ENVIRO DECISIONS

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ELECTRONIC ARCHIVE WILL SPEED SCIENTIFIC EXCHANGE

The National Science Foundation (NSF) has awarded $1.069 million to Los Alamos National Laboratory scientists to stabilize and expand a powerful new tool for scientific communication, called the electronic print archives. The "***e-print archives***" have already speeded up the exchange of scientific information in 25 different fields, even supplanting traditional, printed research preprints in some physics disciplines.

Pioneered by Los Alamos theoretical physicist Paul Ginsparg, the system is an interactive repository where researchers can post their latest articles and preprints as well as search for papers by others. The archive can convey information faster and more cheaply to more researchers than traditional journals. The system is rapidly becoming the major means of scientific communication in the disciplines it serves.

Some 25,000 readers in more than 60 countries are now able to see the abstracts of new scientific papers. The archive handles more than 45,000 electronic requests each day.

"The ***e-print*** archive has become the most interesting destination on the 'infobahn' for a large part of the theoretical physics community," said Richard Isaacson, NSF program director for gravitational physics, who oversees the NSF support. "Its impact is spreading rapidly across all the mathematical and physical sciences and even beyond."

It all began in 1991, when Ginsparg developed an electronic archive for his own field of high-energy physics theory. The system quickly expanded to embrace other sub-disciplines of physics and a breadth of other fields such as astrophysics, algebraic geometry, and economics.

The support provided by the new Office of Multidisciplinary Activities in NSF's Directorate of Mathematical and Physical Sciences will help maintain, stabilize, and document the e-print archive, Isaacson explained. It will also spur the development of new features that are being requested by scientists, he said, providing links to citations, images, or data, and introducing a mechanism for commentary by the reader.

At the end of the three-year NSF grant, the researchers expect to have expanded the database to cover all fields of physics and any other scientific fields whose researchers express interest. They also plan to improve the archive's software so it can be used by a wider network of researchers.

Looking at the future, Ginsparg said, "We can imagine 'interactive journals' in which equations can be manipulated, solved or graphed, and where citations can instantly open references to the relevant page. We hope to support a 'virtual corridor' for communication, which will be like walking down a hallway and talking to fellow researchers — rendering irrelevant where you are located."

For those of you on the Internet, you can reach the ENVIRODECISIONS Editor at: lodbs@uno.edu

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ENVIRODECISIONS

Edited & designed by Lida Durant

The Audubon Institute seeks to cultivate awareness and an appreciation of life, the interdependence of all living things and to help conserve and enrich our natural and human-made world. This publication seeks to impart knowledge and understanding of nature and humankind and promote a balanced approach to understanding increasingly complex environmental and social issues.

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Editor's Corner

This weekend I boated through the LaBranche wetlands, an area of swamps and marshes adjacent to New Orleans, my home town. The weather couldn't have been better: sunny and refreshingly cool – a rarity for New Orleans this summer, which has been one of the hottest on record. For those of you who don't know her, New Orleans is a city defined by water – the Mississippi River as its southern boundary; Lake Pontchartrain, a large estuarine embayment at its northern perimeter; and miles of fringing swamps and marshes. The reason for my marsh visit was to view the site of an illegal tire dump. Rumor had it that several hundred tires had been dumped from Interstate Highway 10, the main transportation artery bisecting this fragile landscape. Interstate 10 connects New Orleans to the more upland areas of the state like Baton Rouge, the state capital. I wanted to see the tires first hand to decide whether our office should sponsor a community awareness, clean-up day to pull the dumped tires out of the wetlands and haul them to a state-approved disposal site. At issue was a debate over whether the tires should be removed or left in place. Some complain that the tires are unsightly and pose a potential risk and need to be removed. Others argue that the tires have settled into place and provide some level of wetland stabilization and interior shoreline protection. Lake Pontchartrain, the LaBranche wetlands, and the surrounding marshes are suffering high rates of interior erosion and shoreline retreat for a variety of reasons including wind and wave action, subsidence of substrate, and development. Stabilization and wetlands protection are high priorities.

Flying across the water by airboat, I was struck by two deep impressions. The first, environmental problems are complex, and what seems as though it should be straight forward (remove dumped tires) isn't always (they may afford needed wetland protection). I was reminded, as I have been before, that environmental action is dependent upon the context (the environmental conditions within which the situation occurs). Second, I was reminded how emotionally fulfilling a venture out into the natural environment can be — a psychic refresher. This awareness gave me pause to ponder: I am an environmental professional who studies, teaches, and writes about environmental issues, one who thinks about the environment frequently, one who considers herself intimately connected to wilderness. More than many I suppose I am — yet even so, my opportunities to feel truly physically connected rather than simply intellectually connected are punctuated and not often enough. Awareness of the need to experience wild places, in order to be able to understand nature, in order to want to preserve and protect wild places arose in crystal clarity this weekend. If we are to expect an appreciation of the natural environment, we need to recognize that opportunities to experience nature forge appreciation. To have true compassion one must have intimate knowledge. Nature, I was reminded, is the best environmental education classroom.

And all this on the way to a dump site!

Lida Durant

My history of the environmental movement

Robert A. Thomas
The Audubon Institute

Just what is the environmental movement and from whence did it come? Each of us has our own answer for how we became involved — the stories are as variable as we are as environmentalists.

Upon reflection, now that my red beard is grey, this is how I see our historical development.

1960s - *The Awakening.* The social/political turmoil of the 1960s spawned a number of movements, and it was the time during which we came to grips with the impact of a growing human population and a degrading environment. Realizing that we were at a critical point, but not yet past the point of no return, groups throughout the world began to coalesce, to interact, and to discuss the need for worldwide reform.

This was a time of stressful concern, tremendous suspicion, placard carrying, anti-war protests, sit-ins, love-ins, die-ins, flower power, and more. Environmentalists, in general, were considered "Long-haired, hippy freaks".

My generation, now in our fifties, were in school. We had time, and we were concerned about our futures. We were, then, in our twenties

1970s - *The Call to Order.* The 1960s culminated with two monumental developments. One was a flurry of legislation which had been introduced into Congress — the The Water Pollution Control Act of 1970 (commonly called the Clean Water Act), The Clean Air Act of 1970, and the Endangered Species Act of 1973. The second was the first Earth Day, April 22, 1970. This internationally celebrated activity, conceived in the United States, was and remains the largest gathering in history of human beings to celebrate a single topic. This world-wide display of concern for the environment, and our collective future, ignited and galvanized the environmental movement.

During this decade, the emphasis was on "the call to order" — that is: discussing problems and calling attention to environmental issues which needed attention. It was largely the work of young adults who had been schooled in the 1960s. By the end of this period, we were entering our thirties.

1980s - *Denial, Disagreement, Greenwashing.* By the end of the 1970s, there was no doubt that the environmental movement had strong grass-roots support and was here to stay. There was still much speculation about the extent to which we should go to protect the environment.

Those who were not happy with the movement were skeptical and non-supportive. During the first few years, there was still much denial that a problem existed. There was wide, sometimes contentious disagreement — with some folks saying "the sky is falling" while others were saying "trust me, everything's okay." The truth was somewhere in between.

("My History" continued on page 4.)

By the mid-1980s, some wise businesspersons figured that an opportunity existed to capitalize on environmental concerns by advertizing their products as enviro-friendly. Some products were "green", and environmentalists advocated their use. Others were not, and the term "green-washing" was coined to mean that the company was making false claims about their product. This resulted in much turmoil and it seemed that no one could be trusted. Even the reputations of good products were tainted.

At the end of the 1980s, the 1960s crowd were entering our forties.

Early 1990s - *New Awakening*: A clean environment is good for the economy, and vice versa. With all the hoopla associated with the 20th anniversary of Earth Day, many felt that the movement *had arrived*, that the world had finally accepted the need to protect and improve the environment. In fact, the blitz by the media did make environmentalists feel better and alert industry that the movement was here to stay. Everyone seemed to jump on board, and things were grand. This period was truly a new awakening. Unfortunately, once the Earth Day celebration was over, media attention to environmental concerns fell to zero. On a more positive note, however, environmental concern has become deeply rooted.

Mid-1990s - *Questioning Motives*: the motives of the environmental leadership are being more vigorously questioned, but, it is important to note, not those of "environmentalism" per se. We are presently undergoing a period of questioning. Many questions have been raised, recently, about environmental "propaganda" and the social costs of excessive regulation. Mainstream America seems to be more conservative, and though citizens want environmental protection, they don't want our already too few funds spent where they are unneeded. There is a feeling that a vocal few have captured the movement to set tenuous priorities.

During the last year or so, the top management of several major environmental organizations has changed. This change reflects an adjustment of priorities and style, **not** a lack of concern for the environment. Main stream environmental groups are hearing the communication of their audience!

Late-1990s - *Resolving the Environmental Direction*: The majority favors resolving these conflicts and deciding upon a sound environmental direction. I believe that, as we move through this decade, the population will demand better environmentalism from themselves, from government, and from those with whom they do business. Things will be getting better day-by-day. We've got a long way to go, but the route is shortening with each step.

As we close the 1990s, my generation is into our fifties.

2000+ - *We've Always Done It That Way*: We've focused on the 1960s crowd who are rapidly becoming old fogies. Our generation has made two noteable contributions. First, we founded the environmental movement. Second, and undoubtedly most important, we have raised our children to think that stewardship for the environment is necessary and the norm.

This came home to me through my experience with recycling education. When we, through the Louisiana Nature Center which opened in 1980, began crusading for people to recycle, we were inundated with requests for information. Everywhere we went, there were huge lines and we received constant telephone and written requests for places to recycle, where to buy recycled products, what can be recycled locally, etc. By the end of the 1980s, we would set up a table at a fair or in a mall, have all our recycling information nicely stacked, and the people simply walked by, glanced our way, and said, "Oh, we already do that!" At first, we were devastated to think that what we considered important was being treated as blasè. Then we realized that what we were experiencing was our own success. The

(Turn to the next page, please.)

audience was no longer interested, not because they didn't care for recycling, but because they felt that they knew all about it.

As I have written before, another important aspect of the passing of time is that we baby boomers, now in our fifties and sixties, are, and increasingly will be, in upper management . We will be in a position to apply our deep-seated love of and concern for the environment while making business-related decisions.

It is hoped that the next century will be peopled by folks who know and practice the basics of good environmentalism. And, yes, there will be improvements for them to seek.

Is it too much to hope that this can be done in one generation?

RUSH MAY BE RIGHT — *AND* WRONG !

There may well be more trees here in this nation today than when the Pilgrims landed. However, the forests of today are largely monoculture and densely planted for one reason — harvest. Those forests of by-gone days included huge expanses of old growth, mixed-deciduous forests that supported very high biodiversity. In zones where there were naturally fewer species of trees (long leaf pine, spruce, and the like), there was a balanced ecosystem that had evolved over long periods of time, allowing many species to adapt to the habitat.

If you want to see for yourself, take a nature walk in a mature, natural forest; then compare it to a modern, managed tract by visiting a densely planted monoculture pulp forest.

We need wood for pulp, and the forest industry is important to our economy and life-styles, but not at the expense of conserving natural ecosystems!

(Climate Change continued from page 8)

than a year, the oceans have a large impact. There is mounting evidence that year-to-year oceanic changes may also be predictable to some extent, because they too seem to fall into a fairly regular cycle.

Unfortunately, the earth system is so complex that it is unlikely, given our lack of knowledge regarding the many important interactions and feedbacks in it, that global circulation models (GCMs) will be able to accurately and completely detail the earth's climate. One of the key problems in predicting climate change is determining how surface temperatures will respond to a given rise in GHG concentrations. This climate sensitivity depends not only on the direct effect of the GHGs themselves, but also on natural climate feedback mechanisms, particularly those due to clouds, water vapor, and snow cover. Each of these may change in response to global warming and might therefore act either to enhance or to suppress any temperature rise.

Our climate change knowledge—where are we?

Important uncertainties about global climate change derive from the fact that temperature is more variable, both spatially and temporally, than GHG concentrations. Therefore increases in global temperatures cannot be tied unequivocally to the enhancement of the greenhouse effect. What we do know is that increasing concentrations of CO_2 and other GHGs will cause increasing climate change, both simple physics and the results of all GCMs agree. But modelling climate change will not be easy because it is not a smooth, linear process.

Although the atmosphere has been widely studied and modelled large uncertainties remain concerning climate variability. One of the greatest unknowns is the role of clouds. Do they act to cool the earth by intercepting and reflecting solar energy, or to warm it by reducing outgoing terrestrial radiation? They probably do both, but their net effect on the present climate is very uncertain. It is even less clear how this net effect will change in response to global warming. Changes in cloud amount and cloud types might lead to a net additional warming (positive feedback) or to a net cooling (negative feedback). A further unknown is exactly how the exchange of heat and gases between the atmosphere and other components of the climate system takes place.

Much more research is needed to enable scientists to better predict how climate change will come about. We need to understand better climate-related processes, particularly those associated with clouds, oceans, and the carbon cycle. We also need to improve the systematic observation of climate-related variables on a global basis; to continue to investigate past changes; and to develop improved models of the Earth's climate system.

Climate Change, the Greenhouse Effect, Global Warming What do they mean? How Are they different?

by Lida Ochsner Durant, The Audubon Institute

Climate is defined as the average weather in an area over a long period of time and can be described in terms of temperature, precipitation, humidity, sunshine, atmospheric pressure, and wind conditions. Global climate change and the effects of increasing greenhouse gases—predicted to include temperature and precipitation extremes which vary from ice storms to heat waves and from droughts to disastrous floods—is a major climate issue.

Global climate change is predicted to include temperature and precipitation extremes which vary from ice storms to heat waves and from droughts to disastrous floods.

An introduction to the climate system

The climate system is complex. It is governed by what happens not only in the atmosphere, but also in the oceans, the cryosphere (glaciers, sea ice, and continental ice caps), the geosphere (the earth's solid surface) and the biosphere (living organisms in the oceans and on land). The interactions among these various spheres which occur on widely differing time scales, ranging in time from a single day to a few centuries, are difficult to predict.

The oceans are an important regulator of climate. Water circulates within the oceans because of differences in temperature and density. As warm water travels from the tropics towards the poles, the surface layer cools and loses moisture through evaporation. The cooler, salty water grows dense enough to sink where it flows back towards the equator. Global temperatures are modulated as warmth spreads from the tropics toward the poles. The ocean surface also absorbs heat and gases from the atmosphere. When surface currents eventually descend, heat is dissipated and removed from the atmosphere and atmospheric gases (e.g., carbon dioxide) become trapped within deep-water currents further modulating the climate.

The composition of the atmosphere is also a primary determinant of global climate and temperature. Levels of so-called greenhouse gases are particularly important — these gases determine how air absorbs and transmits radiant solar energy. Incoming short-wave solar radiation does not directly heat the lower atmosphere, instead it warms the surface of the earth which then emits long-wave radiation which is absorbed by greenhouse gases which warm the lower atmosphere. The amount of warming that results from solar radiation depends, in part, on the nature of the earth's surface— surface variations create complex patterns of surface energy distribution. Land and ocean surfaces, for example, warm at different rates, and land surface covered by vegetation absorbs and reflects solar energy differently than do deserts or ice-caps.

What are greenhouse gases?

Trace gases in the atmosphere, which make up only about one percent of its composition, provide two vital functions: as already noted, they warm the earth's surface by trapping infrared (heat) energy in the atmosphere; they also shield the planet from harmful radiation. These gases are referred to as greenhouse gases (GHGs). Their warming capacity, called the greenhouse effect, is essential to maintaining an hospitable climate. GHGs include water vapor, carbon dioxide (CO_2), methane, nitrous oxide, chloroflurocarbons (CFCs), hydroflurocarbons (HFCs), hydrochloroflurocarbons (HCFCs), and ozone in the lower stratosphere and troposphere. Most of these gases, except CFCs, HCFCs, and HFCs, occur naturally, but human activities, such as combustion of fossil fuels, deforestation, rice cultivation, mining, and the use of nitrogen fertilizers, refrigerants, and solvents, have increased their atmospheric concentrations. Activities that can change GHG concentrations include natural ones, such as changes in solar radiation and volcanic eruptions, and human-induced ones, from industrial and land-use practices that release or remove heat-trapping greenhouse gases. While water vapor has the largest greenhouse-enhancing effect, its concentrations are not directly affected, on a global scale, by human activities.

Greenhouse gases regulate the global climate by stabilizing the balance between the earth's absorption of heat from the sun and its capacity to reradiate heat back into space.

Why do we need to worry about rising concentrations of atmospheric gases?

GHGs regulate the global climate by stabilizing the balance between the earth's absorption of heat from the sun and its capacity to reradiate heat back into space. A doubling of the concentration of long-lived GHGs (which is projected to occur early in the next century) would, if nothing else changed, reduce the rate at which the planet can shed energy back to space. Because increasing GHG concentrations would not affect the rate at which energy from the sun is absorbed, an imbalance would be created between incoming and outgoing energy. Internationally accepted science indicates that rising concentrations of GHGs ultimately will raise atmospheric and oceanic temperatures and could alter associated circulation and weather patterns. Also changes in GHG concentrations have been associated with extreme climatic changes in the past. There is strong evidence, for example, that GHGs played a significant role in the last post-ice-age warming. Most scientists agree that the current increase in GHGs will affect the climate, but exactly how is unclear. The different components of the earth's climate interact on many different time-scales in complex, often chaotic ways. Many of these interactions are still poorly understood and the complexity of the atmosphere itself makes it difficult to link such well documented changes in atmospheric chemistry as increasing CO_2 to the physics of global warming.

> In most scientific circles the issue is no longer whether or not climate change is real, but how it will develop, what its effects will be.

Climate models indicate that one of the main effects of GHG emissions will be global warming. However, climate models are far from perfect, and rely on projections of future emissions that are far from certain. And while emission scenarios and model predictions may overstate the risk, they are equally likely to underestimate it. But, insofar as a consensus exists in the world scientific community, they are believed to provide the best estimates we have of future climate change.

Are climate change and global warming the same thing?

The public perceives the scientific debate about global warming as evidence that climate change is not really occurring. Questions concerning the adequacy of present climate models, or about the lack of conclusive evidence for global warming in a particular data-set don't mean that climate change isn't happening. In most scientific circles the issue is no longer whether or not climate change is real, but how it will develop, what its effects will be, and how these effects can best be detected.

The confusion seems to arise from the popular impression that climate change, the greenhouse effect, and global warming are simply three ways of saying the same thing. *They are not.* Scientists don't dispute the basic physics of the greenhouse effect, but some of the consequences, including global warming, while highly probable, are less certain. This is because energy, which is the key to climate change, is not the same thing as temperature, which is what global warming is all about. Concerns that increasing levels of GHGs are changing the way the atmosphere absorbs and emits energy are real. Because there is a strong link between infra-red radiation and temperature, one probable adjustment to this increase would be a warming of the lower atmosphere. The warming of the oceans and melting of ice caps and glaciers will result in sea level rise which could lead to coastal flooding, the loss of valuable wetlands, and increased threats to coastal areas from storm surges and hurricanes.

Of course a warmer climate is not the only possible change, nor even necessarily the most important one. Prospective changes in precipitation patterns from climate change are predicted to lead to important shifts in world agricultural, forestry, and grassland regions and in the availability of water resources, with the possibility of altering long-established patterns of land-use. The growth rate of some plants might be increased in the presence of additional carbon dioxide, called the "fertilizing effect". Together these changes have the potential to cause important shifts in habitat for flora and fauna. Although average global food productivity may not be affected adversely by climate change, local effects, especially in developing countries, could lead to problems. Climate change also poses a threat to forestry and fishery resources. Slight changes in salinity or temperature may, for example, adversely impact larval stages of fish, the most vulnerable life stage to environmental change. Global warming may be a symptom of climate change, it may be the clearest symptom we have to look for, but it is important that we not to confuse the symptom with the disease.

> Evidence for global warming may have arrived now that an iceberg nearly as large as Rhode Island has broken off an Antarctic iceshelf.

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Is the Earth warming up?

There is some evidence that global warming has already begun. Average world surface temperatures appear to have risen between 0.3 and 0.6 degrees Celsius over the past 100 years. Although many climatologists believe that this indicates a real change, the historical temperature record is poor. Moreover, the climate varies naturally, and this observed warming is still just within the range of natural variability. The problem with all analyses is that natural cycles of warming and cooling are always occurring. It is, therefore, very difficult to tease apart human-induced aberrations from the cyclical patterns.

Climate modeler, Stephen Schneider, agrees "...there is a 10 to 20 percent chance that the temperature rise in the past century is part of a natural warming cycle and has nothing to do with carbon dioxide. On the other hand, there's an equal chance that we're in a natural cooling trend now, and thus our effect is twice as big." Richard Monastersy, writer for *Science News*, speculates that evidence for global warming may have arrived now that an iceberg nearly as large as Rhode Island has broken off an Antarctic iceshelf. The apparent reason for the break is rising global temperatures and seasons which are out of sync. Researchers at the Max Planck Institute for Meteorology in Hamburg, Germany seem to agree saying that there is only one chance in twenty that the recorded temperature increase was caused by natural factors. But they are quick to add that uncertainties still exist. With the data and modeling, the researchers estimate a 95 percent chance that the observed climate changes exceed the range of natural variability. Statistical certainty is 99 percent.

TOO MANY PREDICTIONS ABOUT GLOBAL WARMING ARE BASED ON ASSUMPTIONS THAT WATER VAPOR INCREASES AS TEMPERATURE RISES.

Are climate models reliable?

Determining the reliability of a climate model is surprisingly difficult. Inevitably, models are good at simulating some aspects of the climate system and less good at others. Unfortunately our lack of knowledge about the real climate makes it difficult to verify models. We have scant long-term climate data. It is hard to say if a model has the answer right if we don't know what the right answer is. Observational data on many key climatic variables is extremely limited, particularly for those which act over long periods of time, such as deep ocean currents. Past climates have left records in ice and ocean-sediment cores that provide some of the best available evidence. Ice-core record analysis suggests that changes in GHG concentrations do cause short-term (century time-scale) temperature changes, strongly amplified by cloud, snow, and/or water vapor feedbacks. This is in remarkably good agreement with the picture given by climate models.

However, MIT physicist, Richard Lindzen, finds a problem with climate models. He complains that too many predictions about global warming are based on assumptions that water vapor increases as temperature rises. He says that "[there is] no physical theory or evidence to support the assumption." Most of the temperature rise calculated by the models comes about from an increases in water vapor in the air, not from an increase in CO_2 which we know is occurring. Without such assumptions he believes projected global temperature increases would be much lower in response to a doubling of atmospheric CO_2. Another problem: current models account only very roughly for the large role the oceans play in determining the flow of heat in the atmosphere.

TEMPERATURE IS MORE VARIABLE THAN CARBON DIOXIDE, THEREFORE INCREASES IN GLOBAL TEMPERATURES CANNOT BE TIED UNEQUIVOCALLY TO THE ENHANCEMENT OF THE GREENHOUSE EFFECT.

To improve computer models of the global climate, a better understanding is needed of how small-scale interactions between plants and the atmosphere translate to larger scales. As the techniques used in detection efforts improves, researchers edge closer to statistical certainty making predictions about climate change more reliable.

How predictable is the climate?

It is hard to imagine the possibility of accurate climate predictions, especially seeing how inaccurate weather forecasts can be. Predicting details of the weather more than a few days ahead is difficult because the large-scale motion of the atmosphere is, to a large extent, chaotic. However, although current models might not accurately predict whether or not it will rain next week, they can correctly predict that it won't snow in North Carolina in August. This is the crucial distinction between weather and climate. Climate means, essentially, average weather. Forecasters can definitely say things with confidence about the average weather, even if they can't say what the weather will be on a particular day.

Many long-term climate variations are, in principle, predictable. The most important factor affecting the average weather from month to month is the yearly seasonal cycle, which is of course highly predictable. On time-scales longer

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CFCs : Scientific Uncertainty and Political Decision-making*

As commercial chemicals, chloroflurocarbons or CFCs have several remarkable properties: they are non-toxic, they are non-flammable, and they are easily liquified gases with boiling points between -40 C and 0 C. They are so stable in the environment that, as was realized in the 1970s, almost every gram of CFC that had been synthesized was still circulating in the atmosphere. It took a few more years for scientists to realize that CFCs were only slowly destroyed by UV light when they percolated up into the stratosphere. CFCs transport chlorine into the upper atmosphere and interfere with natural photochemical reactions which maintain an ozone layer around the earth. The ozone layer has the very useful property of absorbing harmful UV radiation, which is known to cause cancer in humans but its effects on other components of the biosphere are largely unknown.

"The history of the science of CFCs and the environment is littered with misconceptions and uncertainties and it should make us humble about the nature of scientific knowledge to remember them."

The risks that CFCs present to the environment cannot be easily measured. CFCs and spray cans came into debate in 1974 when the current view of the role of CFCs in the catalytic destruction of ozone in the stratosphere was illustrated. In 1976 the U.S. passed regulations setting up a timetable for phasing out CFCs in spray cans. In 1985 a hole was definitively identified in the ozone layer over Antarctica.

The history of CFCs and the ozone debate is a story of political decisions being taken against a background of scientific uncertainty. Uncertainty is an important concept for science. Science as you know, means 'knowledge.' Uncertainty is the lack of it. Scientists live in varying but perpetual degrees of uncertainty. Nothing is 100% certain. Science can only disprove things, it cannot prove them. Political decisions, therefore, can only be based an varying degrees of certainty; shades of grey, not black and white.

"Although the public may see this as a betrayal of its confidence in science and technology: there is no way to manage risk."

The depletion of the ozone layer may be a catastrophe in our management of human impact on the environment, of this we are uncertain. Yet we have no control of chlorine in CFCs already released into the atmosphere. We cannot predict it effects on the biosphere, effects which could include increased numbers of skin cancer or blindness in humans and animals, reduced abundance of plankton in the oceans, or subtle climatic changes.

Because of this uncertainty, some people are concerned that we need to do more to regulate industrial chemicals, others feel we go to far, taking costly precautions we are not even sure are necessary. Some see industry as hampered by bureaucracy and spiralling pollution costs, and fear that useful substances and technologies are banned without good reason. Others see science as despoiling the planet. There is no easy way to resolve these positions, They can only be balanced by informed public debate and proactive political consensus.

Even more confusing are the many people, pressure groups, industries and political parties, armed with their respective scientific experts, seeking to influence public opinion to their own advantage. Yet the public needs an understanding of science and an understanding of scientific uncertainty. As important, scientific knowledge must balanced against other social, political, and financial factors.

All groups are to a certain extent, at the mercy of public perception, of financial necessity, of pressure from industry, and of being reelected or refunded or promoted or whatever. For political regulations and policy, one must sometimes forget any ideas of objectivity which may underlie the scientific world, it is often peoples' perceptions which is most important in driving the political process. The perception of risk and uncertainty must be understood by both the scientific endeavor and the political process. An educated and informed public, from a balanced perspective is critical to the human prospect in the coming century.

* This article is an excerpt of a paper by Philip Lightowlers which appeared in *Projections: Science and Environment-The 21st century in prospective.* No. 7/8. 1992.

ASBESTOS: A LESSON LEARNED

Robert A. Thomas
The Audubon Institute

"Experts say asbestos is safe." This headline is significant. Not because of its clearly expressed message; not because it contradicts long held beliefs; but simply because it is misleading.

For years, the public has believed that exposure to asbestos, any asbestos, would lead to cancer. Public policy has held that any and all renovation work on buildings containing asbestos must carry the burden of very expensive removal of the insulation material. Asbestos removal has been especially difficult for schools, museums, government buildings who can scarcely absorb the costs. Literally billions of dollars have been spent to do so - and this is only a partial accounting of the money spent. The only records available are for the dollars spent in public buildings. Unregistered are the removal expenses incurred by private individuals and companies, often to meet the requirements of insurance and loan companies.

> Asbestos removal has been especially difficult for schools, museums, government buildings who can scarcely absorb the costs.

What we do know is that exposure to certain forms of asbestos may result in asbestosis, a type of lung disease, as well as mesothelioma, an inoperable cancer of the chest cavity and breathing anatomy. The relation of these conditions to asbestos exposure is problematic because symptoms may not become obvious for 30 years after exposure!

What we are beginning to understand is that recent studies suggest that some forms of asbestos are much less dangerous than others. Luckily, the less dangerous form, chrysotile, is the most prevalent in buildings. Chrysotile (or white) asbestos, accounting for more than 90% of the asbestos used in construction in the U.S., is mined in Canada. It is used for a variety of insulation needs (electrical, fire resistance), car brake pads, shingles on houses, and more. It now appears that we should have left the chrysotile used in construction in place. It became most dangerous when its removal mobilized the particles into the air that we breath.

By comparison, amphibole asbestos, mined in South Africa, has been used primarily in batteries, insulated concrete pipe, packing and gaskets for valves, and some brands of cigarette filters. It accounts for 5-10% of asbestos used in the U.S. There are two forms of amphibole asbestos: crocidolite and amosite. A recent study reported that until 1956, Kent cigarettes used crocidolite in their filters. For the 11.7 billion Kent cigarettes smoked, each puff could have carried up to 131 million asbestos structures (each containing up to hundreds of fibers) into the smokers lungs. This study is now researching the last decade or so for correlations between asbestos-related disorders and former Kent smokers.

Though there is emerging evidence that amphibole is the culprit, it is obvious that the jury is still out among scientists on the topic. There are many unanswered questions. How much exposure is needed? What triggers an asbestos related disorder? What makes a person susceptible? What we do know is that asbestosis and mesothelioma are most prevalent in people who have had high exposure to copious amounts of asbestos over long periods of time.

One thing is certain. If we've erred, we've erred on the safe side. But at what price? What social and educational improvements have been forestalled due to the high cost of asbestos removal being a higher priority?

Such is the human condition. We simply must make our decisions based on the best science available to us at the time. With the asbestosis example, it appears that one could argue that we did so. But did we ask science for an answer based on the best available data - even if that answer was to give us a few years to really study the issue in preparation for action? Or did we jump the gun and expend hugh amounts of money reacting to understandable but poorly informed emotionalism before asking science to help us with the decision?

If scientific studies exonerate chrysotile indicating that it posed little or no health threat, then we made the wrong decision, for the right reasons, without adequate information. I don't fault the decision, but I do question the procedure.

The Riverside Coalition for Environmental Education

Dinah Maygarden
The Audubon Institute

The Audubon Institute's Office of Environmental Policy, under a grant awarded by the McKnight Foundation, is completing a year-long project to assess the needs for effective environmental education along the Mississippi River. This project, titled the Riverside Coalition for Environmental Education (RCEE), is focusing on the high schools and communities of the Mississippi River Corridor between New Orleans and Baton Rouge. The RCEE is comprised of people from state and local education, universities, environmental organizations and agencies, industries in the corridor, residents of the corridor, and high school students. A broad-based Advisory Council made up of members from the coalition was formed in order to achieve the goals of the grant.

The main goals of the Riverside Coalition for Environmental Education are to: (1) Identify the capabilities (skills and knowledge) needed to enable the residents of the Mississippi River corridor communities to participate in determining the quality of their environment. (2) Make recommendations about and develop a process for curriculum development in the river corridor high schools. These recommendations are to be based on the capabilities identified by the Advisory Council, as well as on information about existing environmental education initiatives. The first two goals are in the process of being accomplished through a series of facilitated workshops attended by our Advisory Council members. (3) Research existing educational initiatives which are helping to develop the defined capacities thereby enabling the RCEE to identify gaps that exist in environmental education in this Mississippi River Region. (4) Collect information using quantifiable survey techniques about which of the capacities are already developed in the residents of the Mississippi River Corridor. Our final product will be complete by Fall 1995.

The RCEE Advisory Council have met at a series of facilitated workshops to identify the following: (1) the capabilities needed by the citizens to make responsible decisions regarding the environment of the Mississippi River Corridor; (2) by what means people generally learn these capacities; (3) what changes the Advisory Committee would like to see in order to develop the capacities in the river corridor; (4) what obstacles lie in the way of developing the capacities; and (5) ways in which these obstacles may be removed.

The final Advisory Council workshop took place in July at which the participants developed a set of recommendations for curriculum development in riverside high schools. We have had excellent involvement from the education community, including officials from the Louisiana Department of Education. We hope to also stimulate interest among science and social studies supervisors of the Mississippi River parishes. It is most important that the hard work and creativity that have gone into the Riverside Coalition for Environmental Education to generate the valuable ideas we have gathered are translated into a product that can be used to improve environmental education in the area. Now is the time to implement new ideas about environmental education as the state of Louisiana moves towards mandating environmental education and developing a program for certifying environmental science teachers. The ideas that have been discussed at our Advisory Committee workshops are on the cutting edge of educational thinking today. The work of our coalition could be very valuable in the process of bringing Louisiana schools into the forefront of national education reform.

Dr. Robert Thomas of the Audubon Institute in New Orleans, LA and Dr. Paulette Thomas of the University of New Orleans are the co-principal investigators for this project.

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  - ***Disappearing BioDiversity***
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