ELECTRIC FENCING REDUCES HERON PREDATION AT NORTHEASTERN TROUT HATCHERIES

MARK E. TOBIN, U.S. Department of Agriculture, National Wildlife Research Center, P.O. Drawer 6099, Mississippi State, MS 39762

JAMES F. GLAHN, U.S. Department of Agriculture, National Wildlife Research Center, P.O. Drawer 6099, Mississippi State, MS 39762

ERICA S. RASMUSSEN, U.S. Department of Agriculture, National Wildlife Research Center, 2622 North 625 East, Attica, IN 47918

Abstract: Great blue herons (*Ardea herodius*) are the most common avian predator at commercial trout hatcheries in the northeastern United States. We evaluated a 2-strand electric fence for excluding this species from raceways at 2 commercial trout hatcheries in central Pennsylvania. Fences consisted of high density polyethylene 400-lb strength tape supported by fiberglass posts and energized by either a battery-powered or a solar-powered fence charger. Labor and material for constructing the fences at the 2 sites averaged $1.32/m of raceway. Bird visitation at the 2 sites initially declined, but returned to pre-installation levels. However, bird use of raceways declined ($P<0.05$) at both sites compared to pre-installation levels for the duration of the study (49-62 days post-installation). Fences must be monitored to detect electrical shortages and to ensure that birds do not gain access to raceways under the bottom strand of the fence or forage between the fence and the shoreline. The 2-strand fence evaluated in this study is a cost-effective method for deterring heron predation at commercial trout hatcheries.

Key Words: *Ardea herodius*, depredation, deterrent, electric fencing, great blue heron, raceway

Proc. East. Wildl. Damage Manage. Conf. 8:70-76

Predation by birds is a significant problem at commercial trout hatcheries in the northeastern United States (Parkhurst et al. 1992, Pough 1941). According to a 1996 survey, 80% of aquaculture facilities in New Jersey, New York, and Pennsylvania sustained annual losses as high as $500,000 (Glahn 1997). At least 8 species of birds forage regularly at commercial fish farms in the northeastern U.S., including great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), green herons (*Butorides virescens*), mallards (*Anas platyrhynchos*), osprey (*Pandion haliaetus*), common grackles (*Quiscalus quiscula*), belted kingfishers (*Ceryle alcyon*). Great blue herons are the most ubiquitous and common predator (Glahn 1997).

Many methods are available for reducing bird predation at fish-rearing facilities (Mott 1978, Draulans 1987, Curtis et al. 1996), but few are both practical and effective. Many farmers harass birds to drive them away from their farms. However, such methods either are prohibitively labor-intensive or eventually lose their effectiveness because of habituation by birds. Farmers also can reduce local populations of depredating birds by shooting or trapping them. However, almost all species of birds are protected by state and federal laws and international treaties, and the required regulatory permits sometimes are difficult to obtain. Physical barriers ranging from overhead wires to complete enclosures provide varying degrees of protection. The most elaborate enclosures potentially are 100% effective, but are prohibitively expensive for most commercial enterprises and may interfere with other farm operations.

Electric fencing may provide a less expensive deterrent that is easier to construct than conventional exclusion systems (McKillop and Sibly 1988). Ramsey et al. (1989) described a 5-strand electric barrier that excluded great egrets (*Ardea alba*) and snowy egrets (*Egretta thula*) from preying on mosquitofish (*Gambusia affinis*) in California. More recently, Mott and Flynt

(1995) demonstrated the utility of a 2-strand electric fence for reducing wading bird predation at commercial catfish farms in Mississippi. We evaluated a similar 2-strand fence for reducing great blue heron predation at commercial trout farms in Pennsylvania.

D.S. Reinhold and C. Shershanovich assisted with the field work. R.M. Engeman advised on the statistical analyses. M.L. Avery, D.T. King, and R.G. McLean reviewed an earlier draft of the manuscript.

METHODS

We evaluated the fencing between August and November 1996 at 2 trout hatcheries owned and operated by Cedar Springs Hatchery in Clinton County, central Pennsylvania. Both facilities contained a variety of trout species (e.g., rainbow, *Salmo gairdneri*; brook, *Salvelinus fontinalis*; and brown, *Salmo trutta*) that ranged in length from 7 to 60 cm. One facility (Barn site) was located 3 km north of Lamar and contained 3 parallel earthen raceways that were 3-6 m wide and 400-550 m long. The Barn site was surrounded by rolling farmland and scattered patches of mature woods. The second facility (Salona site) was located 7 km northeast from Barn site and contained 4 parallel raceways, each of which was 3-6 m wide. Two raceways at Salona were 70 m long, and two were 45 m long. The Salona site was secluded, surrounded by mature woods and grass fields. All raceways at both sites were partitioned at 30-m intervals by wooden walkways. At both sites, human disturbance was limited to normal hatchery operations.

We erected an electric fence around each of 3 raceways at each site; 1 of the raceways at Salona was drained just prior to the start of this study. Each fence consisted of 2 strands of high density polyethylene 400-lb tensile strength tape (polytape) supported by fiberglass posts (1.2 m length and 1.5 cm diameter) positioned at 5-10-m intervals around the perimeter of the raceway. Posts were set in the water 15-30 cm from the edge of the water, depending on the configuration of the raceway and the depth of water. We cleared potentially intruding vegetation from the path of the fence before attaching the polytape to the posts with plastic insulators. The 2 strands of polytape were 15-30 cm apart, with the lower strand 15-30 cm above the surface of the water. The polytape was 1.65 cm wide and was interwoven with 7 tinned aluminum wires. Each fence was powered by a 12-volt battery or a solar fence charger. Each produced a high voltage pulse for 1/4,000 sec every second. We installed "gates" where workers could disconnect the polytape to enter the raceways.

We monitored heron use of raceways before and after installation of the fence at each site by conducting 4 bird counts during each of the weeks preceding and following installation, as well as additional counts up to 62 days after installation. Each bird count consisted of 2 paired 2-h observation periods conducted within 2 h of sunrise and 2 h of sunset, respectively. The morning observation periods were initiated at first light (usually 10-15 min before sunrise), and the evening observation periods usually ended 10-30 min after sunset. During each 2-h observation period, we sat in a vehicle >50 m from the raceways and at 5-min intervals used binoculars to count the number of herons in the raceways as well as the total number of herons (inside and outside the raceways) at the facility.

We used Kruskal-Wallis 1-way analysis of variance and multiple comparison procedures (Hollander and Wolfe 1973) to detect differences over time in number of herons observed. We divided the study into discrete periods at each site for comparison. These periods encompassed 1-7 days before and 0-3, 12-19, and 41-47 days after installation of the fences at Salona and 4-7 days before and 0-8, 11-19, 27-34, and 55-62 days after installation at Barn site. We analyzed the 2 sites separately.

RESULTS

Total number of birds observed at Salona varied among observation periods (χ^2=9.78, df=3, *P*=0.02) and was greater (*P*<0.05) before installation of the fences than either 0-4 days or 12-19 days after installation (Fig. 1). By the final observation period (41-47 days post-installation), heron numbers increased (*P*<0.05) compared to the first post-installation period and were similar to pre-installation levels. Bird use of raceways at Salona also varied among observation periods (χ^2=7.56, df=3, P=0.06) and declined from about 6-14 birds/hour/day before electric fences were installed to <3 birds/hour/day after installation (Fig. 1). We recorded fewer (P<0.05) herons in the raceways during all post-installation observation periods than during the pre-installation observation period.

Total number of herons visiting the Barn site fluctuated widely, but did not vary consistently among observation periods (χ^2=2.34, df=4, P=0.67) (Fig. 2). However, heron use of raceways differed among observation periods (χ^2=9.84, df=4, P=0.04) and was less (P<0.05) during all post-installation observation periods than during the pre-installation observation period (Fig. 2). Number of herons in the raceways declined from 76-159 herons/hour/day before installation of the fences to <58 herons/hour/day after installation. The slight increase on the third and fourth days after installation probably was due to the fence shorting out in several places. After we corrected the problem, bird use of raceways declined to <22 birds/hour/day (Fig. 2).

Costs for materials per meter of fence ranged from \$1.24 at Barn site to \$1.40 at Salona (Table 1). At the former site, we expended 6 person-hours closing gaps where we observed herons entering the raceways. At Barn site, we also installed extra posts near the crosswalks to prevent herons from penetrating under the bottom strand of the fence and added additional fencing to prevent herons from landing on and fishing from the crosswalks.

DISCUSSION

Two-strand electric fences significantly reduced heron use of trout raceways. Birds that contacted a charged fence squawked and quickly retreated, and heron use of protected raceways declined throughout the post-installation observation periods. Besides a few birds flying over the fence to enter the raceways, we saw little evidence that herons habituated to or otherwise learned to circumvent the fence. The fencing may have hampered foraging even of herons that circumvented the barriers (Parkhurst 1989).

The immediate decline in numbers of herons visiting both sites during the first morning after the fences were installed suggests an initial neophobic reaction to the fences. Bird numbers at both sites declined on the first day following installation of the fences even though no birds had contacted the fences or been shocked. Heron visitation subsequently increased at both farms, albeit more quickly at Barn site, and eventually returned to pre-installation levels. Even after heron visitation increased to pre-installation levels, heron foraging in the trout raceways remained depressed.

Fences must be monitored to ensure proper functioning. We used a hand-held voltage meter to detect electrical shortages caused by fluctuating water levels, encroaching vegetation, or sagging wires and to verify that fences were carrying an adequate charge of 3,000 volts. Fences around large raceways may require >1 fence charger and/or battery to maintain sufficient voltage. Birds should be observed periodically to determine whether they are gaining access under the fence or foraging between the fence and the shoreline.

Excluding birds from ponds or raceways often is more effective than lethal or scaring techniques for reducing predation on fish (Draulans 1987). Totally excluding birds with netting probably is the most effective method for reducing damage, but it also is costly and may interfere with other farming operations (Parkhurst 1989). Electric fences provide a cheaper alternative where wading birds are the primary concern (McKillop et al. 1988). The 2-strand electric fencing we evaluated is well-suited for protecting earthen trout raceways from predation by great blue herons and other wading birds. The "gates" allowed for easy access of workers into the raceways, and thus compatibility with other farm operations. The fencing was easy to install, non-lethal, and, most importantly, effective.

LITERATURE CITED

Curtis, K.S., W.C. Pitt, and M.R. Conover. 1996. Overview of techniques for reducing bird predation at aquaculture facilities. The Jack H. Berryman Institute Publication 12. Utah State University, Logan. 20pp.

Draulans, D. 1987. The effectiveness of attempts to reduce predation by fish-eating birds: a review. Biological Conservation 41:219-232.

Glahn, J.F. 1997. Bird predation and its control at aquaculture facilities in the northeastern United States. U.S. Department of Agriculture, Animal and Plant Health Inspection Service Bulletin 11-55-009. 17pp.

Hollander, M., and D.A. Wolfe. 1973. Pages 114-129 *in* Nonparametric statistical methods. John Wiley & Sons, Inc., New York.

McKillop, I.G., and R.M. Sibly. 1988. Animal behaviour at electric fences and the implications for management. Mammal Review 18:91-103.

Mott, D.F. 1978. Control of wading bird predation at fish-rearing facilities. Pages 131-132 *in* Wading Birds, Research Report #7, National Audubon Society.

Mott, D.F., and R.D. Flynt. 1995. Evaluation of an electric fence system for excluding wading birds at catfish ponds. Progressive Fish-Culturist 57:88-90.

Parkhurst, J.A. 1989. Assessment and management of wildlife depredation at fish-rearing facilities in central Pennsylvania. Dissertation, The Pennsylvania State University, University Park. 247pp.

Parkhurst, J.A., R.P. Brooks, and D.E. Arnold. 1992. Assessment of predation at trout hatcheries in central Pennsylvania. Wildlife Society Bulletin 20:411-419.

Pough, R.H. 1941. The fish-eating bird problem at the fish hatcheries of the Northeast. Transactions of the North American Wildlife Conference 5:203-206.

Ramsey, R.T., J.F. Cavier, Jr., and R.L. Coykendall. 1989. The design and construction of an electric bird barrier to prevent mosquitofish depredation. Pages 1-2 *in* Kramer, ed. California Mosquito and Vector Control Association., Biological Briefs 15, Concord.

Table 1. Average costs of materials to construct a 2-strand electric fence around each of 3 trout raceways at the Barn site of Cedar Springs Hatchery in Clinton County, central Pennsylvania, August 1997. The fencing protected 3 raceways with a combined perimeter of 2520 m.

Item	Unit cost ($)	Quantity	Total cost ($)
Fence charger (6/12 volt)	77.99	1	77.99
Battery (12-volt)	86.99	2	173.98
Battery charger	50.00	1	50.00
Polywire (200 m)	44.99	16	719.84
Fence posts	1.49	165	245.85
Insulators (25)	2.49	14	34.86
Ground wire	12.99	1	12.99
Grounding rod	24.99	1	24.99
Gate handles	1.99	10	19.90
Labor (person-hours)	7.00	18	126.00
TOTAL			1486.40

Table 2. Average costs of materials to construct a 2-strand electric fence around each of 3 trout raceways at Salona site of Cedar Springs Hatchery in Clinton County, central Pennsylvania, August 1997. The fencing protected 3 raceways with a combined perimeter of 1260 m.

Item	Unit cost ($)	Quantity	Total cost ($)
Solar charger	204.99	1	204.99
Polywire (200 m)	44.99	8	359.92
Fence posts	1.49	85	126.65
Insulators (25)	2.49	7	17.43
Ground wire	12.99	1	12.99
Grounding rod	24.99	1	24.99
Gate handles	1.99	6	11.94
Labor (person-hours)	7.00	12	84.00
TOTAL			842.91

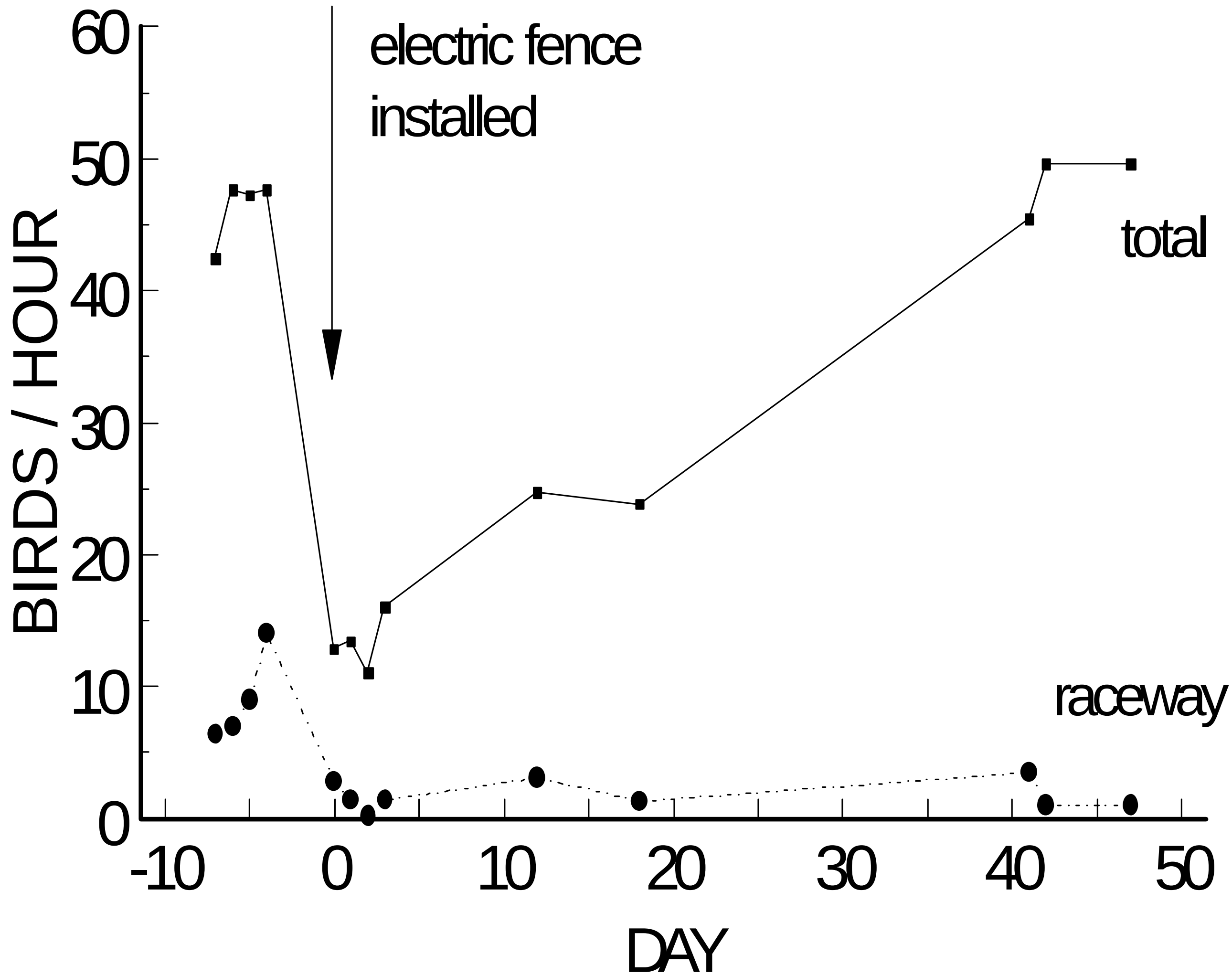

Fig. 1. Great blue heron activity in the vicinity of the site and in raceways before and after installation of 2-strand electric fences around fish raceways at Salona site of the Cedar Springs trout hatchery in central Pennsylvania, August and November 1996.

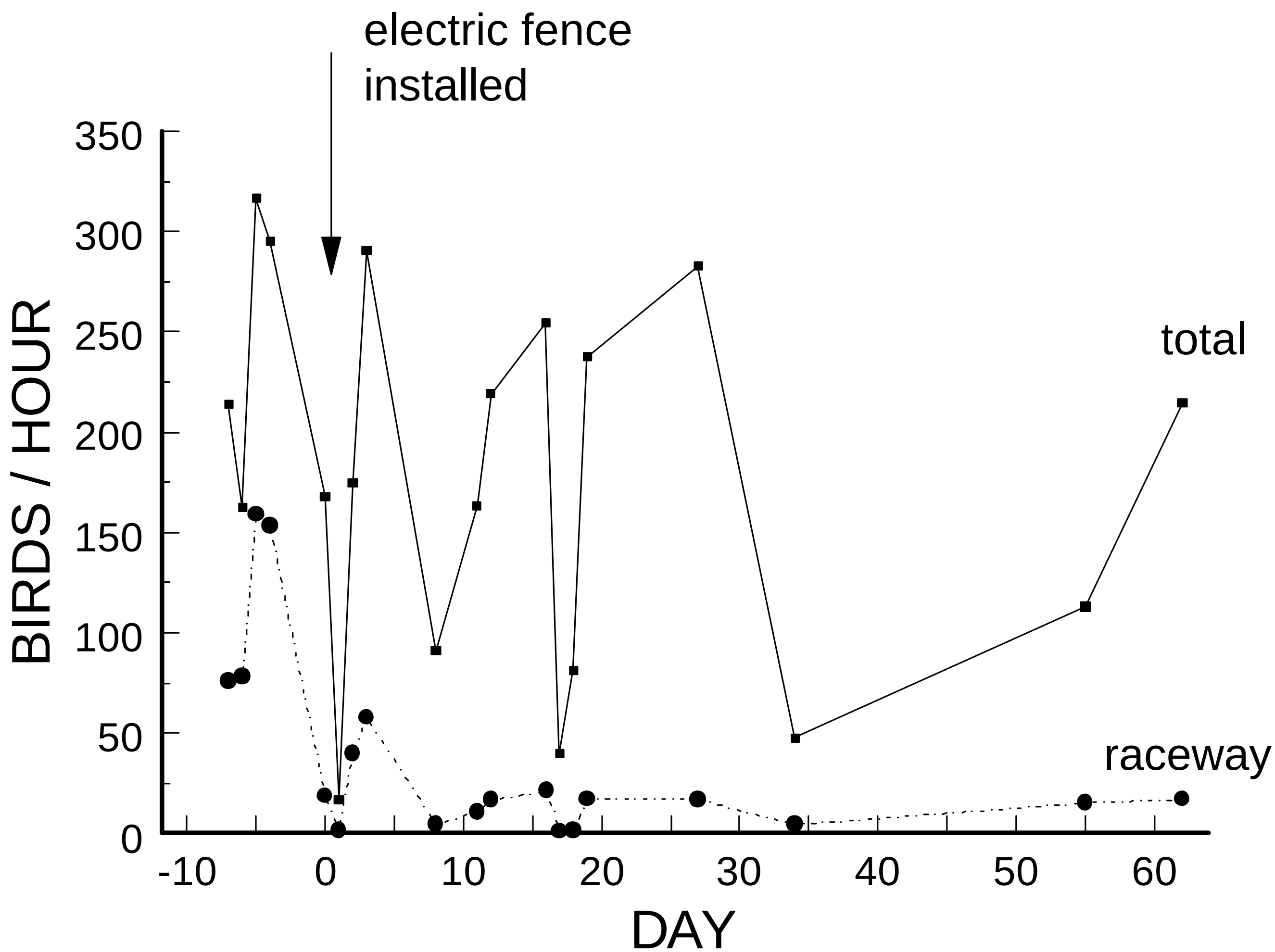

Fig. 2. Great blue heron activity in the vicinity of the site and in raceways before and after installation of 2-strand electric fences around fish raceways at Barn site of the Cedar Springs trout hatchery in central Pennsylvania, August and November 1996.