new problems is the approach to ground transportation. The simple goal is to move people and products from point A to point B. However, largely unforeseen and largely uncontrolled, complex, and interacting adverse effects on the environment have included: trauma by vehicles which can adversely affect populations of slow-moving wildlife species; fragmentation of wildlife habitats by roads and railroads with creation of "island ecology"; stress on wildlife because their movements are obstructed, and they confront extremes of noise, heat, cold, and dessication; and toxic concentrations of carbon monoxide, nitrogen oxides, sulfur oxides and associated acid precipitation, ozone, smog, particulates, metals, salts, and a range of carcinogens. Of course, many such pollutants also affect domestic animal and human populations.

• Aquifer Depletion

Other forms of ecosystem degradation arise due to depletion of surface waters and aquifers. Water recharge is needed not only for natural biota and domestic animals, but also for drinking water as well as irrigation. While depletion of any aquifer is of great concern, in contrast to readily rechargeable aquifers, the effects are far more serious when "fossil waters," i.e. waters that take many centuries to be restored following depletion, are involved. Aquifer depletion often results from inefficient methods of irrigation of crops with high water requirements in arid or semi-arid landscapes. Another cause for aquifer depletion is wasteful urban uses, such as watering lawns.

• Coastal Development
Coastal development, especially filling in estuaries and dredging channels, has devastated local biodiversity and ecological productivity. Such processes eliminate nursery habitats needed by fishes, and they reduce plant communities that slow moving water and filter out nutrients, silt, and microbes. Elimination or degradation of estuaries also eliminates or reduces their value in modulating aquatic temperatures. Without these ecological services, coastal ecosystems including coral reefs become biologically simplified and functionally unstable.

• Agriculture, Deforestation, Monoculture Forestry, and Degradation of Water Quality
Among management approaches that have caused the most severe forms of habitat simplification is deforestation for timber or to clear land for agriculture. Even today, forestry companies may fail to plant trees altogether, or may plant only monocultures. The resultant reduction in genetic diversity in the tree community results in greater susceptibility to outbreaks of tree diseases and potentially severe effects of climate stress on forest productivity. Of course species that depended on niches unique to tree species no longer present tend to be eliminated.
Current soil management and planting practices employed in agriculture and forestry, as well as acid precipitation interact to mine, erode, and deplete topsoil. Also, with practices that reduce plant cover and debris, groundwater recharge is reduced, and run-off of water is more rapid, increasing the flashiness of streams (faster increases and decreases in flow and depth, which leads to flooding and later drying). The flooding can produce mud-slides and pulsatile additions of silt which block sunlight needed by aquatic plants creating hypoxic conditions, degrade breeding grounds of aquatic animals, and harm fish gills. In the subsequent periods of low flow, water becomes shallow, and during warm weather temperatures may increase. Water at higher temperatures cannot hold nearly as much oxygen as cold water. Accordingly, aquatic species that require high oxygen may be eliminated when water is shallow and seasonal temperatures are high.

• Global Warming
The problems with altered hydrology, development, and water quality are aggravated by global warming. The increasing severity of climate extremes, which has been attributed to recent climate change, interacts with altered hydrology to create chaotic problems in a range of locales, sometimes involving extreme rainfall events and flooding with potential mud-slides, and other times involving severe droughts.
With increasing temperatures associated with global warming, other problems may also arise. Animals, such as polar bears, that are well adapted to life in polar regions may find their environments less compatible with their physiologic needs. Moreover, animals from warmer regions may need to move farther from the equator to avoid increasing temperatures and/or desertification, but problems may arise if they cannot migrate because of large areas of human development or even natural barriers, such as deserts, mountain ranges, or water bodies. With increasing temperatures, insect vectors of

disease, such as mosquitoes, may also move beyond their normal ranges, placing additional animal and human populations at risk of infection.

• Habitat Fragmentation
Habitat fragmentation is a critically important form of ecosystem disease in a range of locales in the developed and developing world. Confinement of a population in what was formerly a small part of its range often results in inbreeding which reduces genetic diversity. This, in turn, tends to reduce fertility and reproductive success as well as the population-level ability to resist multiple stressors, such as tolerance to weather extremes, infectious diseases, or food deprivation. Confinement in habitat fragments may also precipitate more common and more severe predator prey imbalances, malnutrition due to heightened competition for food, and intra- and inter-species contact and stress, potentially culminating in emerging and re-emerging infectious diseases. Stress may also cause further reductions in fertility and altered behaviors that impair success in parenting.

• Urban Sprawl
Urban sprawl is rampant in parts of the United States and other developed as well as developing countries. The process not only contributes to habitat fragmentation, but also creates vast areas with hard surfaces and grading which decrease water retention in soils and ephemeral pools. Grading often eliminates the ephemeral pools altogether, which are of critical importance to amphibians. Also, it further increases the flashiness of streams. In addition, rains in urban environments induce pulsatile water pollution in solution or suspension from roads, construction sites, lawns, and local industries.

• Toxicologic and Ecotoxicologic Stress
Perhaps the best known form of ecosystem "disease" caused by human populations is that related to toxic chemicals. Understanding and control of risks associated with chemical contamination requires considerable knowledge of their primary sources and mechanisms involved in their transport to, and fate in, local and global environments.
Despite recent advancements, current methods of mining and transport of mineral resources releases pollutants to land, streams, lakes, estuaries, and coastal zones. Drilling for petroleum not only spills oil and wastes natural gas, but also results in pollution from drilling muds that may contain caustic alkalis, acids, salts, metals, and a range of toxic organic additives. Gold mining in some areas of the world such as the Amazon introduces substantial amounts of elemental mercury into the environment, effects of which are discussed below. In developed countries, gold mining is associated with periodic spills of cyanide, which can readily kill animal life through miles of downstream riverine waters. Considering these pollutants, as well as the toxins produced by bacteria, fungi, algae, plants, and animals, the proliferation of chemicals deliberately produced by industry, chemical byproducts they also produce, chemical reactions in landfills, and chemicals released from transportation accidents, fires and explosions, it is clear that animal and human populations are at risk for toxicologic stress, including that related to complex effluents. Ultimate outcomes depend on a host of factors including the chemical structures involved and the concentrations achieved *in vivo*. The latter are influenced by the local latitude, weather, soils, and geology, as well as the volume and character of the receiving waters, air, and biota.

Among the most well recognized and important environmental contaminants are the bioaccumulative organometals, such as methyl mercury which is produced in aquatic sediments from a number of sources of mercury including coal burning, gold mining, and uses in industry, electrical equipment, and dentistry. Exposure of mammals to methyl mercury exposure occurs primarily *in utero*, via mothers' milk, and via fishes and other animals from contaminated aquatic food webs.

Of course, human and wildlife populations are not exposed to one pollutant at a time. Two important types of bioaccumulative pollutants that are sometimes encountered in appreciable concentrations together are methyl mercury and polychlorinated biphenyls (PCBs). Exposures may impact wildlife most directly because of their higher level exposures, but human populations are also at risk. For example, the people of the Faroe Islands hunt pilot whales for human consumption, the tissues of which contain both PCBs and methyl mercury. A report indicates that the local children with high PCB and methyl mercury exposures *in utero* had deficits in memory, language and attention at 7 years of age. Moreover, PCBs and mercury can also impair hearing and vision.

Other categories of important pollutants with both direct and indirect effects include pesticides, fertilizers, human and animal wastes, and a range of endocrine disrupting chemicals of divergent structure.

The breadth of the challenge and thus the breadth of the opportunities available for the future are illustrated by considering the encompassing definitions of three terms that are relevant to ecotoxicology and some of the current as well as future roles in this discipline for veterinarians. The term ecology can be defined as the science of all living organisms and all their interactions with one another and their shared environments. The term toxicology can be defined as the science of all adverse effects of all chemicals on all life forms. Finally, the term ecotoxicology can be defined as the science of all adverse effects of chemicals on all living organisms and all their interactions with one another and the environments. Because of this breadth, the challenges are daunting, and common sense must be used in getting beyond reactive, after-the-fact damage control, and into prevention as well as increasingly effective remediation for contaminated and otherwise degraded ecosystems.

There are a number of weaknesses in the ways that ecotoxicology has often been practiced. These include that decisions are sometimes unduly influenced by political and economic pressures; that actions often fail to address the highest priority needs; that research can be so disconnected from problems in the environment as to be of limited relevance; and that research initially was focused almost exclusively on residues in the environment and not enough on mechanisms and effects, while in recent years, the opposite may be true, and a more balanced approach to the assessment of exposures, mechanisms, observable effects, and safer alternatives is truly warranted. Another weakness in ecotoxicology is that there tends to be a great deal of risk assessment, but there is insufficient validation of risk (or "safety") predictions. Also, while the direct toxic effects of individual chemicals have been studied in vertebrate animals, the effects of toxic combinations of chemicals and especially the indirect effects, i.e. via toxicity that depletes organisms that provide food, cover, detoxification, or removal of pathogenic agents, are rarely considered and very poorly understood at this time. Furthermore, practitioners of ecotoxicology should be much more humble about unmeasured effects. Indeed, the current concerns regarding chemically-induced endocrine disruption exist largely because adequate reproductive parameters were not measured in pre-approval and post-marketing studies of a range of chemical compounds used for such diverse purposes as pesticides, electrical insulator fluids, and plasticizers.

In the author's opinion, ecotoxicology would be most effective if it were practiced in a more balanced ecological and biomedical context. In other words, ecotoxicology needs to involve increased numbers of broadly educated health specialists who can consider the effects of toxic chemicals on multiple organ systems and their interactions with one another. Ecotoxicologists also need the skills required to study interactions among toxic and non-toxic stressors, such as between a pesticide and changes in climate, exposures to infectious agents, and stress related to habitat loss. Finally, ecotoxicologists also need to be far more active in diagnostic and forensic sciences.

Despite it's shortcomings, ecotoxicology has provided society with some critically important benefits. The discipline has helped terminate or reduce the manufacture and dissemination of some major environmental pollutants, such as DDT or polychlorinated biphenyls (PCBs). It has helped offset some adverse effects associated with proliferation of new manmade chemicals through fostering more astute choices in both chemical and non-chemical methods of management of challenges at hand including pest control. Ecotoxicology also has helped basic and applied ecology to become more problem-driven. In addition, ecotoxicology has helped set the stage for conservation medicine. Moreover, ecotoxicology is beginning to merge with ecological restoration (rehabilitation) science in that remediation of degraded sites can often include cleanups of chemicals among other activities to bring back more substantial and beneficial ecological functions and value.

Interactions

Interactions of the toxic and other stressors listed above contribute to species endangerment, and species extinction. The precipitous process that results in each species elimination has been termed an extinction vortex. As this occurs, species that depend on the declining/extinct species also tend to decline, and they too may disappear. Over time, this process results in substantially reduced regional biodiversity and reduced ecosystem services.

What is Ecosystem Health?

As with human health, ecosystem health is and will be different things to different people, yet there will also be a substantial shared understanding. Ecosystem health infers a desirable condition of the life-support systems of the Earth. Ample ecosystem health will preserve biodiversity and reasonable native species densities, maintain efficient mechanisms of nutrient recycling, sequester and degrade toxic substances, and moderate losses of water from the landscape whether through evaporation or runoff. To achieve a high level of ecosystem health will typically require structural complexity and diversity, ecological connectivity, protection of biodiversity, and maintenance of the associated functional redundancies that are essential for both preservation of ecosystem services and recovery of such services following stress without intensive management intervention. Ecosystem stressors that can reveal weaknesses in ecosystem health through reduced resiliency include seasonal climate extremes; cyclic infectious diseases; seasonal animal migrations, and even human resource abstractions.

What are Some Characteristics and Needed Aims of Ecosystem Health Sciences and Practice?

Ecosystem health sciences involve professional communities to which veterinary and other environmental professionals already belong. These sciences require trans-disciplinary endeavors to yield rational prioritization in environmental research, policy, and management. Ecosystem health sciences already provide opportunities for veterinarians and other professionals to become increasingly relevant in meeting societal and animal health needs.

Ecosystem health practice involves control of chemical contaminants so that they remain below threshold concentrations for direct and indirect toxic effects on non-target biota. It also involves control of exotic and invasive species introductions and spread, as well as the elimination of exotic species when possible and desirable. Ecosystem health practice includes control and prevention of emerging and re-emerging diseases. It involves agriculture and forestry practices that preserve local biodiversity, that build soil over time, and that do not deplete aquifers or stream and lake volumes. Ecosystem health necessarily involves rehabilitation/restoration of estuaries and coastal zones. It also involves harvest of free-ranging wild animals only at sustainable rates. Effective ecosystem health practice in many degraded ecosystems will require the re-establishment of connectivity of natural landscapes especially along streams, and across uplands. It will require the maintenance of natural areas large enough to sustain larger native carnivores and other species with large ranges. To deal with issues at the interface of areas devoted to native/wild biota and those heavily management to meet human needs, ecosystem health managers will establish and maintain ample buffers to limit the off-site effects of human activities.

For societies to increase the benefits of natural ecosystems as well as those of ecosystems that have been purposefully altered to meet human needs, such as areas for intensive agriculture, manufacturing, and urban residence and culture, it will be important that areas devoted primarily to human needs to, once again, be surrounded by networked habitats available for use by native species. The areas devoted to human activities can then be linked with one another by transport systems that allow wildlife to migrate across them to satisfy seasonal feeding, shelter, and reproductive needs, limiting stress and preserving genetic diversity, and thereby helping ensure their long term survival. Ultimately, the restoration of truly healthy ecosystems will yield the re-establishment of margins of safety for wildlife resources by enabling their continued evolution.

The Ambitious Goals and Some General Products of "Envirovet USA"

The goals of Envirovet programs to date have been both broad and ambitious by design. The Envirovet program is one small way to help society address what may be the greatest crisis of our time, specifically the decline in the life-support systems of the Earth and the resultant cascade of negative impacts on animal life. As a part of this effort, Envirovet endeavors to set out a vision of a "world in ecological recovery" and to help expand veterinary capacity to facilitate the needed restructuring of regional planning and management. If Envirovet is successful, it will be because it helps provide new jobs with new responsibilities for veterinarians, and if those who have participated in it's courses help societies move toward a world in which gains in economic and social welfare are routinely accompanied by simultaneous improvements in wildlife health and biodiversity. Envirovet shortcourses help veterinarians to examine the current status of animals in the world as they are influenced by declines in environmental quality. Envirovet sessions critically examine current approaches to environmental management, including reasons why some efforts fall short in achieving ecosystem and wildlife population recovery, while others are highly successful. Thus, Envirovet enables young veterinarians to consider opportunities available to become increasingly effective over time in contributing to the efforts of trans-disciplinary ecosystem health teams. Also, Envirovet is beginning to have a "multiplier effect" whereby "graduates" of the program work with other to develop new groups of scientist-educators, who then evolve course offerings for future generations of generalists and specialists in ecosystem health practice, research, and policy.

Character of the Established Envirovet Summer Institutes

The established Envirovet program provides intensive educational courses in wildlife and ecosystem health. They involve aquatic, terrestrial, developed and developing countries issues.

The Summer Institutes offered have included a 4-week-long program in Aquatic Animal Health and Ecological Toxicology that was held in Duluth Minnesota/Superior Wisconsin with examples drawn from Lake Superior and its watershed including the Duluth Harbor. These sessions were held from 1991 to 1994, and again in 1998. Then, in 2000, a Terrestrial, Developed and Developing Countries program was offered as a 5-week-long program at White Oak Conservation Center in Florida (2 weeks) and at multiple locations in Kenya (3 weeks). This was followed by a 7-week-long Terrestrial, Aquatic and Developing Countries program at White Oak, Duluth/Lake Superior, and Kenya. Finally, in 2002, a 6-week-long Terrestrial, Aquatic and Developing Countries program was held at White Oak, Harbor Branch Oceanographic Institution in Florida, and Kenya. The Envirovet Summer Institutes have provided education for approximately 200 professionals, many of whom are currently employed in wildlife and ecosystem health research, service, and education full time. More information on the character and products of the established Envirovet courses is available at the website for the Envirovet Summer Institute: http://www.cvm.uiuc.edu/envirovet/.

Envirovet Summer Institute is an immersion-like experience. Students are occupied for 60-70 hours a week of instruction, 6-7 days a week. Lecture, laboratory and field experiences are organized in 3 sequential units: terrestrial wildlife and ecosystem health; aquatic wildlife and ecosystem health, emphasizing ecotoxicology; and ecosystem health in international development.

The first unit is organized by the University of California-Davis Wildlife Health Center, and White Oak Conservation Center in Yulee, Florida, where it takes place. This two-week session introduces concepts of wildlife and ecosystem health, the realities of global ecosystem degradation, declines in wildlife abundance and distribution, threats to biodiversity, and strategies for reversing these trends (e.g. flagship species conservation, habitat restoration, ecotourism). Students acquire knowledge and direct experience with a number of wildlife and ecosystem health topics. Lectures are provided on terrestrial and disease ecology, conservation genetics, wildlife epidemiology, population viability analysis, theriogenology, ecological risk assessment, diseases of wildlife, health implications of translocations, and wildlife telemetry. Laboratory exercises focus on wildlife necropsy techniques, radio-tracking of free-ranging animals, wildlife capture, chemical immobilization of wildlife, and navigation using global positioning system (GPS) instrumentation. Other topics of instruction include ecosystem economics, environmental law and policy, and grantsmanship. Interactive training sessions focus on cultural sensitivity and conflict resolution. Also, students give platform presentations on aspects of wildlife and ecosystem health research or management. Finally, included are case study presentations including the Mountain Gorilla Veterinary Project, the Florida Panther Conservation Program, and the "New Ranch" concept.

The second unit is organized by the University of Illinois and Harbor Branch Oceanographic Institution (Fort Pierce, Florida), where it is held. Harbor Branch borders the Indian River Estuary, which is the most biodiverse ecosystem on the East Coast. This week-long unit focuses on aquatic animal and ecosystem health. Included are an introduction to aquatic ecology, and the use of aquatic biodiversity as a sentinel for environmental contamination. Lectures address comparative morphology and physiology of aquatic animals; sources and effects of major physical, infectious, and toxic stressors to which aquatic animals are exposed; transport of manmade contaminants in aquatic ecosystems; and ways by which human activities contribute to buildup of toxigenic phytoplankton and associated risks to aquatic wildlife and human populations. Students participate in field and laboratory exercises examining fish communities, hematology, parasitology, and pathology. Diseases and declines of amphibians, waterfowl, and marine mammals are stressed. Necropsy laboratories include multiple species of water birds and marine mammals available from recent die-off events in the field.

The third unit is organized by Tufts University, and is held in Kenya. This session confronts students with the challenges of applying knowledge and tools gained in the first units in a developing country context. The unit begins in Nairobi focusing on programs of the International Livestock Research Institute and it's technologically advanced programs of disease surveillance, mapping and control, including an emphasis on infectious agents shared by wildlife and livestock. The group travels next to Lake Nakuru, to study a completely fenced national park surrounded by massive deforestation, intensive agriculture, and a rapidly developing city with major recent growth in it's human population. Next, the group moves to Lake Bogoria National Reserve to monitor lesser flamingos, which have recently experienced mass die-offs. Capture, physical examinations, euthanasia, necropsies, and sample submissions are used to identify options for better disease control. Next at Lake Naivasha, students study the Rift Valley through interactions with Kenyan governmental and university scientists at the Kenya Wildlife Service Training Institute. The group examines commercial flower farms and methods employed to limit off site impacts of pesticides and fertilizers. Also included is study of an artificial wetland which purifies the outflow of a sewage treatment plant. The group then moves on to the Laikipia Plateau, to compare the strengths and weaknesses of three large private ranches that maintain profitability while contributing to wildlife conservation and research. Finally, the group works at Meru National Park, witnessing the effects of earlier political strife and poaching, and current efforts to repopulate the park with wildlife, as well as methods to establish positive relationships with human communities residing in wildlife dispersal areas. In this unit, the students participate in targeted discussions with local chiefs and elders, park wardens, government biologists, and others to understand specific concerns and how they are working together.

Job Opportunities

There are many environmental jobs already available, and they will likely increase as society continues to feel the consequences of environmental mis-management. While most of these jobs are currently going to non-veterinarians, societies urgently need experts with an integrated understanding of genetics, physiology, immunology, disease organisms, toxicology, diagnostic medicine, epidemiology, public health, and the methods needed for judicious intervention. Veterinarians can be involved full time in the environment either by staying close to traditional veterinary medicine or by coupling their veterinary background with divergent fields to provide unique perspectives.

To undertake an environmental career through a more traditional path, veterinarians can choose from a wide array of specializations either alone or in combination to become an effective environmental researcher, practitioner, or manager. Such fields include epidemiology, infectious, nutritional, or other non-toxicological diseases, pathology, toxicologic pathology, diagnostic toxicology, systemic toxicology, (e.g. nervous system, urinary system, cardiovascular system, etc.), and immunotoxicology and the incidence/severity of diseases from viruses, bacteria, fungi, and parasites. Veterinarians may also become experts on indirect effects of contaminants (via effects on plants, the microbial environment; the fate and toxicity of other contaminants in water, soil, the atmosphere, plants, and animals; or toxicants and risk assessment and risk management, including ecological rehabilitation of contaminated sites. Veterinarians may also choose to specialize in a given toxicant or infectious agent group that is important in the environment. For example, they might become an expert on one or more of the following toxicant groups: metals, hazardous wastes, pesticides, endocrine disruptors, polyaromatic hydrocarbons, viruses, bacteria, macroparasites, or prion proteins. Alternatively, they may choose to specialize by focusing on a given species group such as primates, whales, ungulates, carnivores, bats, birds, reptiles, amphibians, fishes, or bivalves. As another way of focusing, veterinarians may develop expertise relevant to the wildlife communities of a given habitat type such as rainforests, estuaries, coral reefs, polar areas, high altitude regions, agricultural zones, or urban areas. Moreover, they may choose to become an expert on the health and well-being of wildlife communities of a specific region of the world such as the Baltic Sea, the watersheds of the rivers of Russia, the farms of Poland, Germany, or Estonia, the lakes of Finland, or even the cities and suburbs of Denmark and Sweden.

Veterinarians who choose a more divergent job path may complement their veterinary education with a less traditional course of study and gain work experience to become a unique specialist in such fields as the interface of toxicology with environmental law, reconciling agriculture with ecological stewardship and repair, research on methods of human population control, or even politics and policy.

To be most effective as collaborators in ecosystem health teams, it will be essential for veterinarians to: value the capabilities and contributions of other experts; work hard and network with others; maintain both a reasonable perspective and a sense of humor; insist on a reasonable income; and help the next generation to do more.

Funding of the Established Envirovet Program and Contrast to the Baltic Regional Project

To date, the Envirovet program has generated around $1M in funding from a range of sources including the Geraldine R. Dodge Foundation, the New York Community Trust, the Bay Foundation, Dow AgriSciences, Monsanto, Eli Lilly and Company, and course fees. Students have come to the program from 23 countries around the world. The program benefits immensely from "in-kind" donations of faculty and staff expertise, and from the free provision of facilities as well as room and board of the White Oak Conservation Center which is funded by the Howard Gilman Foundation. Course fees for students from developed countries range up to $6,500 for the six week course and include all living expenses including travel to, from, and within Kenya. Because of differences in regional cultures, a Baltic program will likely depend on much smaller course fees, and thus will require a greater share of government funding. However, as a regional undertaking, involving primarily faculty and students from the 9 countries in the shared Baltic watershed, travel costs will be limited.

Ecosystem Health and the Veterinary Curriculum

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During the last two decades it has become increasingly clear that veterinary educational institutions are not responding to changes in the society as effectively as expected by the constituencies they serve. Particularly, public practice (e.g. public health/food safety, environmental health, and animal well-being) is considered an area in which veterinary medicine is not adequately responding to the needs of a changing society. A rigid curriculum and fear of change have for a long time made both North American and European veterinary schools adhere to traditional programs and practices producing a uniform type of graduate.

Fortunately, the past ten years have led to increasing efforts to modernize/diversify the veterinary curriculum. The process includes the development of electives and areas of emphasis forming a core- elective curriculum, sometimes referred to as "tracking" or "streaming", allowing students to obtain in-depth experience in a field of the student's choice and increasing the opportunity to address contemporary needs of society and market place. Furthermore, introduction of problem based learning (PBL) has made the students more actively involved in their own training shifting the traditional emphasis on teaching to an emphasis on learning.

A recent study in the United States, "*The current and future market for veterinarians and veterinary services in the United States"* commonly known as the Mega Study**)** analyzed the veterinary profession's responsiveness to the changing needs and expectations of society. **Environment** was one of the non-private practice areas studied.

Environmental health has earlier surfaced as an important challenge to veterinary medicine in many reviews, reports, articles, and policy statements during the past three decades. Sadly but not surprisingly, the conclusion of the Mega Study was that environmental health will remain a relatively small segment of the veterinary profession. Regrettably, the Mega Study did not look at the potential market for veterinarians in a situation where new programs would be available to meet societal needs. However, an interview with employers of veterinarians and veterinarians ranked environment in the top 33 % of areas that would impact the future demand for veterinary services. The Mega Study rightly concluded that additional training is required for veterinarians to be competitive on the environmental job market.

Reversing the present situation will require major innovative and purposeful efforts to build research and outreach programs as well as professional and graduate courses to enable our young veterinarians to market themselves and compete with other professionals in the environmental field.. Then, contrary to the prediction of the Mega

Study, environmental health services will no longer represent only a small segment of the veterinary profession.

There appears to be a consensus that veterinary students are taught several of the most important components of environmental health (e.g. conventional toxicology, environmental toxicology, conservation medicine, emerging disease epidemiology, population medicine, wildlife disease) but in a fragmented and isolated fashion. Thus, there is need for a more holistic approach to teaching environmental health, more field-oriented experiences, and more international experiences.

To begin remedial efforts in the U.S. veterinary curriculum, I envision the development of an elective **ecosystem health area of emphasis** ("track"), consisting of **basic education** (lectures, courses) using existing resources in each school and university coupled with **seminar series, directed readings, and distance education** throughout the first three years of the DVM curriculum. As the clinical education starts, the students will, as part of their clinical education, participate in **field-oriented ecosystem health rotations** such as the Envirovet Summer Institutes and/ or other field-oriented rotations in academic, industrial, governmental or non-governmental settings. An example of such rotations is the ecosystem health clinical rotation for senior veterinary students conducted cooperatively by the Canadian veterinary schools.

The field-oriented experience could be obtained at an international site as such cooperative ventures are developed. Envirovet Baltic should eventually be able to offer an international environmental health experience. For European students, the ERASMUS (the European Community Action Scheme for the Mobility of University Students) program could be a vehicle to use. A relatively well funded program, ERASMUS provides European university students with valuable international experience.

European countries involved in the Envirovet Baltic Network should begin develop possible avenues for giving students a combined international and ecosystem health experience under the auspices of the ERASMUS program. Such an experience would not be limited to field exercises but could include lectures and PBL exercises. It could also involve faculty members.

I recommend the interested reader of this abstract to consult the following publications:

Nielsen Ole : Ecosystem Health and Veterinary Medicine (Can Vet J, 33,23-26,1992).

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Environmental Policies of the Baltic Countries

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After regaining their independence in 1991, the three Baltic countries – Estonia, Latvia and Lithuania have inherited a complex environmental legacy from the Soviet era. Although each of the three countries had specific anthropogenic ecological problems, general causes of these problems were similar. The state of the environment in general was far from being satisfactory - biggest problems were related mainly to the use of out-of-date technologies in the extensively developed industry and agriculture, lack of appropriate wastewater purification and waste storage facilities as well as military pollution caused by Soviet troops. Low prices of energy and raw materials have lead to the creation of material-, energy- and transport intensive and, therefore, heavily polluting industries. Practically unlimited Soviet market caused an excessive concentration of agriculture and related environmental pollution. On the other hand, forestry and nature protection in the Baltic countries were comparatively sustainable and maintained much higher levels of biodiversity than the western countries.

Environmental problems do not recognize the state borders and, therefore, international cooperation is inevitable to solve these problems. One of the main priorities of the Baltic authorities since the restoration of independence in was to integrate the three countries into the fastly growing net of multilateral legal arrangements - environmental conventions and related international regimes, aimed at enhancing international cooperation in order to mitigate global and regional problems. Although every Baltic country has developed their strategies and action plans to deal with their "own" environmental problems (Latvian National Environmental Policy Plan in 1995, Lithuanian Environmental Strategy in 1996, Estonian National Environmental Strategy in 1997 and Estonian National Environmental Action Plan in 1998), the general emission trends, as well as behavior in respect to international environmental regimes, were very similar. First, the Baltic countries joined preventive international regional (nuclear safety) and global regimes (biodiversity protection, climate change), while regimes, which could be seen as more beneficial from the point of view of solving their own environmental problems, came on the agenda next. All the three Baltic countries have joined almost simultaneously respective preventive regimes, which contain less stringent qualitative obligations, however, being more important from the point of view of broader ecological security. This has happened despite of different level of importance of the related problems in the respective countries (*e.g.* importance of nuclear issues in Lithuania and very high *per capita* greenhouse gases emissions in Estonia, while neither can be seen as a priority for Latvia). Quick and simultaneous accession to global environmental regimes allows on the one hand to suggest significant influence of the global environmental society on the Baltic countries to deal with the problems important for the global community first, and on the other hand, the readiness of the Baltic countries to accept such a course of actions.

The Baltic countries have made relatively fast progress in developing their environmental policies and drafting legislation during the last decade. Strategic environmental documents and programmes have been elaborated and implementation of the goals set in these documents has successfully started in each of these countries. Implementation of agreed environmental policy goals requires significant financial resources as well as know-how, and international cooperation is one of the most important sources of them. Bilateral environmental co-operation with Northern and Central European countries, which is based on international regime-like arrangements and is well institutionalised, has been and still is an important source of know-how as well as financial assistance for the improvement of the state of the environment of the Baltic countries. Experience acquired in this cooperation process has also helped the three countries to pave the way towards successful accession negotiations with the European Union.

In December 1997, at the European Council held in Luxembourg, Estonia was invited to start accession negotiations with the European Union. In December 1999, the official negotiations on the possible closure of the Environmental Chapter of the *Acquis Communautaire* were opened, preceded by the period of the so-called “screening” or comparison and transposition of the EU environmental norms and standards into the relevant Estonian legislation. In 1999, at the Helsinki European Council meeting, Latvia and Lithuania joined the list of applicant countries. By 2002, all the three countries have successfully finished accession negotiations concerning the Environmental Chapter. They have agreed to take over by the date of accession the whole *Environmental Acquis* with the exception of very limited number of investment-heavy directives.

As a result of economic restructuring and goal-oriented environmental policies, the state of the environment in the Baltic countries has been improving during last ten years. Significant improvements have been achieved especially in reducing the emissions of pollutants into atmosphere and hydrosphere. Emissions into atmosphere have been reduced mainly due to changed economic structure – the share of energy-intensive industry has substantially diminished and the share of less energy depending sectors, like tourism and services, has increased rapidly. At the same time a lot of efforts have been invested into the improvement of energy-efficiency in different economic sectors. This has been to a large extent result of major restructuring of industry and the whole economic system, however, elaboration and implementation of goal-oriented environmental policy has also played its positive role. In general, environmental policies of the Baltic countries, which were elaborated in mid-1990s, can be described as largely laying on international cooperation. They are based on internationally accepted legal norms and principles of environmental protection and they are built upon explicit policy planning, raising both short- and long-term goals as well as envisaging the ways and means of their achievement.

Strategic Issues Facing the U.S. Swine Industry: Efficiencies and Environmental Stewardship

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The United States' Swine Industry continues to go through a shift in ownership, location, and the very manner in which pigs are being produced. Corporate ownership is rapidly approaching 50% of the entire industry. Fewer pigs are being raised in the Midwest. Only the state of Iowa currently produces more pigs than North Carolina. One-site production has been replaced with multi-site production including a shift to wean-to-finish facilities.

In the past 80 years, the U.S. has gone from having over 5.2 million farms of which 94% raised pigs to currently having 2 million farms with only 4% involved in the production of pork. During this same time period the average number of pigs on a farm has increased by a factor of 70. The number of pork producers has decreased from 650,000 to less than 80,000 in just the last 25 years. Currently just 8.2% of the producers raise over 86% of the pork in the United States. Conversely 84% of the operations have an inventory of less than 500 head and account for only 6% of production.

The growth rate of the largest producers continues at a dramatic rate. In the last seven years the largest 25 producers have gone from having less than 17% of the sows to currently having over 40% of all of the sows in production. The shift to vertical integration in the swine industry is also moving at an ever increasing rate. The ten largest vertically integrated pork processing companies now own 25% of the sows as compared to less than 4% in 1994.

The U.S. Swine Industry is facing a relatively new set of strategic issues as compared to the issues that have dominated this industry in the past. The ultimate challenge facing this industry is to produce a product the consumer desires in a manner that they find acceptable. Paramount in this area is the public acceptance or ultimate rejection of the increasing size of modern production units.

In a recent survey conducted by a newspaper in Iowa it was reported that 65% of Iowa adults feel large confinement animal facilities should be discouraged. That is an increase of five percentage points since the last survey. 70% feel that there should be more local control in determining if large animal feeding operations should be allowed in their area. Policy makers have stated their goal is to strike a balance between environmental protection and the continued support of the livestock industry. The question must be asked as to the future of livestock production in rural America if public opinion leads to legislation and local control that limits the ability to produce livestock.

Price discovery of the value of a live pig produced for market is being lost as vertical integration increases in the swine industry. The fact that vertically integrated corporations view production of livestock as a cost center makes it difficult for producers to continue to realize a profit out of this segment of the food production chain. If independent producers are unable to raise pigs and generate a profit for their efforts, production will shift entirely to a vertically integrated situation where profit is realized at the end of the supply chain and strictly costs are tracked through the chain including the production phase.

Environmental stewardship will play a key role in determining where pigs are produced. The viability of the pork industry is dependent on improving the environmental quality around production facilities and within surrounding watersheds. The public's concern is increasing relative to potential contamination of water supplies and soil quality from the manure produced at livestock production units. Air quality remains an issue that is yet to be resolved near these operations. While the perception is that it is the Concentrated Animal Feeding Operations(CAFOs) that are to blame due to having too many animals in one location, the reality is that environmental challenges and management problems can occur at all levels of size.

Protecting the environment is being attacked from multiple fronts. Regulatory legislation such as the Livestock Management Facilities Act has been a positive step in defining the location of facilities, construction standards, and manure management practices. More stringent environmental federal legislation directed towards livestock feeding operations is projected to be debated and voted on in December of 2002. Producer groups such as the National Pork Board have also been actively involved in the development of programs designed for producers to manage their operations in an environmentally friendly manner.

The role feed grade antibiotics in livestock production are playing in the development of antibiotic resistance is currently being examined. Science based decisions must be utilized to determine the appropriate future use of antibiotics in livestock production. The Preservation of Antibiotics for Human Treatment bill has been introduced in the U.S. House of Representatives and the Senate. It states that all new animal drug applicants must demonstrate that human health will not be harmed as a result of the development of antimicrobial resistance attributable to the nontheraputic use of such a drug. The bill would also rescind approval for nontherapeutic use of penicillins, tetracyclines, macrolides, lincomycin, bacitracin, virginiamycin, aminoglycosides, and sulfonamides in animals. The bill has been referred to the subcommittee on Health.

The issue of animal wellbeing is one that has the attention of consumers, producers, legislators, and the groups that market retail meat. Efforts are underway in two states to legislate regulations covering the housing of pregnant sows. The Food Marketing Institute and the National Council of Chain Restaurants have presented guidelines on how all animals used in agricultural production should be cared for in order to account for their daily wellbeing and health. Their recommendations include the development and use of a measurable audit process, the establishment of an advisory council of third party animal welfare experts, and improved communications across the supply chain on all animal welfare issues.

The future of pork production co-existing with rural America will be determined in a large part by the public's concept of livestock production, the producer's environmental management, and the ability to generate economic returns during the production phase for pork producers.

Hygienical aspects on recycling of biowaste back to food production

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The collection and utilisation of biowaste (e.g. slaughterhouse offal, sewage sludge, wastewater, manure, household- and restaurant swill) is a central component in the development of a sustainable society. By recycling biowaste its potentially negative impacts on the environment can be minimised in a profitable way. Also for agriculture it may be attractive to use recycled biowaste, mainly as a fertiliser but also for energy and as feedstuff. Especially organic farming need alternative supply of plant nutrients. However, the quality must be assured concerning the content of heavy metals and organic contaminants, residues from medical treatments and the presence of pathogen micro-organisms. This is necessary to avoid harmful effects on soil, vegetation, animals and man.

This presentation will focus on the variety of pathogens that can be found in biowaste. The use of biowaste on arable land may facilitate the spread of infectious diseases. Hence, new routes of disease transmission between animals, human and the environment can be created. Large-scale changes in waste treatment strategies may result in an increased risk for disease transmission for certain diseases, which could have serious societal impacts. Some of the pathogens relevant here may cause zoonotic infections, such as enterohaemorrhagic *Escherichia coli* (EHEC) and salmonella and is thereby highly interesting for public health. Some other cause epizootic diseases in livestock, such as classical swine fever, and is thereby of enormous importance for animal production. Furthermore the disease situation is always very dynamic; thus there is a risk that pathogens recently introduced into a country or an area will be further spread in connection with biowaste applications. In the last years import regulations for animals and animal products have been relaxed both within the EU as well as between EU-countries and EU-associated countries.

Post-spreading survival time varies considerably between species of pathogens. Some bacteria may produce spores that can remain viable in the environment for decades. Eggs of some parasitic worms, *Ascaris* in particular, are very persistent and have been reported viable in soil for up to 7 years. Several viruses are also very persistent, and in certain extreme environments they can survive longer than indicator bacteria. Under favourable circumstances some bacteria and fungi are able to multiply in the environment. The number of micro-organisms needed to cause illness, i.e. the infectious dose, varies considerably between pathogen species and also depends on the infection route (e.g. oral, inhalation, through a wound). For many helminths and protozoa, including *Taenia* and *Cryptosporidiae*, a single egg may suffice to initiate an infection.

Pathogens from biowaste spread on farmland can be transmitted by vector animals, to surrounding populations of animals and humans. Vectors may carry pathogens on their bodies, or in their intestines. Infection may result directly from animals grazing on or passing over the land. Wild animals may also act as a live reservoir for a specific pathogen for a long period of time and then transmit the infection back to humans or other animal species. Other ways of transmission of pathogens may be on dust particles transported by wind, in surface water, and in or on food or feed harvested from the treated land. It can thus be very difficult to trace a disease outbreak in domestic animals or humans back to biowaste spread on farmland. This is especially hard when vector animals or pathogens persistent in the environment are involved.

The effectiveness of a hygienic treatment of biowaste often depends on the temperature, treatment duration, pH and oxygen availability. The reduction of pathogen numbers varies greatly depending on the method used and species of pathogens involved. Goals of a suppressive treatment can also vary: For some serious or exotic pathogens a complete kill-off is desirable, whereas for many others a marked reduction is sufficient. Biological treatment methods such as anaerobic digestion, aerobic composting and long-term storage are frequently used today. When using such treatment methods, even if a separate pasteurisation step is included, bacterial spores, some heat-resistant viruses and prions may persist in the treated material. However, with the present disease situation in Sweden this is not regarded as a biosecurity problem. Also it has been observed for example in a study of Swedish biogas plants performed by SVA that treated biowaste may be recontaminated during handling and storage. Efficient reduction of pathogens during pasteurisation is not enough if such recontamination cannot be avoided since a multiplication of pathogens may occur in the end product.

The biosecurity-related legislation regulating the use of biowaste as fertilisers vary between countries from no regulation at all to rather detailed legislation. However, concerning animal risk waste the legislation is coordinated within the EU, mainly due to the efforts to control bovine spongiform encephalopathy (BSE). Specified risk material (SRM) has to be incinerated. Animal high risk waste has to be rendered at 133ºC/20 min./3 bars pressure, while animal low risk waste may be used in a biogas or composting process if first treated at 70ºC/60 min.

If biowaste is to gain general acceptance as a fertiliser for farmers both a low contamination of noxious elements and its hygienic standard must be assured. Biowaste must be hygienically treated **before** use in agriculture. The hygienic standard should be based either on a treatment of known efficacy or on microbiological analysis. Preferably a combination of these two control methods should be performed. Recirculation of nutrients from urban areas to agricultural land is one of the big challenges of our time.

Our Food supply in a Global Environment and Ecosystem; What are the Drivers?

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A question that needs to be asked is, what does global environment and the ecosystem have to do with the world's concerns for food safety? Another more specific way to ask that question is, what is the role of our global environment and ecosystem in the effort to improve food safety?

First of all, data from the World Health Organization (October, 2000) indicates that 1.8 million children plus 400,000 adults die each year from food-related illness. More specifically, it has been reported by the Center for Disease Prevention (CDC) that in the United States 76 million people suffer illness, 5,000 people die, and 325,000 people thousand are hospitalized each year from food-related disease. The United States figures are compiled from only six major foodborne pathogens while it is known that more that 200 diseases are transmitted through food. (Mead et al., CDC, 1999)

Surveys on food safety confirm that concerns (real or perceived) vary in different regions of our globe. Major concerns in South America include *Staphylocccus aureus*, *Salmonella spp.*, Botulinium toxin, and pesticides. In the United States the greatest concerns rest with *Salmonella spp.*, Campylobacter, *E. coli* O157:H7, and chemical residues. On the other hand, European concerns have been most prominent with Bovine Spongiform Encephalopathies (BSE), chemical residues, antibiotic resistance, genetically modified organisms (GMOs) and hormones. While the above might lead one to conclude that issues may vary for sociologic or political reasons, more likely, there may also be scientifically substantiated environmental and ecological basis for varying concern.

There are significant numbers of scientists throughout the world providing good data on the contamination of our environment. Speakers at this conference have reported differing environmental priorities of concern even within the Baltic States. If a Baltic States survey were done in regards to food safety issues, it might be found that there are varying food safety concerns. There are significant numbers of scientists who are now addressing global food safety concerns. Driving environmental food safety research in the past has been public health concern centered on chemicals and carcinogenesis. Recent data is providing additional information as it relates to microbial contamination and acute food safety concerns.

The 1993 outbreaks of *E. coli* O157:H7 and resulting food recalls in the United States, followed by huge recalls of meat products contaminated with *Salmonella spp.* and *Listeria monocytogenes* and other food products similarly contaminated have driven public policy decisions which encourage pathogen reduction practices. Limited success is achieved when only the processing industries are targeted thus there is now acknowledgement that the food chain is a continuum. Attention must also be given to the start of the food source and continue through consumer use. It is neither possible nor reasonable to expect the processor to correct or successfully eliminate the risk associated with contaminated raw produce.

A 2001 conference on pre-harvest food safety sponsored by the National Food Safety and Toxicology Center at Michigan State University revealed a very complex array of contributing factors which influence the composition of our raw food supply (www.foodsafe.msu.edu/). Conclusions from data presented indicate that: 1. A food product must be initially presented as a clean and pure food product. 2. Plant produce is as much of a concern as are animal products. 3. Wildlife is a huge factor in determining the pathogen flora of raw produce. 4. Water and air play a very significant role in environmentally induced food safety problems.

Geographical localization of food production and consumption, as was the case a century ago, is no longer a reality even in developing countries. Food products, both raw and processed, are moving with increased frequency from one part of the world to another. Driving this trend is a world consumer market that wants more variety of produce with less seasonal limitation. Facilitating this trend are improved transportation systems, improved food handling systems, and improved communication systems. Providing service to this trend are global companies with worldwide food acquisition and distribution capabilities.

As part of the emerging global food economy, food related companies and industries must protect their market share and food safety concerns contribute to a substantially increased financial risk. Both regional and global source-targeted trace-back systems for food products are becoming more sophisticated. Economic hardship will be experienced in those regions and states where pure and wholesome raw product cannot be easily and efficiently produced.

Contributing to enhanced trace-back systems is the application of improved food contaminate diagnostic capabilities, improved monitoring of food and improved surveillance of foodborne outbreaks. Both private industries and governments contribute to the above trend--Industry because of economic necessity, and government because of the need for consumer protection and the need to maintain international trade. To facilitate the above, international organizations are formed to develop ISO 9000, HACCP, Codex Alimentarius, and other regulatory methods to help govern grades and standards for improved and more consistent food safety.

In summary, all regions of the world are part of a global society and what contributes to a local food supply may affect consumers and trading partners in distant regions. Also, there is ample data to demonstrate that raw food products are not produced in an isolated local environment. Chemical toxicants and microbial pathogens travel by ocean, sea, lake, river, stream, underground aquifer and irrigation systems. Migrating wildlife and aquatic species are carriers of both clinical and non-clinical pathogens as well as many harmful chemicals.

Food safety is but one more reason to diligently pursue environmentally and ecologically sound practices. Research and education in the above areas will continue to be a mandatory societal need.

Anthropogenic environmental change and the emergence of infectious disease in humans and animals

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Emerging infectious diseases (EIDs) have gained considerable attention in the scientific literature and in the public eye. Despite recent advances in our understanding of the biology of specific pathogens and their effects on hosts, several questions about the epidemiology of infectious disease emergence remain:

1) Are EIDs emerging at an accelerated rate?
To date, there has been little quantitative evidence that infectious diseases are emerging at rates greater than they have in the past. Database searches of the scientific and popular literature reveal that emerging diseases have received steadily increasing attention over the last 12 years in both spheres. Nevertheless, this phenomenon alone does not indicate an accelerated rate of infectious disease emergence. The trend is further confounded by improvements in diagnostics and surveillance.

2) What biological characteristics differentiate EIDs from non-emerging diseases?
Epidemiological studies have demonstrated that emerging pathogens are distinguished from other pathogens by having certain properties: they tend to be viral, multi-host pathogens that infect both humans and animals, including domestic animals and wildlife.

3) What are the principal ecological factors underlying the emergence of new pathogens?

The factors underlying infectious disease emergence have been poorly studied in an epidemiological context, but anecdotal evidence supports the hypothesis that anthropogenic environmental changes are responsible for the emergence of many EIDs. Such anthropogenic changes can occur on spatial scales from global to microgeographic, but the scale of the anthropogenic change is not generally proportional to the scale of its effects on host populations.

In conclusion, the epidemiological study of EID biology is in its infancy. Making the study of EIDs more rigorous will require the adoption of novel paradigms of infectious disease biology that emphasize the interactions between hosts and pathogens in an envoronmental context.

Long term disease monitoring in Swedish wildlife

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In the early 20th century the knowledge was limited regarding the disease panorama among wildlife in Scandinavia and the survey of different infectious wildlife diseases in Denmark published by Christiansen in 1935 is the first known report (6). In Sweden a health-monitoring program for wildlife was started in 1945, sponsored by the Swedish Hunters Association, the Swedish Environmental Protection Agency and the Swedish Government. The program was lead by Dr Karl Borg at the National Veterinary Institute (NVI). The program was based on investigations on dead animals found in the wild and on monitoring of normal material from different animal species. Swedish hunters initiated the monitoring program with funds originating from the annual hunting fee. The program is today an integrated part of the National Environmental Monitoring Programs in Sweden. On an annual basis 1 000 – 2 000 animals are investigated and the total material today comprises more than 80 000 recorded investigations.

The health-monitoring program is mainly a "passive" collection and investigation of dead wild animals, submitted to the laboratory by landowners, hunters or the public. All kinds of wildlife, including both game and protected species, are investigated. Annually around 600-800 mammals, including deer, hares, rodents, carnivores and others; and 600-800 birds of different species are investigated. The examination is free of charge for the submitter, and financed mainly by a government fund generated from annual hunting fees. The submitter receives an answer about findings and the cause of death (if possible to determine). The result of the investigation and different collected specimens will also be included in monitoring programs for certain microorganisms, parasites or environmental pollutants.

The "passive" collection of dead animals represents a statistical sample of different diseases and causes of death. The program gives only to a limited extent information about changes in the wildlife populations, since the submission of animals to NVI can depend on several factors and does not always reflect increased mortality. However, in order to study the impact of diseases on wildlife populations, focused studies are performed at regular intervals.

The cool sub-arctic climate with relative short summers with maximum temperatures at 25-30^{o} C, and long winters with temperatures below freezing point guarantees a good condition of the majority of material submitted. Examination of well-preserved carcasses are preferred and rotten material is rejected, with the exception of forensic cases where illegal hunting is suspected. It is also preferable to examine whole body carcasses, instead of examinations of specimens sampled by less experienced pathologists in the field.

A large number of “new” diseases have been discovered during the 50 years the program has been running. Viral infections have included Inclusion Body Hepatitis in Eagle owls (*Bubo bubo*) (2), papilloma virus in moose (*Alces alces*) (11), myxomatosis in rabbits (*Oryctolagus cuniculi*) (3), European Brown Hare Syndrome (EBHS) in hares (*Lepus* spp.) (8) and Rabbit Haemorrhagic Disease in rabbits (9). Several diseases caused by bacteria have also been studied. Long before the program started, in 1911, Hülphers reported (10) of a newly discovered bacterial species in rabbits, today known as *Listeria monocytogenes*. This bacterium has continuously been isolated from Swedish wildlife (1, 16). Infections with *Francisella tularensis* (tularemia) has also frequently been studied in hares and other species (13, 14) as well as infections caused by *Yersinia pseudotuberculosis* (1), *Mycobacterium bovis* and *M. avium* (12) and others. Infections with *Sarcoptes scabiei* in red fox (*Vulpes vulpes*), arctic fox (*Alopex lagopus*), lynx (*Lynx lynx*) a marten (*Martes martes*) (5), and with *Elaphostrongylus* spp. in moose and other deer (17) are the most important parasitic diseases studied.

Management actions are normally not taken in Sweden if disease outbreaks occur in wild populations, with some exceptions. Action can be taken to manage wildlife diseases in cases of zoonoses where wildlife act as a reservoir, or where diseases transmissible between wild and domestic animals are found, or when diseases threaten endangered populations, e.g. bovine tuberculosis in deer. Another example of this is the discovery of sarcoptic mange among arctic foxes in the North of Sweden, when 23 foxes, approximately 10% of the total Swedish population, were caught and treated for mange since the disease occurred in one small isolated population (14).

The monitoring program has also revealed several environmental pollutants that have an impact on Swedish wildlife. In the early 1950s, the intoxication of wild birds with mercury, originating from seed-dressing, was discovered as a result of pathological studies in combination with analytical chemistry (4). Since 1950, further environmental toxicological studies have been in progress at NVI, mainly concentrating on cadmium and lead (1,16). Lead poisoning is still a common cause of death in ducks, geese and swans, but are also seen in birds of prey and woodpeckers. Several studies has also been performed on organic compounds like fenoxy acids (7).

According to the Swedish law, the right of hunting belongs to the landowner or the person/persons renting the hunting rights for the land. Because of this, landowners and hunters are always interested in diseases and causes of death in “their” wildlife. This is true for both game species and protected species. A very close cooperation is therefore maintained with the Swedish Hunting Association (SHA) and their game wardens. SHA has approximately 25 field stations and approximately 75 employees, with a majority of them being involved in the system of reporting and submitting material to NVI. Cooperation with other conservation organizations like the Swedish Society for Nature Conservation and the Swedish Ornithological Society is also an important factor in the monitoring program’s success.

One very important collaborator for a successful program is media, including the daily papers, weekly magazines, specialist press, radio and TV. The attitude of the “health program” is always an open one towards the media. All possible information is provided upon request. Several journalists visit NVI and the post mortem room regularly and are given relevant information about wildlife, wildlife health and pollutants. The only restriction is with forensic cases, which are handled under security.

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Wildlife Diseases in a National & International Perspective

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From a wide range of infectious diseases, veterinary topics or species related problems (e.g. *B. burgdorferi*, *E. coli, O157:H7,* Salmonella, DT104, Antibiotics / resistance, rabies, swine fever (hog cholera), West Nile virus, *T. gondii, Sarcoptes scabiei,* whales, roe deer, European brown hares, manure) three examples of wildlife diseases were chosen. The examples were chosen to demonstrate some of the complicated interactions between wildlife, domestic animals, wildlife and human beings ecologically and economically.

Introduction

Wildlife disease investigations is an important topic regarding

- Wildlife health and wildlife biology
- Veterinary emergency control / surveillance / risk assessment
- Health status of domestic animals / risk handling
- Balanced evaluation of disease risks in outdoor husbandry
- Studies of environmental effects on populations

Apart from that it is professionally very interesting and satisfying to work with the veterinary aspects of wildlife disease and health as well.

Handling of wildlife disease situations

In order to handle major outbreaks of wildlife diseases it is important to secure

- National & international cooperation (usually based upon well established co-operation with a thorough knowledge of your own and your partners' capabilities)
- Examinations aimed at establishing precise knowledge of actual health and disease status (usually based upon multidisciplinary experience within the institutes)
- Reliable, precise and fast diagnostic work up
- Risk assessment and risk handling
- Regulation of the population may be the outcome of a serious disease situation especially if natural predators are missing or present in insufficient numbers
- Protection of the population is the more usual result of major outbreaks of wildlife diseases
- Introduction and/or reintroduction of species may be the result of ecological disasters.

In a long term strategy of wildlife surveillance it is important to secure a coordinated national and international surveillance of disease and health in wildlife populations.

1. Human trichinellosis 2002
The first example given was a large outbreak in January 2002 of human trichinellosis (*Trichinella spiralis*) northeast of Belgrade. Human clinical cases reported so far were 247, and the source of the infection was "domestic smoked sausages" produced by a small slaughterhouse.
A finding of this parasite in meat products may be devastating to the export of meat products and hence presents a potentially very serious economical threat to the society's economy as well as a health hazard to man. Such a finding must urge the relevant authorities to implement and enforce control measures to reduce the general level of infection in wildlife and among domestic animals.

2. Introduction of *Echinococcus multilocularis* in Denmark
E. multilocularis has been found in 3 wild foxes in Denmark in 2000-2001. This finding immediately caused some politicians to demand the eradication of thousand of wild foxes living in almost every major city of Denmark.
A novel finding of a potentially life threatening parasite in a hitherto uninfected region causes political problems usually based upon lack of knowledge of the extent of spread of the disease resulting in public anxiety fuelled by an eager press corps. Lack of money for acute prevalence studies adds to the public anxiety.

3. Re-emergence of phocine distempervirus infection among North European harbour seals
Phocine distempervirus decimated the Danish harbour seal population by 50 % in 1988. The infection reemerged in harbour seals in Denmark in 2002.
A reeemerging, serious, infectious disease calls for explanations to a lot of corresponding problems including the influence of pollution, maximum level of a sustainable population of marine mammals in shallow waters, negative effect of seals upon fish production for human consumption and introduction of hunting licenses for seals. Upon this the press is extremely interested in the problems of carcasses drifting ashore in the middle of the bathing season and in related problems of the precise risk for dogs to acquire distempervirus infection and the risk for babies swimming close to dead seal bodies of acquiring measles. The logistic problems of handling > 10,000 dead seals in a complicated, multidisciplinary and multinational cooperation and funding the operation from day one should not be underestimated.

A Brief Review of Environmental Research in Lithuania

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Environmental Research is carried out by research institutes and laboratories, specialized departments at the universities and scientific research centers in Lithuania.

During past several years Lithuanian Veterinary Academy also is involved in the environmental research. In years 1999-2001 together with Lithuanian National Veterinary Laboratory the project "Accumulation of Some Chemical Risk Factors in Wild Game in Lithuania (1999-2001)" was carried out. The objectives of this study were to determine environmental health indicators - chemical risk factors - in wild game and to evaluate their impact on game meat safety and ecosystem health. Determined chemical risk factors in wild animals were heavy metals (Pb, Cd, Hg) and radionuclide Cs^{137} in meat, liver and kidney, organochlorine pesticides (alfa-,beta-,gama-HCH, HCB, Heptachlor, Aldrin, Dieldrin, DDT) and polychlorinated biphenyl's in fat tissues. There were examined four wild animals' species: wild boar (*Suis scrofa*), roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*) and moose (*Alces alces*). The examination of fat tissue from wild animals for organochlorines and PCB demonstrated very low contamination of these substances. The amount of pesticides in 86% of samples was lower than minimal range of determination. Alpha-HCH and HCB - were found in seven samples. These chemicals are not permissible according Lithuanian Hygiene Norm 54-1998 in Food and food material. It is necessary to stress that alpha HCH, beta HCH, DDT and hexachloranes have not been used in agriculture since 1970, other organochlorines were forbidden to use at the end of ninetieth. According to the pesticides monitoring program, more than 900 places were identified which could potentially contaminate environment with pesticides during period of 1995-2001 and only 18% of storehouses for pesticides are inventoried. In 2001 there were stored 214t forbidden for use and 1 347t unknown old pesticides in 185 storehouses (Ministry of Environment, 2001). The mean of Cs^{137} activity concentration (Bq/kg) in analyzed game meat samples were only 2,5% of the maximum permissible Cs activity concentration level – 600 Bq/kg in food and raw food material (Lithuanian HN 54–1998). According to the monitoring results radionuclides from Ignalina NPP origin constitute only 0,5% irradiance dose of natural irradiance and do not exceed 1% of allowed irradiance dose (State of Environment 2001, Lithuania). The highest concentration of heavy metals in wild animals' samples has been found in viscera. The average amount of heavy metals in main hunting product – muscle tissue (game meat) – was lower than in liver and kidney and did not exceed highest allowed amount.

Another project - Improved meat production in the Baltic Region through Epidemiology based control of Trichinellosis – a Parasitic Zoonosis – involved three Baltic countries - Lithuania, Latvia, and Estonia. FAO gave the financial support to this technical cooperation project. The objectives of this project were determination of trichinellosis prevalence in wildlife reservoirs (using digestion methods), determination of *Trichinella* species and its transmission ways (using PCR). Results showed that prevalence of trichinellosis was high - 30-40% in foxes and raccoon dogs, martens. It was defined item that *Trichinella* transmission from domestic environment to wildlife and backwards to domestic pigs was intensive.

Lithuanian Veterinary Academy had several projects related to the parasites of wild animals: 1) epidemiology of gastrointestinal neamatodes in farmed sika deer (*Cervus Nippon*) in Lithuania; 2) prevalence of helminthes in wild red fox (*Vulpes vulpes*) with special reference to *E. multilocularis* a zoonotic parasite; 3) monitoring and control of helminthes infections in bison (*Bison bonasus*) ranged for reintroduction into wild.
Furthermore other universities also carry out researches in this field, for example the Department of Environmental Sciences of Vytautas Magnus University implements projects: integrated impact of natural factors and environmental pollution on the plant communities and individuals and integrated impact of environmental and social factors on human health.

Kaunas University of Technology (faculty of Chemical Technology, dep. of Environmental Engineering) carried out projects: Kaunas Municipal Air Quality Monitoring System; Sustainable Urban Patterns around the Baltic Sea Region; the Ecological Consequences of use of Biomass and Inciberable Waste in the Baltic Region – Baltic States and Kaliningrad.

The Lithuanian Forest Research Institute (dep. of Forest Soils, Typology and Hydrology) carried out projects: **s**tudies on forest soils technogenic pollution and theoretical as well as methodical principles for regional monitoring (1991-1996) ect.

Areas under investigation of the Institute of Chemistry (dep. of Environmental Chemistry) are environmental chemistry and environment protection from chemical pollution. There were carried out studies about the interaction between heavy metal complexes and natural compounds and studies on the interaction between heavy metals and natural sorbents in soils during the decontamination of environment affected by metals.

Laboratory for Investigation of Radioisotopes of Institute of Geology is carrying out several investigations: geophysical and geochemical investigation of migration of radio nuclides in environment; investigation of the impact of Ignalina NPP on the environment; radio ecological monitoring and modeling and radiogeochemical cartographering.

Activity objectives of the subdivision of the Ministry of the Environment of Lithuania - Center of Marine Research are to carry on the ecological monitoring in the river Nemunas mouth and the Kursiu Lagoon; to coordinate and to carry on the National monitoring program in the Baltic Sea; to examine the influence of dumping on the environment; to study extreme situations (fish decay, oil spills) and other.

Institute of Ecology carried out several international projects: EU 5FP on biological impact of environmental pollution on sea littoral ecosystems; development, analysis and implementation of standardized evaluation method of ecological status in European river, reasoned by fish data basis. Some projects were supported by Lithuanian government: regularity and mechanism of tolerance and adaptation of water animals (rainbow trout) to the chemical environmental agents; analysis of ecotoxic influence biomarkers in freshwater and marine ecosystems, etc.

Also governmental institutions are involved in environmental research activity, mainly in formation of general policy. As example of the activities of the State Public Health Center are preparation and coordination of National Environmental Health Action Plan for 2002-2006 (together with other institutions). The long term aim of this action plan is to protect and improve health of Lithuanian inhabitants by improving environmental health management and by ensuring threat less environment quality for human health. Also the State Public Health Center is developing information system “Environment and Health” with aim to develop expeditious and accessible information system for timely and effective decision making in the area of environmental health.

Environmental history and aspects on the present situation of the Baltic Sea

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The Baltic Sea

The Baltic Sea, one of the largest brackish seas in the world, has been under severe ecological pressure for many decades due to industrialisation, urbanisation, agriculture, forestry, and hydrological and climatic conditions. The drainage area, which is four times the area of the Baltic Sea, is inhabited by more than 100 million people. The Baltic Sea is divided into a few major basins, with the deepest parts in the Baltic proper. It is connected to the Atlantic North Sea by the Kattegat and the Danish straits, both of which have constituting shelves restricting the inflow of salt-water from the Atlantic North Sea. Salinity decreases from 10-20‰ in the Kattegat strait to 3-5‰ in the northern Gulf of Bothnia, forming a salinity gradient that affects the distribution of several species. Well-defined halo- and thermoclines stratify the water mass. The biological diversity is low with few, but relatively abundant species, forming simple food chains.

Baltic fish and some aspects on recruitment

The Baltic cod (Gadus morhua) has been the most important species for fisheries in the Baltic Sea. The stock increased to a maximum during the early 1980s, with a peak catch of 450,000 tonnes in 1984. However, after 1977 no major inflows of Atlantic water occurred until 1993, this with a major impact on recruiment. Since 1981, recruitment decreased continuously and this, together with overfishing, has led to a dramatic decline of the cod stocks and in 1993, the catch was only about 10% of the 1984 level. In 1991-93, recruitment was far below what could be expected from the extent of the reproduction volumes. For species with pelagic eggs, such as cod, a low salinity has been shown to increase the vertical distribution of cod larvae. The avoidance of stressful oxygen conditions by maintaining egg buoyancy is an important factor for successive spawning in Baltic cod. During recent years because of reduced salinity cod eggs have been most abundant below the halocline (50-80 m) where oxygen levels are less suitable. The concentration of oxygen may consequently play an important role in the survival of Baltic cod embryos. Today, the cod is in a situation when actions must be taken in order to save its survival in the Baltic Sea, and reduced fisheries must be considered to give the cod a possibility to restore the population.

The Baltic salmon (Salmo salar) belongs to the Atlantic salmon species, but is genetically isolated from the populations living in the North Atlantic. At the beginning of this century more than 60 rivers draining into the Baltic Sea had naturally reproducing salmon stocks. Damming in connection with construction of hydropower plants has since reduced the number of rivers available for natural salmon reproduction to around 20. In 1974, a high incidence of yolk-sac fry mortality was reported for the first time in Swedish compensatory fish farms. The mortality was designated the M74 syndrome and increased dramatically during the early 1990s. A peak in mortality was recorded in 1993 when 72% of the progeny from Swedish hatcheries died from M74. During the period 1994-1997 the mortality decreased slowly to 26%. In 1998, the incidence was only 8%. However, the trend was changed in 1999 when the M74 mortality increased to 38% a incidence, which has been approximately the same between 2000-2002. The M74 syndrome is linked to the progeny of certain females and develops during the yolk-sac resorption process. Yolk-sac fry developing M74 have been shown to have a deficiency in thiamine. The deficiency is treatable by immersion of the eggs or newly hatched yolk-sac fry of the affected family groups in thiamine-enriched water. Recent research has been focused on to describe thiaminase activities in major food items, i.e. herring, sprat and three-spined stickleback.

There are numerous reports concerning other Baltic fish species affected by reproduction disorders. In the southern part of the Baltic Sea, species with pelagic eggs, e.g., flounder (Platichtys flesus), plaice (Pleuronectes platessa) and whiting (Merlangius merlangus) suffer from high egg mortality, low hatching rates and different types of abnormalities. Already, in 1979 abnormal embryos of sprat (Sprattus sprattus) were described. High mortalities in herring (Clupea harengus) have been attributed to brown algae, emissions from metal industries and chlorinated hydrocarbons.

Also Baltic fish species living in coastal zones have been affected by different types of environmental distress, especially reproduction disorders affecting both individuals and at population level, e.g., burbot (Lota lota), perch (Perca fluviatilis) and roach (Rutilus rutilus). During the period 1970-2002, different types of reproduction disorders, including inadequate gonad maturation, low fecundity and early life stage mortality, have been documented for a number of fish species in the Baltic Sea and in some major tributaries which constitute important spawning areas for anadromous species.

Local populations of burbot in the Bothnian Bay failed to spawn in the years 1987-1990 due to incomplete gonad maturation. In some estuaries, the percentage of non-maturing burbots was as high as 93-100%. The only location in the investigated region with a high degree of mature fish (100%) was the River Tornio at Pajala, 150 km from the river mouth in the Baltic Sea, a location investigated that is relatively uninfluenced by anthropogenic activities indicating the involvement of contaminants. Local populations of perch living close to pulp and paper mill effluents have been shown to be affected by poor recruitment, larval deformities and mortalities. Reduced gonadal development, acute fin erosion and indications of ovarian atresia have also been recorded. The abnormalities decreased with increased distance from the source of the emissions. Serious gonadal anomalies have been recorded in roach stocks in Swedish, Danish and Finnish waters. In some cases, the gonads display both male and female genital products in different parts of the same gonad, i.e., intersex. Reduced gonad growth in roach is also documented from pulp mill effluents. Oocyte degenerations, asynchronic gonad and oocyte growth, in addition to an increased variation in gonad development, affect local roach populations living in cooling water discharges.

Possible causes and explanations of reproduction disorders and population disturbances

The capacity of the Baltic Sea ecosystem to withstand environmental disturbances is poor since many species are living at the edge of their range and there are many alarming signs concerning the health of the Baltic Sea ecosystem. The Baltic Sea is directly and indirectly affected by many different environmental problems. Eutrophication, acidification of spawning areas for several species of anadromous fish, halogenated hydrocarbons and heavy metal contamination, are among the most well-known threats to aquatic life. Furthermore, other potential less investigated environmental threats like leaking canisters of war gases dumped after the first world war, recently introduced industrial chemicals (brominated flame retardants, plasticisers, antifouling agents) and altered nutritional food webs due to eutrophication causing algae blooms must be considered from ecotoxicological points of view.

Abiotic factors

Reproduction disorders in Baltic fish species must be considered from the very specific conditions characterising the Baltic Sea ecosystem. The subarctic environment with long winters, ice-cover and low water temperatures, low oxygen concentrations and the reduced salinity gradient from south to north may have a negative impact on early development in certain species. During the twentieth century, periods with oxygen depletion of some areas of the Baltic Sea have resulted in anoxia in benthic habitats and thereby loss of biological productivity. During recent decades, the situation has worsened due to a combination of low salt-water inflow and increased eutrophication. For species with pelagic eggs, such as cod, a low salinity has been shown to increase the vertical distribution of cod larvae. The avoidance of stressful oxygen conditions by maintaining egg buoyancy is an important factor for successive spawning in Baltic cod. During recent years because of reduced salinity cod eggs have been most abundant below the halocline (50-80 m) where oxygen levels are less suitable. The concentration of oxygen may consequently play an important role in the survival of Baltic cod embryos.

Infectious and nutritional disorders

Important biotic factors affecting recruitment include parasitism, infectious diseases, malnutrition and eutrophication resulting in altered primary production and consequently altered food webs. Parasitic infestations may cause larval mortality in Baltic cod and turbot. Brown trout and salmon are affected by Ulcerative Dermal Necrosis (UDN), a fungi infection causing high mortality during their migration to their native rivers for spawning. Other infectious diseases of specific concern are viral heamorrhagic septicaemia and furuncolosis.

In M74-affected Baltic salmon, lowered concentrations of carotenoids, thiamine, tocopherol and ubiquinone have been recorded. The causes of these sometimes severely lowered levels may be of ecological character resulting from alterations in the community composition of primary producing algae and microorganisms of the Baltic Sea ecosystem. However, the key nutritional factor in the etiology of the M74 syndrome is thiamine. This vitamin is involved in many physiological processes including normal metabolism and detoxification.

Chemical contamination in Baltic fish

Chloroorganics, i.e. DDT, PCBs, TCDD/Fs and other highly persistent bioaccumulative compounds are still widespread in the Baltic Sea ecosystem and generally at higher levels than in adjacent salt-water areas. These pollutants come from atmospheric deposition (Falandysz, 1994) and various point sources. A variety of halogenated hydrocarbons bioaccumulate in fish, particularly in fat-rich fish, e.g., in Baltic salmon. Larval deformities and increased mortalities in pelagic eggs of plaice, flounder, whiting and herring have been suggested to be caused by these compounds. Baltic flounder eggs with PCBs exceeding 120 ng/g (ww) showed reduced survival, and at concentrations near or higher than 250 ng/g the viable hatch was below 15%. In whiting, the ovarian threshold values for the major contaminants DDTs, dieldrin and PCBs were 20, 10 and 200 ng/g (ww), respectively, giving rise to abnormal mortality (>90%). In the Baltic herring, 18 ng DDE/g ovary (ww) reduced reproductive success and similar effects were recorded with PCB-values of 240 ng/g ovaries (ww). High concentrations of PCDD/Fs and heavy metals such as Cd, Cu and Pb were suggested to be responsible for inadequate maturation of burbot in the Bothnian Bay. Pulpmill effluents contain many different environmentally active compounds, including chlorinated hydrocarbons, resin acids, dissolved nutrients and dissolved and particulate organic matter. These substances may cause a variety of responses from eutrophication to toxic stress. The debate on pulp mill effluents has mainly concerned chloroorganic compounds and their effects on biota. In the Baltic Sea, a number of abnormalities have been observed in fish living close to pulpmill effluents, including skeletal jaw deformities in northern pike (Esox lucius), and vertebral curvature in perch and fourhorn sculpin. Several studies have demonstrated induced activities of the cytochrome-P450-system-dependent enzyme systems in Baltic cod compared with Barents Sea cod, and in fish exposed to pulp mill effluents, such as perch and roach and bream (Abramis brama). There is also evidence of increased rates of larval mortality and malformed embryos in perch and reduced gonad growth in roach and perch. During recent years there are reports of improved survival rates in perch, which was attributed to improved technical methods in the pulp and paper mills resulting in lowered emissions of chloroorganics. The concentrations of metals in the Baltic Sea are of similar magnitude to those in the north Atlantic. However, there are some reports on high concentrations of metals involved in reproductive disorders, such as, in burbot in the Bothnian Bay and in high egg mortalities in Baltic herring in the Gulf of Bothnia.

Today, the enviromental situtaion is still very complex and high concentrations of TCDD (20pg/g fresh weight) have recently been detected in herring from the northern parts of the Baltic Sea. Furthermore, a nummer of "new" chemicals and other modes of action have been disclosed. These includes feminisation and masculinisation of certain species, i.e., roach and eelpout.

Commercial fishing

Two-thirds of the annual catch of Baltic salmon is taken in unselective off-shore fishery on a mixed salmon stock of hatchery reared and naturally reproducing salmon (Swedish Salmon Research Institute, Annual Report, 1995, Älvkarleby). The latter constitutes one-tenth of the total stock biomass. The pressure on naturally reproducing populations has been severe due to the high fishing pressure. The situation for the cod has also been worsened by commercial fishing mainly for the large spawning cod. Today, the large Baltic cod are rare today and since there seems to be a relationship between the size of cod and success in spawning, high fishing pressure on large cod may have resulted in lowered recruitment. Actions to protect the cod must be taken not only from a Swedish perspective, but from all countries “sharing” the unique ecosytsem the Baltic Sea.

The future

Human activities resulting in eutrophication and pollution of the Baltic Sea must be further evaluated. It is important that a search for the possible causes of fish reproduction disorders in major species, such as cod, salmon and brown trout, and population declines in other species is undertaken using a multidisciplinary approach. It is also important that the complex interrelations between fluctuations in the fish ecosystem and other specific characteristics of the Baltic Sea are considered. The significance of various halogenated organic micropollutants and their metabolites must be evaluated in aquatic food chains, especially with regard to biomagnification, biotransformation and interactions with different antioxidant systems. Fluctuations in primary production and variations in species composition of algae must also be considered since several species of algae producing toxins, such as cyanobacteria, have been shown to affect fish. It must be realized that production of reactive metabolites is an integral part of both detoxification as well as normal biological processes, but is highly controlled by the body antioxidant defenses which normally cope with the free radicals generated. Only when there is an imbalance between free radical production and the protective antioxidant dependent systems can damage occur as seen in the relatively high frequency of DNA-adducts in Baltic cod eggs and larva, that indicate an uncontrolled production of free radicals. The concentration of many xenobiotics has decreased in Baltic fauna during the last decades since substances such as PCB and DDT were banned. There are indications however that during this period other types of substances have also decreased in a similar or more extensive manner and is exemplified by reduced concentrations of vitamins of Baltic salmon affected by the M74 syndrome. This relatively larger decrease of essential substances, which are of vital importance in detoxification systems, may explain the imbalance between reactive metabolites and antioxidants, and thereby the dramatic increase in reproduction disorders in Baltic fish species. The complex situation in the Baltic Sea is also indicated by recent investigations showing increased concentrations of coplanar PCBs (77, 126, 169) and two of the most toxic PCDFs in muscle tissue of Finnish ascending spawning salmon during the early 1990s and high concentrations of TCDD in herring. This further complicates the assessment of the impact by halogenated pollutants and other toxic substances on biota in the Baltic Sea.

In order to improve possibilities for risk assessment and management's there is a demand from industry and governmental authorities to find the right tools to evaluate chemicals. Today, three key species have been identified for this purpose, zebrafish, fathead minnow and medaka. The work to finalise test protocols and guidelines are in the pipeline and under discussion.

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Assessing the Impacts of Environmental Contaminants on Marine Mammals

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There are a number of persistent organic pollutants (POPs) of major concern worldwide that include pesticides such as dichlorodiphenyl trichloroethane (DDT) and polychlorinated biphenyls (PCBs). These chemicals are persistent because they are resistant to degradation, undergo very slow biotransformation (low metabolic (enzymatic) capabilities), have generally low water solubility, are lipophilic and highly bioaccumulative (i.e. higher tissue concentrations with increasing trophic level)

These chemicals have a number of adverse health effects on animals including the disruption of multiple organ systems including endocrine disruption,immune function modulation, teratogenic, carcinogenic, neurobehavioral, neurologic, hepatic and renal, integumentary effects.

With each of the POPs, toxicity varies by species, route of exposure, timing of exposure, length of exposure. For example, robins are most sensitive to acute toxicity of DDT while pelicans are most sensitive to egg-shell thinning, mink are most sensitive to reproductive effects. Guinea pigs and mice have suppressed cell mediated immunity and no liver lesions at doses that cause severe liver lesions and no immunosuppression in rats. Developing organisms are more sensitive to lower doses, even single dose exposure. Timing is critical for teratogenic and developmental effects to occur.

There is mounting field evidence that marine mammals are adversely affected by organochlorine contamintants (OCs). Examples of lesions detected include: Ringed seals in Bothnian Bay, Baltic (Helle, Olsson, & Jensen, 1976a; Helle, Olsson, & Jensen, 1976b) with a severely reduced pregnancy rate of only 27% (80-90% expected). This was due to uterine stenoses and occlusions. It was found that the tissue concentrations of DDT and PCB were higher in non-pregnant seals. In grey seals also from the Baltic, it was found that there was a high prevalence of skull-bone lesions after 1960 compared to pre-1950 and British Isles (Bergman, Olsson, & Reiland, 1992; Mortensen, Bergman, Bignert, Hansen, Härkönen, & Olsson, 1992). Additional lesions in grey and ringed seals included skin and nail lesions and bilateral adrenal gland hyperplasia (Mortensen, Bergman, Bignert et al., 1992). In the less contaminated (compared to the Baltic) Pacific Ocean, a condition known as Northern Elephant Seal Skin Disease (Beckmen, Lowenstine, Newman, Hill, Hanni, & Gerber, 1997) has been recognized. This is an ulcerative dermatitis with hyperkeratosis, squamous metaplasia and atrophy of sebaceous glands. These histologic lesions are remarkably similar to the human PCB poisoning lesion, chloracne. Affected seals had PCBs & DDTs significantly elevated vs. an age matched reference population. Additionally, depressed thyroid hormones and retinol (biomarkers of PCB exposure) correlated to elevations in PCB concentrations.

There have been a number of infectious disease outbreaks that may have been worsened by contaminant induced immune suppression. For example, the Baltic/North Sea seal die-off of '88-'89 due to phocine distemper in which over 20, 000 harbor seals and hundreds grey seals died. A number of findings were published including:

- Thyroid fibrosis and colloid depletion in harbor seals (HS) (Schumacher, Zahler, Horny, Heidemann, Skirnisson, & Welsch, 1993)
- Elevated PCBs in HS that died vs. survived infection (Hall, Law, Harwood, Ross, Kennedy, Allchin et al., 1992)
- Seals with higher OC levels may take longer to recover from the immunosuppressive effects of phocine distemper virus (PDV) infection (Kendall, Safieh, Harwood, & Pomeroy, 1992)

However a follow up feeding study with PCB-loaded fish did not effect the clinical course, duration of cell-associated viremia, PDV-antigen distribution in tissues or humoral immune response in PDV infected harbor seals in a captive experiment though it is important to note that the PCB dose accumulation in the test seals was lower than found in free-ranging seals. Additionally, high IgG titers did not correlate with recovery.

Additional morbillivirus epizootics have also been studied for a contaminant 'contribution'.
The western Mediterranean striped dolphin die-off of '90-'92 was attributed to a new dolphin morbillivirus. Adults hardest hit and had the highest PCBs found to date (mean 855.9 ppm), which may have triggered the initiation and subsequent development of the epizootic. In 1987, a dolphin morbillivirus killed 50% of the population of bottle-nosed dolphins on the eastern coast of the US.

There is mounting field evidence that contaminants have adverse reproductive effects in marine mammals. For example, the frequently cited California sea lion abortions that were associated with elevated OCs (DeLong, Gilmartin, & Simpson, 1973). These results were complicated by a concurrent leptospirosis outbreak (Gilmartin, DeLong, Smith, Sweeney, DeLappe, Risebrough et al., 1976). In Wadden Sea harbor seals, elevated PCBs were associated with decreased reproductive success (Reijnders, 1980). Captive study then demonstrated a failure of implantation (Reijnders, 1986). A study in a cetacean species found increasing DDT in blubber of Dall's porpoise negatively correlated with blood testosterone (Subramanian, Tanabe, Saito, & Miyazaki, 1987). In polar bears from Svalbard, an presumably abnormal observed rate of female pseudohermaphroditism was 1.5% (4/269) in a population with previously documented high levels of OC contamination (Wiig, Derocher, Cronin, & Skaare, 1998).

There is also evidence that neoplasia in a cetacean species may be linked to contaminant exposure. In St. Lawrence Beluga whales 129 belugas were examined (49% of those stranded) from 1983-1999 and cancer was diagnosed in 27% of adults (Martineau, Lemberger, Dallaire, Labelle, Lipscomb, Michel et al., 2002). This was an annual estimated cancer rate (AR) of 163/100,000, which is similar to humans, cats, and cattle. However, the AR of cancer of the proximal small intestine was 63/100,000, which was substantially higher than humans or animals except sheep where environmental chemicals are believed to be the cause.

There have also been a number of population declines possibly linked to contaminant exposure. For example, the rapidly declining stock of sea otters sampled from the Aleutian Islands had much higher levels of both PCBs and DDTs than otters sampled from Southeast Alaska. Also, the sympatric populations of Steller sea lions and northern fur seals have also been found to have high OC exposure associated with decreased immune function especially in areas of population declines.

In general, investigators have had to rely on building a weight of evidence of adverse effects of contaminant exposure on health in free-ranging marine mammals because the lack of controlled studies and species-specific reagents. Instead, scientists try to determine if the exposures in the wild are sufficient to pose a risk of adverse effects. This has historically been done through the determination of tissue residues or Toxic Equivalency Quotient that are then compared to No Observed Adverse Effects Level, Lowest Observed Adverse Effects Level, or threshold levels extrapolated from laboratory animal studies. For the future, biologists and veterinarians must strive to incorporate a holistic approach, that is examine the health of the entire animal in the context of the population, to determine if POPs are having a significant negative impact on populations of marine mammals.

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Endocrine Disruptors and Reproductive Health

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Eggshell thinning in birds, deformed external genitalia in alligators, reduce fertility in Baltic Sea seals and decreased sperm counts in Danish men are all observations where we know or suspect that endocrine disruptors play a key role.

Then, what is an "endocrine disruptors"? According to the definition shared by *CSTEE* and *IPCS* at the European Commission and WHO, respectively, it is "*an exogenous substance or mixture that alter function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub) population*"

Initially the EDs were thought on only as substances causing adverse effects on reproduction. However, now there are several evidences of effects on other endocrine systems (and physiological functions). Even so in the scientific literature as well as the public debate there has been a focus on "environmental oestrogens". It should be noted though that there are both naturally occurring oestrogens in the environment, such as phytooestrogens in feedstuffs and true environmental contaminants with oestrogenic activity. Classical examples of such substances are DDT, DDE, PCB, TBT and alkylphenols.

Generally, the reproductive system is one of the most sensitive physiological systems with respect to disturbance from chemical compounds. That is, very low exposure may affect the reproductive performance of an individual. This is of course very bad for the survival of an exposed individual, population or species. On the other hand, disturbances in the reproductive performance may serve as a "monitoring system" for contamination in the environment.

There are several scientific challenges connected with studies of effects of EDs on the reproductive system: for instance since we are dealing with additative effects from endogenous sex hormones, phytoestrogens and chemical pollutants it is hard to determine the contribution of the latter to the particular effect. Also, there may also be so called "late effects", that is there is a considerable time gap between the time of exposure and overt effects on the reproductive performance. Many times, this makes tracking of the exposure very difficult.

Because of the growing scientific concern that chemicals in the environment may impair human and wildlife reproduction the Swedish Government and the European Commission have emphasized the need to develop better test methods for the assessment of adverse effects of chemicals on reproduction. Most chemicals on the market have not been tested and assessed regarding their potential reproductive toxicity. The test methods in this area that are in use today were largely developed decades ago. In many respects, they have a low sensitivity and consequently more sensitive endpoints have to be identified. There is also a need for establishment of robust endpoints that are convenient to use for monitoring of alterations in the reproductive performance of wildlife.

The ReproSafe programme addresses these issues. The scientific novelty and leverage of the programme is a holistic analysis of new and established endpoints in reproductive toxicology. This is made possible through a comparative approach in which new methods and test systems for assessing reproductive performance will be developed in several species and on different levels of biological organisation. Furthermore, identification of sensitive endpoints and elucidation of mechanisms for reproductive toxicity will provide possibilities for development of in vitro tests. Also, a basis for the development of novel biomarkers for environmental monitoring of reprotoxic pollutants in wildlife populations will be gained.

In addition to this scientific objective, one important component of the ReproSafe programme is postgraduate training aiming to supply the society with personnel with high competence in reproductive toxicology. Therefore, a national graduate school on reproductive toxicology is included in the programme. Finally, by regularly arranging seminars and stakeholder meetings, the ReproSafe programme will communicate and inform stakeholders on national, EU and international level about the scientific progress in this area. For further info loc into the website http://www-cru.slu.se/ReproSafe.htm.

Reports From Fact Finding Visits

Environmental Protection Programs, Policies, and Problems in Lithuania and Latvia:

A Summary Report of a Fact-Finding Visit to Lithuania and Latvia
(August 11- 15, 2002)

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Lithuania

Coordinating the Lithuanian section of the fact-finding trip was Mindaugas Malakauskas, DVM, MS, PhD, Lecturer, Department of Animal Sanitation and Food Hygiene, Lithuanian Veterinary Academy. A total of five meetings were attended in Lithuania. Summaries of the meetings are given below.

1) Regional Environmental Center for Central and Eastern Europe
Meeting with Dr. Laima Galkute, Director.

A variety of programs are currently in progress for sustainable environmental and economic development in Lithuania and nearby countries. Programs discussed included the Baltic University Initiative on Sustainable Development and Baltic 21E (education), with foci on health, environmental conservation, sustainable development and education in the Baltic Region. Opportunities exist for involvement of Envirovet participants in Center activities at the national political level, local political level, in University-associated research, and with partnering non-governmental organizations. The Center would be an excellent source of expertise on Baltic-specific environmental law and policy.

2) Department of Environment and Health, State Public Health Center
Dr. Ingrida Zurlyte, Coordinator of National Health Action Plan and Head of Department
Meeting with Aida Laukaitiene, Environmental Indicators specialist

The Lithuanian National Health Action Plan: Environmental Health Indicators project was discussed. The goal of this project is to collect and integrate data on key environmental indicators of human health, including (but not limited to): Air Quality, Housing and Settlements, Waste and Contaminated Lands, Radiation, Water and Sanitation, Food Safety, and Chemical Emergencies. Flexibility exists in the project to add and modify specific environmental indicators. Data on projects relevant to animal health and ecosystem sustainability would be welcome. The Department, and the Environmental Health Indicators project, could provide excellent subject material for Envirovet students or faculty to pursue in a workshop or research setting.

3) Lithuanian Academy of Sciences, Institute of Ecology
   Dr. Habil Virbickas, Director
   Meeting with Dr. E. Budrys, Vice-Director, Dr. Linas Balciauskas, Head of Department of Terrestrial Ecosystems; Dr. Jadvyga Grikieniene, Associate Professor in Laboratory of Ecological Parasitology

The Academy of Sciences, Institute of Ecology is an independent research institution with links to Vilnius University. Departments include Hydroecology, Terrestrial Ecosystems, Ecological Physiology and Ethology, and Ecological Parasitology. Expertise in ecological parasitology is probably the best in the Baltic Region, with projects currently running on sarcocystosis, trichinosis, toxoplasmosis and hemosporidiosis in Lithuanian wildlife. Excellent opportunities exist for this Institute as a source of students and faculty, and as a source of local expertise in ecosystem health. Involvement of the Institute of Ecology in Envirovet Baltic should be given high priority.

4) National Veterinary Laboratory
   Meeting with Dr. Vidmantas Paulauskas, Deputy Director.

The National Veterinary Laboratory is a state-of-the-art, internationally-funded, new facility. With a throughput capacity of >5,000 samples per week, it is the best-equipped diagnostic facility in Lithuania, and perhaps in any of the three Baltic States. Equipment and expertise is currently concentrated in environmental toxicology, although plans are underway for significant expansion into infectious disease diagnostics, including molecular techniques. Current issues include: toxins (e.g. dioxins) in Baltic fishes; Antibiotic usage in domestic livestock; Classical Swine Fever monitoring; Rabies in wildlife, and ensuring disease – free status for specific pathogens, for EU integration. Excellent opportunities exist for involving veterinarians at the Laboratory in Envirovet Baltic, either as faculty or as students. Epidemiological analyses of archived diagnostic case data would also be possible as a research project. Involvement of the National Veterinary Laboratory in Envirovet Baltic should be given high priority.

5) Department of Environmental Engineering, Kaunas University of Technology
   Meeting with Dr. Linas Kliucininkas, Head; Dr. Judita Sukyte, Lecturer in Environmental Toxicology/Risk Assessment

The Department of Environmental Engineering has its main strengths in traditional environmental engineering, sustainable development and, ecology (e.g. “bioindicators” for air quality monitoring). Current research foci of the Department include (but are not limited to): Chemical waste monitoring for compliance with EU standards; Wastewater treatment; Leaching of pesticides from Soviet-era storage facilities; Internal combustion engine emissions and Tire fires. Students in the Department currently receive little or no training in the health sciences or in the concept of “ecosystem health.” Excellent opportunities therefore exist for involvement of Departmental faculty and students in Envirovet Baltic.

Latvia

Coordinating the Latvian section of the fact-finding trip was Iveta Kocina, DVM, MS, Lecturer, Food and Veterinary Service, Ministry of Agriculture. A total of two meetings were attended in Lithuania. Summaries of the meetings are given below.

1) Ministry of Environmental Protection and Regional Development, Environmental Protection Department
   Vladimirs Makarovs, Minister
   Meeting with Ms. Evisa Abolina, Inspector from the Environmental Protection Department

The main current focus of ministerial activities is preparation for meeting the environmental requirements of EU integration. Some key Latvian environmental issues receiving current attention are: Greenhouse gas emissions; Ozone depletion; Transboundary air pollution; Eutrophication; Nitrate runoff from agricultural sources; Transboundary water pollution; Drinking water quality. For example, an “Example Farm” has been set up in which systems have been constructed that minimize nutrient runoff, for research purposes. Excellent opportunities exist for integration of the activities of this Ministerial Department with those of other Departments and other Ministries also engaged in projects relevant to Ecosystem Health. The Ministry would be a logical source of expertise for issues in Latvian environmental policy and law.

2) Ministry of Environmental Protection and Regional Development, State Environmental Impact Assessment Bureau
   Vladimirs Makarovs, Minister
   Meeting with Ms. Inga Gavena, Specialist in Hydroecology, and Dr. Atis Brants, Food and Veterinary Service, Deputy Head of Animal Health Division

The major current task of this Bureau is national environmental preparation for EU integration. The principal duties of the Bureau center on issuing permits for new industrial projects, and on monitoring animal health/veterinary activities. The Ministry is currently involved in surveillance and monitoring of animal infectious diseases, including (but not limited to): Bovine Spongiform Encephalopathy; Foot and mouth disease; Classical swine fever; Rabies; OIE A group diseases; OIE B group diseases regulated by the EU. Because of the current focus on infectious disease monitoring, the Food and Veterinary Service Animal Health Division has excellent opportunities for involvement in Envirovet Baltic, as a source of faculty and students, and as a source of up-to-date regional information.

Summary for Lithuania and Latvia

In both Lithuania and Latvia, the most pressing problems center around how to prepare for EU integration while addressing environmental problems inherited from the Soviet era. The principal problems relate to Air Quality, Water Quality, and Envioronmental Radioactivity. The principal difference between the countries is that Lithuania is currently experiencing a period of agricultural and industrial economic expansion, while Latvia is currently experiencing a period of agricultural and industrial economic contraction. The greatest future opportunities in both countries are in the integration of the efforts of a diversity of Ministries, Departments and Institutions, all doing excellent but independent work towards sustainable development, conservation, and ecosystem health.

Contemporary Issues in Animal Health and Well-being.
Report from a study visit to Denmark and Sweden
August 7-15, 2002

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1. Danish Bacon and Meat Council
Copenhagen, Denmark
Dr. Poul Baekbo, Project Manager, Veterinary and Food Advisory Service
Dr. Bent Nielsen, Head of Section, Veterinary and Food Advisory Service

This council is the umbrella organization for all pork production in Denmark. There are two slaughter companies that slaughter 98% of all of the pigs. The slaughter companies produce the product and the DBMC produces the knowledge. DMBC runs the Danish Breeding System that consists of 40 nucleus herds and 300 multiplication herds. There are approximately 13,000 production herds. It is projected that the number of these herds will decrease to 6-8,000 within 5 years. Production has increased from 11.3 million head in 1970 to a projected 23.8 million in 2002. Expectations are that production will be at 30 million within 5 years.

Dr. Nielsen delivered a presentation on his work with Salmonella control. A copy of that presentation is available upon request.

2. Danish Veterinary Institute
Copenhagen, Denmark
Dr. Frank Aarestrup

There are 500 people employed at this location. They have departments of Bacteriology, Immunology, and epidemiology as well as the Zoonosis Center. This is a totally independent institution. Their responsibilities include diagnostic, surveillance, and control programs. They have gone from primarily a diagnostic laboratory to now 70% of their efforts are in the zoonotic area(salmonella, campylobacter, BSE, resistance testing, etc). Starting in 1999, they have been conducting training courses throughout the world. They have worked with 160 laboratories in 103 countries. They are monitoring eight isolates of salmonella for antibiotic resistance on an international level.

DANMAP 2001 details the use of antimicrobial agents and occurrence resistance in bacteria from food animals, food, and humans throughout Denmark. This institution is working on coordinating this reporting worldwide.

Their current efforts include monitoring the use of antibiotics in animals though tracking prescriptions to the farm from vet records and tracking the sales records of what is purchased. With this information they will be able to match antibiotic use with diagnosis and determine the locations of the use. This will serve as valuable information for the directing of research to the areas that are being diagnosed as requiring the use of antibiotics

3. Danish Agricultural Advisory Center
Aarhus, Denmark
Dr. Niels Ove Nielsen, Head, Department of Pig Production

This center employs 504 individuals along with the 2800 that are located at the 53 local centers throughout the country. The organization is owned and operated by the farmer/users. The farmers also own the agricultural schools. A certificate from one of these schools is required to purchase land for farming. These agricultural schools would appear to be an excellent source for environmental stewardship to be covered. I am unsure to what extent that this area is currently in the curriculum.

The center disseminates as well as generates information through conducting research. The system flows through the local centers. They give direct guidance on situations.

There is a section focusing on nutrition and the environment. One of their primary areas of interest is reducing the nitrogen and phosphorus output of swine farms. A copy of a Powerpoint presentation detailing the work performed by the Center is available upon request.

4. Rugballegaard Experiment Station
Horsens, Denmark
Frank Oudshoorn, Manager

Frank would be a tremendous addition to Envirovet Baltic. He is committed to the integration of ecological swine and dairy production in the agricultural management of land. They currently have both an outdoor ecologic swine operation and an ecological dairy operation. The primary challenge to ecologic production of pigs is the cost of production being 23% greater than the price they are able to receive for organic pigs. Only 50% of the production of organic pigs in Denmark is sold as organic. That is all the market will support. The market price for regular pork only covers 50% of organic production costs. Frank developed and successfully demonstrated a method for raising finishing pigs that is good for the pigs and the environment, but due to the labor requirements there has been no interest among producers to adopt this method of production.

Their dairy herd is split so that 50% of the cows do not receive any concentrates. They are strictly on a pasture rotation system. He reported that approximately 20% of the milk in Denmark was produced organically, but only 11% was sold that way

5. National Veterinary Institute
Uppsala, Sweden
Dr. Lars-Erik Edqvist, Director General

The Director General and his 28 Department Heads run the National Veterinary Institute. They oversee 400 employees of which 74 are veterinarians. 60 of the veterinarians also have their PhD. Their funding is approximately one-third from the government with the reminder coming from fee-based services.

In addition to the diagnostic work, each veterinarian also spends on average 20% of his or her time conducting research. Research was described as being part of everyone's daily life. They are also actively involved in teaching at the University.

This operation is a center for excellence in veterinary medicine. They are pursuing strengthening their cooperation with the university. One of the major areas of emphasis is working on the antibiotic resistance issue. They have published the 2001 SVARM Antimicrobial Resistance Monitoring.

6. Swedish University of Agricultural Sciences (includes Veterinary Medicine)
Uppsala, Sweden
Dr. Stig Einarsson, Department Head, Department of Obstetrics and Gynecology
Dr. Anne-Marie Dalin, Associate Professor, Dept. of Obstetrics and Gynecology

The Department of Obstetrics and Gynecology has a most impressive reputation in terms of productivity both in the publishing record of their research and in the quality and number of PhD recipients they annually produce. One of the areas of focus in the department is looking at the effects of stress on reproduction. Members of this department are also undertaking an intensive research trial looking at comparing numerous aspects between traditionally and ecologically reared pigs.

7. Swedish Animal Health Service
Uppsala, Sweden
Dr. Lena Eliasson-Selling
Dr. Maria Lindberg

We visited three farms. The first was a nucleus herd, the second was a sow pool, and the third was a farmer using sows from the sow pool.

The Swedish Animal Health Service (SAHS) is a private company owned jointly by the private slaughter companies and the cooperative slaughter companies, but ownership is still by the farmers. They pay a fee for every sow they have and every pig that they market. They do not pay for individual visits by the vets. There are 35-40 veterinarians in this organization and over 1/3 of them also have a PhD. The farmers developed the organization because they wanted on group of vets to have control over the health of the pigs sold in their systems. Every farm gets visited from 1-3 times a year. Local vets also work on these farms. The local vets write the prescriptions. The SAHS veterinarians work with the University on research and education. The service also provides education for local vets and the producers.

The size of the livestock units does not appear to be a major problem with the public. They are more concerned with how and where the pigs are raised. The concerns are that the farmers have enough land to handle the manure and that pigs are treated and raised in the right way. How the pigs are raised is more important to the public at this time than environmental control.

8. Swedish Ministry of Agriculture, Food, and Fisheries
Stockholm, Sweden
Dr. Aase Tronstad, Senior Administrative Officer, Animal Health and Welfare
Dr. Anna Carlsson, Senior Administrative Officer, Animal Health and Welfare
Dr. Anders Franklin, Laboratory Veterinary Officer, National Veterinary Institute
Dr. Christina Greko, Laboratory Veterinary Officer, National Veterinary Institute

We received a packet of information from Dr. Tronstad. It details the antibiotic history of the antibiotic resistance issues and the ban that took place in 1986. That material is available to anyone interested in this area. I will not attempt to replicate any of that information in this report, except to state that the amount of material is extensive.

The majority of the meeting was spent learning about the extensive efforts in obtaining the ban and in the issues surrounding this subject with the European Union was formed. The original ban came about following a media debate about concerns with resistance due to the use of antibiotics in livestock for growth promotion. It is interesting that the ban on the use of sub-therapeutic antibiotics was fully endorsed and actually requested by the farmers.

There has been a drop in the usage of antibiotics since 1994, but during the four years following the ban there was a tremendous increase in the total use of antibiotics in livestock. This was for treatment of disease. The drop in the usage of antibiotics since 1994 is due to the change in management and pigflow, eradicating other diseases such as pseudorabies, and the animal welfare legislation that occurred during that time. This legislation decreased the density of livestock and that in turn decreased the use of antibiotics.

The EU Council of Ministries has adopted a resolution calling for an improvement of animal health and welfare with a reduction in the use of antibiotics.

They are now monitoring the use of antibiotics in Sweden through tracking the sales of products from wholesalers to pharmacies, the sales of medicated feed from feed mills, and the sales of feeds with additives. Therapeutic antibiotics can only be sold through prescriptions and vets cannot sell antibiotics.

They are monitoring the resistance of salmonella and campylobacter. Data was presented that showed that resistance to E. coli strains in Sweden was significantly less when compared to France and Denmark. They are projecting a total ban in the EU on antibiotics for other than therapeutic use in 2006.

It was reported that there is good consensus by all groups in Sweden on the issue of antibiotic resistance. They also mentioned that it was recently reported that it is estimated there was room for a 40% reduction in the amount of antibiotics that are prescribed by physicians in Sweden.

Anna Carlsson is an expert in animal well-being issues including transportation of livestock.

9. National Veterinary Institute
Uppsala, Sweden
Dr. Per Wallgren, State Veterinarian
Dr. Marie Sjolund, Assist. Professor at Veterinary College

We visited the farm of the president of the Swedish Pork Producers.

We discussed the challenges that the producers faced in 1986 when antibiotics were banned for sub-therapeutic use. Initially vets were hesitant to write prescriptions for treatment with antibiotics. The feeling was that they should not be used. That led to real problems with production. Management changes since that time such as batch farrowing, multi-site production, AI-AO, and the eradication of some diseases have increased production since the ban. Primary focus of the producer should be in cutting costs.

Sow pools have worked well for relatively small producers so they did not have to convert their housing to accommodate the law. Producers that also work off of the farm have made this system work well when they get one group of sows at a time. For bigger units it may be more cost effective to just own the sows instead of leasing them from the pool.

The public does not want to see the industrialization of farms. They want to see small farms with pigs and cows. Odor is the primary complaint, but mainly they do not want to see the larger units.
Dr. Sjolund prepared a 3-page outline covering swine medicine education in Sweden. A copy of this paper is available upon request.

Aquatic Wildlife Issues in the Baltic Sea Region :
A Summary Report of a Fact- Finding Visit to Sweden (August 7-12, 2002) and Finland (August 13-15, 2002).

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From the extensive discussions with various veterinarians and other scientists in Sweden and Finland, I was able to surmise new information not yet available in the published, peer- reviewed literature. In addition, I was able to synthesize, for myself, and summarize the important issues and concerns of these scientists studying and living around the Baltic Sea region.

With regards to historic and current contaminant trends, I learned that the concentrations in biota of 1,1-bis(p-chlorophenyl)-2,trichloroethane(DDT), hexachlorohexane(HCH), hexachlorobenzene (HCB), and most metals decreased significantly over the last 3 decades and continue to decline. Of major concern was the fact that polychlorinated biphenyls (PCBs) are no longer decreasing and in some cases may be slightly increasing but sources are unknown, possibly sediment mobilization.. Although mercury is still a concern, especially in inland Swedish lakes, the metal that is on everyone's mind is cadmium. The concentrations of cadmium in biota are increasing for unknown reasons. In the case of the organic contaminants, a puzzling finding is that HCB is now showing an increasing trend in Finnish reindeer.

Overall, everyone is concerned about the newer contaminants and other chemicals of unknown ecotoxicological impacts. For example, an important emerging group of compounds are the *polybrominated fire retardants*. Questions that need to be addressed include:
–They are higher in Peregrine falcons so are they bioaccumulative?
–Where did they come from?
–Are they increasing?
–How does degree of bromination effect toxicity?

The next highest on the agenda are the Perfluorinated compounds (PFOS). These are man-made compounds most commonly used in the 3M product "ScotchGard" which was removed from the market when it was discovered in the tissues of arctic wildlife such as polar bears. Prior to this it was not known that it was bioaccumulative or that it had been transported great distances away from where it was used. The Swedish EPA has started to screen for these in various biota. The interest is in discovering how these chemicals move through the environment.

Tributyltins (TBT) are compounds used in ship hull anti-fouling paint. Their use is now widely regulated and generally banned but the true ecotoxicological impact remains unclear. Although you can't apply then, many ships are coming into the Baltic that already have these compounds on their hulls that then constantly leach into the water. In the Baltic countries, although there is concern, no one is studying it except a Polish group. Since TBT has been banned, new copper based antifouling agents were introduced. This has lead to the question of what are the risks of these copper introductions. It is likely the EU will also ban them in the near future. Alternatives must be found. Because the Swedish National Tissue Bank was initiated and created collaborations and standardized tissue banking in other Baltic countries through the Nordic Council of Ministers , this should make the study of these new compounds and their trends in the environment possible.

Since my interests in seal pathology and because there is currently a phocine distemper epizootic in the North Sea region at the entrance to the Baltic, I spent time on these issues. This new outbreak, based on the experiences of 15 years ago, appears to be due to a reintroduction of the virus into a naive population (although this is not accepted by everyone). The population numbers of harbor seals recovered from the previous mass die-off and now there were sufficient numbers of susceptibles to set off an epizootic. Last time, hooded seals, know carries of the phocine morbillivirus, were seen south of their usual range in Norway. This time, hooded seals were not sited. This is probably because there was an enzootic maintenance of the virus (my opinion). It is highly unlikely that the virus made the jump from pet dogs or from dumped mink carcasses. Those animals do not harbor this particular strain. In the previous outbreak, it was suggested that contaminant-induced immunosuppression lead to the outbreak or at least increased the mortality. In the current outbreak, contaminants could again play a role since the levels of contaminants in seals are still above the threshold of adverse effects on immune function.

The occurrence of lesions of the Baltic seal disease complex that were associated with the high levels of PCBs and DDTs in harbor seals and grey seals are decreasing with the exception of intestinal ulcers in young grey seals. The trend of decreasing lesions corresponds quite well with the trend of reducing concentrations of organochlorines in tissue. However, PCBs are no longer following a significantly decreasing trend in recent years. The prevalence of uterine occlusions in ringed seals has also decreased but is still present at a rate sufficient to suppress population growth.

It was especially interesting that although the populations of seals are still orders of magnitude below the numbers of 30 years ago, fisherman now days are complaining that there are too many seals now. The increase in seal numbers has lead to increasing fisheries interactions (poaching) and calls for legalized hunting as well as culling of seals to supposedly increase fish numbers available to fishermen.

Eggshell thinning from DDT exposure previously devastated sea eagle populations around the Baltic region. Some populations have begun a very modest recovery through an intensive supplemental (pig meat) feeding program in Sweden. Although the eggs are getting thicker and don't break so easily under the weight of brooding adults, they are still so thin that the eggs desiccate (thus impairing reproductive success and population recovery). In addition, there is some evidence that the prior exposure to female birds (that now have decreased residues) may have caused permanent effects on reproductive capacity.

Guillemots, another fish-eating bird, show a similar trend to the eagles with eggs that are thicker now but are still thinner than pre-1940's. Guillemots are particularly important because they have provided a better monitoring tool for contaminant trends and the contents of eggs are systematically collected during surveys for specimen banking. Additionally, contaminant concentrations in eggs show a better correlation with seal lesions that the seal blubber contaminant concentrations.

In fish, M74 syndrome in salmon is the overwhelming problem. The severely reduced survival of fry with this syndrome is alarming and is somehow linked to dioxins or PCBs. However, no funding is available to study the mechanism in Finland, only to monitor the occurrence. In Sweden, there is some research ongoing with modest funding to try to elucidate the cause of this syndrome.

Another interesting research finding in fish in the Baltic has been the induction of P450 enzymes in the liver of cod and dab despite decreasing OC residues. This brings up the concern of perhaps a new contaminant that is not currently being detected (because we don't know what to look for).

Additional issues

Global warming and the potential devastating effect this might have on Baltic ecosystem is a major concern. For example, ice conditions are changing this is known. Animals such as the ringed seal are dependent on ice for survival. Ringed seal mothers give birth to pups in lairs within the pack ice and then need specific ice conditions to breed again. If the ice changes reproductive success could be severely impaired.

Multiple scientists I talked to also expressed other issues of concerning research unknowns. Examples of these include:

- Research funding for PCBs and studies in grey seals difficult to obtain while dioxin funding good
- Full details of Baltic food web still unclear
- Uncertain which fish are the main transporter of contaminants to seals
- Sources of PCB and dioxins previously and currently are still uncertain.
- Potential impacts of increased newer contaminants and cadmium of major concern

Overall, sizeable research efforts are still made to monitor pollution and pollution trends in the biota of the Baltic Sea region. Although there are still adverse impacts depressing the recovery of certain marine animal populations, the degree of contamination for many compounds has decreased. Still, PCBs, cadmium and newer contaminants are problems that will continue to be at the forefront of concern for the health of the Baltic Sea ecosystem.

Overall, there is a huge research effort still ongoing to monitor pollution and pollution trends in the biota of the Baltic regions. Although there are still adverse impacts depressing recovering of certain populations, the degree of contamination for many compounds has decreased. Still, PCBs, cadmium and newer contaminants are problems that will continue to be at the forefront of concern for the health of the Baltic sea ecosystem.

Environmental Protection Activities in Poland:
A Summary Report from a Fact-Finding Visit to Poland, July 7- 14, 2002

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My contact person at **Warsaw Agricultural University** was Professor Andrzej Krynski, a veterinarian and Head of the Division of Animal and Environmental Hygiene in the Faculty of Animal Science, Dr. Krynski had arranged a meeting with all faculty involved in environmental work. The Division conducts research on the effects on environment of industrialization of livestock production, environmental pollution, and the use of non-antibiotic growth promoting agents in animal production. Programs include both domestic and wild animals.

One faculty member, Dr.Marta Chudzicka, was in the beginning of a project on the environmental health risks of liquid manure from intensive livestock production. Another project dealt with effects of environmental pollution (e.g. cadmium) on small game caused by illegal dumps.

The department has a strong interest in participating in Envirovet Baltic.I visited also with Vice Dean, professor Jacek Skomial (Dean for Research and International Relations), who reiterated the interest in working with Envirovet Baltic.

In the **Veterinary Inspectorate in Olsztyn** I was the guest of Drs. Lech Maslowski (Director) and Ludwik Bartoszewicz (Vice- director) assisted by Ms. Joanna Lipinska (food hygiene specialist and interpreter). We discussed the structure of the livestock industry. The family farm is still by far the most important farming unit in Poland. The industrialization of livestock production has not progressed to the extent earlier predicted. Ecological farming is increasing. Commercial fertilizers are used to a relative low extent in Poland (kilo nitrogen/ hectare) compared to that in other major agricultural countries. Belarus and Ukraine are considered “big” polluters to the Baltic Sea.

At the **University of Warmia and Mazury, Olsztyn** (formerly Olsztyn Agricultural University), a large university with over 30,000 students in 12 colleges (faculties),
my contact person was Professor Krystyna Iwanczuk- Czernik, Animal Scientist, Head of the Division of Animal and Environmental Hygiene in the Faculty of Animal Science. She had arranged a meeting with faculty members from other colleges as well.
Most of the research in this division focused on factors affecting animal production in several species. There were seemingly few projects directly aiming at environmental health but several projects dealt with animal well-being issues (housing and transport).
Two faculty members, Professor Josef Koc and his assistant Dr. Kataryna Gliinska-Lewczuk, are active in the area of water quality research.

Division faculty members as well as faculty members from other colleges are very interested in participating in Envirovet Baltic. It was agreed that professor Krystyna Iwanczuk will serve as contact person. Dr. Kataryna Gliinska- Lewczuk speaks fluent English (she was interpreter at our meeting) and has water quality competence. She is interested in helping teach this area in Envirovet Baltic.

Hosts at the **Polish Ecological Club, ul. Chylonska 262/4, 81-016 Gdynia,** were Waldemar Wolniakowski, Manager, Polish Ecological Club (PKE) East, and Grazyna Wolniakowski, Board Member, PKE East.

The PKE was founded in Cracow in 1980 during the early days of the first legally established independent, non- profit, non- governmental environmental organization in the socialist-block countries of Central and Eastern Europe. It was the first organization to openly protest against the environmental policies of the government.

The PKE consists of 14 regional branches and 120 local circles operating throughout Poland. It's headquartered in Cracow. PKE brings together various experts working on environmental education, waste management, national parks, law, organic farming, publications, and health. The environmental education is conducted through editing and publishing of books and organization of seminars and workshops. PKE publishes a wide variety of scientific reports, bulletins and newsletters and organizes actions and campaigns for protection of environmental and human health. It provides leadership for environmental research projects.

PKE has a wide network of cooperating organizations, e.g. Coalition Clean Baltic where PKE is the lead on development of ecologically sustainable agriculture in the Baltic Sea Region. Examples of other cooperators are Swedish Society for Nature Conservation, World Wide Fund for Nature, and World Conservation Union.

I had a very interesting and informative session with the two Wolniakowskis. Grazyna Wolniakowski is a teacher. Among other teaching responsibilities, she teaches environmental protection to high school teachers.

In my assessment, this is a good organization to work with. They have excellent contacs not only in Poland but also in Russia (Kaliningrad). If we wish, a possibility may exist for us to publish (e.g. on Envirovet Baltic) in the national bulletin (Polskiego Klubu Ekologicznego).

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