

Integrated Pest Management (IPM) and Wildlife

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Fish and Wildlife Habitat Management Leaflet

Number 24



C. Rewa

Conservation buffer practices such as field borders provide valuable habitat for wildlife as well as beneficial insects.

General Information

Integrated Pest Management (IPM) ideally combines biological and cultural controls with limited pesticide use to keep pest populations below economically damaging levels, prevent future pest problems, and minimize the harmful effects of pesticides on humans and natural resources, including wildlife. Practitioners of IPM can reduce pest damage and economic loss by recognizing and using natural controls such as weather conditions, pest diseases and predators, pest life cycles, and modified agricultural practices.

Pest elimination is typically not a goal of IPM, however, prevention of crop damage is an integral component. If and when pesticides are used, they are used at lower application rates and lower toxicities in combination with other control methods. IPM can increase profits in the long run by reducing chemical pest control costs, reducing environmental and human health risks associated with pesticide use, improving soil health and productivity, and increasing revenues from land leased for recreational use. Although generally associated with cropland, IPM is implemented by a variety of private landowners and managers including farmers, ranchers, foresters, homeowners, and groundskeepers.

This leaflet provides an introduction to the use of IPM on agricultural lands and general guidance on integrating fish and wildlife considerations into IPM plans. The role of wildlife as an agent of integrated pest management is also introduced. Landowners and managers should be familiar with proper use of and restrictions on pesticides and requirements for pesticide applicators. Landowners and managers should also be familiar with state and federally listed rare, threatened, and endangered plant and animal species in their area to ensure their consideration and protection.

IPM and wildlife

Beneficial insects, birds, and mammals are natural enemies of many crop pests and can play an important role in IPM. Landowners and managers spend a considerable amount of time and money to control pest populations where natural pest inhibitors are lacking. Modified farming techniques, increased crop diversity, and use of cover crops and conservation buffers can increase food and cover on croplands for many species, including those beneficial in controlling pest populations.



S. Bauer, USDA ARS

Lady beetle adults and larvae prey on aphids, mites, and other pest insects.

Terms and Definitions Associated with IPM

Pest

- An organism, plant or animal, which is undesirable or is detrimental to the interests of humans and capable of causing injury or damage.
- Major pest types include insects and other arthropods, nematodes, pathogens, vertebrates, and weeds.

Pesticides

- Chemical compounds used to control individuals or populations of pests.
- *Herbicides* are pesticides used to control undesirable vegetation, such as weeds or invasive woody plants.
- *Insecticides* are used to control undesirable insects on plants or on/in the soil.
- *Fungicides* are used to control fungus growth and spore dispersal.
- Individuals applying pesticides must comply with federal and state laws and regulations.

Resistance

- Genetically inherited ability of organisms to evolve strains that can survive exposure to pesticides formerly lethal to earlier generations.

Resurgence

- Occurs when insecticide application initially reduces an infestation, but soon afterwards the pest rebounds (resurges) to higher levels than those before treatment.

Economic Injury Level (EIL)

- This is the economic break even point where the cost of pest damage equals the cost of control.

Economic/action Threshold Level

- Population level at which control measures are needed to prevent pest populations from reaching economic injury levels; action threshold is lower than EIL to allow for control measures to take affect before the pest population reaches the EIL levels.

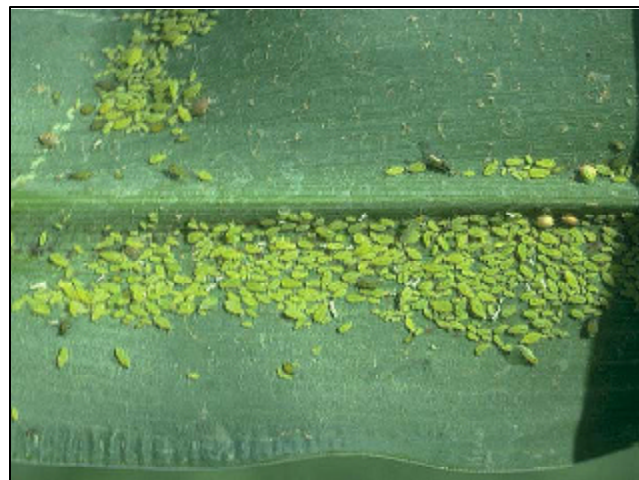
IPM incorporates the flowering patterns of native plants and crops and the life history and movements of beneficial insects and wildlife.

IPM limits pesticide use, which affects non-target species such as beneficial insects and wildlife. Estimates of wild birds killed in the United States every year by exposure to legally-applied pesticides range in the tens of millions. Aquatic invertebrates, fish, amphibians, mammals, and others are also at risk. Insects are a major vehicle for pollination in orchards and vineyards, but their populations decrease after pesticide misuse. Herbicides can reduce or eliminate potential wildlife food and cover plants. Use of insecticides can reduce beneficial invertebrate populations that help control pests and are important food sources to many wildlife species. By using insecticides to address pest problems only where other measures fail to achieve the desired level of control, IPM seeks to minimize the negative effects of pesticide use on wildlife and other natural resources.

IPM Strategies

IPM follows a sequence: pest identification, scouting, management treatments, and post-treatment monitoring. Together, these actions form the key to IPM, which is long-term pest *prevention*. Preventing pest problems is the most effective and efficient pest control method.

Prevention contributes to the long-term protection and productivity of crops, as well as wildlife habitat and other natural resources. Local extension agents can help landowners and managers develop a scouting schedule, correctly identify pests and symptoms, and determine economic thresholds and management actions. Cooperative relationships and information sharing between adjacent crop growers can further reduce pest problems.



Texas A&M Department of Entomology

Greenbugs are aphids that feed on sorghum. Lady beetles are natural predators of greenbugs and can help keep their populations from reaching economically damaging levels.

Pest Identification

Pest identification is an important component of IPM. Whether pests are insects, vertebrates, diseases or weeds, landowners and managers should be familiar with pests associated with their crops. Landowners and managers should be able to recognize seasonal conditions that favor pests, potential hosts, and signs of pest damage. Local extension agents may be able to assist in pest identification.

Scouting

Scouting is used to monitor pest densities. Landowners can use scouting data to determine the pest population size and correct method for controlling pests before the economic threshold is reached. Scouting tools include: 10x hand lens for viewing insects, larvae, or eggs; notebook and pen for recording notes; sweep net or other device for catching insects on the wing; and a vial or other closed container for insect samples. Regular, systematic sampling is crucial to estimate pest populations and prevent future outbreaks. Notes should be taken during each scouting run, and permanent records kept to track trends. During weekly scouting trips, each crop should be sampled for pests. Landowners and managers should take samples from the field interior, not just around the field border. Record the crop stage and condition, the date and time of day, moisture conditions, the number and type of pests, and other insects or wildlife observed. Also note nearby buildings, vegetation, buffers, water sources, or other features that might serve as overwintering or migrating grounds for pests, beneficial insects, and wildlife. Collect samples of pests and other insects that cannot be positively identified, as well as samples of plant materials.

Management Treatments and Their Effects on Habitat

Whenever possible, landowners and managers should avoid disturbing high-use wildlife areas, especially during the breeding and nesting season (March-July). Many ground-nesting birds, small mammals, and reptiles and amphibians may use croplands and ground cover crops for breeding and raising young. When possible, avoid treating frequently used foraging areas. Woody draws, riparian vegetation, wetlands, native grasslands, and other sensitive habitats should be preserved.



Ring-necked pheasants can benefit from a variety of cultural pest control practices. However, mechanical treatments should be avoided from March-July to protect these and other ground-nesting birds and their eggs and young.

Cultural control

Cultural controls can help create, maintain, and enhance habitats that harbor beneficial insects and wildlife. Cultural controls generally target some weak point in the pest's life cycle through physical or genetic treatments. Physical controls modify the growing environment to help control pest populations. Some physical controls are actual barriers, such as buffers, hedgerows, or windbreaks, that help prevent pests from entering cropfields and serve as habitat for beneficial insects and wildlife.

Crop rotation is a physical control mechanism that can significantly reduce pest populations, especially those



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Conservation tillage practices leave at least 30% residue cover, which helps reduce erosion and provide winter cover for wildlife inhabiting cropfields and surrounding areas.

that are crop-specific or overwinter on site. In order for crop rotation to be effective, the alternate host crop must be unacceptable to the pest. For example, corn rootworm populations are reduced or eliminated by rotating from corn to just about any other crop. Rotating crops to native grasses or legumes, small grain cover crops, and winter cover crops can provide food and cover for some wildlife species while disrupting the corn rootworm life cycle and reducing their numbers. Landowners and managers should avoid continuous crop monocultures, which can increase reliance on pesticides and reduce soil fertility. In some cases, adjusting planting or harvesting dates is an effective control method. For example, early alfalfa harvest dates can help reduce alfalfa weevil populations by eliminating their overwintering source (alfalfa stalks).



USDA

Crop residue can provide winter cover for birds and small mammals. Snow trapped in the stubble creates pockets of space used by small mammals in winter. Trapped snow also adds ground moisture in the spring for new plant growth.

Table 1. Cultural controls and their application in Integrated Pest Management*.

Cultural control	Application in IPM	Advantages/disadvantages
Crop rotation	Cultivated area that alternates between different kinds of crops to reduce crop-specific pest populations and improve soil health, tilth, and increase crop vigor.	Planting the same crops year after year can lead to a buildup of crop pests and reduced soil fertility. Crop rotation breaks the life cycles of some pests, especially if pests are crop-specific or over-winter on-site. Rotation can significantly reduce pesticide use. Not all crops in a rotation are equally profitable.
Tillage	Practice of cultivating soil to prepare a seedbed or control weeds.	Can significantly reduce herbicide use. Moving soil increases erosion; exposes weed seeds on soil surface, which encourages new weed growth.
Conservation tillage	All-encompassing term for minimum tillage, no-tillage, and other farming practices that reduce or eliminate plowing; newly planted crops protected by at least 30% residue cover.	Enhances soil and water conditions by reducing erosion. Can improve wildlife habitat, especially cover for many wildlife species. After many years, no-till can result in soil compaction unless cut below soil surface. Relies heavily on herbicides.
Sanitation	Cleaning or sterilizing equipment or materials used in pest-infested fields to help reduce the spread of pests to other crops.	Spraying or cleaning contaminated equipment can help reduce the spread of fungi, diseases, and weed seeds to noninfested crops. Sanitation also includes removing trash from waterways and removing heavy vegetation from around buildings and structures.
Exclusion	Actual barriers used to prevent pests from entering fields.	Fences, both aboveground and underground are used to prevent vertebrate pests from entering fields. Other types of barriers include certified disease-free and weed-free seeds.
Prescribed burning	Fire set deliberately by management to achieve a particular management objective. A fire plan must be approved and/or meet legal requirements.	Clears residual materials that may harbor overwintering pests and helps control woody or undesirable vegetation. Smoke may be a problem in more urban areas.

**The cultural controls listed are most effective when used in combination and with biological controls to reduce pesticide use and improve long-term crop and soil health.*

Tillage is the primary cultural control method, and is particularly effective when used in combination with spot herbicide treatments. However, tillage can increase soil erosion and if conducted during the breeding season, can destroy eggs, young, and adult ground-nesting birds and other wildlife.

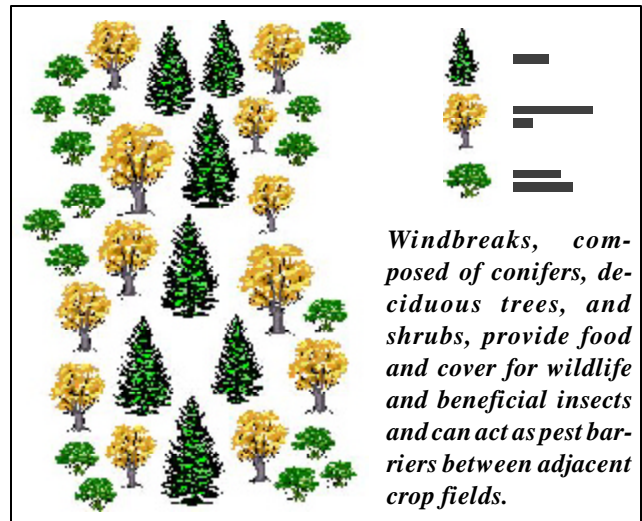
Conservation tillage practices reduce or eliminate plowing, and newly planted croplands are protected by at least 30 percent residue cover. Crop stubble can provide winter cover for wildlife by creating space in snow trapped against the stubble. These snowdrifts also increase soil moisture for spring planting. Over time, conservation tillage can also improve soil and water quality by increasing organic matter, reducing soil erosion and pesticide runoff, and increasing soil clumping, which promotes root establishment.

Other cultural controls like mowing, disking, sanitation, and increased row spacing (to increase airflow and reduce dampness) can be used in various combinations to control pest populations. Genetic controls use resistant plant strains to help prevent pest outbreaks. Weed- or disease-free certified seeds can be planted to help reduce herbicide and fungicide use. Table 1 describes some commonly used cultural controls that when combined and integrated with biological controls and limited pesticide use, typically improve wildlife habitat and long-term crop and soil health on agricultural lands.

Biological control

Predators, parasitoids, and pathogens are the three main agents of biological control. Common predators include insects, birds, and bats and other mammals. Parasitoids are typically tiny wasps that lay eggs on insect hosts. The wasp larvae then feed on and kill the hosts. Parasitoids are not dangerous to humans, livestock, or poultry. Pathogens are selective organisms that cause disease and include viruses, bacteria, fungi, and nematodes.

Biological control agents, particularly predators, need suitable habitat near or adjacent to crops. There are several habitat management practices that landowners and managers can implement that create, maintain, or enhance habitat for beneficial species. Agroforestry, a combination of agriculture and forestry, is a land use system that retains or introduces a mix of trees and other woody perennials in crop and animal production systems to take advantage of economic and ecological



Windbreaks, composed of conifers, deciduous trees, and shrubs, provide food and cover for wildlife and beneficial insects and can act as pest barriers between adjacent crop fields.

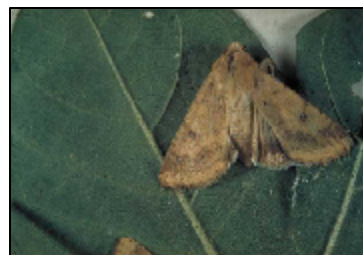
interactions, providing habitat for beneficial animals and other wildlife. Some agroforestry practices include:

- **Windbreaks**—multiple rows of trees and shrubs planted and managed to protect farmsteads or incorporated as part of crop or livestock operations to enhance production.
- **Alley cropping**—growing food, forage, or other crops between rows of planted trees or shrubs.
- **Riparian forest buffers**—Natural or re-established forests along waterways comprised of trees, shrubs, and grasses designed to filter non-point source pollution from adjacent croplands.

Agroforestry and other habitat enhancing practices often benefit wildlife that use edge habitats. Establishment of non-native or woody plants in areas



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Big-eyed bugs (top) are important predators in many crop systems in North America, particularly in cotton. They feed on eggs and larvae of bollworm (bottom), pink bollworm, tobacco budworm, and other pests. Big-eyed bugs also prey on whiteflies, mites, and aphids.

of native prairie grassland is generally not recommended. Many grassland wildlife populations, especially birds, are rapidly declining; introduction of woody vegetation to native grasslands may accelerate this decline.

When maintaining or enhancing habitat for beneficial species, there are treatments that improve habitat quality. As a general rule, the wider the windbreak or buffer, the more beneficial it is for wildlife. Choose native trees, shrubs, grasses, and legumes for planting conservation buffers and ground cover crops that best support beneficial species without harming crop growth. Fruit- and seed-producing vegetation provides a rich food source for many wildlife species. Diverse, vertical vegetation structure provides for various nesting, roosting, and foraging needs. Snags should be preserved when possible for cavity-nesting birds and small mammals. Leaving a vegetated buffer strip between crops and high-use wildlife areas can be beneficial to insects and animals during tillage operations and chemical treatments. Windbreaks and other conservation buffers should connect habitat patches on the landscape where possible.

Beneficial insects—predators and parasitoids

Introducing beneficial insects can be expensive, and there is no guarantee that beneficial species will stay in a particular field, especially if suitable habitat is not available. Perhaps the best way to integrate beneficial insects into an IPM plan is to ensure that habitat



J. Dykinga, USDA ARS

Green lacewing larvae prey on aphids, spider mites, small caterpillars, and the eggs of leafhoppers, leafminers, moths, and other pests.

attractive to these animals is available near crop fields in need of protection. Field borders and other conservation buffer practices containing a diversity of native vegetation is one way to provide this habitat near and between crop fields. Beneficial insects and other arthropods include predators and parasitoids.

Predators feed on the eggs, larvae and adults of insect pests. Beetles, mites, and spiders are common predators. Lady beetle larvae feed on aphids and the eggs of other pest insects. Green lacewings consume aphids, mites, and other pests. Predatory mites consume spider mites. Damsel bugs, big-eyed bugs, mantids, minute pirate bugs, assassin bugs and others are important pest predators in various seasons.



B. Blossey Cornell University



B. Blossey Cornell University

Galerucella calmeriensis (top) and G. pusilla are European beetles introduced in 1992 to North America to control purple loosestrife (bottom), an exotic weed that chokes our native vegetation in North American wetlands, greatly decreasing wildlife habitat value.



S. Long Cornell University

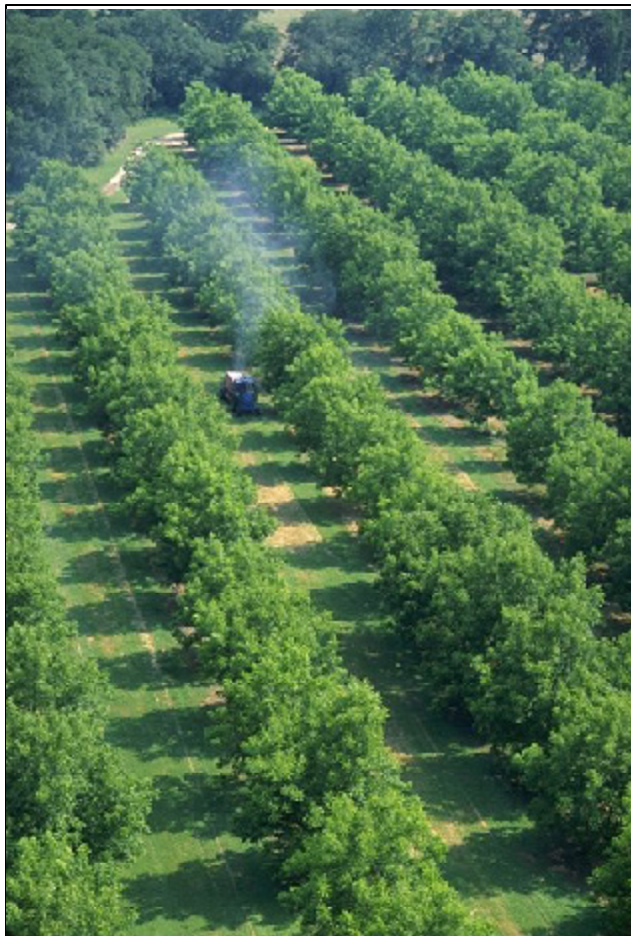
Muscidifurax raptor is an important parasitoid of house flies, stable flies, and other fly species.

Parasitoids are insects that attack and lay eggs inside the pupa case of another species. After hatching, the parasitoid larva consumes the host pupa before emerging as an adult. *Encarsia* spp., *Muscidifurax raptor*, *Nasonia vitripennis*, and *Spalangia cameroni* are a few important parasitoid species. Parasitic nematodes also consume grubs, beetles, grasshoppers, and other pests.

Pathogens

Pathogens are micro-organisms, including bacteria, fungi, protozoa, and viruses, that cause disease and live on and in the bodies of insects. Pathogens occur naturally and can substantially reduce pest populations. They are highly selective, so they have limited negative effects on humans and non-target organisms.

The most commonly used pathogen is Bt (*Bacillus thuringiensis*), which is a bacterium that controls a variety of plant pests from caterpillars (Lepidoptera) to



Ken Hammond USDA

Bats can help control insect pests in orchards and reduce the need for pesticide application.



Bat Conservation International

Big brown bat preying on insect.

mosquito and small fly larvae (Diptera) to beetles (Coleoptera). As a biological pesticide, Bt also controls simuliid blackflies, which are vectors for river blindness in Africa. Landowners and managers can use variations of Bt that are used to control particular families or species of insects without harming non-target insect species. Varieties of some crops, such as Bt corn and Bt cotton, have been genetically altered to contain the Bt bacterium toxin to kill susceptible insect pests. However, there is controversy regarding the ability of pests to develop resistance to Bt crops.

Different kinds of pathogens control different types of pests. For example, Japanese beetle grubs can be controlled using milky spore disease (*Bacillus popilliae*), which occurs naturally in some grubs. Milky spore disease bacteria are cultured in living hosts and used for long-term control of chafer beetles, particularly Japanese beetles. Fungi can also act as important pest controls. Pine root rot (*Heterobasidion annosum*), one of the most damaging root pathogens of coniferous trees, spreads quickly from infected roots to healthy roots and also colonizes freshly cut stumps. Another fungus, *Phlebiopsis gigantea*, helps prevent invasion of pine root rot when applied to freshly cut stumps.

Bats and IPM

Bats are a recently recognized form of biological control useful in IPM. Bats play key ecological roles in many plant communities, eating insects, pollinating flowers, and dispersing seeds. Bats are useful in controlling pest populations in agricultural fields and orchards, and are the only major predator of night-flying insects. The food items consumed by bats depend on the bat species, season, and available prey. Listed below are some little-known bat facts.

An average-sized maternity colony of 150 big brown bats can consume 38,000 cucumber



Bat Conservation International

Monitoring bat boxes during daylight hours minimizes disturbance to roosting bats.

beetles, 16,000 June bugs, 19,000 stink bugs, and 50,000 leafhoppers in one summer.

One endangered gray bat can eat 3,000 insects per night, including moths, flies, and midges.

One little brown bat can catch 600 mosquitoes per hour.

In a Georgia pecan orchard, Mexican free-tailed bats took up residence in bat houses installed by the landowners. The colony contained about 600 individual bats and virtually eliminated problems and pesticide use associated with tent caterpillars, hickory shuckworms, and other pests.

A Willamette Valley, Oregon organic farmer nearly eliminated pesticide use for corn earworm moths by attracting local bat colonies to the orchards. The Oregon farmer reduced pesticide use from 13 to two applications per year, and did not need to spray until after birds and bats had migrated south for the season.

Attracting bats to croplands and orchards requires proper bat house construction and placement in proximity to reliable food sources. If there is a local colony of bats nearby, bats will likely take notice of bat houses more readily. For more information on bat habitat and building and installing houses for bats in North America, see Fish and Wildlife Habitat Management Leaflet No. 5, *Bats*.

Birds and IPM

Birds are another recently recognized addition to the list of biological pest control agents. When used in combination with other pest control treatments, birds may help reduce populations of insects and small mammals. Erecting perches and artificial nesting structures for raptors and songbirds is an easy way to complement IPM efforts. Perches and nesting structures can be placed around the perimeter of crop fields or in nearby suitable habitat. Designs for nest boxes and other wildlife nesting structures are provided in Fish and Wildlife Habitat Management Leaflet No. 20, *Artificial Nesting Structures*.

A study in the Pacific Northwest found that hawks, kestrels, and shrikes were attracted to sites where artificial nesting structures were installed. Voles were a major diet component, but the results of the study concerning the effect of raptor predation on small mammal populations were inconclusive. In a separate study, barn owls consumed large numbers of gophers, mice, and other rodents that are potential pests to crops, tree plantations, orchards, and vineyards. These and



WHC

Eastern bluebirds, which prefer the open field habitat associated with agricultural lands, may benefit from reduced pesticide use on crop fields.

other studies indicate that raptors can be effective biological pest control agents on agricultural lands, especially when used in combination with other control methods.

Chemical control

Chemical control agents include pesticides, biopesticides, pheromones, and other chemicals used to suppress pest outbreaks. Under IPM, some level of pest activity is tolerated, and most crops survive some damage before economic loss occurs. IPM chemical controls, specifically pesticides, are used when routine scouting trips show that pest populations reach levels that reduce yields and breach economic thresholds. Chemical controls are applied as a last resort, and are still used in combination with other management treatments. Individuals applying chemical pesticides must do so in compliance with applicable federal and state laws and regulations. For more information contact your state pesticide regulatory agency, state department of agriculture, or state department of environmental quality.

Pesticides can negatively affect non-target organisms and natural resources, including beneficial insects, natural pest enemies, fish, wildlife, humans, and soil, air, and water quality. Pesticides such as herbicides also reduce food and cover that is important to beneficial insects and fish and wildlife. The list below includes some of the important concepts of chemical use under IPM.

- Choose the least toxic chemical to reduce the chance of harming beneficial organisms, fish, wildlife, and humans. Choose a less persistent chemical to increase the rate of chemical breakdown in the soil. Remember to consider the whole landscape when choosing pesticides. Some chemicals do not affect certain species, but can be detrimental to others, both on-site and elsewhere in the watershed.
- Minimize spray drift during application by using the appropriate nozzle, pressure, and volume to regulate droplet size. Also Consider: (1) adding a drift control agent, (2) using groundbooms, fitted with a skirt, instead of airplanes, (3) applying at a lower temperature and higher humidity, (4) not spraying during a temperature inversion, (5) using a soil incorporation method instead of spraying.

- Avoid spraying if wind speeds are greater than 10 mph.
- Avoid spraying over, or washing equipment near, lakes, ponds, streams, or other bodies of water. Immediately report any chemical spills to the proper authorities.
- Conduct chemical controls through spot treatments if pest outbreak is limited to particular areas. Spot treatments reduce costs and save time by treating only the affected area, and conserve beneficial species and surrounding habitat in untreated areas.
- Use less volatile pesticides to minimize volatilization, which occurs when a solid pesticide converts to a gas and is carried away from the target area by wind.

Post-treatment Monitoring

Post-treatment monitoring determines the short- and long-term effectiveness of management treatments. If management actions do not produce the desired results, then re-evaluate and adjust the treatments.

Organic Farming

Organic farming is an alternative to conventional farming that incorporates many principles of IPM. This type of farming does not use chemical control methods, but relies on techniques such as crop rotation, natural manures, composting, organic fertilizer, and biological pest controls. Some farmers are concerned with lower yields associated with organic farming, but low production costs usually compensate for lower yields. When properly conducted, organic farming techniques increase soil organic matter and soil tilth, minimize runoff and erosion, and provide quality fish wildlife habitat. Overall, organic farming is an environmentally friendly, sustainable agricultural practice that can benefit producers and wildlife.

Landowner Assistance

There are many agencies and organizations experienced with IPM treatments and effects on fish and wildlife habitats. The USDA NRCS produced the Core4 Conservation Practices Training Guide (see References), which contains information about integrated pest management, conservation tillage,

nutrient management, and conservation buffers. Extension agents and NRCS technicians can supply landowners with information about IPM. The National IPM Network lists contacts by region and state, gives technical information about specific pests and management treatments, and contains a directory of state IPM coordinators on-line at www.reeusda.gov/nipmn. The EPA Office of Pesticide Programs also has information and links to IPM information on-line at www.epa.gov/pesticides. The Consortium for International Crop Protection (CICP) and IPMnet website contains IPM technical information and links at www.ipmnet.org. Many universities also develop IPM handbooks through agriculture, forestry, or entomology departments.

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In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staffs and others to promote conservation stewardship of fish and wildlife, and deliver sound habitat management principles and practices to America's land users.



www.whmi.nrcs.usda.gov

Wildlife Habitat Council

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The mission of the Wildlife Habitat Council is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.



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Acknowledgments

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