INTEGRATED PEST MANAGEMENT: A USEFUL APPROACH TO WILDLIFE DAMAGE CONTROL?

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Integrated Pest Management (IPM) has become a popular phrase and is looked upon by some persons as the solution to all pest problems and many environmental issues. Unfortunately, the concept of IPM is often misunderstood and at times misused.

For the purpose of this paper, IPM is defined as an interdisciplinary and systems approach used in controlling pest damage. In general, IPM uses all available methods of prevention and control to keep pest situations from reaching damaging levels, while minimizing potentially harmful effects of pest control measures on humans, other nontarget species, and the environment. The goals of IPM are to (1) ensure proper use of pesticides, (2) minimize any detrimental effects of pest control measures on humans and ecosystems, (3) improve the cost-effectiveness of pest control by ensuring maximum efficiency, and (4) protect the resource from pest damage.

Entomologists are usually given credit for development of the basics of IPM through the "cotton field scouting" program implemented in the southern U.S. in the 1930's. The field scouting aspects of IPM have been greatly enlarged upon and effectively promoted by the U.S. Dept. of Agriculture and by several other federal agencies including the Environmental Protection Agency and the Council on Environmental Quality. The Extension Service of USDA has been the main in-field promoter of the concepts of IPM, and federal extension funds have been available to all states since 1978 for this purpose (Gold 1982).

Some concern has arisen over a misunderstanding of IPM's goals. On occasion, persons or organizations have declared that one purpose of IPM is to reduce or eliminate use of chemical pesticides. While this may result from the implementation of IPM in some instances, it may not be a result in others. Essentially, the ultimate goal of IPM programs is to reduce pest populations to tolerable levels or manage pest populations in such ways as to reduce damage to an acceptable level. This may or may not require the use of pesticides.

Over the years, progress has been made in applying the IPM approach to nematodes, plant diseases, and weeds as well as to insects. Often such IPM programs have included such aspects as field monitoring of pest levels, use of resistant varieties of plants, encouraging natural enemies (predators and parasites) of the pest species, and use of cultural practices that reduce pest damage. Are such approaches useful in dealing with vertebrate pests?

A vertebrate pest is "any native or introduced, wild or feral, non-human species of vertebrate animal that is currently troublesome locally, or over a wide area, to one or more persons, either by being a health hazard, a general nuisance, or by destroying food, fiber, or natural resources" (Howard 1962). By definition, vertebrate pests include a wide variety of animals: commensal rats and mice, bats, skunks, muskrats, beaver, ground squirrels, moles, pocket gophers, prairie dogs, coyotes, deer, starlings, carp, and sharks, to name a few. But unlike insects and other pests, most species of vertebrates possess positive values, both biological and aesthetic, which are recognized by the general public as well as by wildlife managers. For this reason, it is usually undesirable to control vertebrate damage solely through reducing the population of the pest species. Eradication of the pests in a given area becomes an acceptable goal only when the species has relatively few positive values, as in the case of the Norway and roof rat, the house mouse, and the European starling.

In one sense, IPM is not new to vertebrate control. It has seldom been possible to control wildlife damage exclusively by the use of chemical toxicants; therefore people often have employed such things as sound and visual frightening devices, repellents, barriers, habitat manipulation, and other non-lethal tools. Yet, there have been very few instances where it has been possible to establish a complete IPM program for any vertebrate pests. There are some very good reasons why this has not been accomplished.

In many instances, we have little knowledge of the mechanisms causing vertebrate pest populations to increase and thereby compete with humans for resources. People's modification of habitats has allowed and perhaps stimulated the increase of some native species such as the coyote and some microtine rodents. On the other hand, some species such as the California condor have found themselves ill-suited to the changed habitat. Non-native species, when introduced into a new habitat, have in some cases spread rapidly and increased dramatically in number. The house sparrow, European starling, house mouse and Norway rat are examples of such exotic introductions that are now important pests in North America.

Vertebrate populations are not necessarily limited in density by their food resources. Social interactions, which are manifested through such mechanisms as territoriality and social rank, may limit vertebrate numbers well below what the habitat's food resources could otherwise support. We need to develop much more knowledge about the mechanisms that limit vertebrate species so that we can possibly exploit these mechanisms for management or control purposes. Additional knowledge about the rate of growth of vertebrate populations, and the economic damage that vertebrates may cause at given densities in particular habitats, is necessary for us to develop economic threshold models for vertebrate pests. This is a first step in making a predictive model for a pest species and is one of the basic informational needs in developing a sound IPM program.

Development of economic thresholds for vertebrates is difficult and may in fact be impossible for some species. Some vertebrates are hard to census. Furthermore, damage may not be directly related to population density. In some cases, this occurs because of the behavioral complexity of the species. Predation on livestock by coyotes, for example, may be variable according to the behavioral tendencies of the individual predator. This behavior may be affected by the availability of alternate prey, by learned behavior, or by any number of other factors.

Further, vertebrate pests tend to be long-lived in comparison to insects. Therefore the economics of pest control must consider more than one crop season. It may not be cost-effective to control pocket gophers in an alfalfa field that is soon to be plowed, but it may be very cost-effective to do so in a newly planted alfalfa field. For a given situation the economics of damage will vary according to the resource, time of year, proposed method of control, and planting cycle of the crop (Marsh 1982).

Economics are not, in many cases, the sole determining factor in deciding whether to control a vertebrate pest. While this is true of some invertebrate pests as well, it becomes a major consideration with many vertebrate pests, particularly when the damage is of a nuisance type in urban or suburban areas, for example. We are thus into the area of defining an "aesthetic threshold" or a "tolerance threshold" which may be completely independent of the economic value of damage caused. How many raccoons will the homeowner tolerate in his yard when they persistently turn over his garbage cans, night after night? How many mice will a housewife allow to live in her kitchen, regardless of whether they cause any actual damage to stored food items? The answer to such questions may vary widely, depending on the species involved and the person's perception of that animal's negative or positive values.

In designing IPM programs, we must guard against blindly "following the leader" and adopting entomological methods or principles and applying them uncritically to vertebrate pest problems (Marsh 1982). There are three broad areas where care must be taken in applying IPM techniques to vertebrate pests. These areas are the use of introduced diseases, predators, and habitat manipulation.

Biological control of a vertebrate pest through use of disease has been successful in only one major instance. This is the classic case of the control of the European rabbit in Australia through introduction of the myxoma virus (Fenner and Ratcliffe 1965). Some important rules that must be basic to any consideration of introducing a potential disease-causing organism into a wildlife population as a control method are outlined by Herman (1964):

1. The disease organisms must be highly pathogenic to the prospective host; usually, this requires that it be an exotic organism with which the host has not co-evolved.
2. The potential killing power, residual duration, and ultimate resistance must be anticipated.
3. The disease must be host-specific. We cannot introduce a disease that would threaten other wildlife, livestock, or humans.
4. The disease organism must be available in adequate supply, and it must be able to survive in the natural environment. Any necessary vectors or intermediate hosts must also be present.
5. If initiated, the control program must be closely monitored in every detail to guard against adverse, detrimental events which were not anticipated.

Control of wildlife populations by disease has much merit if the above conditions can be met. This is, however, a complex problem (Herman 1964). For these and other reasons, it is unlikely that biological control of vertebrates through disease will be useful in the future in any significant number of instances.

Predation is sometimes suggested as a means of controlling vertebrate pest populations. Population densities of vertebrate prey species usually are a function of habitat suitability interacting with the species' own self-limiting mechanisms. In most instances, predators take insufficient numbers of their native prey to limit prey populations; they often select sick, weak, or otherwise vulnerable or surplus individuals because these usually are the ones most easily captured. Predation often increases the health and vigor of the prey population and stimulates the reproductive rate of the prey.

Further reasons why predators often are unsuccessful in controlling vertebrate prey are their own reproductive rate (in relation to the prey) and their lack of host-specificity. Many vertebrate predators have a diverse diet, taking those prey species that are most available or vulnerable. In general, an efficient vertebrate predator which was obligate on a single prey species would have poor survival value; it would exhaust its own food supply. Even in situations where predators are thought to be depressing the size of a vertebrate population, the extent of "control" may not be adequate for people's need to prevent damage caused by the prey.

In some situations, however, predation may work. Evidence indicates that in some cases natural predation can be sufficiently effective to be of economic value. Effective predation may occur when the habitat conditions are marginal for the prey, or when the prey are restricted to a localized area where their predators are highly mobile and range over a larger area. Connolly (1978) has reviewed situations where predation was thought to be limiting the numbers of large herbivores. Elton (1953) found that cats would not rid a farm of rats, but if the rat numbers were reduced by other means, the cats could hold the population at a low level, provided the cats were supplemented periodically with other food. In another study, Davis (1957) found that four cats on a farm killed enough young rats to reduce the population substantially, but in the spring the cats turned to killing young birds, thereby allowing the rats to survive and increase.

Aside from their ability to kill prey, predators occasionally have been employed as frightening devices. Dogs can be used to chase coyotes and small predators away from poultry yards, to scare deer out of small gardens or orchards, or to keep rabbits away from plots of seedling trees, for example. Trained falcons have been used to reduce the number of birds that present potential hazards around airports (Solman 1976).

Habitat manipulation, which in agricultural situations may involve changes in cropping methods, has been suggested as a method of preventing vertebrate pest damage. While it can be effective in some situations, it is not without serious drawbacks. Habitat suitability is the most important single factor determining the presence or absence of an animal at a particular location. Many vertebrate pest problems largely can be alleviated if one is willing to suffer the ecological consequences of altering habitats. The difficulty in utilizing habitat modification is that often it is not specific to only the pest species. Changing the vegetative base of an ecosystem will affect all vertebrates present which use the area for food, shelter, or nesting. "Clean farming" may substantially reduce problems caused by field rodents since their habitat is eliminated, but it will also permanently eliminate the many types of game species and songbirds that are supported by the same habitat (Howard 1967).

The scientific literature does contain a number of examples of how habitat alteration can fit into an integrated pest management scheme without apparent negative effects on ecosystems. Ducks and geese can be frightened away from valuable crops if waterfowl refuges are available nearby which provide adequate resting areas and sufficient food to sustain the birds until crops are harvested. Without the refuges, various herding and frightening techniques are much less effective. Lewis (1946) found that a 16-foot vegetative barrier of rye around the perimeter of a barley field reduced jackrabbit damage to the barley. Campbell and Evans (1978) demonstrated that planting highly desirable native forbs significantly reduced deer browsing damage to nearby Douglas-fir seedlings. Application of lime and superphosphate fertilizers to rangelands in New Zealand has been employed to produce a rank growth of grass that makes that habitat unsuitable for European rabbits (Howard 1958).

Sanitation long has been recognized as a means of making urban and suburban areas less suitable for commensal rodents, particularly Norway rats. The Norway rat problem in Baltimore was greatly reduced when a program to limit their food and cover was undertaken (Emlen 1947). Cultural practices such as timing of crop planting and harvest, and the use of bird-resistant varieties of cereal grains, may be important in reducing bird damage (Besser 1962, De Grazio 1964, Bridgeland 1979).

Making a resource unavailable to vertebrates through the use of barriers or mechanical protectors is a form of habitat modification that often is quite effective. The main limitation of this technique's use is the cost of materials and labor. Fencing has been employed to keep deer out of vineyards, orchards, and haystacks, and to exclude predators from poultry yards and sheep pastures. Mechanical barriers, such as plastic mesh tubes and wire cages, have been effective in protecting tree seedlings from browsing animals. Metal protectors or wires may be used to prevent birds from roosting on buildings, and netting may protect fruit or other crops from bird depredation. Rodent-proof construction is an important means of preventing entry of rats and mice into homes, food storage and processing plants, and farm buildings. In swine confinement housing, problems with house mice are much less severe when mice are prevented from using wall spaces or other parts of the structure for shelter and nesting.

A variety of frightening devices, both auditory and visual, have been used to keep birds from roosting or feeding at particular sites. These tools reduce the attractiveness of a particular habitat, thus making it less suitable for use.

The above examples are primarily instances where a single non-chemical approach has been used to control vertebrate damage. Such examples do not in themselves constitute an "integrated" approach to pest management, but they are an important step in that direction.

Recently, more success has been noted in formulating systems approaches to vertebrate pest problems. Palmer (1976) described an integrated approach to deal with bird damage at feedlots. Dolbeer (1979) described a system for determining when control of blackbird damage to corn is cost-effective. An IPM project in Nebraska has dealt primarily with commensal rodents in swine confinement units, and this project's progress is described elsewhere (Timm 1982a, 1982b).

As mentioned earlier, all states have received IPM Extension funds for IPM projects since 1978.

Unfortunately, few states' projects have involved vertebrate pests. There remains the opportunity for persons interested in vertebrate pest control to compete for such funds and utilize them to promote state-of-the-art vertebrate control programs. Many states have taken an approach that deals with the entire spectrum of pests that affect a particular crop and have developed an entire pest control program for that crop or commodity. In such cases, there is a need for vertebrate control researchers and specialists to work closely with persons from other disciplines to include vertebrate control recommendations such pest control systems. Progress in vertebrate pest control has been limited in past years by lack of funds, lack of interested researchers and specialists, and failure for these persons to communicate across traditional disciplinary boundaries. IPM offers the opportunity for wildlife damage specialists, working with others, to make new and significant progress that will be of importance to this field.

REFERENCES CITED

Besser, J.F. 1962. Research on agricultural bird damage control problems in the western United States. Proceedings Bird Control Seminar, Bowling Green State University, Ohio.

Bridgeland, W. 1979. Timing bird control applications in ripening corn. Pp. 222-28 in: Proceedings 8th Bird Control Seminar, Bowling Green State University, Ohio.

Campbell, D.L. and J. Evans. 1978. Establishing native forbs to reduce black-tailed deer browsing damage to Douglas-fir. Pp. 145-51 in: Proceedings 8th Vertebrate Pest Conference (W.E. Howard, Ed.), University of California-Davis.

Connolly, G.E. 1978. Predators and predator control. Pp. 369-94 in: Big Game of North America: Ecology and Management (J.L. Schmidt and D.L. Gilbert, Eds.), Wildlife Manage. Instit. and Stackpole Books, Harrisburg, PA, 494 pp.

Davis, D.E. 1957. The use of food as a buffer in a predator-prey system. J. Mammal. 38:466-72.

De Grazio, J.W. 1964. Methods of controlling blackbird damage to field corn in South Dakota. Pp. 43-50 in: Proceedings 2nd Vertebrate Pest Conf., University of California-Davis.

Dolbeer, R.A. 1979. The challenge of cost-benefit determinations in bird-damage control programs. Pp. 239-50 in: Proceedings Fourth Great Plains Wildlife Damage Control Workshop (F.R. Henderson, Ed.), Kansas State University, Manhattan.

Elton, C.S. 1953. The use of cats in farm rat control. Brit. J. Anim. Behav. 1:151-55.

Emlen, J.T., Jr. 1947. Baltimore's community rat control program. Am. J. Public Health 37:721-27.

Fenner, F. and F.N. Ratcliffe. 1965. Myxomatosis. Cambridge Univ. Press, Cambridge. 379 pp.

Gold, R.E. 1982. IPM–an overview. Pp. 97-100 in: Proceedings 5th Great Plains Wildlife Damage Control Workshop (R.M. Timm and R.J. Johnson, Eds.), University of Nebraska-Lincoln.

Herman, C. 1964. Disease as a factor in bird control. Pp. 112-20 in: Proceedings 2nd Bird Control Seminar, Bowling Green State University, Ohio.

Howard, W.E. 1958. The rabbit problem in New Zealand. New Zealand Dept. Sci. Industr. Res. Infor. Ser. No. 16, 47 pp.

———. 1962. Means of improving the status of vertebrate pest control. Trans. 27th No. American Wildl. and Nat. Res. Conf., pp. 139-50.

———. 1967. Biocontrol and chemosterilants. Pp. 343-86 in: Pest Control: Biological, Physical, and Selected Chemical Methods (W.W. Kilgore and R.L. Doutt, Eds.), Academic Press, New York.

Lewis, J.H. 1946. Planting practice to reduce crop damage by jackrabbits. J. Wildl. Manage. 10:277.

Marsh, R.E. 1982. The unrealistic IPM parameters of vertebrate pest control. Pp. 109-110 in: Proceedings 5th Great Plains Wildlife Damage Control Workshop (R.M. Timm and R.J. Johnson, Eds.), University of Nebraska-Lincoln.

Palmer, T.K. 1976. Pest bird damage control in cattle feedlots: the integrated systems approach. Pp. 17-21 in: Proceedings 7th Vertebrate Pest Conf. (C.C. Siebe, Ed.), University of California-Davis.

Solman, V.E.F. 1976. Aircraft and birds. Pp. 83-88 in: Proceedings 7th Bird Control Seminar, Bowling Green State University, Ohio.

Timm, R.M. 1982a. A vertebrate IPM project in Nebraska. Pp. 101-108 in: Proceedings 5th Great Plains Wildlife Damage Control Workshop (R.M. Timm and R.J. Johnson, Eds.), University of Nebraska-Lincoln.

———. 1982b. An IPM approach to rodent control of midwestern farms. Pp. 147-50 in: Proceedings 10th Vertebrate Pest Conf. (R.E. Marsh, Ed.), University of California-Davis.