PURDUE PESTICIDE PROGRAMS

Purdue University Cooperative Extension Service

PESTICIDES AND WILDLIFE

An Introduction to Testing, Registration, and Risk Management

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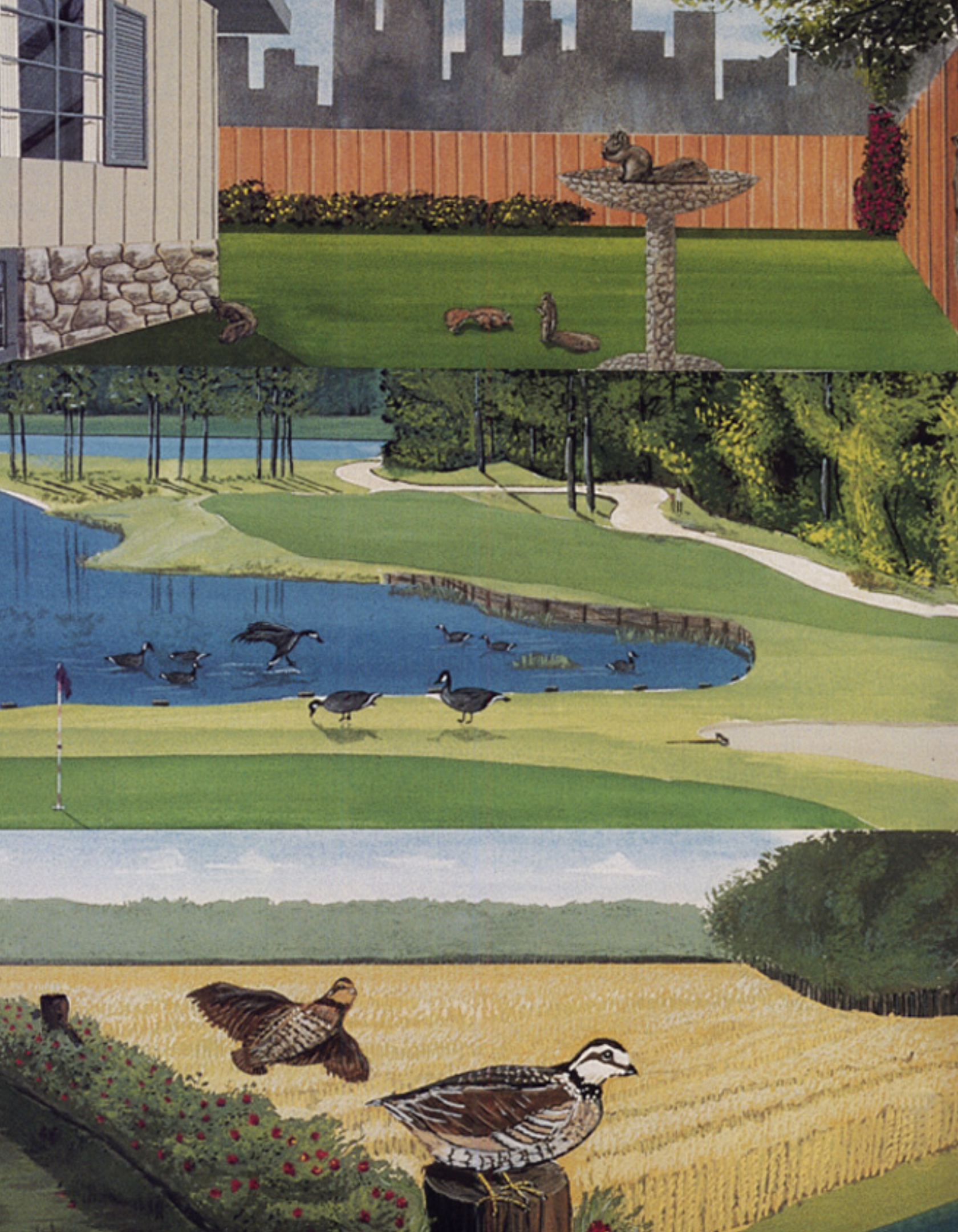


INTRODUCTION

The diversity of wildlife habitats throughout our country is surprising. In rural areas fence rows, fields, pastures, ponds, wetlands, and woodlands comprise important habitats for many species of wildlife. Wild species also inhabit urban landscapes, finding food and shelter in lawns, cemeteries, golf courses, parks, etc. Collectively, these habitats—urban, rural, public forest, and pristine areas—provide resources to support plants (flora) and animals (fauna) that are important and necessary.

Lands that provide habitat for wildlife also may bring them into contact with human activities. Wildlife species living adjacent to farmlands may benefit from the crops grown but may be inadvertently exposed to pesticides used to reduce insect, weed, and disease pests of those crops. Urban expansion for new housing, manufacturing facilities, and other activities not only consumes valuable habitat but also may bring wildlife into contact with pesticides used on turf, ornamental and landscape plantings, gardens, highway rights-of-way, parks, and rodent and mosquito abatement programs. *Pesticides and Wildlife* introduces its readers to the potential effects of pesticides on wildlife and aquatic organisms; to the process by which ecological safety assessments are made for registered pesticides; and to pesticide use recommendations to protect wildlife.

Stephen Adduci

BENEFITS OF WILDLIFE

Watching wildlife in natural settings appeals to persons of all ages and all ethnic, educational, and social backgrounds. Eighty-five percent of Americans participate in some wildlife observation activity (e.g., whale, bird, and butterfly watching). Ecotourism has become a lucrative market; many businesses and communities actively advertise and attract tourists to

Gene White

Endangered species: Mitchell's Satyr *(Euptychia mitchellii)*

observe wildlife. Wildlife viewing tours organized by professional wildlife biologists are in demand, and tourism is supported by a cadre of jobs related to lodging, meals, transportation, art, equipment, and the media. Taxes dedicated from the sale of hunting and fishing licenses and certain outdoor equipment provide revenue to purchase, maintain, and restore wildlife habitats while monetary support from some government agencies is dwindling. These user-based taxes also help finance scientific research on wildlife communities. It is important that we as a society do all we can to maintain and preserve the natural world and benefit from its existence.

Fewer than 20 plant species are responsible for feeding most of the world's population. However, it is estimated that 80,000 species of edible plants may have potential as new food sources; and wild plant and animal species may become sources of new genetic material with agricultural or medical applications. For example, the purple cone flower (a native prairie plant) has an oilseed content greater than that of commercially grown sunflowers; and the South American corn

variety *Zea diploperennis* has been used to breed resistance to northern corn leaf blight into North American corn hybrids, thereby curtailing the likelihood of a major blight outbreak which might impact grain markets. Plants (e.g., Pacific Yew, which produces taxol) and animals also have been shown to harbor an array of pharmaceutical chemicals whose medicinal properties may be used to combat disease. Wildlife also play a role as natural enemies of pest species (e.g., birds eat mosquitoes; snakes consume rodents).

Many of these relationships are known, but many are yet to be discovered. It is for this reason that we must ensure that the vast array of plants and animals on our planet is maintained for future generations. It is likely that important connections exist between species diversity, environmental quality, and the long-term sustainability—and profitability—of farming operations.

PESTICIDE IMPACT DEPENDS ON WILDLIFE ECOLOGY

The term wildlife as used here shall include insects, spiders, mammals, birds, fish, amphibians, reptiles, and plants. Each species fills a certain niche which includes its *specific* food, cover, water, space, and breeding site preferences. The location where a species can meet all of its living requirements becomes that species' habitat. Wildlife habitats are not just the Grand Canyon, ancient forests of the Pacific Northwest, or rich coastal marshes off of the eastern seaboard; they exist across the American landscape. Wildlife habitats—large and small, native and man-made—exist in urban settings, in agricultural fields, and in the wilderness.

Wildlife ecologists and natural resource managers study the needs and habits of wildlife. An important goal of wildlife research is to discover and understand the critical factors that affect survival and sustainability of viable populations. Most wildlife will adapt and flourish, given sufficient quantity of quality habitat, even in the presence of people. While ecological studies may pinpoint very specific requirements for individual species, the lives of plants and animals and their habitats can be integrated collectively into a matrix (ecosystem).

Knowledge of the biological and ecological relationships of any given plant or animal and the role that species plays in the ecosystem is required to evaluate the potential impact of a *specific* pesticide on a *specific*

species. The impact of a specific pesticide may be negative, neutral, or positive to a species or its habitat as the chemical's residues move through the soil, water, food, or air. The interaction of wildlife, its habitat, and pesticides is evaluated by scientists trained in wildlife ecology, population dynamics, physiology, and environmental chemistry.

PESTICIDE POISONING OF WILDLIFE

Pesticides are applied in many forms via various delivery methods to forests, rangeland, aquatic habitats, farmland, rights-of-way, urban turf, and gardens. Their widespread use makes contact with pesticide residues inevitable for some wildlife. Pesticide poisonings to wildlife may result from *acute* or *chronic* exposure. Additionally, pesticides may impact wildlife via *secondary exposure* or through *indirect effects* to the animal or its habitat.

Acute Poisoning

Short exposures to some pesticides may kill or sicken wildlife. Examples of acute wildlife poisoning include fish kills that are caused by pesticide residues carried to ponds, streams, or rivers by surface runoff or spray drift, and bird die-offs caused by foraging on pesticide-treated vegetation or insects, or by consumption of pesticide-treated granules, baits, or seeds. These types of poisonings generally can be substantiated by analyzing tissues of affected animals for the suspected pesticide or by investigating impacts on biochemical processes (e.g., cholinesterase levels in blood and brain tissue). In general, acute poisoning to wildlife takes place over a relatively short time, impacts a very localized geographical area, and is linked to a single pesticide.

Chronic Poisoning

Exposure of wildlife over an extended period of time to pesticide levels not immediately lethal may result in chronic poisoning. The most well-known example of a chronic effect in wildlife is that of the organochlorine insecticide DDT (via the metabolite DDE) on reproduction in certain birds of prey. DDT and other organochlorine pesticides such as dieldrin, endrin, and chlordane have been implicated in bird mortality resulting from chronic exposure. The reduction of these compounds in the 1970s and early 1980s has resulted in decreased organochlorine residues in most areas, and reproduction in birds such as the bald eagle has greatly

improved. Organochlorine pesticides used in some foreign countries may pose risk to migratory birds which overwinter there.

Secondary Poisoning

Pesticides may impact wildlife through secondary poisoning when an animal consumes prey species that contain pesticide residues. Examples of secondary poisoning are (1) birds of prey becoming sick after feeding on an animal that is dead or dying from acute exposure to a pesticide, and (2) the accumulation and movement of persistent chemicals in wildlife food chains.

Indirect Effects

A pesticide may affect wildlife in ways other than direct or secondary poisoning. Pesticides may impact wildlife indirectly when a part of its habitat or food supply is modified. For instance, herbicides may reduce food, cover, and nesting sites needed by insect, bird, and mammal populations; insecticides may diminish insect populations fed on by bird or fish species; insect pollinators may be reduced, thereby affecting plant pollination. The study of indirect effects is an emerging area and one that may be difficult to investigate.

INVESTIGATING PESTICIDE EFFECTS ON WILDLIFE

Not all pesticides have detrimental effects on all wildlife, nor do pesticide residues necessarily lead to serious consequences for wildlife. The potential impact must be evaluated by simultaneously considering the availability of the pesticide or its degradation product(s), the toxicological properties of the pesticide, and the ecological characteristics of the exposure. Due to the complexity of these issues, many scientific disciplines must play a role in both the studies and the interpretation of results. The results from scientific studies aid numerous federal and state natural resource agencies to assess and manage the effects of pesticides on wildlife, including endangered species.

The degree of direct impact a pesticide has on wildlife is determined by the sensitivity of a species to the chemical and the degree to which the species is exposed. Just how safe are pesticides to wildlife? The following questions help to summarize the complexity that biologists and toxicologists face when attempting to evaluate pesticidal effects on wildlife.

- What level of a pesticide residue or its breakdown product (metabolite) is introduced into a wildlife habitat through direct application or via the transportation of residues in air, water, food, or soil?
- How long does the pesticide remain in the environment?
- Is the animal or plant exposed to the pesticide by mechanisms including dermal contact, inhalation, or consumption of contaminated food or water?
- Is the pesticide capable of producing biochemical effects, illness, or death through either single or multiple exposures?

FEDERAL PESTICIDE TESTING REQUIREMENTS FOR WILDLIFE

Ultimately, in making decisions and adopting attitudes about pesticides, one should consider both the potential benefits and the potential risks of their use. Pesticides contribute many positives to our society: reduction of insect-vectored and waterborne diseases; production of an abundant food supply that takes only 10 percent of our disposable income; a positive impact on our balance of trade; nourishment for the world; and reduction of soil erosion in conservation tillage programs. Pesticides facilitate the production of grains, meats, and fibers by less than two percent of our population, freeing the rest of us to pursue other vocations. With the world's human population steadily increasing (to 8 billion by the year 2025), and with limits on the amount of "new" land that can be converted into production, it is likely that pesticides will continue to play an important role in meeting our demands for food and fiber.

Though chemical technology has great potential to benefit humankind, we should act carefully. The benefits need to be evaluated continually so that the balance sheet clearly favors the benefit quotients. In order to prevent the use of pesticides that might cause unacceptable adverse effects, testing requirements and review processes are implemented to identify problem chemicals and allow development of precautions and instructions for proper use.

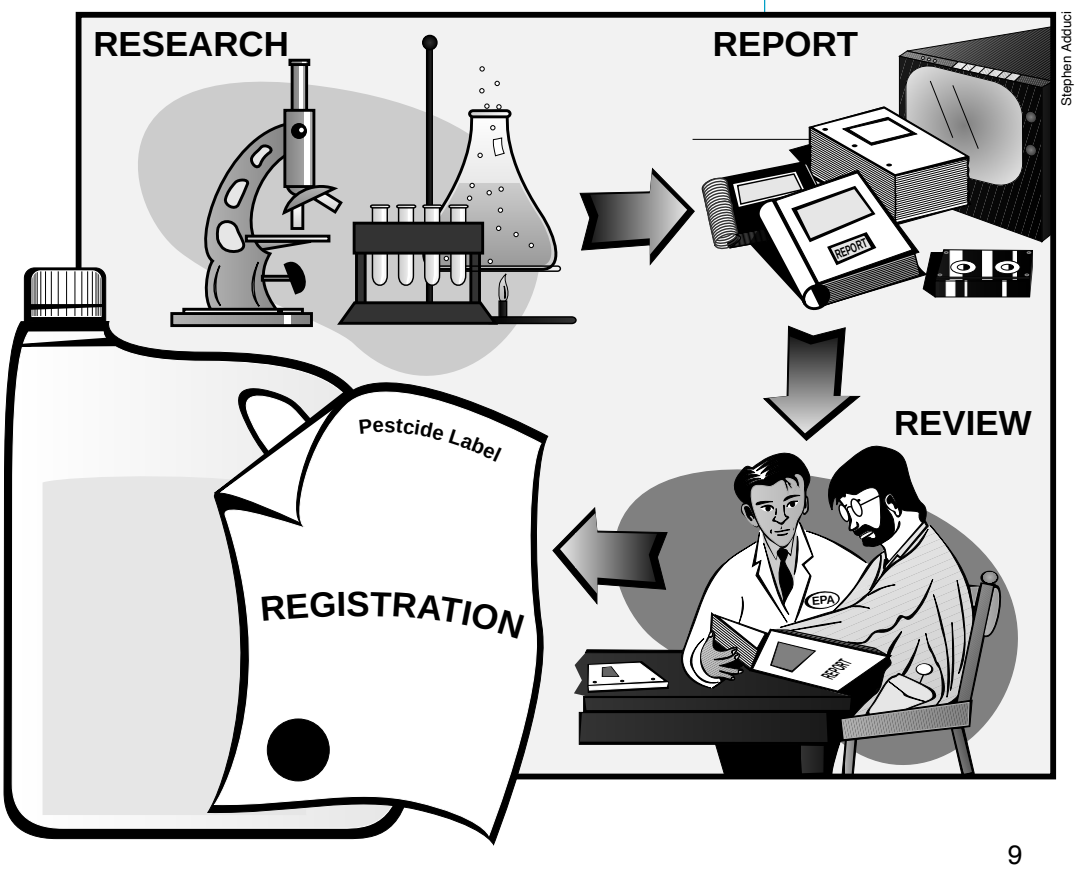
The Law Mandates that Pesticides be Tested on Wildlife

Pesticide registration is a process that is mandated by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The details of implementation are described in the Code of Federal Regulations Section 40. Both FIFRA and the regulations outline the basic

framework for registration, rules of conduct, implementation mechanisms, and decision-making guidelines.

Congress delegates the U.S. Environmental Protection Agency (EPA) to assume regulatory responsibilities and decision-making authority to administer the federal pesticide registration process. The registration process is complex and takes considerable time, resources, and expertise on the part of EPA, the pesticide manufacturing industry, and various public interest groups. This process is ever-evolving to answer new questions and meet challenges posed by the use of pesticides. An expanding series of tests is required in response to public concern and improved technology that provides more precise pesticide residue detections and toxicological assessments. In addition, improved methods for hazard predictions, novel approaches to hazard reduction measures, and incorporation of the broadening scope of relevant scientific knowledge into industry and government policy decisions contribute to changes and improvements in the pesticide registration process.

The basic pathway for pesticide registration is: (1) research conducted by the manufacturer prior to its decision to pursue registration; (2) data submission report by the manufacturer to EPA; (3) EPA review; and (4) a decision by EPA either to register the pesticide based on the merits of the data submitted, or to deny registration. The congressional mandate that



Stephen Adduci

guides EPA decisions to register a pesticide hinges on a benefit-to-risk analysis of the data. Evaluation of available registration data must provide EPA with an assurance that the pesticide will perform its intended function without unreasonable adverse effects on people, wildlife, and the environment.

The EPA registration process for a single chemical requires the manufacturer (registrant) to conduct, analyze, and pay for 142 different scientific tests. These tests define product chemistry, risks to humans and domestic animals, the environmental fate of the pesticide, and the pesticide's impact on nontarget wildlife. Generation of such data for a single compound may take 6–10 years and cost millions of dollars.

The following table illustrates the scientific information required by EPA when considering the registration of a pesticide.

Ecotoxicology Studies for U.S. Pesticide Registration

Oral LD_{50} Duck	Acute LC_{50} Trout	Nontarget Plants (Tier 1)	Acute Honeybee
Oral LD_{50} Quail	Acute LC_{50} Bluegill	Nontarget Plants (Tier 2)	Honeybee Foliage
Dietary LC_{50} Duck	Acute LC_{50} Daphnia	Field Testing (Tier 3)	Field Testing - Pollinators
Dietary LC_{50} Quail	Acute LC_{50} Marine Fish		
Wild Mammal LC_{50}	Acute LC_{50} Marine Shrimp		
Duck Reproduction	Oyster Shell Growth		
Quail Reproduction	Fish Early Life Stage		
Field Pens	Invertebrate Life Cycle		
Field Monitoring	Fish Full Life Cycle		
	Microcosms		
	Replicated Ponds (Mesocosm)		
	Field Monitoring		

LD_{50} = Single oral dose estimated to kill 50% of exposed organisms

LC_{50} = Concentration in food or water estimated to kill 50% of exposed organisms

Use of Indicator Species to Determine Impacts of Pesticides on Wildlife

It is impossible, inadvisable, and illegal to test every species—abundant, threatened, or endangered—with each pesticide. In the regulatory testing process, the test species selected are intended to broadly represent nontarget organisms. Chosen wildlife species typically satisfy the following criteria: ecologically significant; abundant and broadly distributed geographically; susceptible to chemical exposure; commercially available for testing; and easy to handle in the laboratory. For life cycle tests, the species must have a relatively short life span. When possible, species that are aesthetically, recreationally, or commercially important are studied. These indicator species provide the research scientist and the regulatory decision-maker with an information base for assessing potential risks to a broad range of nontarget birds, mammals, fish, aquatic invertebrates, predatory insects, insect pollinators, and plants. The following table lists typical indicator species.

UPLAND GAME BIRDS	*WATERFOWL*	*ESTUARINE/MARINE FISH*	*MAMMALS*
northern bobwhite	mallard	sheepshead minnow	mink, rat

---------- *FRESHWATER FISH* ----------		---------- *CRUSTACEAN* ----------	
COLD-WATER	*WARM-WATER*	*FRESHWATER*	*ESTUARINE/MARINE*
rainbow trout	bluegill	*Daphnia*	mysid shrimp

TERRESTRIAL PLANTS	*AQUATIC PLANTS*	*INSECTS*	*MARINE MOLLUSK*
corn, soybeans, lettuce, ryegrass, carrot , sugar beets	green algae, diatoms, duckweed	honeybee	eastern oyster

Wildlife Testing Must Be Conducted by Scientifically Accepted Methods

Toxicological testing and scientific measurements are conducted under stringent guidelines, approved methodologies, and specified reporting requirements. Exacting standards are necessary for consistency in evaluations of pesticide safety and for comparisons among chemicals. EPA's pesticide assessment guidelines stipulate the following general practices which must be adhered to when conducting the various tests required for registration:

- Toxicological or phytotoxicological testing normally is not performed on endangered or threatened species.
- Only EPA-recommended wildlife and aquatic organisms should be used for laboratory testing purposes.
- The test organisms should be uniform in weight, size, and age.
- Control groups—those not exposed to pesticides—should be maintained in a manner similar to that of the test groups.
- The substance to be tested—the technical grade of the active ingredient, or the end-use product—is clearly specified. If the test substance is diluted or dissolved for administration, the carrier should not interfere with adsorption, distribution, or metabolism of the test material; alter the chemical properties of the substance; enhance or reduce the toxic characteristics of the test substance; affect food and water consumption; or impact the physiological processes of the test organism.
- Detailed descriptions of the nature, incidence, time of occurrence, severity, and duration of all observed toxic effects should be recorded.
- All data generated must be in accordance with established Good Laboratory Practices for handling and care of test organisms.
- Final reports should include all information necessary to provide a complete and accurate description of test procedures and evaluation of the test results.
- Responsible parties must confirm by signature that appropriate quality assurance and quality control methods were followed.

Examples to Illustrate Wildlife Testing

Test species are exposed to measured amounts of pesticide to establish acute and chronic responses to varying concentrations. A dose can be delivered to the test organisms by various means, depending on the test: mixed with water in aquarium tanks stocked with fish or invertebrates; given as a single oral dose to mammals and birds; applied topically to honey bees; or incorporated into the diet. Typically, in every short-term test ten organisms each are exposed at four to five dose levels to determine mortality or other end point effects.

In addition to short-term mortality studies, the effects of long-term (chronic) pesticide exposures on reproduction, survival, and behavior are measured. If laboratory studies indicate that the pesticide has a potential for adverse effects on wildlife, the research may be expanded beyond laboratory settings to include studying and monitoring impacts under actual use conditions.

Northern bobwhites (upland game species) and mallards (waterfowl) are used to conduct a series of toxicological tests to quantify the short- and long-term impacts of pesticides on avian wildlife. These species generally are obtained from pen-reared stock and maintained under temperature, humidity, lighting, and pen size that conform to good husbandry practices and protocols established by EPA.

Single-Dose Acute Oral Toxicity LD_{50} Test

The purpose of this test is to determine the chemical's acute oral toxicity, expressed as a single dose of material (milligrams per kilogram of body weight) that will result in 50 percent mortality among test birds. The test provides a measure of a species' sensitivity to a toxic substance. Birds tested must be in good health, from the same source, and preferably from the same hatch. Birds must be at least 16 weeks old at test initiation and must have been preconditioned to the test facilities for at least 15 days prior to experimentation. The standard study uses ten birds for each of five dose levels. The test material is administered orally to each bird by direct injection into the stomach or crop, or through the use of capsules. Birds are observed for a minimum of 14 days, and any mortality or signs of intoxication are recorded. In addition, an internal examination is made to determine the condition of major organs.

Eight-day LC_{50} Test

The purpose of this test is to determine a chemical's toxicity to birds, expressed as a concentration of the pesticide in the diet (parts per million) that will produce 50 percent mortality among test birds. Birds selected for experimentation must be in good health and preferably from the same source and hatch. Bobwhites

Jim Rathert

should be from 10 to 14 days old at the beginning of the test. Birds are preconditioned from hatch on a standard commercial game bird diet. Three to five days prior to testing, bobwhites or mallards are randomly segregated into six groups, ten birds per group. Five groups are given unrestricted access to feed containing known concentrations of the pesticide; one group serves as a control and receives standard commercial feed that contains no pesticide. Birds are allowed to feed on the test diets for five days and observed for an additional three days. During the study period, mortality and all signs of intoxication, such as immobility and any abnormal behavior, are recorded daily.

Reproduction Test

The most commonly used test for chronic pesticide effects on terrestrial wildlife is the avian reproduction test. The objectives of the study are to determine pesticidal effects on the health and reproductive performance of egg-laying adults, on embryo viability, and on the survival of hatchlings. One control and three pesticide-treated dietary concentrations (selected to bracket environmental exposures) are fed to four test groups of first year breeders. Exposures begin 10 weeks prior to egg laying and continue during 10 weeks of egg laying. Eggs are collected daily, artificially incubated, and checked periodically for embryonic development; hatchlings are grown on untreated feed for two weeks to check their viability and growth. This test is now conducted for virtually all pesticides.

Testing Under Field Conditions

From 1987 to 1992, EPA's Office of Pesticide Programs increasingly required ecotoxicological field studies both for new chemical registrations and as part of the ongoing reregistration process for older pesticides. Two major documents, *Guidance for Conducting Terrestrial Field Studies* and *Guidance for Conducting Aquatic Mesocosm Studies,* were issued to provide detailed recommendations on the implementation of these tests. The former document was concerned primarily with field monitoring of pesticidal impact on birds under actual use conditions; the latter concerned the use of test systems composed of constructed ponds (0.1 to 0.25 acre surface area) treated with pesticides at rates approximating chemical contamination that might result from runoff and spray drift following agricultural applications.

After approximately five years of ecotoxicological field testing under these guidance documents, more than 45 avian field studies and 10 aquatic mesocosm studies were conducted. But the results did not add sufficient information to agency risk assessments to justify the time and resources necessary to support the testing, so EPA discontinued it. In the absence of such field testing, EPA is evaluating the risks of pesticides based largely on laboratory test results, estimation of environmental exposures through the use of computer models and literature sources, measured pesticide residues, and pesticide incident data. When such analyses indicate a potential for adverse environmental effects, EPA requires pesticide registrants to implement changes in product use recommendations to lessen that potential. Under this new testing approach, EPA may still require field testing in special circumstances or may require field monitoring to determine if pesticide use changes have adequately reduced exposures or effects.

Risk Assessment: Interpretation of Environmental Effects from Toxicity Testing Data

The first tier of testing consists of short-term, acute toxicity tests that determine lethal dosages and the general responses of the test animal to the pesticide. These tests include the single-dose oral test for birds, the 8-day dietary subacute test for birds, a 96-hour LC_{50} test for fish, and a 48-hour test for aquatic invertebrates. A fundamental end point of these tests is to determine the lethal dose (LD) or lethal concentration (LC) required to kill 50 percent of the test organisms.

This value is calculated statistically and expressed as an LD_{50} value (single oral dose) or LC_{50} value (dietary exposure or concentration in water). The LD_{50} values are expressed in milligrams of a pesticide per kilogram of animal body weight (mg/kg). The LC_{50} values are expressed in milligrams of a pesticide per kilogram of feed (mg/kg) or per liter of water (mg/l). The metric units are normally converted to parts per million (ppm) to aid in comparison to environmental residue data.

An initial interpretation of these statistical laboratory values concerns their magnitude: the lower the LD_{50} or LC_{50} value, the less chemical is required to kill test organisms. Toxicologists have developed rating scales for interpretation of the potency of pesticides, as follows:

FOR AVIAN DIETARY LC_{50}

LC_{50} < 50 ppm	very highly toxic pesticide
LC_{50} = 50–500 ppm	highly toxic pesticide
LC_{50} = 501–1000 ppm	moderately toxic pesticide
LC_{50} = 1001–5000 ppm	slightly toxic pesticide
LC_{50} > 5000 ppm	practically non-toxic pesticide

FOR AVIAN ACUTE ORAL LD_{50}

LD_{50} < 10 ppm	very highly toxic pesticide
LD_{50} = 10–50 ppm	highly toxic pesticide
LD_{50} = 51–500 ppm	moderately toxic pesticide
LD_{50} = 501–2000 ppm	slightly toxic pesticide
LD_{50} > 2000 ppm	practically non-toxic pesticide

FOR MAMMAL ACUTE ORAL LD_{50}

LD_{50} < 10 ppm	very highly toxic pesticide
LD_{50} = 10–50 ppm	highly toxic pesticide
LD_{50} = 51–500 ppm	moderately toxic pesticide
LD_{50} = 501–2000 ppm	slightly toxic pesticide
LD_{50} > 2000 ppm	practically non-toxic pesticide

FOR FISH OR AQUATIC INVERTEBRATE LC_{50}

LC_{50} < 0.1 ppm	very highly toxic pesticide
LC_{50} = 0.1–1 ppm	highly toxic pesticide
LC_{50} = 1–10 ppm	moderately toxic pesticide
LC_{50} = 11–100 ppm	slightly toxic pesticide
LC_{50} > 100 ppm	practically non-toxic pesticide

Tests in the second tier evaluate longer-term impacts that might occur. These tests evaluate survival, growth, reproduction, body weight, physiological abnormalities, and other effects that may be chemically induced. An important statistical end point of these studies is the highest concentration producing no observed effect: the No Observed Effect Level (NOEL).

Understanding the short- and long-term toxicological effects from exposure is the first step for measuring hazards, but pesticide toxicity is only a partial indication of relative risks to wildlife. Potential exposures have to be evaluated in order to assess risks accurately. An estimation of the exposure of wildlife to pesticide residue in the environment must be determined. It is called the Estimated Environmental Concentration (EEC). The EEC for birds and mammals is the concentration of the pesticide in or on foods that they might consume. This may be determined in special field studies but is most often estimated from various published sources. The EEC for aquatic organisms may be a range of concentrations representing typical and worst-case exposures (caused by runoff or spray drift) that may occur in bodies of water adjacent to treated fields. Aquatic EECs usually are calculated, often with the aid of computer models, but also may be derived from field studies. Field monitoring of exposure and ecological effects still may be required on a case-by-case basis to assess the effectiveness of risk reduction measures.

Cumulative evaluation of laboratory toxicity studies, chemical fate analyses, and (when appropriate) evaluations under actual use conditions provides the manufacturer and EPA with data necessary to evaluate

and estimate the direct risks to wildlife from the use of a pesticide. Hazard analysis is a comparison between toxicity information and the estimated environmental concentrations. If the EEC is significantly less than levels found to pose acute or chronic problems, the assumption is that the pesticide will not have a significant adverse impact on wildlife. Conversely, if the EEC exceeds levels known to produce problems, the pesticide residues being

evaluated may be expected to produce harm. If the data indicate a high likelihood of hazard to wildlife, the EPA may require additional or more refined testing, mandate specific label language, classify the pesticide for restricted use, or recommend against registration.

	Presumption of Minimal Risk	Presumption of Unacceptable Risk	
		Non-endangered species	Endangered species
Acute Toxicity			
Mammals	EEC < 1/5 of LC_{50}	EEC ≥ 1/2 of LC_{50}	EEC >1/10 of LC_{50}
	EEC < 1/5 of LD_{50}	EEC > 1/2 of LD_{50}	EEC > 1/10 of LD_{50}
Birds	EEC < 1/5 of LC_{50}	EEC[1] ≥ 1/2 of LC_{50}	EEC > 1/10 of LC_{50}
Aquatic Organisms	EEC < 1/10 of LC_{50}	EEC ≥ 1/2 of LC_{50}	EEC > 1/20 of LC_{50}
Chronic Toxicity	EEC < lowest effect level	EEC ≥ lowest effect level	EEC ≥ lowest effect level

[1]Another criterion for birds and mammals specific to granular products is whether the amount of exposed granules per square foot of soil surface exceeds 1/2 of the LD_{50} for non-endangered species or is greater than 1/10 of the LD_{50} for endangered species.

SCIENTIFIC RESEARCH AND REGULATORY REVIEW OF THE PESTICIDE LABEL

Each pesticide must receive an EPA registration before it can be sold, distributed, or used in the United States. EPA's Office of Pesticide Programs grants registration of a product only at the conclusion of a thorough evaluation process wherein toxicological, environmental, and product use information is examined. The EPA's review of the data and the issuance of a registration complies with the agency's mandate by the Federal Insecticide, Fungicide, and Rodenticide Act that the potential benefits of use outweigh any potential risks: that use according to label directions will not cause unreasonable adverse effects on humans, wildlife, or the environment.

A pesticide's label is its primary communication to users. It reflects the numerous scientific studies and regulatory reviews generated by the registration process. The law requires pesticide users to read and follow label specifications. Through specific and general language, the label addresses potential and actual risks to wildlife (e.g., a label might state that drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas).

Environmental Hazards Statement

The Environmental Hazards Statement forewarns the user of potential adverse effects on wildlife and/or the environment which might result from the use of the product. This section of the pesticide label also identifies precautions to reduce or prevent exposure of wildlife and contamination of the environment. Much of the label language is determined by the reaction of the indicator species during laboratory toxicity testing or as a result of actual cases of wildlife poisoning attributed to the pesticide. For example:

If the toxicological data indicates...	***Then the label must give the following instructions:***
...Mammalian acute oral LD_{50} of 100 ppm or less	This pesticide is toxic to wildlife.
...Fish acute LC_{50} of 1 ppm or less	This pesticide is toxic to fish.
...Avian acute oral LD_{50} of 100 ppm or less	This pesticide is toxic to wildlife.
...Avian dietary LC_{50} of 500 ppm or less	This pesticide is toxic to wildlife.
...Bee acute toxicity of 2 micrograms or less	This pesticide is highly toxic to bees.
...Field studies or investigations indicate that the use of the pesticide may result in fatality to birds, fish, or mammals.	This pesticide is extremely toxic to wildlife or fish.

The following advisory statement must appear in the environmental hazard statement if the product is intended for outdoor use other than aquatic applications:

- For terrestrial uses, do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water by the cleaning of equipment or disposal of wastes.

Where a hazard to a nontarget organism (excluding humans and domestic animals) exists, statements describing the nature of the hazard and the appropriate precautions to avoid potential accident, injury, or damage are required. These hazard statements are prescribed according to toxicological data (LD_{50} or LC_{50} values) and field testing.

Examples

- This pesticide is extremely toxic to fish and wildlife. Birds and wild mammals utilizing treated areas may be killed. Do not apply directly to water or to areas where surface water is present.
- This product is highly toxic to bees exposed to direct treatment or residues on crops or blooming weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the areas to be treated.

Information designed to protect valuable resources and potential habitats may be indicated in the environmental hazards statement of the label by the listing of these advisories.

Examples

- Pesticide X is a chemical which can travel (seep or leach) through soil and contaminate ground water. Users are advised not to apply pesticide X where the water table (ground water) is close to the surface and where the soils are very permeable.
- Do not apply when weather conditions favor drift from target areas.
- This product may not be mixed or loaded within 50 feet of intermittent streams and rivers, or natural or impounded lakes and reservoirs.

MANUFACTURERS MUST REPORT ADVERSE EFFECTS ON WILDLIFE

Pesticide registration does not end the oversight process by EPA or the responsibility of the manufacturer. Employees of manufacturers are required under penalty of fine and/or imprisonment to report any adverse pesticidal effects not previously submitted to EPA. Manufacturers may become cognizant of new information as a result of continued laboratory testing or learn of incidents where field use of a product harmed wildlife or contaminated the environment. EPA, in cooperation with the pesticide manufacturer, may review labels as new information becomes available to ensure that the language is specific enough to protect wildlife. In addition, EPA may undertake a special review to determine whether their prior registration decisions continue to provide adequate environmental protection.

THE EPA SPECIAL REVIEW PROCESS FOR WILDLIFE

The special review process (40 CFR Part 154.7) allows EPA legal recourse to reconsider all data, wildlife incidents, and regulatory decisions relevant to a prior registration of a pesticide. Four of the six criteria listed for special review specifically mention nontarget effects, effects on endangered species, habitat destruction, and the environment. Wildlife considerations, therefore, are important to decisions on the continued registration of pesticides.

A special review can be initiated anytime there is evidence that the use of a pesticide will cause unreasonable adverse effects on wildlife. Typically, a special review goes beyond the comparison of estimated environmental concentration to toxicity values and includes evaluations of field studies or field incidents. Following a comprehensive reevaluation of the pesticide, EPA may 1) take no action, 2) alter the pesticide label language to further minimize risk, 3) classify the pesticide for restricted use, 4) eliminate specific uses, or 5) cancel or suspend the registration.

WILDLIFE STEWARDSHIP AND PESTICIDE MANAGEMENT

Often there is more than one product or management practice available to control a particular pest. But, ideally, the *decision to purchase* a pesticide should be based on more than a comparison of cost and performance among product choices. An important consideration is a review of the various pesticide labels for hazards to wildlife; users should select a product that is efficacious and presents the least potential for hazard to nontarget wildlife in the area to be treated.

The *decision to protect wildlife and practice pesticide stewardship* goes hand and glove with any purchasing decision. For wildlife protection and product stewardship to occur simultaneously, special attention has to be given to the biological and environmental uniqueness of the application site and to any adjoining wildlife habitats. The *decision to use* a pesticide implies that the user is willing to follow precisely all instructional and precautionary language and accepts the label as a legal document; yet the label cannot predict and give precise advice for every situation where that pesticide may be applied. The pesticide user should exercise common sense and be alert to wildlife that inhabits the application site and surrounding areas.

Users also can supplement label directions with additional measures beyond label guidelines to protect the integrity of a habitat and its corresponding wildlife populations.

PRACTICAL SUGGESTIONS TO BENEFIT WILDLIFE

Seek the advice of wildlife, conservation, and pesticide professionals at universities, state and federal agencies, and private foundations for strategies to improve wildlife habitat and for advice on the use of pesticides and alternative pest control strategies. Implementation of the management suggestions that follow will benefit wildlife and simultaneously allow for control of damaging insect, weed, and disease pests. Remember, with all of these suggestions the user must be consistent with the pesticide label.

Be Careful around Natural Areas on Your Property

- All wildlife need natural areas in which to feed, rest, reproduce, raise young, and take shelter. Create wildlife habitat by encouraging and promoting the growth of native vegetation. This also reduces mowing costs and saves time.
- Select disease and insect resistant trees and shrubs to plant on your property, thereby reducing the need for pesticide use.

- Prevent wildlife poisonings by storing pesticides and wildlife feed separately.
- Do not feed wildlife near pesticide storage and mixing areas.

Wildlife Will Benefit When You Understand and Follow Pesticide Labels

- Keep wildlife habitats in mind when reading labels.
- Compare labels and select highly specific products which pose reduced risks to nontarget species. Read the label carefully and use the lowest effective rate.
- Calibrate equipment carefully to assure that the pesticide is applied at labeled rates.
- Ask the retail outlet for the Endangered Species Bulletin when indicated by the label, or contact federal and state agricultural and conservation agencies for bulletins.
- Take heed of the label. The environmental and wildlife precautions on labels are based on scientific and regulatory actions. They must be followed. It's the law, good business, and the right thing to do!
- Consult state agricultural agency and Cooperative Extension Service educators for additional assistance on label clarification or to determine potential pesticidal impacts on wildlife. Also, consult state natural resource agencies, natural heritage programs, and the Nature Conservancy for additional information about wildlife, native vegetation, and endangered species.

Be on the Alert for Wildlife Before and During Pesticide Applications

• If you can identify areas that are frequented by wildlife–especially flocks of birds–avoid spraying near those areas or, if possible, reduce the application rates.

• Homeowners should search for bird and mammal nests prior to spraying fruit trees, shrubs, or lawns, then avoid spraying near those areas.

• Investigate the use of alternative pest control tactics—mechanical, cultural, biological—when available and practical (e.g., tillage, crop rotation, pest resistant plants, natural predators, trapping).

Gene White

• Scouting and pest identification are critical components of wise pesticide use. To save money and reduce impacts on wildlife, apply pesticides only when pests are present at unacceptable levels. Your Cooperative Extension educator can provide guidelines.

• Remember, it is important to guard against pesticide drift and runoff. Apply pesticides under low, directional wind conditions; and use adjuvants when appropriate. Use buffer zones of unsprayed crops or grass strips adjacent to important habitats to help protect wildlife.

• Adjust application schedules to reduce likelihood of runoff. Do not make pesticide applications when rain is imminent. Surface runoff may move some pesticides into ponds, streams, and wetlands inhabited by wildlife. In urban areas, such runoff may flow into storm drains leading directly to streams and rivers, without treatment. Moreover, pesticide that is washed off is money lost.

• Multiple pesticide applications may have cumulative effects, especially during breeding seasons. Reduce frequency of applications, when possible, and target each application to the specific site of the pest instead of making broad applications over entire fields or lawns.

• Control weeds and insects in home lawns and gardens by spot treating to reduce the amount of pesticide applied.

• Where practical, eliminate the use of pesticides in and around field edges and corners, fence rows, set-

aside acreage, nesting sites, vegetation near streams and wetlands, and areas that are dedicated to wildlife (except for spot treatment to control state listed noxious weeds). Especially important are sensitive areas such as endangered species habitats, native plant communities, and sinkholes.

- Check the label for instructions on incorporating pesticide granules into the soil or watering them into turf: The product reaches the target pests more readily, and foraging birds are less likely to ingest granules.

- Never spray leftover pesticides or wash off equipment near wetlands, rivers, streams, creeks, potholes, ponds, marshes, sinkholes, other wildlife habitats, or drains leading to these areas. Dispose of leftover pesticide in an approved manner as specified by the label.

SPECIAL WILDLIFE PROGRAMS

U.S. Fish and Wildlife Service

(United States Department of the Interior)

National Marine Fisheries Service

(United States Department of Commerce)

The Endangered Species Act (ESA) of 1973 and its subsequent amendments comprise the major federal legislation that protects not only threatened or endangered wild plants and animals, but also critical habitats and ecosystems that support those and many other species. Referring to endangered or threatened plants and animals, ESA states in the preamble that "these species of fish, wildlife, and plants are of aesthetic, ecological, educational, historical, recreational, and scientific value to the nation and its people."

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service are responsible for identifying candidate species for federal endangered species protection. Species proposed for listing are made public through a notice of review in the Federal Register. This notice of review is the process whereby these two federal agencies ask all interested persons and organizations for biological and ecological information on each species on the proposed list. Currently 3,600 species or subspecies of plants and animals have been identified as candidates for listing.

In the United States, information sufficient to move approximately 600 species from candidate status to the United States List of Endangered and Threatened Wildlife and Plants has been gathered. Federally listed species are given full federal protection: No one shall

"harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." All federal agencies (e.g., Environmental Protection Agency and U.S. Army Corps of Engineers) must comply with ESA by ensuring that their activities will not jeopardize the continued existence of a listed species.

EPA Office of Pesticide Programs' Endangered Species Protection Program

ESA mandates that federal agencies shall not undertake activities or make decisions whose consequences will adversely impact the existence of federally threatened or endangered species or their habitats. EPA must comply with the provisions of ESA in assuring that a pesticide registration does not create the potential for exposure of, or otherwise jeopardize, a federally listed species. The scope of this program covers all outdoor uses of pesticides, including home and garden uses.

The Endangered Species Protection Program has two phases: consultation and implementation. The EPA's "may affect" determination takes place prior to formal consultation with the United States Fish and Wildlife Service (FWS) and is the key to initiating consultation. Following are the fundamental steps in the process:

- *Species which potentially could be impacted by the use of pesticides are identified*. EPA, the United States Department of Agriculture, and FWS have collaboratively ranked approximately 93 species for pesticide vulnerability.
- *Pesticides that may impact any of these spec*ies *are identified*. EPA identifies the pesticides registered for use in areas within the range of a protected species and issues what is known as "may affect" determination.
- *EPA may eliminate a "may affect" determination*. EPA may remove a "may affect" determination through pesticide use limitations that are sufficient to achieve a "no effect" determination.
- *Environmental Protection Agency consults with the Fish and Wildlife Service on the remaining "may effect" determinations*. EPA requests a formal consultation with the Fish and Wildlife Service. A thorough review of the species allows FWS to develop a Biological Opinion, which indicates if harm is likely to result from pesticide exposure to a specific organism in a specific habitat. This Biological Opinion will specify reasonable and prudent measures, such as specific pesticide use limitations, that EPA must implement to protect the species.

• *Habitat maps are developed*. Where there is potential for impact, EPA develops species habitat maps within an Endangered Species Bulletin. The bulletin identifies pesticides that may harm the species and describes use limitations necessary to protect them.

• *Pesticide users must read labels*. Pesticide labels alert the pesticide user to refer to county Endangered Species Bulletins. If the area in which the user will be making an application is included in the bulletin, **the user must comply with all of the provisions.** The bulletin becomes a part of the labeling and therefore carries the full force of law if not properly followed.

Program implementation includes several components, depending on the approach to protection selected by state pesticide regulatory agencies. Currently, there is an EPA interim program in which some pilot states are conducting activities to protect endangered species from pesticides. The federal approach to protection is through labels, bulletins, and fact sheets. The label refers the user to a bulletin and a toll-free endangered species hotline number to call for information about endangered species, such as whether there is a bulletin available for the county. The user must comply with use restrictions in the bulletin, which contains a map, a list of pesticides, and use limitations such as buffer zones or limitations on application methods.

State "Protection from Pesticides" Plans

About one-fourth of the states manage or are developing their own programs to protect federally listed species from pesticide injury as an alternative to, or in addition to, the EPA labeling program. In many cases, protection is accomplished by providing information and education on endangered species and pesticides directly to affected landowners, land managers, operators, applicators, and dealers. Pesticide management plans are negotiated jointly with users for lands near these species. Some states are involved in mapping, developing protection guidelines, or in other ways providing protection from potential harm from pesticides. State plans need the approval of FWS and EPA and can substitute for EPA bulletins and fact sheets. Some excellent brochures have been developed by state programs.

State Wildlife Resource Management Programs

States have considerable responsibility in protecting wildlife. State biologists are actively creating species inventories from which a better understanding of distribution and abundance can be obtained. Using the

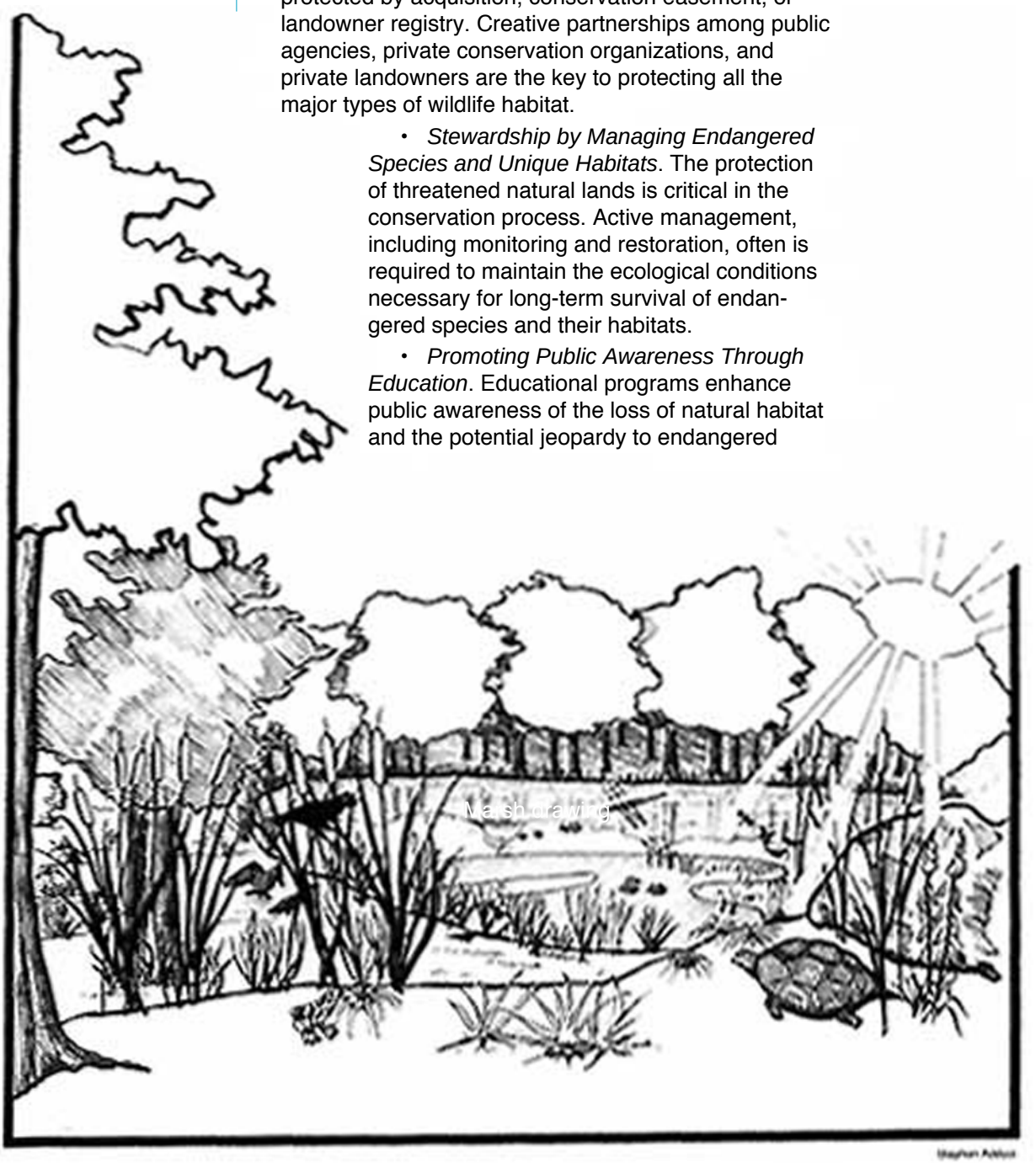
guidelines established by the Minnesota Department of Natural Resources, most states adopt similar strategies to help protect wildlife and habitat.

• *Identification of Species and Habitats and Setting Priorities for Conservation*. A comprehensive biological inventory of the state's endangered species and natural habitats is the first step toward their protection. Without this information, responsible management decisions cannot be made concerning the fauna and flora of an area.

• *Protection by Saving the Best and the Rarest.* After identification, ecologically significant lands are protected by acquisition, conservation easement, or landowner registry. Creative partnerships among public agencies, private conservation organizations, and private landowners are the key to protecting all the major types of wildlife habitat.

• *Stewardship by Managing Endangered Species and Unique Habitats*. The protection of threatened natural lands is critical in the conservation process. Active management, including monitoring and restoration, often is required to maintain the ecological conditions necessary for long-term survival of endangered species and their habitats.

• *Promoting Public Awareness Through Education*. Educational programs enhance public awareness of the loss of natural habitat and the potential jeopardy to endangered



Marsh drawing

species will result in increased public support for conservation initiatives.

Federal/State Pesticide Applicator Certification Programs

The certification process was established to provide technical knowledge for those using restricted-use pesticides—those pesticides that pose the greatest risk of harm to people, wildlife, and the environment if handled improperly. The certification process generally involves educational training and examinations that cover pest biology, human health and safety, environmental issues (e.g., water quality and endangered species), regulatory updates, label interpretation, and other job-specific information. Nationally, there are approximately one million applicators certified to purchase and apply restricted-use pesticides. Certified applicators are generally required to retest periodically or attend pesticide education programs to maintain their certification.

GENERAL INSTRUCTIONS FOR DEALING WITH INJURED OR POISONED WILDLIFE

The handling of listed species requires a federal endangered species permit except for employees or agents of a state or federal conservation agency who are acting in an official capacity. If you discover injured or dead wildlife, do not handle it. Call a wildlife law enforcement agent with either your state conservation agency or the U.S. Fish and Wildlife Service for information and instructions; both should be listed in your telephone directory under government agencies.

The primary objective for sick or injured wildlife is effective treatment and care; for carcasses, the objective is preservation for proper diagnosis of the cause of death. If pesticides are suspected or known to be the cause—whether the species is endangered or not—information on pesticides known to have been used in the area will be useful: product name, EPA registration number, date of application, conditions before and after application, etc.


Stephen Addiuci

THE TRIANGLE OF WILDLIFE PROTECTION

Among the goals of society is our ambition to provide citizens with meaningful employment, appropriate food, good health, decent housing, a safe environment, and quality education. Government, industry, and the general public must approach economic productivity in a manner that is ecologically and environmentally sound. Most wildlife species do not have the luxury of moving to new habitats when exposed to pesticides. Wildlife species must adapt to changes in their habitat—or cease to exist.

A diverse, healthy flora and fauna are indicators of a healthy ecosystem. It behooves each of us to take our environmental responsibilities seriously and to take all reasonable steps necessary to protect wildlife from hazards posed by pesticides.

The responsibility for ensuring that wildlife is protected from potential adverse pesticidal effects can be viewed as a *triangle of wildlife protection: manufacturers, government, and the pesticide user.* The manufacturer must develop products, supported by sound scientific studies, that allow for the maximum benefits of use with minimal risk to wildlife and its habitat. Local, state, and federal government must establish standards for pesticide use and promote research addressing wildlife contaminant issues. The pesticide user—farmer, homeowner, and professional applicator—must follow pesticide label instructions and strive to apply pesticides as carefully as possible, with wildlife protection in mind. Protection and sustainability of our environmental heritage is a task requiring the support of all.

WILDLIFE AND PESTICIDE RESOURCE AGENCIES

Purdue University

West Lafayette, Indiana

- **Purdue Pesticide Programs,** Purdue University Cooperative Extension Service. (765) 494-4566
  - ~ For pesticide applicator education and public outreach
- **Department of Forestry and Natural Resources.** (765) 494-3591
  - ~ For wildlife management education
- **Office of the Indiana State Chemist.** (765) 494-1492
  - ~ For pesticide applicator certification and licensing; pesticide registration; enforcement

Indiana Department of Natural Resources

402 West Washington Street, Room W296
Indianapolis, Indiana 46204

- **Division of Forestry**
  - ~ For forest management assistance
- **Division of Fisheries and Wildlife**
  - ~ For wildlife management assistance

U.S. Department of Agriculture

National Program Leader, Cooperative Extension Service
South Ag Building
1400 Independence Avenue, SW
Washington, DC 20450-0900

- **National Pesticide Program**
  - ~ Liaison between federal government and state pesticide educators
- **National Integrated Pest Management Program**
  - ~ Liaison between federal government and state IPM specialists
- **National Fish and Wildlife Program**
  - ~ Liaison between federal government and state wildlife specialists

WILDLIFE AND PESTICIDE RESOURCE AGENCIES (continued)

U.S. Department of the Interior

- **Fish and Wildlife Service**
  1849 C Street, NW
  Washington, DC 20240
  ~ For wildlife management—research, technical assistance, and enforcement
- **Patuxent Wildlife Research Center**
  Laurel, Maryland 20708
  ~ For wildlife research—pesticide and contaminant effects on wildlife
- **Division of Endangered Species**
  Fort Snelling Federal Building
  Twin Cities, Minnesota 55111
  ~ For fisheries research—pesticide hazards to aquatic organisms
- **National Fish Contaminants Research Center**
  Route 2, 4200 New Haven Road
  Columbia, Missouri 65201
  ~ Fisheries research—pesticide hazards to aquatic organisms

U.S. Environmental Protection Agency

401 M Street, SW
Washington, DC 20406

- **Office of Pesticide Programs**
  ~ For pesticide registration, environmental risk assessment, and evaluation of environmental and wildlife data for registration
- **Regional Offices**
  ~ Atlanta (404) 562-9900
  ~ Boston (617) 918-1111
  ~ Chicago (312) 353-2000
  ~ Dallas (214) 655-2000
  ~ Denver (303) 312-6312
  ~ Kansas City, KS (913) 551-7003
  ~ New York (212) 637-3000
  ~ Philadelphia (215) 814-5000
  ~ San Francisco (415) 744-1305
  ~ Seattle (206) 553-

STATUTES GOVERNING WILDLIFE AND PESTICIDES

U.S. Code	Title	Intent	Fine/Penalty
16 U.S.C. 688-668C	Eagle Protection Act 1940	Prohibits import, export, taking of bald and golden eagles.	Civil: $5,000 Criminal: $100,000/one year, $250,000/two years (second offense)
16 U.S.C. 703-712	Migratory Bird Treaty Act 1918	Prohibits hunting, taking, possession, etc., of migratory birds.	Criminal: $25,000/six months, $250,000/two years (felony sale)
16 U.S.C. 718	Migratory Bird Hunting and Conservation Stamp Act 1934	Requires hunting stamps prior to taking migratory waterfowl.	Criminal: $25,000/six months
18 U.S.C. 42; 16 U.S.C. 3371-3378	Lacey Act 1981	Ensures humane treatment for wildlife shipped to U.S. Controls smuggling/ trade in illegally taken fish and wildlife.	Civil: $10,000 Criminal: $100,000/one year $250,000/five years (felony sale/purchase)
16 U.S.C. 1361-1407	Marine Mammal Protection Act 1972	Moratorium on taking and importation of marine mammals. Defines federal responsibility for conservation of marine mammals.	Civil: $10,000 Criminal: $100,000/one year

STATUTES GOVERNING WILDLIFE AND PESTICIDES (continued)

U.S. Code	Title	Intent	Fine/Penalty
16 U.S.C. 742j-1	The Airborne Hunting Act 1956	Prohibits taking wildlife from aircraft except when protecting wildlife, livestock, or human health.	Criminal: $100,000/one year. Allows forfeiture of guns, aircraft, and equipment.
16 U.S.C. 668dd-668ee	National Wildlife Refuge System Administration Act 1966	Guidelines and directives for management of wildlife refuges and areas for protection of fish, wildlife, etc.	Criminal: $100,000/one year
16 U.S.C. 1531-1543	Endangered Species Act 1973	Prohibits importation, taking, etc., of fish, wildlife, and plants that are listed as threatened and endangered. Also implements the convention on international trade in endangered species of wild fauna and flora (CITES).	Civil: $25,000 Criminal: $100,000/one year (knowing violation)
16 U.S.C. 721-731	Upper Mississippi Refuge Act 1924	Guidelines for the upper Mississippi National Wildlife and Fish Refuge.	Criminal: $25,000/six months. Forfeiture of fish, wildlife, guns, fishing equipment, and boats used contrary to the statute.

STATUTES GOVERNING WILDLIFE AND PESTICIDES (continued)

U.S. Code	Title	Intent	Fine/Penalty
16 U.S.C. 4901 et seq.	Wild Bird Conservation Act 1992	Moratorium on all imports of exotic birds except for scientific research, breeding, personally owned pets.	Civil: $25,000 Criminal: 2 years
7 U.S.C 121-136y	Federal Insecticide, Fungicide, and Rodenticide Act 1947*	Registration of pesticides; risk/benefit standard; data requirements.	Civil: $5,000 (companies and commercial), $1,000 (farmer). Criminal: $50,000/one year (companies), $25,000/one year (applicator), $1,000/30 days (farmer)
33 U.S.C. 2401-2410	Organotin Antifouling Paint Control Act 1988	Prohibits use of antifouling paints on ships <25 meters; toxicity to shellfish.	Civil: $5,000 Criminal: $25,000/one year
16 U.S.C. 4701-4751	Aquatic Nuisance Prevention and Control Act 1990	Research into environmental effects of ballast; zebra mussel demonstration project; prevention and control of aquatic nuisance species.	Civil: $25,000/day Criminal: $250,000 (indiv.) or 2 x value of the loss or damage; $500,000 (corp.) or 2 x the value of the loss or pecuniary gain/0-25 years

*The first legislation regulating pesticide use was the Insecticide Act of 1910.

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