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Hazard Management for the Next Decade

by Dorothy Noyes Kane and Robert W. Kates

At the turn of the century about one child in 4 never reached maturity; today one child in 40 does not. This tenfold improvement occurred both as a result of a conscious effort to prevent death, injury, and disease and as a by-product of other improvements in societal well-being. More recently we have made major strides in the U.S. in reducing childhood mortality from fires and burns, falls, and ingestion of poisonous substances. Since 1960 deaths from thermal injuries have been reduced by 40%; those from gravity-induced trauma, by 50%. From 1968 to 1975, there was a 60% reduction in deaths from toxic ingestions. Whereas a certain percentage of this reduction can be attributed to improved medical care, much of it is probably a function of increased public awareness regarding these hazards and by preventive strategies in the form of technological change and designs.

On the other hand, we have as yet been unsuccessful in reducing mortality and morbidity generated in the traffic environment and in water—2 hazards that exact the greatest toll in terms of lives lost among young children in the U.S. today. Our affluence, manifested in numbers of automobiles and swimming pools, is in and of itself a hazard.

The U.S. accident-reduction record—in contrast to those of other countries—is nothing to engender a sense of national pride, for many countries have achieved considerably better childhood accident mortality rates.

Table 1 lists 12 countries whose industrial development and standard of living are on par with those of the U.S. Using the "external" category of the International Classification of Diseases (which includes accidents, poisonings, and violence), the U.S. is ninth among the 12 nations in mortality of children aged 1–4 and tenth for those aged 5–14.

TABLE 1. Death from Accidents, Poisoning, and Violence, Children Ages 1–4 and 5–14, in 12 Selected Countries, 1974 or 1975

	DEATH RATE	
	Age 1–4	Age 5–14
Sweden	13.0	13.5
England and Wales	16.6	10.7
Italy	16.8	14.1
Denmark	17.8	18.7
Netherlands	26.8	14.2
France	26.9	15.6
Germany (Federal Republic)	27.7	17.9
Norway	27.9	17.1
United States	32.7	20.3
Canada	35.9	24.9
Australia	36.0	17.9
New Zealand	36.4	20.4

Source: *World Health Statistics*, Vol. 1, Geneva: World Health Organization, 1977.

For the consequences of the "newer morbidity"—sonic and radiation energy and of materials releases from metals, fibers, gases, and particulates—the record is not yet clear. Though the consequences of acute and heavy exposure to these hazards are recognized, evidence of the impact from long-term, low-level exposure is not as thoroughly documented as impact from the "new morbidity" and in some cases is just beginning to surface. In fact, some of these hazards are

not universally acknowledged as significant threats to the physical well-being and optimal growth and development of young children. This is due in large part to the fact that some of the consequences are asymptomatic, producing slow-to-develop conditions that may remain latent for decades or even generations. These problems do not originate entirely in the home or in close proximity to it, unlike most of the new morbidity. Thus, the newer morbidity is not subject to as much individual control as are burns, falls, poisonous ingestions, traffic collisions, and submersion. For the most part, control of the newer morbidity is a larger problem involving the community, the region, and even, the nation and the world.

In looking toward hazard management for the next decade, this chapter considers the types of preventive efforts available and the factors that influence our choices.

THE LOCI OF MANAGEMENT

In examining the efforts at prevention in a comparative framework, it is helpful to have ways of categorizing such efforts. Describing the causal evolution of hazards as energy or materials releases provides such distinction in grouping preventive efforts independent of the particular hazard. All hazard prevention can then be described by the functional locus of the preventive effort: Where in the causal sequence of a hazard's evolution is the effort made?

Using this notion of energy and materials release, 4 loci for preventive efforts can be described (see Table 2). Some efforts aim to *prevent the release,* as in the case of the FDA limiting food additives, diminishing the beam of an X ray machine, or placing a guard over an upper-story window. A second effort is to *reduce the exposed population* —placing reflectors on pedestrian

TABLE 2. Major Efforts at Prevention

	PREVENT RELEASE	REDUCE EXPOSURE	PREVENT CONSEQUENCES	MITIGATE CONSEQUENCES
Motor Vehicles				
Passengers		traffic clubs	child restraints change car-interior design	medical treatment
Pedestrians	protected walkways	reflective devices		medical treatment
Pedalcyclist	separate bikeways	reflective devices	protective headgear	medical treatment
Fire and Burns	heater guards tap water controls covers, nontippable pots	smoke detectors	flameproof sleepwear girls wearing pants	burn treatment centers
Falls	window guards		"yielding" playground surfaces	medical treatment
Noise	incubator-noise standard classroom-noise standard			
Radiation				
Ionizing	nuclear disarmament X ray design	reduce X ray use evacuation	potassium iodide tablets	medical treatment
Nonionizing	radio antennas TV transmitters			

TABLE 2. Major Efforts at Prevention (continued)

	PREVENT RELEASE	REDUCE EXPOSURE	PREVENT CONSEQUENCES	MITIGATE CONSEQUENCES
Submersion	fencing of pools self-locking gates		swimming and water safety instruction	emergency CPR/CPCR
Toxic Ingestions				
Household products	childproof lids childproof storage		emetics	poison control centers/hospitals
Food Additives	noncarcinogenic and neurotoxic additives			
Metals and Fibers				
Lead	ban leaded gasoline restrict lead use remove paint-leaded soil	guard against parental occupational exposure		chelation screening programs
Mercury	remove mercury-containing consumer products			
Cadmium	reduce emissions			
Asbestos	replace school ceilings/floors limit insulation	guard against parental occupational exposure		medical treatment
Gases and Particulates				
Outdoors	limit emissions	remain indoors during pollution alerts		medical treatment
Indoors	eliminate smoking use electric stoves	properly vent gas- and wood-burning stoves		medical treatment

children, discouraging pediatric X ray use, or staying indoors during a pollution episode. A third type of effort is intended *to prevent consequences* after a release. Flameproof sleepwear, car restraints, bicycle protective headgear, and potassium iodide pills are examples of such efforts. Finally, specialized burn treatment criteria, chelation of lead, or asthma medication can all be used *to mitigate consequences* after they have begun.

This fourfold division of preventive effort can be seen as a stream of hazard evolution, with upstream efforts occurring early in the process of hazard evolution. In general, upstream actions are more effective. It is better in terms of hazard-reduction efficiency to prevent releases or exposure than to mitigate consequences. But upstream efforts to curb use or production of the technology may limit its value, and—given the widespread benefit connected with many hazards, such as auto travel—it may be more efficacious to prevent death and serious injury by child restraint rather than by keeping children at home.

The more mature the hazard prevention effort, the greater the use of the full range of prev-

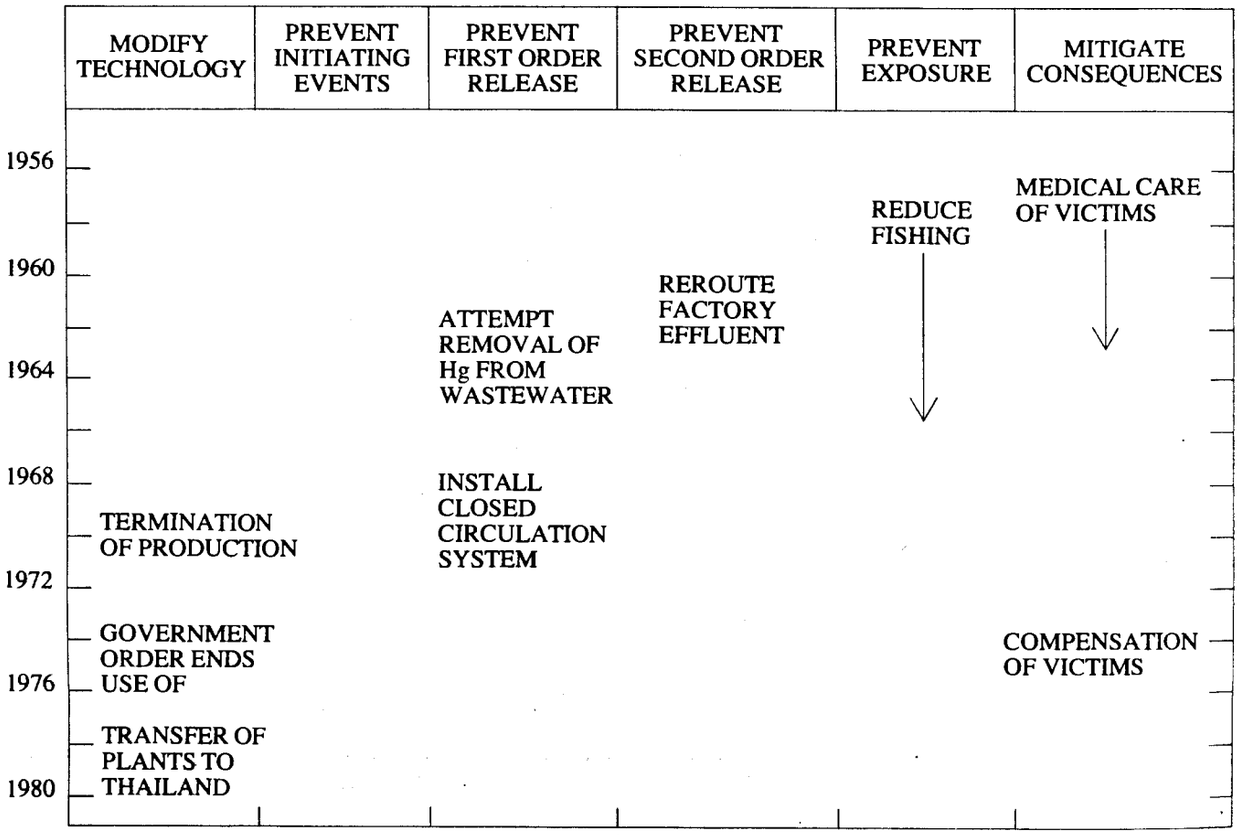
entive efforts in all loci in the causal chain. Table 2 suggests that only in the prevention of traffic accidents, burns, and, possibly, toxic ingestions has a wide array of preventive efforts been successfully employed at each point of intervention.

Choice of Preventive Efforts

For most hazards there are favored preventive efforts. Early in the recognition of a hazard, there is little prevention, and the mitigation of consequences, usually by medical treatments, dominates coping efforts. Later, as the chain of causal occurrence is better understood, efforts are found at other loci but are constrained by the perceived need for the technology. A classic example was the occurrence of Minamata disease, which poisoned seafood-eating Japanese over a period of some 20 years, leaving an enormous toll of warped and stunted human beings, including many children. Figure 1 charts the chronology of prevention for Minamata disease. The unconscionable amount of time it took to ban the mercury process reflects both the influence of the industry involved and the lack of concern for the victims.

But other factors besides a reluctance to forego production or specific uses of the product limit preventive efforts. As a society, we fluctuate between faith in technological "fixes" and efforts to change behavior through education. In general, well-designed technological fixes seem to be more efficacious than exhortation and education: The child-resistant cap, for example, has saved 2,000–3,000 lives since its institution. But efficacious technological designs may pose some problems: For example, TRIS, a mandated fire retardant used to flameproof children's sleepwear, is now known to be a carcinogen; less dangerous but still annoying are the difficulties

FIGURE 1. Chronological distribution of preventive efforts for Minamata disease. This is a classic map of upstream hazard coping, beginning with mitigation and ending with changed technology.



posed by the child-resistant caps to elderly people and arthritics.

Related to the reluctance to employ behavioral change is the difficulty of inducing such change by present educational means and the excessive zeal for protecting the rights of the individual that characterize our society. Over 29 nations, including countries as oriented toward the individual as Australia and France, have compulsory and enforced seat belt legislation; in our country such legislation has been enacted in all 50 states for child restraints and as of press time in one state (New York) for all passengers.

The meshing of technological fixes, behavior change, and societal action to mandate or encourage such change is well illustrated by the car child-restraint seat. These restraints could conceivably save at least 50% of the 3,700 lives of children under 15 now lost in auto accidents and a similar percentage of the 180,000 injuries—if correctly used. Improved design with quick-strapping and standardized fastenings; parental education at birth centers, day-care centers, etc.; and standard state laws with uniform enforcement are all required to move the current 25% use in the best of the voluntary programs to at least 75% use.

Misuse, which is so flagrant, must also be corrected. The issue of involuntary controls raises troubling issues of free choice and governmental paternalism. Nonetheless, paternalism is more easily defended in the case of protecting children than in any other hazard reduction effort. A long tradition of societal action justifies infringing on individual rights to protect those who cannot protect themselves. A more important issue in mandatory protection is the degree to which a society should aspire to reduce risk, an issue we examine in the next section.

PRIORITIES FOR THE NEXT DECADE

There are 2 approaches for deciding priorities in hazard reduction: needs and opportunities. In terms of needs, the effort should be made where the hazard is greatest. Thus, in terms of catastrophic potential, our greatest need is to prevent nuclear war. However, in terms of our day-to-day experience, our greatest need is to reduce the toll of traffic accidents, drownings and near-drownings, and low-level lead poisoning. Substantial progress can be made in each of these areas in the years ahead.

A complementary approach in deciding priorities is to identify opportunities for cost-effective prevention. Thus, there may be hazards whose toll is smaller but where effective preventive measures are readily at hand. There are 2 methods for identifying priority opportunities. The first is to examine the U.S. experience in the context of international experience: If the best prevailing practice in hazard management were employed in the U.S., what would the result be? For the second method, this chapter examines case-by-case the priority efforts suggested in each of the hazard chapters.

COMPARATIVE INTERNATIONAL EXPERIENCE

Using the 12-nation comparative group, divided into thirds by mortality rates for some of the major causes of death among children (see Table 3), the risk ratios can be calculated by age groups from the highest third of nations to the lowest third. There are small ratios in cancer and birth defects, suggesting common noncontrollable natural causes (e.g., background radiation). But twofold to threefold differences are

TABLE 3. Risk Ratios of Average Highest Third to Lowest Third of 12 Selected Countries

	Age 1–4	Age 5–14
CANCER	1.4	1.2
BIRTH DEFECTS	1.4	1.7
ACCIDENT, POISONING, AND VIOLENCE	2.2	1.6
Motor Vehicles	2.3	1.6
Fire and Burns	5.3	4.0
Falls	2.9	2.2
Drowning	3.3	2.1
Poisoning	2.8	12.0

TABLE 4. U.S. Death Rates Compared with Average of Lowest Third of 12 Selected Countries

	Lower Third		U.S.		% reduction in U.S. rate if lower third rate prevailed in the U.S.	
	Ages 1–4	5–14	1–4	5–14	1–4	5–14
CANCER	6.4	5.8	6.3	5.6	-	-
BIRTH DEFECTS	8.8	2.1	9.0	2.1	2%	-
ACCIDENT, POISONING AND VIOLENCE	16.0	13.1	32.7	20.3	51%	35%
Motor Vehicle	5.4	7.0	10.0	8.7	46%	20%
Fire and Burns	0.9	0.3	4.9	1.5	82%	80%
Falls	1.1	0.4	1.2	0.4	8%	-
Drowning	3.0	1.4	6.3	3.2	52%	56%
Poisoning	0.4	0.02	1.0	0.3	60%	93%

common for all the accident causes in the 1–4 age group and most of the 5–14 group.

What if the best practice—the lower third—prevailed in the U.S.? U.S. mortality rates can be compared to the lower third of the 12 selected nations by hazard as shown in Table 4. The U.S. rates for cancer, birth defects, and falls are close to the average, but the overall accident rate—motor vehicle, fires and burns, drowning, and poisoning—could be reduced by 42–82% (for ages 1–4) if the rate prevailing in the lower third of countries were applied to the U.S. Thus, substantial opportunity exists for further prevention in 4 of 5 of the major accident hazards.

SPECIFIC PREVENTION OPPORTUNITIES

The specific measures that might be used to made such a reduction can be gathered by the review of the best in the U.S. and international preventive experience. Several promising measures are listed for environmental hazards groups in Table 5. These can be combined into three priorities for the mid-eighties, considering first the level of societal organization at which efforts need to be made and then the type of effort.

This analysis urges child advocates in the mid-eighties to strengthen and support a number of efforts currently under way. These include the following: major global efforts to reduce the threat of nuclear war; national efforts to continue the reduction in air pollutants, particularly lead, and to address the serious and worsening problem of contaminated groundwater; state and municipal efforts to enforce the correct use of child restraints in passenger vehicles, limit noise in classrooms, require smoke detectors in homes as well as fences around swimming pools; and community efforts to provide safe bikeways, walkways, and play areas and to distribute reflector devices.

New regulations are required for reducing children's access to kerosene, iron compounds, and psychopharmacological preparations, for mandating fire-safe cigarettes, designing stable water-heating pots, controlling tap-water temperature, licensing X ray operators, and providing complete and accurate labeling of food and food products. Standards are needed for fine particulates, nonionizing radiation, incubator noise, and exposure to X rays. Research is needed on the behavioral effects of food additives, the biological effects of microwave radiation and low-

level impacts of heavy metals, and methods of reducing indoor air pollutants, as well as the development of flame-resistant materials for building construction and upholstery. Education of parents and children, with the help of health and education professionals, is particularly needed to cope with traffic and water environments.

If these steps are taken in the next decade, it is possible to look forward to a one-fourth to one-half reduction in the toll of 20,000 deaths and 20 million injuries and illnesses caused by environmental hazards. Such a reduction would not lead to a risk-free world for children. Nor would we desire this, for the development of cognitive and motor skills requires some risk in the lives of children. But coping with a nuclear holocaust, steel behemoths, a lead-laden atmosphere, bottled hydrocarbons, or penetrating X rays has little place in natural development. To coexist with these hazards, young children need our help.

TABLE 5. Hazard Management for Young Children for the Next Decade

	MEASURES	RATIONALE
Traffic Environment		
Passengers	Strictly enforce child-restraint legislation in all states	CRs can reduce deaths and injuries by 50–75%
	Set up in-service training for highway patrol officers in a public information and education program	In Tennessee, first state to enact CR law, considerable credit for success is attributed to troopers carrying a CR at all times
	Correct loopholes in existing laws	All children under 4 years need properly anchored seats, and all adults should be held responsible
	Improve car interiors so they are more "yielding"	Will help to reduct impact in a collision or sudden stop
	Caution against dangers of misuse of CRs	Heavy percentage of incorrect use is self-defeating
	Mandate belts for school buses	Children of all ages need protection when being driven to and from school
Pedestrians	Start a child pedestrian safety association	Child passenger safety associations serve an important function, but as many children are killed on foot as riding in cars
	Distribute more reflector devices	In Sweden reflectors have reduced fatalities by 25%; in Vermont, by 50%
	Provide more protected walkways and play areas	Child pedestrian deaths are a "social disease of urban areas," and children's "darting out" behavior is largely responsible for deaths and injuries
Pedalcylists	Mandate use of protective headgear (as in Japan)	Head injuries to bike riders are common and serious; helmets help to cushion impact in a collision
	Discourage sale of minibikes to children under 10	Tremendous velocity is too difficult for young children to handle safely
	Provide more segregated bikeways	Children desparately need a safe space for their play

TABLE 5. Hazard Management for Young Children for the Next Decade (continued)

	MEASURES	RATIONALE
Fire and Burns	Press for legislation for fire-safe cigarettes	To eliminate number one source of ignition in homes fires—where children experience most deaths and injuries
	Mandate installation of more smoke detectors, particularly in inner-city areas	Estimated to reduce loss of life by over 40%
	Encourage regulation of tap water temperature to no higher than 125°F	Painful, often disfiguring scalds are caused because young children's skin is thin, soft, and tender, much more sensitive to heat than older children's and adults'
	Promote better design of coffee pots and similar appliances	To lessen the risk of tip-overs, as Norway has done
	Develop more flame-resistant materials, furnishings, etc.	Fumes can prove highly toxic in fires involving plastic materials. Ignition-proof sleepwear has dramatically reduced childhood trauma.
	Promote use of covers for electrical outlets	Burns from unprotected outlets are common in children and can be extremely disfiguring
Falls	Install more window guards, especially in upper stories	In New York City, a 50% reduction in mortality rate was achieved by this means
	Set standards for more "yielding" surfaces for playgrounds	Concrete surfacing is the "biggest killer" in falls from playground equipment
	Urge the use of more guard gates in homes with young children	A simple preventive step yields tangible results
Noise	Set standards for infant incubators	AAP's recommendation to protect newborn's hearing competence has been waiting over 10 years for adoption
	Press for passage of state laws (as in California) for classroom-noise standard	Children's classroom performance is better in quieter schools, and teachers have more time for teaching
	Press for standards for truck and motorcycle noise	These vehicles represent a major source of high-decibel noise plaguing schools situated near busy thoroughfares
	Encourage installation of sound-absorbing materials in homes and publicize methods for quieting household equipment	The AMA states that a 50% reduction in noise can be achieved through improved acoustical design at a cost of 5–10% per unit.

TABLE 5. Hazard Management for Young Children for the Next Decade (continued)

	MEASURES	RATIONALE
Radiation	Avoid nuclear war	To save children as well as adults from annihilation
	Set guidelines for X ray exposure to children, including lower dosage for males	Young children should be subjected only sparingly to ionizing radiation
	Establish standards and license all X ray operators	Up to half of people operating X ray equipment are reported to have no training
	Devise effective preventive measures for persons in vicinity of nuclear reactors	The TMI incident proved that "public health was tested and found wanting"
	Redouble efforts to clean up radioactive waste sites	The numbers are legion and the potential damage pernicious
	Push for ambience standard for nonionizing radiation	To reduce exposure, as has been done in certain European countries
	Continue research on microwave radiation bioeffects	Evidence is accumulating that effects are more than merely thermal
Submersion	Tighten regulations on private swimming pool fences, locks, etc, to ensure "kid-proof" pools	Death rate is considerably lower in cities where locks are mandatory
	Create a physicians for pool safety organization	Patterned after Physicians for Automotive Safety, such a group could help to reduce drowning deaths
	Persuade pool manufacturers to become child safety advocates	Granted incorrect use, their products result in many unfortunate sequelae which are preventable
	Establish more instruction for both children and adults in both swimming, water safety, and cardiopulmonary resuscitation (CPR) techniques	Testimony as to benefits of such instruction comes from many sources
Toxic Ingestions	Modify "reversible" cap legislation	If not done, material benefits which child-resistant containers (CRCs) have achieved will be substantially reduced
	Develop methodologies to protect against kerosene, iron preparations, and psychopharmacologic agents	These 3 product types result in highest percentage of hospitalizations of young children
	Screen food additives for behavioral effects	Certain sensitive children should receive special protection

TABLE 5. Hazard Management for Young Children for the Next Decade (continued)

	MEASURES	RATIONALE
Toxic Ingestions (continued)	Require complete and accurate labelling on food and food products, including substances that may migrate from wrapping and containers that come in contact with foods	This will enable sensitive subgroups to avoid troublesome items
	Pass strong measures to clean up groundwater pollution	Young children take more nourishment in form of water than at any other time of life, yet water quality is worsening materially
Metals and Fibers	Phase out leaded gasoline as quickly as possible	Proved to correlate closely with blood lead levels
	Encourage childhood educators as well as parents groups to push for extension and expansion of lead-screening programs	With new low level of 25 μg/dl, twice as many young children, or 1.5 million, are at risk; early detection may prevent impairment in learning capabilities
	Encourage more AAP members to make lead screening part of their regular routine for children under 6 years	The Rhode Island Chapter of AAP is setting a noteworthy example by joining with the public health profession in controlling lead exposure
	Remove contaminated lead-laden soil from children's play places, particularly in urban areas	Will prove cost-effective in terms of saving children from ingesting and inhaling this highly toxic metal
	Upgrade methodology for removing old lead paint from buildings and other structures	Wet sand-blasting aids materially in curtailing dispersion of lead flakes and dust
	Promote elimination of asbestos materials in public and private schools	This carcinogen has been found in friable form in 11,000–14,000 buildings with over 3 million children exposed
	Continue monitoring and encourage research on impact of other metals such as mercury and cadmium	Their deleterious impact on the central nervous, renal, and other systems is well known
Gases and Particulates	Resist attempts to lower present standards of air quality	Many areas in the country still do not meet primary standards for health
	Set standards for fine particulates	Action is long overdue on these; often their effect is more deleterious than those for which standards have been established
	Press for action to clean up toxic waste sites	Their impact on air quality can only be guessed at; however, there is no doubt as to their negative effects

TABLE 5. Hazard Management for Young Children for the Next Decade (continued)

	MEASURES	RATIONALE
Gases and Particulates (continued)	Concentrate on devising means to contain and curtail worst of indoor pollutants	Young children need this protection, since so much of their time is spent indoors
	Ban sale of formaldehyde- and asbestos-containing furnishings and materials	Strong measures are essential to reduce indoor concentration of CNS depressants, mutagens, carcinogens, etc.
	Urge legislators to strive for adequate funding to preserve air quality	At both the federal and state levels, funds must not be curtailed in the interest of protecting the public, particularly the most sensitive segments of the population