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RESPONSE OF BIRDS TO RAPTOR MODELS

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INTRODUCTION

Today, more than ever, there is an increasing need for non-lethal methods to effectively control crop depredation by birds. One such method, involving the use of fear-provoking stimuli, has been used since ancient times but often with little success. If fear-provoking stimuli are to be improved, we must identify those features that are most effective and incorporate these into scare devices.

Models of raptors are promising fear-provoking stimuli (Rowe 1971, Brown 1974, Messersmith 1975, Blokpoel 1976). Unfortunately, birds usually habituate to these models rather quickly. More efficient models have not been devised, in part because of the lack of experimental studies on predator models and other fear-provoking stimuli. Therefore, I have examined the effectiveness of three predator models by quantifying how birds respond when exposed to them for various lengths of time.

MATERIALS AND METHODS

Raptor Models

Three models were tested. Two were museum mounts of a sharp-shinned hawk *(Accipiter striatus)* and a goshawk *(A. gentilis),* which were loaned to me by the Peabody Museum of Yale University. The third model was a kite-hawk which was a clear plastic kite on which was printed a colored drawing of an eagle with its wings outstretched in flight. This kite, manufactured in West Germany by P. Gunther K.G., D-8330 Eggenfelden, was obtained from AAA Industries in Oregon City, Oregon.

To keep the kite aloft in little or no wind, it was suspended from a helium balloon. The helium ballon was 40-60 meters above the ground, and the kite-hawk was mid-way between the balloon and ground. The goshawk and sharp-shinned hawk models were mounted as perching hawks and were placed 1.25 to 2 m above the ground.

Feeder Station Experiments

The first series of experiments tested the predator models at feeding stations. For these tests, five feeders were established in the vicinity of New Haven, Connecticut. Three located at the Lockwood Farm in Mt. Carmel, Connecticut, were placed 200 to 400 m apart, out of sight of each other. Another feeder was located in Woodbridge about 15 km from the Mount Carmel feeders, and the fifth feeder was placed in Orange, Connecticut approximately 7 km from the Woodbridge feeder and 20 km from the others. All feeders were in open fields and were near community garden plots or small fields of cultivated row crops.

Each feeder consisted of a 1 m^2 wooden platform with 5 cm side boards, and was positioned 1.0 to 1.25 m above the ground. Each feeder was baited daily, or on alternate days, with 400 g of cracked corn and 400 g of sunflower seeds which were kept separate by a divider placed in the center of the platform creating two equal sections. The food remaining on successive days, or at the end of a test, was reweighed to assess the amount of food consumed by the birds. Each feeder was pre-baited for at least six weeks prior to the start of the tests.

Blueberry Planting Experiments

Additional experiments were conducted at a 0.15 acre high-bush blueberry planting, also at the Lockwood Farm but located over 400 m from the closest feeder. The planting contained two early blueberry varieties (Weymount and Concord), two mid-season varieties (Pemberton and Atlantic), and two late varieties (Dixi and Burlington). The blueberries ripened from early July until September, allowing adequate time to run several replicate tests with each of the raptor models.

Experimental procedures

Three different tests were conducted in which the raptor models were left out for varying periods of time to assess how their effectiveness changed over time. The first test measured the initial reaction of the birds to the models, tne second examined how the birds' response changed during a 5-8 hour period, and the third examined the effectiveness of the models over a seven-day period.

Initial Response. - The initial effect of the raptor models on the number of feeding birds was determined by comparing the number of birds at the feeder or landing in the blueberries during two 15-minute periods, one immediately prior to and one following the placement of a model in the area.

A decline in the number of birds following the introduction of a model might be attributed to the frightening presence of the model itself or to the disturbance caused by the experimenter in setting up the model. To test this, we entered the feeding area during one test but did not leave a model. In another test, I placed a light-brown cylinder, of approximately the same size as the goshawk model, in the blueberries and observed its effect on the number of birds present. The response of birds to the cylinder was compared to their response to raptor models to test whether raptor models were more effective in scaring birds than a novel object.

The results of all of these tests were compared to the results from the control feeders and to their pre-treatment controls by using the sign test to determine whether there was any significant decrease in the number of birds. In these and in all other tests, the results were considered statistically significant if $P<0.05$.

Short-term Response. - Next, tests were conducted to assess the models' effectiveness after a 5 to 8 hour period. In these experiments, a count of the number of birds at a feeder or landing in the blueberry field was made, first during a one-hour period prior to the setting up of a predator model (pre-test control), and then during a one-hour period immediately following its placement. The results were then compared to the number of birds present after the model was left in place 5 to 8 hours. Because these tests continued for several hours, some variability in bird visits might occur, owing to daily feeding patterns. To account for this, the results of these tests were compared to the number of birds present on other days at this same feeder. Furthermore, on the same day that a raptor model was being tested at one feeder, the number of birds at another feeder, where no model was present, was also monitored as a control. Tests with raptor models were compared to controls using the sign test and the median test.

Long-term Response. - In this test, the kite-hawk was set up for a seven-day period over the blueberries. The number of birds that visited the blueberries during the week was counted daily and compared to the number observed during the prior week using the median test.

RESULTS

Feeder Tests

More than 10 species of birds ate grain from the feeders. The six most common were the following: the blue jay *(Cyanocltta cristata)* which accounted for 35% of all bird visits, house finch *(Carpodacus mexicanus)* 30%, mourning dove *(Zenaidura macroura)* 14%. bronzed grackle *(Quiscalus versicolor)* 11%, house 0sparrow *(Passer domesticus)* 5%, and starling *(Sturnus vulgaris)* 3%. Other species constituted only 2% of the total sample.

Initial Response. - All predator models significantly reduced the total number of birds visiting the feeders (Fig. 1). The goshawk model was slightly, but not significantly, more effective in reducing bird visits than the sharp-shinned hawk model. The kite-hawk, however, was significantly more effective than either the goshawk or sharp-shinned hawk model in reducing bird visits.

The initial response of bird species varied (Fig. 1). Blue jays rarely approached any of the predator models. Mourning doves avoided feeders associated with the kite-hawk significantly more often than those paired with either goshawk or sharp-shinned models. House finches actually were more common at feeders with sharp-shinned and goshawk models than at control feeders by 77% and 6%, respectively. A possible explanation for this unexpected development is that these models repelled blue jays whose presence normally kept the smaller house finches out of the feeders.

Short-term Response. - Figure 2 shows how birds responded to the goshawk and kite-hawk models after 5 to 8 hours. The sharp-shinned hawk model was not included in these tests because its presence had little impact. The goshawk model and the kite-hawk continued to be effective, both in reducing the amount of food eaten and the number of birds at the feeders. Interestingly, the kite-hawk caused a greater drop in the number of birds than in the amount of food eaten. Apparently, the few birds that entered the feeder continued to feed heavily.

The various bird species also continued to react differently to the models. Although blue jays still avoided both the goshawk and kite-hawk models, some habituation was evident from their higher numbers than in the initial tests. Mourning doves and house finches again avoided the kite-hawk but had completely habituated to the goshawk model.

Blueberry Planting Tests

Initial Response. - Although nine different bird species were observed eating blueberries, over 70% of the loss was caused by a single species, the mockingbird (Table 1). Immediately upon introducing any of the predator models, there was a significant reduction in the total number of birds and in the number of mockingbirds, starlings, and catbirds, although the type of raptor model was not a significant factor (Fig. 3). In contrast, the number of birds present did not decrease after a brown cylinder was placed in the blueberries.

Short-term Response. - The results of tests monitoring the birds' reaction to the goshawk model and kite-hawk after 5 to 8 hours are shown in Fig. 4. Both models significantly reduced the total number of birds and the number of mockingbirds and catbirds in the blueberries. The kite-hawk also significantly reduced the number of starlings,but the goshawk model had no such effect. In fact, the kite-hawk was more effective than the goshawk model in keeping away all bird species, although the differences were not significant for catbirds. Apparently this differential response to the two models was due to birds having habituated to the goshawk model but not to the kite-hawk. There was no significant difference in the number of birds present during these kite-hawk tests and during the initial response test. Tests on the goshawk model revealed a different trend. After 5 to 8 hours, the total number of birds and the number of mockingbirds and starlings increased significantly in comparison to the initial response tests.

Long-term Response. - The results of tests assessing the Kite-hawk's effectiveness in deterring birds from entering the blueberry field over a seven-day period are shown in Fig. 5. Generally, the kite-hawk reduced the number of birds by about 40% during the week when compared to the control. Evidently, some habituation occurred during the week because the number of birds in the field increased as the week progressed.

Considerable daily variation occurred in the effectiveness of the kite-hawk in repelling birds. Much of this variability can be accounted for by the presence or absence of any appreciable wind, because the number of birds coming into the blueberries increased sharply on calm days (Fig. 5). To test the importance of wind on the effectiveness of the kite, the results of the short-term response experiments were reanalyzed, taking into account the amount of wind during each test. The results from the kite-hawk test at both the feeders and blueberries demonstrated a significant decrease in the number of birds in the area on windy days (Fig. 6). Importantly, there were no significant differences in the number of birds at control feeders on windy or calm days.

DISCUSSION

These experiments tested three raptor models at a series of feeding stations where birds had been attracted by placing out corn and sunflower seeds. While somewhat artificial, these stations allowed me to run replicate field tests while maintaining adequate controls; hence the effectiveness of the models could be accurately determined. The use of feeding stations might be helpful in other comparative studies on bird control, since it avoids both the problems involved with conducting tests on captive birds and the large amount of time required to run the same kind of test in agricultural fields where conditions are rarely similar.

The results of this study indicate that currently available raptor models cannot provide total protection of crops from bird damage. The models' usefulness is limited in at least two ways. First, not all birds react to raptor models in the same manner. For instance, the models were very effective against blue jays and starlings; less so with mockingbirds, mourning doves, and house finches. While some species, like the mockingbird, responded similarly by avoiding all predator models, other species, such as the house finch, bronzed grackle and starling, avoided some but not others. Thus when seeking protection from these latter species, the grower has less freedom in selecting a predator model.

Secondly, birds habituate to predator models after prolonged exposure. While most birds intltially responded to the models by fleeing the immediate area, they began to habituate and start re-entering the feeding area after only a few hours of exposure to the models.

Probably the fear-provoking potential of the predator models is diminished because of the birds' predator attraction behavior. That is, many different bird species congregate near predators, or other unusual objects, and this behavior apparently allows them to observe the predator and learn from their observations (Kruuk 1976).

This predator-attraction behavior was observed during my tests. The feeders and the blueberries were bordered by brushy areas and dense trees, offering birds a protected position from which to observe the models. A few minutes after the introduction of a predator model at a feeder or the blueberries, there appeared to be many more birds in the surrounding trees than had been in the entire area prior to the introduction of the model. This was especially true for blue jays and mockingbirds. Apparently from the safety of cover, the birds were able to observe that the predator models did not act like real predators and that nothing happened to their bolder conspecifics which entered the feeding area. Hence, once a few birds entered the area, others soon followed and the model's effectiveness was lost. Perhaps the models would be a more successful deterrent if they were used in an open field and not close to trees and shrubbery.

Another important conclusion from my study is that raptor models differed in their ability to repel birds, and that the mobility of the models was a critical factor. Two of the models, the goshawk and sharp-shinned hawk, were museum mounts of perching birds and, except for movement, appeared identical to live birds. Although both of these initially were successful in repelling birds, the birds soon started to habitutate to them. Far more effective in repelling birds was the kite-hawk, even though it was much less realistic in appearance than the other two models. At least two reasons could explain this difference. First, the kite-hawk depicts a flying or soaring hawk ratner than a perching one and this may increase the birds' fear because only flying raptors can capture them. Hence birds may be more cautious of a hawk flying over them than one perched level with them. An alternative hypothesis is that the kite-hawk's mobility makes it appear more life-like than the stationary goshawk and sharp-shinned hawk models.

I tested these hypotheses by comparing the effectiveness of the kite-hawk on calm days, when it hung motionless beneath the helium balloon, to its effectiveness on breezy days, when it moved about. The results showed an increased effectiveness on windy days, indicating that its ability to frighten birds is due primarily to its mobility. The movement of the Kite-hawk probably hindered the birds' ability to discriminate between it and a real raptor, and thus the birds habituated to it more slowly than to the two perching models. My results showed that this model reduced the number of birds feeding on blueberries by about 40% over a seven-day period, indicating that it can provide some help in protecting crops from birds.

Unfortunately, the kite-hawk has some practical problems which limit its usefulness to growers. First, it is relatively fragile and will tear or break apart in a brisk wind. Consequently It must be taken down whenever a high wind is expected, an unpredictable and time-consuming process. Second, the helium balloons must be refilled every few days. Third, the kite-hawk obviously cannot be used around tall trees or power lines.

SUMMARY

I tested the ability of three predator models to repel birds. Most birds initially responded to all three models by vacating the feeding area, but they did not shy away when a brown cylinder was set up. Therefore, birds seemed to be reacting to the predator models because they looked like predators and not because they were novel objects. After 5 to 8 hours of exposure to the models, however, birds began to habituate to them.

Species of birds responded differently to the models. The models were most effective against blue jays and starlings but were less effective against mockingbirds, mourning doves and house finches.

A mobile kite-hawk was more effective in repelling birds than either the goshawk or sharp-shinned hawk model which was immobile. The kite-hawk reduced the number of birds feeding on blueberries by 40% over a seven-day period, indicating that this model may provide at least some crop protection from birds.

ACKNOWLEDGEMENTS

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DISCUSSION

Q: What was the color of the balloons?

A: We used a variety of colors. One of the tests we conducted was the effectiveness of the balloon colors. In the tests here we used white balloons. One of the experiments I did not report on used just balloons launched in the blueberry fields and feeder stations. What we find is that the balloon itself has a certain degree of deterrence that reduces the number of birds coming in by about 20%. Hanging a hawk kite beneath it increases the efficiency of that balloon, so there is certainly an additive effect.

Q: Will this work with Canada geese?

A: Yes, we found that red balloons were more effective than white ones in deterring them. We found that pink was more effective than white.

Q: What crops besides blueberries have you worked with?

A: Well, we've also tested these balloons with silage corn fields. You have to realize that in Connecticut our fields are much smaller than they are in the Midwest or other more heavily agricultural regions, so that our largest field is usually about 10 acres. Models are effective, or potentially effective, in our fields, whereas they wouldn't be in a 200-acre corn field; at least I wouldn't think they would be effective. Our two main testing sites right now in Connecticut are with silage corn blackbird damage and different passerine birds coming into our blueberries.

Q: Are you varying the height or length of the kite?

A: Yes, as you might expect, the higher the kite is, the less effective it is immediately beneath the kite, but the broader its range is. So there are some pretty nice curves you can obtain in terms of protection versus height. The higher up it is, the further your protection; but the less effective it is immediately beneath it. So there certainly is a response in that way.

Q: Did you notice any small birds mobbing the kite?

A: No. The one exception is we found that swallows and swifts were really excited by the presence of that helium balloon, and they would slowly run into it and bounce off. They found a certain amount of pleasure doing this, and they would literally spend hours bouncing off this balloon.

Q: What about use of sound in addition to the kite?

A: Some of the other experiments I'm involved in use this approach. We're testing different types of predatory models, varying certain features. One of the features we are looking at is the use of sound, coupling especially the stress calls with the presence of these different models. There certainly is a highly additive effect in that regard, but right now my results are too preliminary. I'm not ready to report on that, but that certainly is the way of the future. We've also found out that if you combine a predator model with a dead bird, so that you make it appear that this bird has just caught a prey, the model becomes more effective.

Table I. Birds species observed eating blueberries and the relative frequency of their visits.

Bird Species	*Relative frequency of visits* (in percent)
Mockingbird	70.9
Starling	11.9
Yellow-throated vireo	7.3
Catbird	4.6
Brown thrasher	2.8
Robin	0.8
Flicker	0.6
Baltimore oriole	0.4
Blue jay	0.4

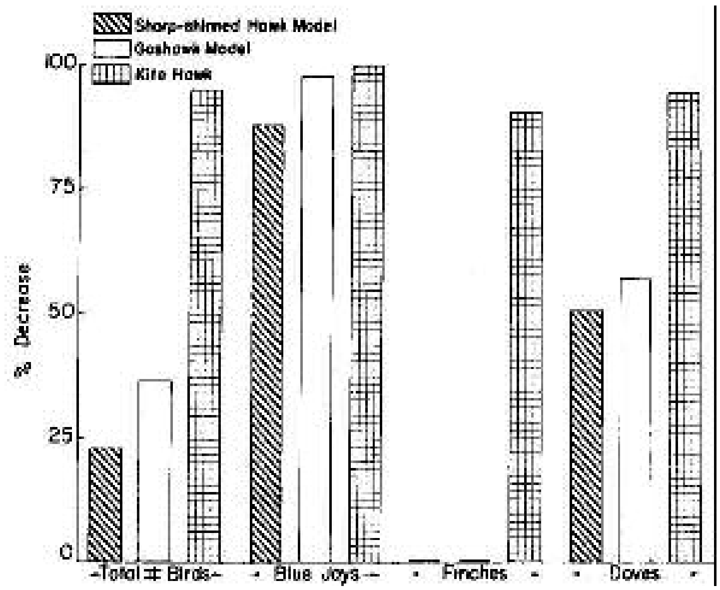

FIGURE 1. **Percent decrease in the number of birds at feeders immediately after the placement of the raptor models. The number of Finches actually increased when the Goshawk and Sharp-shinned Hawk models were placed out and this has been indicated by a horizontal line just above the abscissa.**

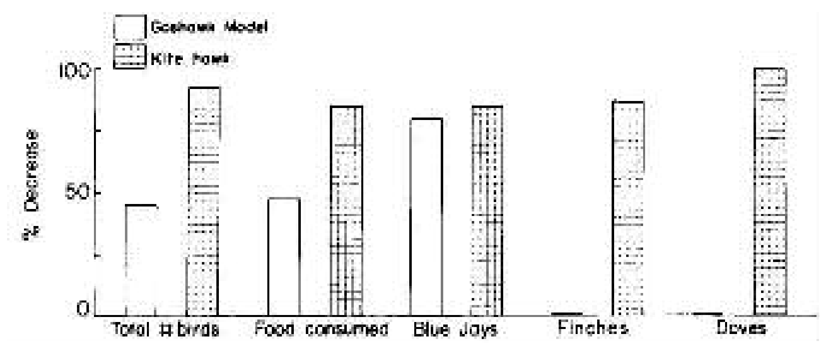

FIGURE 2. **Percent decrease in the number of birds and in the amount of grain consumed at feeders when the Goshawk or kite-hawk had been set up for 5-8 hours. The number of doves actually increased when the Goshawk model was placed out and this has been indicated by the horizontal line just above the abscissa.**

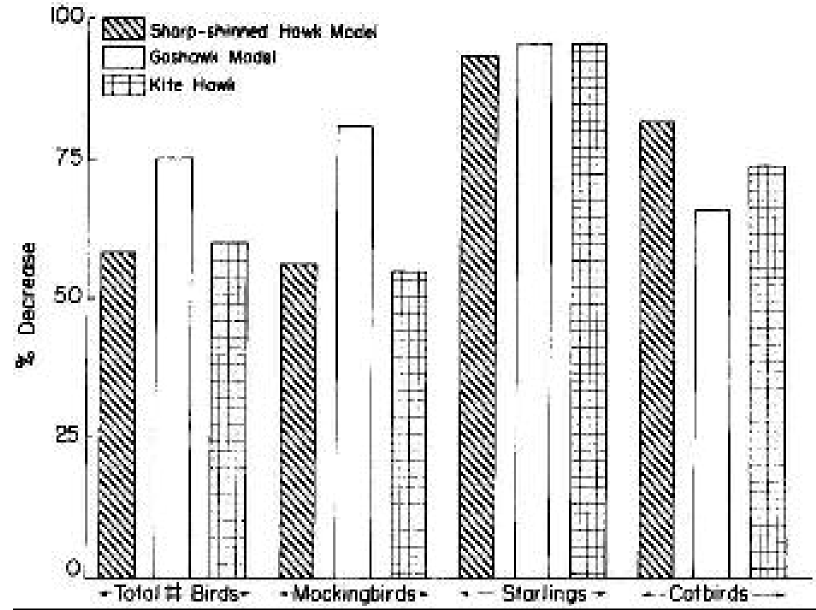

FIGURE 3. Percent decrease in the number of birds feeding on blueberries immediately after the placement of raptor models.

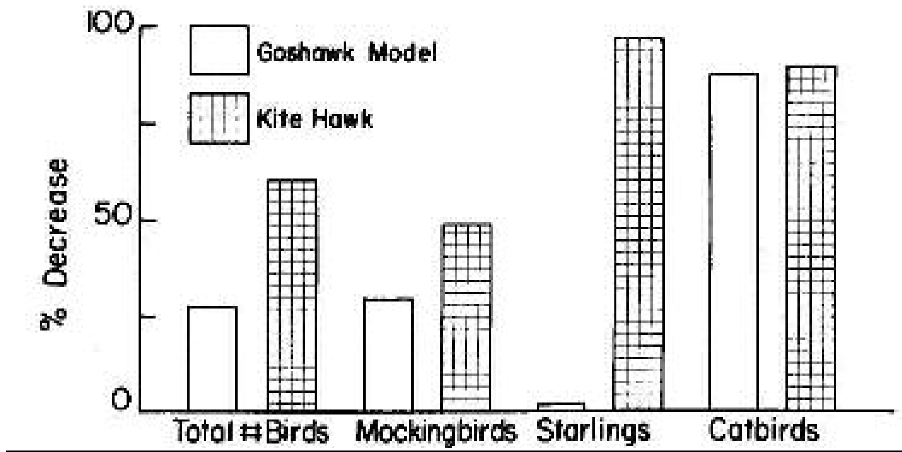

FIGURE 4. Percent decrease in the number of birds feeding on blueberries 5-8 hours after the placement of either a Goshawk or kite-hawk model.

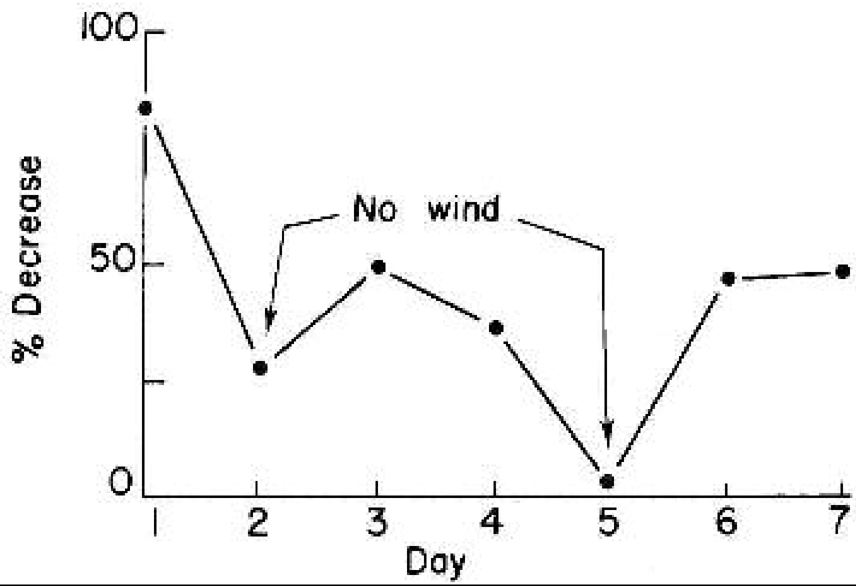

FIGURE 5. Percent decrease in the total number of birds feeding on blueberries during a seven-day period when the kite-hawk was flying over the field. The effectiveness of the kite was substantially reduced on days having no appreciable wind.

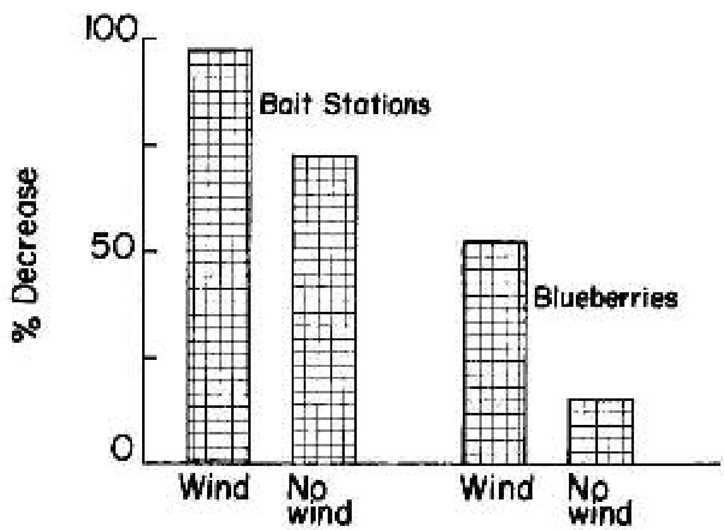

FIGURE 6. Effectiveness of the kite-hawk In decreasing the number of birds feeding on blueberries or visiting a feeder on windy days and on days with no appreciable wind.