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POPULATION DYNAMICS OF PEST BIRDS

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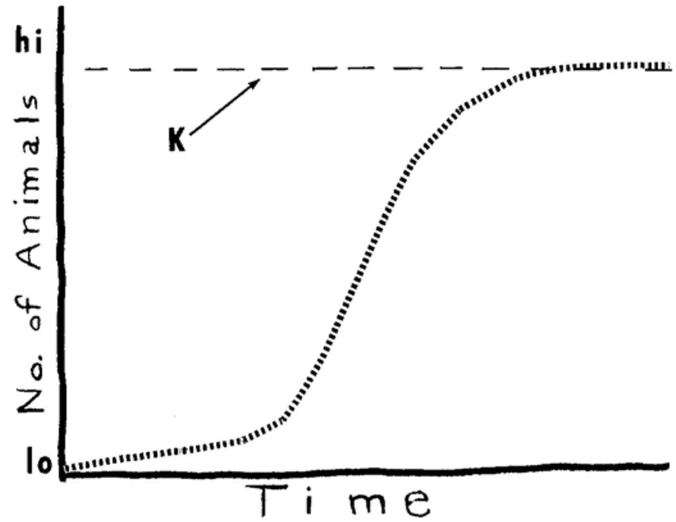
We want to talk now about population principles; this is our main problem dealing with populations. We should discuss the general application of population principles and the management of bird populations. The reason we can discuss this is because many species follow established principles; population growth and later regulation of its size follow certain basic rules. Many pest species follow these principles, but not always to the letter. Populations of different species, as well as of a species, vary depending upon local conditions. Local environments dictate what population levels and the growth of populations will be. Minor variabilities still fit into the general picture.

To apply these principles we must consider the level of reduction desired in the pest population. This is determined usually by 1) economic damage or 2) disease potential or much too often by 3) the budget. You can go from a complete reduction or local eradication of a species to a very minor change in the population level depending upon the methods you use. One of the major questions which I am sure most of you are faced with is: "Which method does what? "

We'll briefly go through some of the basic principles of what we call population ecology. First, we'll consider the natural growth of a population. We can describe the theoretical natural growth of a number of animals compared to time by what we call an "S" shape or sigmoid curve. This shape is the result of a change in the rate of increase in the population. We have a very low population at the outset and it increases, and the reason we have an "S" shape is that the rate of increase changes with time. So we can see that there is a maximum rate of increase at the mid-point. At the beginning of population growth we have fewer animals, and of course, a lower rate of increase. And, at mid-point, you have your maximum rate of increase. Looking at this theoretical graph we see that the population levels off near the end of our given time span. This is what is commonly referred to as the carrying capacity of a particular environment or how many animals the environment can support; the "K," some people call it. The carrying capacity changes with local conditions. We might say at this last point



Theoretical pattern of population growth shows initial slow growth, a middle period of maximum growth, and an endpoint which levels off as the growth rate slows again. The upper limit of population growth is controlled by the "K" or carrying capacity. Growth slows as essential factors for living occur in scarcer supply.

that the population is at an equilibrium with that environment. So this is, more or less, a stable population, at an equilibrium with its environment.

An example of a stable population might be rats in a city where there is a constant amount of shelter and food. So the rat population has probably reached an equilibrium in that particular urban area. A downtown area, especially in a city, like Baltimore which has been investigated, the rat population is relatively stable because the conditions are stable. Other examples, particularly with birds, would be the quail population in the United States or in a particular state; it is relatively stable; it's reached an equilibrium. Heron populations have reached equilibria, and even crows. Crows in the United States have had a relatively stable population for the past fifty years. So we say they have reached an equilibrium with their environment.

We asked this morning--How do you define a population? We have a similar problem--How do you define environment? It depends on where you are. Food, water, and shelter are three basic factors of "environment," but there are others, many which are difficult to measure—and probably some yet undiscovered.

We have different slopes of growth as the rate changes. The slope as well as the carrying capacity (upper limit) are determined by what we call the law (Liebig's) of the minimum. Populations or organisms are controlled by the weakest link in the chain of ecological requirements, such as food, shelter, temperature tolerance. The weakest link, or the requirement in least supply, is what controls the population in that local environment. There may be only a certain amount of food to support a population at a level, so the population is not going to increase above that level because there is only so much food energy available. So this is a limiting factor in that environment.

If we introduced 100 rats in a large room and supplied only so much food each day the rats would attain an equilibrium with this amount of food. We might see an increase of rats to 150, give or take a few, but no higher, because there is only enough food for 150 rats. If we then double the food supply, we are increasing this minimum link, so the population will grow again and reach another equilibrium (perhaps 200 rats) with this new amount of food, as long as no other factor was limiting it. There could be another factor then, limiting the population such as the space defined by the walls. So you have a very complex interaction of all the factors of the environment; it is the weakest one or the one that is in the minimum supply that controls the final population size (carrying capacity).

These same factors can control the rate of growth of the population. For instance, take temperature. The population of red-winged blackbirds in upper Canada does not increase very rapidly because the temperature (as well as a number of other factors) actually slows down the potential rate of increase of the population.

Something else we must consider are density-dependent factors. These are factors whose effect increases as the population density increases. We'll pick out a factor, such as predation, which kills 10% of the animals at a low population level, but as the population increases to a higher density, these predators may kill 50% of the animals. So this illustrates density-dependency. I think you can see that only this type of factor can catch up with the growth of a population. If we have a constant, independent factor, not dependent upon the density, it would not eliminate more than 10% of the animals as the animals increased. You are not going to have a population leveling off. As a matter of fact, at 10%, this population would eventually go sky high. So the independent factor could not possibly catch up with the increase of the population. Ten per cent at low population levels will have a much greater effect than ten per cent at a high point. Ninety per cent left at the upper end of our sigmoid curve is still many animals. Ninety per cent left of a small group isn't too many animals. Say there's only ten animals at the low end; they're still not going to be able to reproduce very rapidly. But you may have 10,000 animals; take away 10% and the animals are still going to increase very rapidly, simply because there are so many of them to have offspring.

Besides predation and disease as examples of density-dependent factors, another major group would be competition in the population:

competition for food, competition for space, competition for a mate. As you can see, this is a density-dependent factor. With a larger number of animals, you'd have more competition for available food and space. The space would stay the same. If we would increase the number of people in here, you'd have more competition for the amount of air that's in the room. We'd reach a point where this room could not support any more people, either for space or for air or for any other factor.

Some species have evolved mechanisms to control their own population growth. We can see a self-limitation in the growth of some populations. Just as there are environmental factors that control growth, there are also factors within the population or within the organisms which limit the growth by several mechanisms; one very obvious one is territoriality. Look at a red-winged blackbird. You couldn't increase the number of breeding red-winged blackbirds in a space of so many acres, mainly because of territoriality. The birds would not increase above a certain level because the territoriality prevents any more birds being squeezed in. They'll have competition for space; they'll have aggressive behavior preventing any other birds from moving into their territory. This in itself is a density-dependent factor and would serve to limit the population.

We also have what we call a feedback mechanism, or endocrine feedback mechanism. Quite a bit of research has been done on this. As animal density increases we see a reduction in the survival of the animals and also a decrease in reproduction and longevity and/or an increase in mortality. An endocrine system works through the brain and the adrenal gland to produce a hormone which specifically reduces reproduction. An example occurs, for instance, in a mammal's resorption of embryos in the uterus. There is a physiological mechanism that at times of stress, causes a greater resorption of the embryos. As the density increases you have more competition, more aggressive behavior, a greater response from the brain, producing more hormone from the adrenal gland and this, in turn, causes a reduction in reproduction through various mechanisms. The same hormone also decreases the survival of the animals. They are more susceptible to disease. These animals at a high population level are much more susceptible to a particular disease. A disease that at a low population may only take 10%, may take 90% of the animals at a high level. This is hypothetical; it is what we call an endocrine feedback mechanism which is a self-limitation of the population. There are a number of other things that we can talk about in population principles, but these are some of the general things. If you have any questions at the end, I'll be glad to see if I can answer them. I think that we should move on to applying these principles to the control of pest populations.

First, I'd like to talk about some of the available methods that we have now to control populations. We start off with something like repelling birds. This has problems in that it is only temporary.

Generally, something that scares the birds or repels birds is not a good control for the population. It is good in a local situation, such as on a building. Now, if we were dealing with a whole city we couldn't move the birds all around the city; we would run out of places to move them. So, if we're trying to reduce the population of a whole city, we couldn't use a method to scare the birds away, mainly because it is temporary in a local situation. But, if you did want to chase the birds out of the courthouse or some building, this is a good method.

There is a chemical, I mentioned before, Avitrol, 100 and 200, that has apparently had some success. It produces a flock disturbance reaction and I think it's been tried on four or five species of birds. Individual birds ingest the chemical and produce a flock-disturbing reaction. This scares all the other birds away and apparently, in certain local situations it is a good repellent.

Of course, another method of controlling a population is killing birds, increasing the mortality rate. In doing this, what actually happens, you remove a large number of birds, reduce the level of population to perhaps one-half the carrying capacity. To get the population lower than half takes a great amount of work. If you reduce the population to about one-half, I think you're doing pretty good control. When you get to this level, and if you stop controlling that population, it won't take very long for it to be right back up where it originally was. This is the main objection to the killing method of control. The population compensates for this reduction and improves survival of the remaining animals. There is increased reproduction in the remaining animals, and through more clutches, and as I mentioned this morning, more yearlings breed. The average age of the first breeding is lowered, so you're increasing reproduction at a much faster rate than it would have been normally. And, of course, you have an influx of animals or immigration into the population. All of these go then, to increase the population or to compensate for the decrease.

Crop management, such as altering harvest dates, might work for some pest birds. Changing corn harvest dates would foil the red-winged blackbird, though this has not been tried. Also, the difficulty of applying this kind of measure is great.

Now a fourth available method we have would be protection of a particular site. In some cases they have used nets around hangers to prevent bird entry. If you expand this technique to any degree you can see it's very expensive and must be limited to certain local situations.

Another technique, which hasn't been used as much as it could, and is probably one of the best methods we have: management of the habitat. This has been used very successfully in certain situations. I remember one airport where they had a starling problem and the starlings were roosting adjacent to the runways. Airport managers just cut down these low trees where the starlings were roosting and no longer had a problem. This was a pretty easy solution. We usually don't get that easy a problem. Another problem involves gulls. A lot of airports are located near the sea coast or in the poorest area of a city, in a filled swamp or something like this. Usually adjacent to airports are garbage dumps, and this attracts, especially along the coast, a large number of gulls. In several instances they have been able to reduce their problem by removing this garbage dump: filling it in and no longer dumping garbage there.

And another method which I discussed at length this morning would be chemosterilants, or altering reproduction, reducing the birth rate of a population. As I mentioned, there has been success with red-winged blackbirds. I have had success with experimental populations. This needs to be tried in field experiments. I was a little disappointed to hear that my source of apholate was gone because I was planning to try this material this fall with a city population. It does have some problems in practicality, in getting the bait out at the appropriate time and place; these things need to be worked out. But I do think that this is probably one of the most promising areas that we have so far, mainly because it takes into consideration the population principles that we talked about. Lowering the population but preventing compensation by reducing the birthrate and preventing immigration and replacement of animals is a very promising technique.

So, I would like to conclude that when we think about controlling a bird population, one of the first things we should know is the life history of the species and also the history of the local population. Such things as the movement of the population, where it feeds, roosting habits, flying habits, are important. Management of a habitat to control a species appears to be one of the best methods, but it has its limitations. Increasing mortality through the killing method has been inadequate to control the populations mainly because of the reproductive compensation in the population. Finally, reproduction appears to be the most vulnerable place for control and does have some prospect for the future. Thank you.

DISCUSSION

DR. DYER: It was a very excellent presentation on population dynamics. There are a couple of points I'd like to bring out. This is something that has haunted the vertebrate biologists for a long while, as you pointed out. I think that I can safely say that we are in no position to control any bird population because we lack the points that have been brought out. All of the data that are known to describe population dynamics are unfortunately only known from laboratory insect populations, with the possible exception of a few populations of blow flies, Drosophila and maybe screwworm; and as a worker in this field we're constantly pressured to do something on population control. If we do so at this time, we will do so only with the full realization that we lack the basic knowledge on the points that have been brought out--what is the innate capacity to reproduce, how many are there in the environment, what is the sex ratio and so on. Now, this is a point which I wish to amplify. I think it was brought out very well in this past discussion and so then, in closing, I think that we should restate that any pressures brought upon groups to manage bird populations at this time must be done so at the knowledge that we're doing this with insufficient material and knowledge, and we'd better be prepared for the consequences.

R. MCLEAN: It's easy to talk about the theoretical control. At least, it's easier for me than it is for you.

DR. JACKSON: The question has come up, Mel, what kind of consequences did you have in mind with your prediction of gloom?

DR. DYER: We're hopeful, and if we knew these then we wouldn't have to worry about them, obviously. But it was pointed out that every application in the past to control populations by just killing them off just simply is not worth it because of this very beautiful feedback mechanism. And the points which were brought out on the population control certainly are the only places that we have to attack. So the consequences, I suspect, are failures. Failure to do the job with the expenditure of time and money. This is the only thing that I can see.

DR. CORNWELL: I think I would like to point out along that line, that with a few dramatic exceptions most of our bird problems do not involve widespread bird populations, but relatively small numbers in localized situations. Even for the starling, we might remember that the Russian people put out millions of boxes of grain to attract starlings because of what they regard to be their beneficial feeding habitat. We need to look at the food habits of these birds in terms of their large numbers and wide areas inhabited, before we make any judgments about mass destruction.

DR. JACKSON: I think in part this is what Mel is saying--that we need to look at the birds as a population. I think that I would like to comment briefly here. There are a number of problems which are more than of a local nature. You control or alter a population in one area and this is going to have impact on another geographical area. When you're talking in terms of millions or tens of millions of birds, these are not restricted to one city or one county. Their migratory habits are going to effect several areas of the country or several areas of the world.

DELEGATE: What bird species have been controlled by removing trees besides starlings?

R. MCLEAN: I can't remember the species but one researcher dug up the trees that birds used for the calling stations. In other words, they have boundaries to their territory. This is their territory and they fly to their tree and call from their particular tree; this sets up the limits to their territory. What he tried to do was dig up these trees and move them, either move them in or move them out to see if the bird changed its territory sides. He never got any conclusive results. He had, as you can imagine, quite a few problems because one tree was about 50 feet tall. But people are trying this now. There is another individual at Penn State who is trying to change aggressive behavior to see if the birds will reduce the size of their territory. In other words, if they're less aggressive, will they have smaller territory? This may have some consequences, I don't know. This area certainly needs some work in it.

DR. JACKSON: I think we could comment that territory size depends on the habitat. If you're talking about redwing territory in a cattail marsh, X acres will be an average territory. If you're talking about redwing territory in an alfalfa field, you're going to have quite a different parameter to deal with. You can't talk about what the average red-winged territory is. There is no such thing.

R. SMITH: I was wondering whether the animal will stop reproducing or restrict its territory and keep reproducing?

DR. JACKSON: The figures which I have seen on redwings indicate that the territory is squeezed to a certain extent but then after that point you increase the peripheral non-breeding animal.

R. MCLEAN: It appears to be much more rigid in the red-winged blackbird.

DR. JACKSON: In rats, and we keep going back to mammals because so much more work has been done with mammals, breeding will stop when you get to the high population level.

J. STECKEL: How about low population level?

DR. JACKSON: Breeding generally increases. That's why the pest control operator is the rats' best friend.

D. LIEB: On that redwing problem, there was a farmers' meeting last Friday and they've had several in the past in which the farmers threw the government men out. These farmers are standing a loss. They can't understand your answers, and in fact they did run some of the government men out of one meeting or threatened to. But the farmers know that if you burn the marshes where the birds are living you can reduce them and move them. Then come along the boys with the ducks and the wildlife and they won't let you burn the marshes because you're going to move the ducks; so there's a problem there. How to reduce one and not harm another? That's the answer they're looking for.

R. WETZEL: What do you do if you get one farmer who's going to burn his marsh; he gets permission and another farmer can't get permission? You just let the two farmers fight it out after the birds from the burned marsh go to the unburned one?

D. LIEB: Well, this is why they didn't like it when one farmer killed a lot of birds or moved a lot of birds with one poison and pushed them onto another fellow's farm. We had the same problem there. Who's going to pay the bill now? You've gotten rid of your birds and I've got them.

D. GRAY: I've found the same thing in terms of the species of birds that might be feeding on insects in one section of the country. They migrate, and we have to feed them on rice in Arkansas. You have them in one section of the country where they might be feeding on good grain and in another section of the country they might be feeding on harmful insects, and we don't know how to put up with this.

DR. CORNWELL: Yeah, I just got back to the local nature of the problem. I'm impressed in western Virginia by the starling roosts that number in the millions, that feed without disturbing anybody for four months of the year, and the only time that you get a complaint is because of the offensiveness of the roost. So now, that same number of birds in your rice country could raise hell. The same number up here would raise hell.

J. STECKEL: We're impressed when they come up here in the summertime. (Laughter)

DR. JACKSON: In terms of straight and sheet economics, Ohio has a bill from redwing somewhere around 15 million dollars a year in terms of agricultural loss. This is a fair amount of money going down the gullet. And, we don't have a real solution to it.

J. DILL: The starling is a fairly recent inhabitant of the North American continent and it seems to be increasing by leaps and bounds. I think that the next five, ten, fifteen years that come there's going to be a lot more effort directed toward the control of these birds. They're destroying our food. In the past the destruction of maybe 100 million or maybe 200 million dollars worth of grain or food, or put it another way, the food that would feed millions of people, was only lowering our surplus according to the attitude of the government. But I was at a meeting at Michigan State University last month when they were running feeding experiments on cattle and feeding them on pre-digested sawdust and bark from trees and one thing and another. The head of this department suggested that by 1975 it might be illegal to feed an edible grain to livestock because it would be necessary to keep the human population alive. In fact, he said it could be a felony. Well, if it reaches that point, and we're talking about nine or ten years, I think there's going to be a demand, whether we have duck marshes or not or whether we have a lot of other things, for control of the blackbirds and the starlings that are taking this tremendous toll. I was traveling through Canada and picked up a newspaper in Hamilton. There was an area that was declared a disaster area because 65% of the corn crop had been destroyed by blackbirds. We've got a lot of answers to get and maybe we don't have as long as we think we do to get them.

[Recent population estimates suggest that the nationwide starling and blackbird populations have stabilized. See B. Meanly and J. S. Webb, Atlantic Nat. 20:189-191, 1965, or D. E. Davis, Auk 67:460-465, 1950. Ed.]