J. Field Ornithol., 66(1):37–43

AN INEXPENSIVE AND AUTOMATIC MULTIPLE-EXPOSURE PHOTOGRAPHIC SYSTEM

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Abstract.—This paper describes the design, construction and deployment of a simple automatic camera system that was used to document the identities of scavengers on the carcasses of migratory fishes. The camera system functioned properly in adverse weather during extended deployment, and recorded a wide range of terrestrial vertebrate species under natural conditions. Bird species recorded by the device included Red-shouldered Hawk (*Buteo lineatus*), Common Crow (*Corvus brachyrhynchos*), Turkey Vulture (*Cathartes aura*), and Great Blue Heron (*Ardea herodias*). The inexpensive photographic system may have wider application to other studies of bird behavior and distribution.

UN SISTEMA AUTOMÁTICO ECONÓMICO PARA TOMAR MÚLTIPLES EXPOSICIONES FOTOGRÁFICAS

Sinopsis.—Se describe el diseño, la construcción y el montaje de un sencillo sistema fotográfico que se usó para documentar la identidad de animales carroñeros que se alimentaron de los cuerpos de peces migratorios. El sistema fotográfico funcionó bien bajo condiciones climáticas adversas a través del tiempo, y recopiló evidencia de una gran variedad de vertebrados terrestres bajo condiciones naturales. Aves identificadas gracias a este sistema incluyen *Buteo lineatus, Corvus brachyrhynchos, Cathartes aura* y *Ardea herodias*. Este económico sistema fotográfico puede tener un uso más amplio en otros estudios sobre el comportamiento y la distribución de aves.

Few descriptions of inexpensive camera systems designed to document automatically the activities of birds and other wildlife have been published. Early camera system designs employed a shutter release mechanism that was manually reset between each exposure (Gysel and Davis 1956) or a movie camera with a synchronized flash (Dodge and Snyder 1960, Osterberg 1962). Carthew and Slater (1991) presented an effective but relatively expensive multiple-exposure automatic photography system. Goetz (1981) described an inexpensive, multiple-exposure automatic photography system using a polaroid-type camera; however, the number of consecutive exposures was limited by the size of the flash bar and film pack. We designed a simple, 35-mm automatic photography system that cost under $100 (U.S.) to document terrestrial scavengers of post-spawning blueback herring (*Alosa aestivalis*) carcasses.

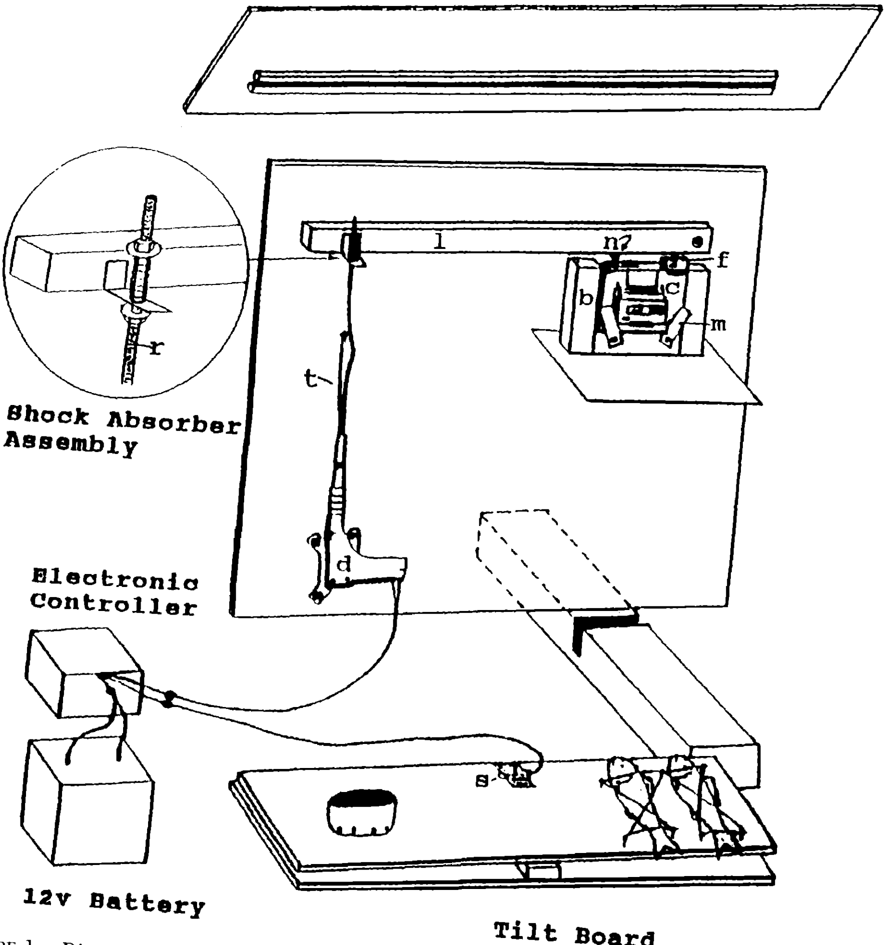

FIGURE 1. Diagram of camera mount, 12-V battery, control panel, shock absorber assembly and baited trigger mechanism in the ready position.

DESCRIPTION OF DEVICE

Camera and mount.—We used an inexpensive ($30) focus-free, compact camera (Concord model AW905) featuring a motorized film advance and an electronic flash. The camera (c) was held on a rigid board between three wooden braces (b) and two movable tabs (m) (Fig. 1). A 3-cm diameter hole was drilled in the board behind the view finder to enable the operator to aim the camera. The camera, with the flash (f) in the up position, was placed in the holder and a lever arm (1) with a rubber nipple (n) over the shutter button was mounted above the camera. A 12-

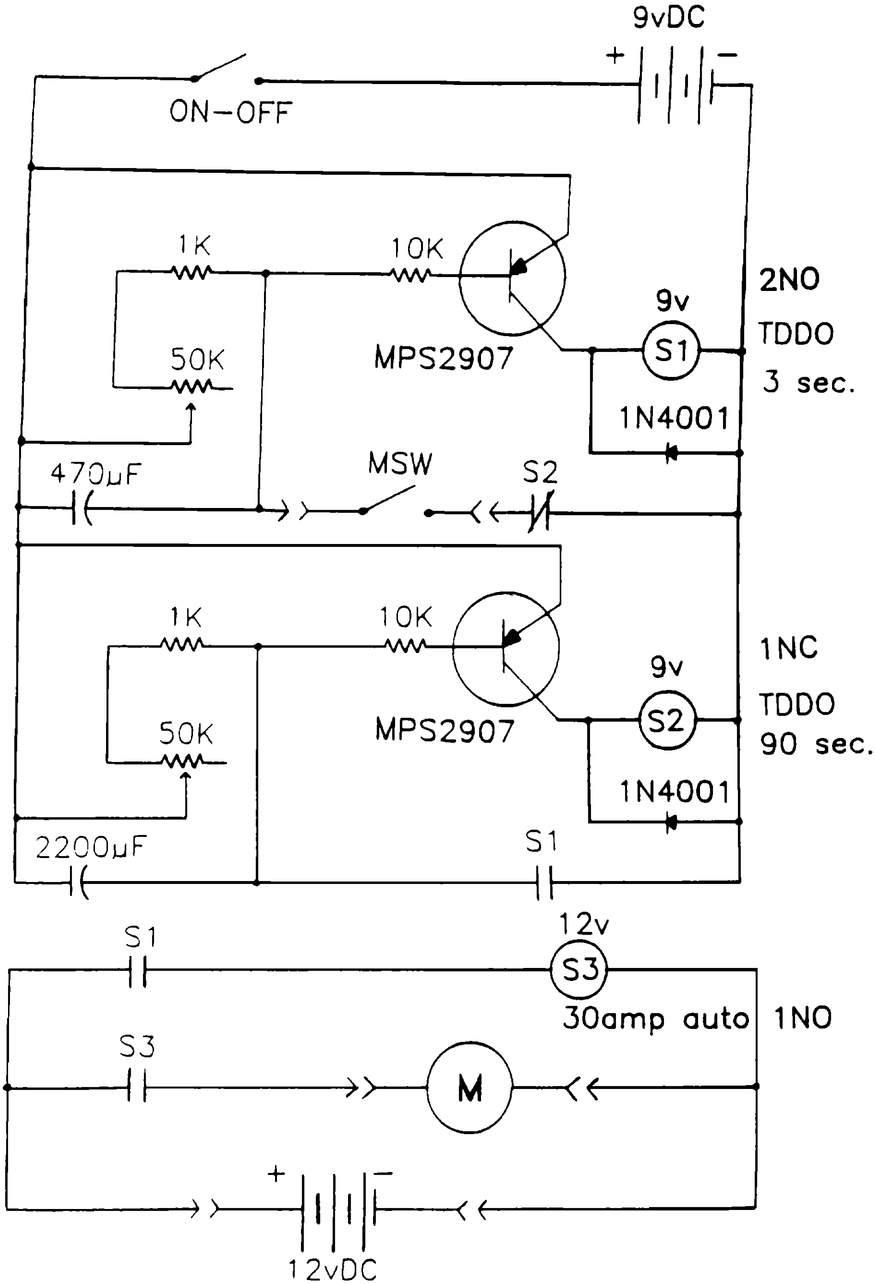

FIGURE 2. Schematic diagram of electric control panel for the automatic camera system.

TABLE 1. Basic parts list for automatic camera system.

Part description	Quantity
Relay SPDT, 7-9V 2L	2
Auto relay, 30 amp	1
Transistor MPS2907	2
Resistor PK2 1K, ½w	2
Resistor PK2 10K, ½w	2
Diode PK2 1N4001	2
Capacitor 470MFD	1
Capacitor 2200MFD	1
Rheostat 50K control	2
Knob PK4, 1.91-cm	2
Miniature toggle switch	1
Battery holder 6 "D" cells	1
Mercury bulb switch	1
Automotive throttle-return spring	1
Threaded rod 25.4- × 0.32-cm	1
Automotive electric door locker	1

V automobile door-lock motor (d) was positioned so that the lock linkage held the rubber nipple of the lever arm 3 mm above the shutter button. An adjustable shock absorber assembly, consisting of a small spring, threaded rod (r), two nuts, and two washers cushioned the impact on the camera, and an automobile throttle-return spring (t) retracted the arm. A slotted wooden beam was used as a base to hold the camera mount in a vertical position. To weatherproof the camera, a plywood splash guard was mounted below the camera holder and a roof was constructed from plywood and two wood strips. The base and roof were removable to facilitate transport of the camera system.

Trigger mechanism.—Fish carcasses were secured with monofilament line to a tilt board, and the opposite end of the board was counter-weighted such that a slight downward force tilted the board (Fig. 1). When the herring carcass was disturbed and the tilt board was depressed, a mercury bulb switch (s) completed an electric circuit.

Electronic panel.—The system controller consisted of two simple timing circuits. When the mercury switch on the tilt board was closed, relays S1, S2 and S3 were energized (Fig. 2). Relay S3 actuated the door-lock motor causing the camera to take a photograph. The energized S2 relay de-energized S1, and after an adjustable time delay of 1–7 s, S1 "dropped out." When S1 dropped out, S3 immediately dropped out and a spring retracted the lever arm. Also, S2 was de-energized and dropped out with an adjustable time delay of 20–90 s. The time delay dropout of S2 inhib-

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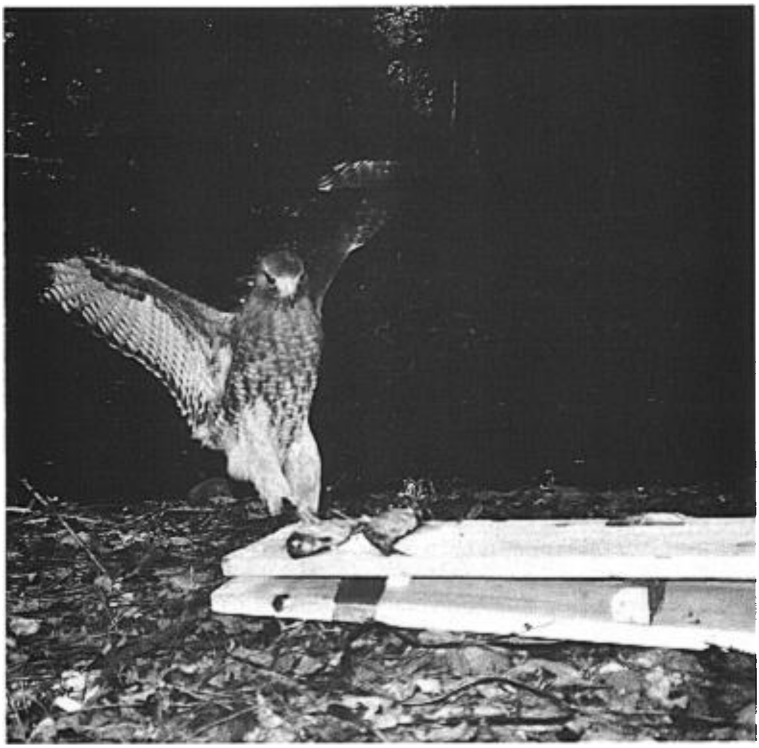
FIGURE 3. Red-shouldered Hawk (*Buteo lineatus*) and Raccoon (*Procyon lotor*) scavenging on fish carcasses.




12
9
3
6

ited another cycle. After S2 dropped out, another cycle could be initiated when the mercury switch was closed. The electronic panel and its 9-V power supply were contained in a weatherproof plastic box. System hookup involved three connections to the electronic panel: (1) the mercury switch, (2) the motor and (3) a 12-V automotive battery. A list of specific camera system components is provided in Table 1.

RESULTS AND DISCUSSION

In addition to low cost and portability, our system provided several advantages over previously published photographic systems used to document the feeding activities of animals. Specifically, the system required infrequent monitoring, photographed a wide diversity of taxa and organism sizes, and when a clock was placed in the camera's field of view, the time of activity was recorded.

When the trigger device was placed at the camera's minimum focal length (1 m), the system produced good photographs and permitted easy identification of scavengers (Fig. 3). Best results were obtained using ASA 100 film in the day and night. The flash tended to frighten animals after the first picture, but most returned to feed again. To prevent prolonged application of current to the door lock motor and to provide sufficient time for the electronic flash to recycle, the dropouts of the timing relays were set at 3 and 90 s, respectively. When the camera system was inactive, energy drain on the three power supplies was minimal. The camera batteries (two AA alkaline cells) and the 9-V electronic control battery pack (six 1.5-V "D" cells) lasted ≥5 d. The automotive battery was recharged biweekly.

The system performed successfully under extreme weather conditions, including heavy sleet and rain. During our study, the system documented daytime scavenging by a feral dog (*Canis familiaris*) and four bird species: Red-shouldered Hawk (*Buteo lineatus*), Common Crow (*Corvus brachyrhynchos*), Turkey Vulture (*Cathartes aura*), and Great Blue Heron (*Ardea herodias*). At night, opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and northern water snake (*Nerodia sipedon*) were photographed.

This photographic system is applicable to other studies because the trigger mechanism can be anything that closes or opens an electrical circuit. Other possibilities to document the presence of animals along trails and runways include a trip wire or a motion detector. An infrared breakbeam mechanism was employed initially as a trigger by the present study, but was later replaced by the tilt-board because the former mechanism was activated by the large number of insects attracted to the fish carcasses.

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Received 16 Aug. 1993; accepted 18 Mar. 1994.

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