Effectiveness of Lithium Chloride Induced Taste Aversions in Reducing Waterfowl Nest Predation

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Abstract: Field experiments to evaluate the efficacy of lithium chloride (LiCl) as an aversive conditioning agent on waterfowl nest predators were conducted at Sand Lake National Wildlife Refuge (NWR) during 1980 and 1981. Three experimental plots were treated by placing artificial nests containing chicken eggs injected with 1 g LiCl along transects throughout the plots. A significant decline in LiCl egg consumption ($P<0.01$) 4-6 weeks after initiation of treatment indicated that predators were avoiding treated eggs. Comparisons of waterfowl nest success on treated with that on untreated plots showed no significant difference in 1980 ($P>0.10$), but a significant reduction in nest success on treated plots in 1981 ($P<0.01$). We conclude that LiCl is not an effective deterrent to waterfowl nest predators under the conditions in which it was tested during this study.

Introduction

Predation is often a major factor limiting success of waterfowl nests (Byers 1974, Duebbert and Kantrude 1974, Sargeant and Johnson 1977). Predator control techniques, such as trapping and poisoning, can reduce predator numbers, but are time consuming, expensive and often undesirable because of lethal effects on nontarget species. LiCl is a non-toxic chemical that has been used extensively as an aversive conditioning agent to reduce coyote (*Canis latrans*) predation on domestic livestock (Gustavson et al. 1975, Conover et al. 1977, Olsen and Lehner 1978). The application of LiCl as a deterrent to waterfowl nest predation could potentially provide a more effective and acceptable method of predator control.

The objective of this study was to test the efficacy of LiCl as an aversive conditioning agent in upland nesting habitat used by waterfowl.

Methods

Three pairs of plots (ranging in size from 37 to 64 ha) were studied for 12 weeks (4/13-7/19), 1980 and 1981 at Sand Lake NWR in Columbia, SD. Plots were paired based on similarity in size and topography. Each plot contained a dense mixture of brome (*Bromus* spp.) and legumes planted to encourage nesting by waterfowl. Major waterfowl predators included the red fox (*Vulpes*

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vulpes), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*) and Franklin's ground squirrel (*Spermophilus franklinii*).

Plots #1, #2 and #3 were treated with LiCl eggs and paired with control (untreated) plots #4, #5 and #6, respectively. Artificial nests, consisting of scrapes lined with grass, were constructed at 61 m intervals around the perimeter of each treated plot and along transects spaced at 61 m intervals throughout the plots. Plots #1-3 contained 84, 94 and 98 artificial nests, respectively. Three white chicken eggs injected with 1 g LiCl per egg were placed in each nest. Nests were marked with willow sticks placed 2 m from their location. Beginning in mid-April, each artificial nest was monitored at weekly intervals, and eaten or missing LiCl eggs were replaced with freshly treated eggs. Weekly percentages of eggs eaten on each plot were determined. In 1981, artificial nests were placed only along the plot perimeters during the first 3 weeks. A z-test was used to detect significant differences between weekly egg consumption percentages.

During 1980, we modified the method of treatment for plot #2. Counts of shell remains at treated nests indicated that within a 5-week interval 90% of the LiCl eggs were removed from the nest. These eggs were presumably carried away by predators. Apparently the predator removing the eggs was not only failing to consume the LiCl but was greatly reducing the number of LiCl eggs available to other predators in the area. To ensure that LiCl would be ingested, wires were placed through treated eggs and secured to the ground during weeks 6, 7 and 8 of 1980. Wired eggs would split open when removed from the nest, increasing the likelihood of consumption.

Waterfowl nests were located on each plot by use of a cable-chain drag (Higgins et al. 1977). The stage of incubation for each nest was determined using a field candler (Weller 1956). Waterfowl nests were marked with the same procedures used for LiCl nests and were monitored at weekly intervals until hatched or terminated. To determine if predator aversion to LiCl eggs was transferred to waterfowl eggs, nest success on treated and control plots was calculated using methods developed by Mayfield (1961, 1975) and modified by Johnson (1979).

Results

We hypothesized that predator response to treated eggs would be characterized by an increase in egg consumption during the period of initial exposure, followed by an avoidance phase during which consumption would decline. Weekly percentages of LiCl eggs eaten on all plots followed the expected pattern (Fig. 1). With the exception of plot #2 in 1980, LiCl egg consumption remained significantly below peak consumption during the remaining weeks ($P<0.01$). The wiring of LiCl eggs on plot #2 during weeks 6-8 in 1980 resulted in a significant reduction in egg consumption ($P<0.01$). However, egg consumption on this plot increased significantly ($P<0.01$) after the wires had been removed.

Species found nesting on the area included blue-winged teal (*Anas discors*), mallard (*Anas platyrhynchos*), common pintail (*Anas acuta*), gadwall (*Anas strepera*) and northern shoveler (*Anas clypeata*). Sample sizes were inadequate to reliably calculate nest success for individual plots and, therefore, nest data were pooled for analysis. Estimated nest success on treated plots was 6.7% (SE = 1.2%, n = 54) in 1980, and 9.5% (SE = 1.3%, n = 34) in 1981. On control

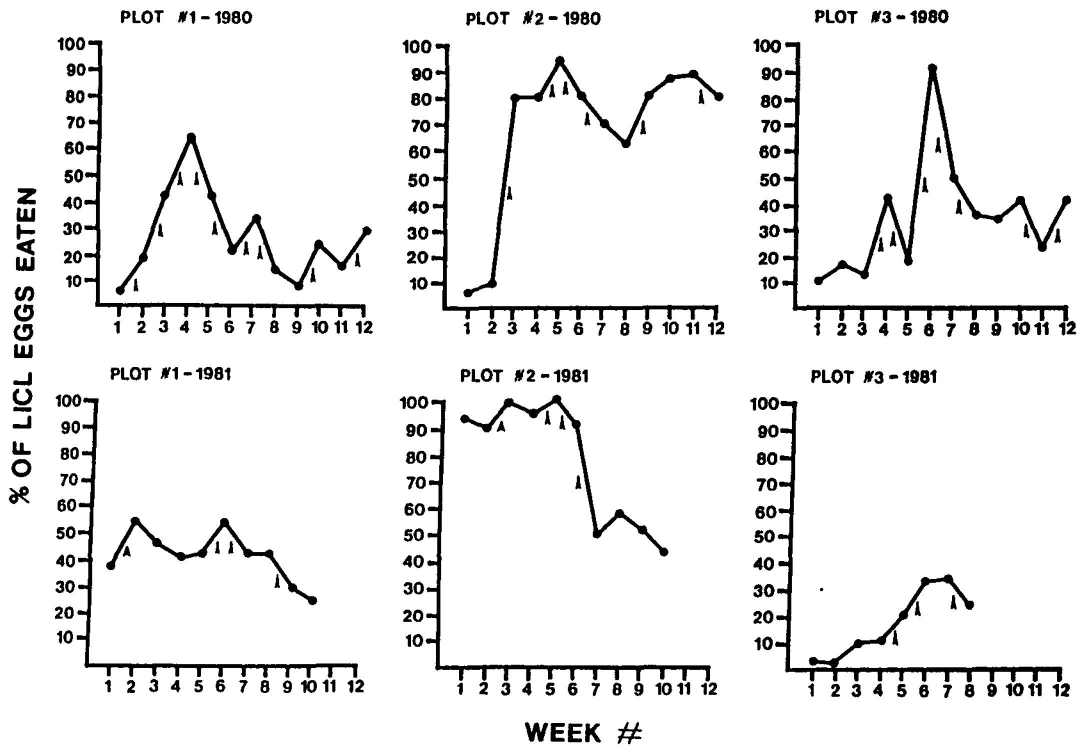

Fig. 1. **Weekly percentage of lithium chloride (LiCl) treated eggs eaten on study plots (n = 252, 282 and 294 for plots #1, #2 and #3, respectively). In 1981, LiCl eggs were placed only along plot perimeters for weeks 1-3 (n = 150, 126 and 135 for plots #1, #2 and #3, respectively). Significant differences (z, P<0.01) between the percentage of eggs eaten during 2 consecutive weeks are designated by arrows.**

areas, nest success was estimated to be 8.2% (SE = 1.5%, n = 27) in 1980, and 20.8% (SE = 1.4%, n = 18) in 1981. Nest success did not differ significantly between treated and control plots during 1980 ($P>0.10$), but was significantly lower on treated plots during 1981 ($P<0.01$).

Discussion

The pattern of LiCl egg consumption indicates that predators can be conditioned to avoid treated eggs. However, LiCl did not completely eliminate predation of treated eggs on any of the plots (Fig. 1). The magnitude of the reduction in predation varied between plots and within plots from week to week. These findings are probably due to differences in the species composition of predators on the 3 plots (Sheaffer 1982) and to temporal changes in their numbers and distribution. It is also possible that conditioning to LiCl eggs was not complete for some species of predators or individuals.

The deviation of treated egg consumption from the expected pattern on plot #2 in 1980 was most likely attributable to the removal and caching of eggs by predators. This behavior is commonly found in red fox (MacDonald 1976), and there was an active fox den in close proximity to the plot. The escalation in LiCl egg consumption following removal of the wires indicates that some predators require frequent exposure to treated eggs to achieve continuous conditioning.

The lag time between placement of treated nests in the field and the peak in consumption that preceded the decline ranged from 4 to 6 weeks. This lag is most likely a function of the time needed to expose predators in a given area to treated eggs rather than a delayed response by predators that have consumed LiCl. Differences in the size and species composition of predator populations probably account for variations in response time between plots. An important implication is that if the LiCl technique is to effectively reduce waterfowl nest predation, treatment of an area should be initiated at least 1 month before nesting begins.

A 2-phase process for mammalian taste-aversion conditioning was first proposed by Gustavson et al. (1974). During phase I, the taste of the LiCl treated prey becomes aversive to a predator after induced illness. Auditory, visual and olfactory clues may still elicit attacks on prey, but the taste inhibits ingestion by the predator. Phase II occurs when the predator associates the distal clues (auditory, visual and olfactory) with the aversive taste and subsequent attacks are avoided. Our results indicate that conditioning of predators to LiCl eggs could have been complete for some predator species or individuals; however, there was no evidence of transference of taste-aversion to waterfowl eggs.

We propose that the lower nest success on treated plots could be due to one or more of the following factors: (a) predator densities were higher on treated than on control plots, (b) LiCl eggs may not have been placed in the field far enough in advance of waterfowl nest initiation to allow for sufficient exposure, (c) conditioning could have been adequate for some predator species or individuals, but ineffective for others, (d) the presence of LiCl eggs could have attracted predators to treated plots thereby increasing waterfowl nest predation and (e) predators could have detected differences between LiCl eggs and waterfowl eggs, and subsequently waterfowl eggs were not avoided. Additionally, investigator activity was greater on treated plots because of weekly visits to LiCl nests and could have negatively affected waterfowl nest success. We conclude that the LiCl taste-aversion technique is ineffective for increasing nest success under the conditions in which it was tested during this study.

Acknowledgments

Support for this study was provided by Sand Lake NWR. We thank S. J. Waldstein and B. Schultze for their advice and assistance during the field phase of this research, and A. Olsen for his help in designing the study. Helpful comments on drafts of this manuscript were provided by P. W. Brown, M. R. Conover, E. K. Fritzell, S. R. Hopkins, D. H. Johnson, and R. A. Malecki.

Literature Cited

Byers, S. M. 1974. Predator-prey relationship on an Iowa waterfowl nesting area. Trans. N. Am. Wildl. Nat. Resour. Conf. 39:223-229.

Conover, M. R., J. G. Franlik and D. E. Miller. 1977. An experimental evaluation of using taste aversion to control sheep loss due to coyote predation. J. Wildl. Manage. 41:775-779.

Duebbert, H. F. and H. A. Kantrude. 1974. Upland duck nesting related to land use and predator reduction. J. Wildl. Manage. 38:257-265.

Gustavson, C. R., J. Garcia, W. G. Hankins and K. W. Rusiniak. 1974. Coyote predation control by aversive conditioning. Science 184:581-583.

Gustavson, C. R., D. J. Kelly, M. Sweeney and J. Garcia. 1975. An evaluation of taste aversion on coyote control. Final Report to the Washington State Department of Agriculture, 30 June. 33pp.

Higgins, K. F., L. M. Kirsch, H. F. Duebbert, A. T. Klett, J. T. Lokemoen, H. W. Miller and A. D. Druse. 1977. Construction and operation of cable-chain drag for nest searches. U.S. Fish Wildl. Serv., Wildl. Leaflet 512.

Johnson, D. H. 1979. Estimating nest success: the Mayfield method and an alternative. Auk 96:651-661.

MacDonald, D. W. 1976. Food caching by red foxes and some other carnivores. Z. tierpsych. 42:170-185.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bull. 73:255-261.

Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456-466.

Olsen, A. and P. N. Lehner. 1978. Conditioned avoidance of prey in coyotes. J. Wildl. Manage. 42:676-679.

Sargeant, A. B. and D. H. Johnson. 1977. Impact of red fox predation on the sex ratio of prairie mallards. Final Report: U.S. Fish Wildl. Serv. Wildl. Res. Rep. 6. 30pp.

Sheaffer, S. E. 1982. Effectiveness of lithium chloride in reducing waterfowl nest predation. MS Thesis, Univ. Michigan, Ann Arbor. 124pp.

Weller, M. W. 1956. A simple field candler for waterfowl eggs. J. Wildl. Manage. 20:111-113.