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A portable, remote-controlled nest-box trap

Cardy H. Saunders[1,2] and Dave Shutler[1]

[1]*Department of Biology, Acadia University, 15 University Avenue, Wolfville, Nova Scotia B4P 2R6, Canada*

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ABSTRACT. Many researchers catch adult birds at nest boxes using a vertical prop that supports a horizontal flap that drops down when an adult enters to feed nestlings. Because the prop is visible, some birds may be too wary to enter nest boxes, or they may dislodge the prop when they lean in; either way, they are not captured. We describe a remote-controlled nest-box trap that has the advantages of portability and being invisible to adults delivering food to nestlings. A receiver is installed on the ceiling of a nest box, the receiver is connected to a spring-loaded flap that is triggered remotely with a transmitter from > 30 m away, and the flap drops down to cover the box entrance. In 2017 and 2018, our remote-controlled traps did not increase the likelihood of capturing female Tree Swallows (*Tachycineta bicolor*), but did improve the likelihood of capturing males. We captured 16 male Tree Swallows in 30 attempts (53.3%) using our remote-controlled trap compared to only 41 captures of males in 139 attempts (29.5%) with prop traps. In addition, whereas prop traps required an average of ~ 50 min to capture adults in successful attempts, our trap required only ~ 25 min. These results suggest that the savings in time for field researchers using our remote-controlled trap can be substantial, with the added ethical benefit of reducing the amount of time that nestlings are not being fed. Our remote-controlled trap is also economical to construct, requiring ~ $60 USD for parts and < 3 h to build.

RESUMEN. **Una trampa de nidos portátil y controlada a distancia**
Muchos investigadores capturan aves adultas en cajas nido utilizando un soporte vertical que soporta un solapa horizontal que cae cuando un adulto ingresa para alimentar a los pichones. Debido a que el pilar es visible, algunas aves pueden ser demasiado cautelosas para ingresar a las cajas nido, o pueden expulsar el pilar cuando se apoyan; De cualquier manera, no son capturados. Describimos una trampa de nidos con control remoto que tiene las ventajas de ser portátil y de ser invisible para los adultos que entregan alimentos a los pichones. Un receptor se instala en el techo de una caja nido, el receptor está conectado a una solapa accionada por resorte que se activa de forma remota con un transmisor > 30 m de distancia, y la solapa cae para cubrir la entrada de la caja. En 2017 y 2018, nuestras trampas controladas a distancia no aumentaron la probabilidad de capturar golondrinas de árbol (*Tachycineta bicolor*), pero sí mejoraron la probabilidad de capturar machos. Capturamos 16 golondrinas macho en 30 intentos (53.3%) usando nuestra trampa con control remoto en comparación con solo 41 capturas de machos en 139 intentos (29.5%) con trampas de utilería. Además, mientras que las trampas de utilería requerían un promedio de ~ 50 min para capturar adultos en intentos exitosos, nuestra trampa solo requirió ~ 25 min. Estos resultados sugieren que el ahorro en tiempo para los investigadores de campo que utilizan nuestra trampa controlada a distancia puede ser considerable, con el beneficio ético adicional de reducir la cantidad de tiempo durante la cual no se alimenta a los polluelos. Nuestra trampa con control remoto también es económica de construir, ya que requiere ~ $60 USD para las piezas y < 3 h para la construcción.

Key words: cavity-nester, prop trap, radio-controlled trap, *Tachycineta bicolor*, Tree Swallow

Many traps designed to catch cavity-nesting birds rely on concealed, hinged flaps that are propped inside and above cavity entrances, particularly for species that use nest boxes. Flaps drop down and cover the exit when the prop is dislodged (e.g., Magnusson 1984, Stutchbury and Robertson 1986; hereafter, prop traps). However, props are visible and can deter birds from entering boxes (Friedman et al. 2008), such as male Tree Swallows (*Tachycineta bicolor*; Lombardo and Kemly 1983). A second problem with prop traps and Tree Swallows (DS, pers. observ.) is that birds may lean into a nest-box hole and dislodge the prop without being captured. Both wariness and inadvertent triggering can add substantial time to efforts to capture adults. A wig-wag trap, essentially a wooden lath drawn remotely by an observer over the front of the door using a string or fishing line (http://golondrinas.cornell.edu/), may circumvent this problem, but these traps can be difficult to operate where vegetation obscures a researcher's view of a box entrance (DS, pers. observ.). Birds may also detect the string; again, wariness may reduce capture

[2]Corresponding author. Email: dave.shutler@acadiau.ca

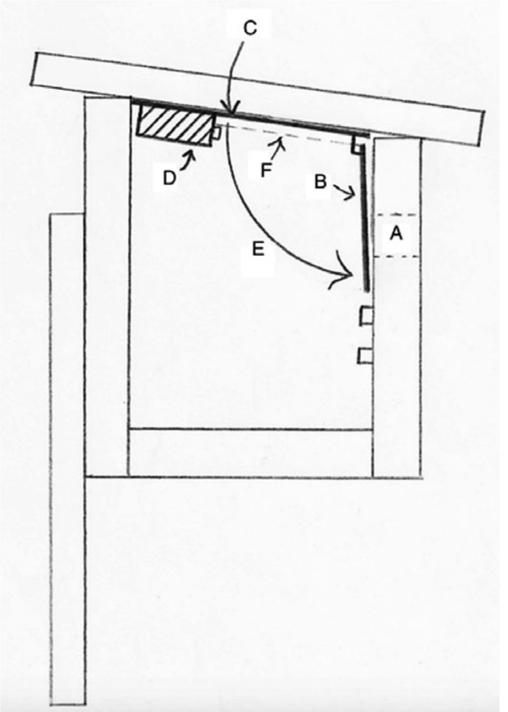

Fig. 1. A Golondrinas nest box shown with the door removed. (A) Box entrance, (B) Metal flap that has been released from the trap in the ceiling, (C) Original, resting position of flap in B, (D) Electronics (see Figs. 2 and 3), (E) Path of metal flap once remotely triggered, and (F) Metal plate that houses the unit. Our trap is slid above where the door would be along the ceiling to the far side of the box, where metal tongues (right side of F) engage with spaces above the far wall and below the ceiling.

success (DS, pers. observ.). Finally, there is also the risk of a bird getting caught between entrance holes and laths.

Lombardo and Kemly (1983) developed a radio-controlled mechanism that used a radio-frequency (RF) transmitter/receiver link to activate a servomechanism to block nest-box exits. Their design required nest boxes with removable roofs that allowed their trap to be installed; moreover, if not properly secured afterwards, loose roofs could facilitate access by predators. More recently, Friedman et al. (2008) described a horizontal prop that was inserted through ventilation gaps above the door and the far wall and close to the ceiling of a nest box. The prop supports the same type of flap as above, but makes the prop invisible from outside a box. However, this design requires a draw string to pull the prop out, and the draw string may be difficult to conceal under some circumstances. Here we describe a portable, electronic trap that is not visible from the outside of a nest box, does not use a draw string, and does not require removing a box's roof.

METHODS

Our compact unit was designed for use with the Golondrinas nest-box design (http://golondrinas.cornell.edu/) that has a lateral, hinged access door (Figs. 1 and S1). With this design, the door swings up on a pair of pivots so there is only a small space below the ceiling available for a mechanism to slide in and fit without interfering with researcher access. Securing the unit is facilitated because part of the box design leaves narrow slits for aeration along both top edges where the roof meets the access door and the opposite wall. An ~ 1-mm-thick metal plate has trap components epoxied to it. The metal plate has a few "fingers" that extend out from one side that are inserted in the far side of the box over the far wall; the unit is then secured by the hinged access door on the near side, keeping the unit against the ceiling of the box (Fig. 1; operation of the trap is shown at https://youtu.be/ghzg6Kz_wR8; detailed instruction on assembly and operation are at https://www.youtube.com/watch?v=Fys-OZnUw9s; also see Videos S1 and S2 and Appendix S1).

To allow multiple units to work independently in a small area, learning-code receivers and unique-code transmitters (Figs. 2, 3, and S2–S6) were used to prevent radio-signal interference; we encountered no problems with operating four units, and suspect that any number could be used, provided that each had a unique radio-frequency code. Effective range of the transmitter/receiver we used was > 30 m, a distance sufficient to prevent wariness for most male Tree Swallows. The pre-built transmitter module was designed to use an uncommon battery (type A23, a 12-volt cell in a sub-AAA format; Figs. 2 and 3). Step-up buck-type voltage converters were used with standard 9-volt batteries to provide the 12 volts needed for transmitters and to provide the 12 volts that receiver units require

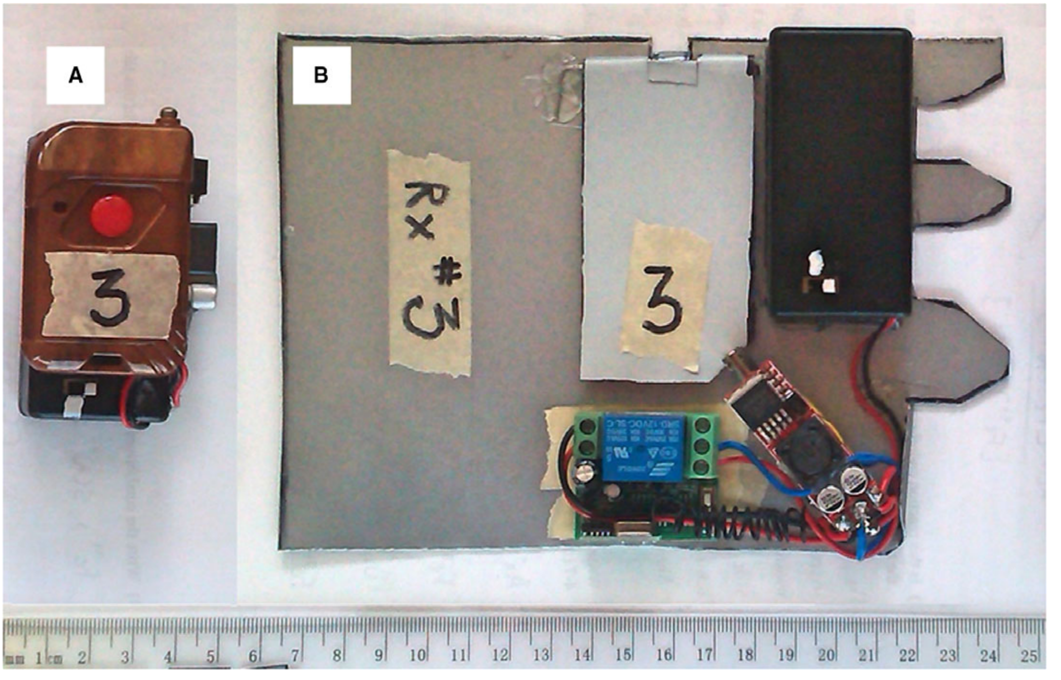

Fig. 2. Image of remote-controlled nest-box trap (also see https://youtu.be/ghzg6Kz_wR8). The “3” identifies one of four units we tested in 2017 and 2018. [Color figure can be viewed at wileyonlinelibrary.com]

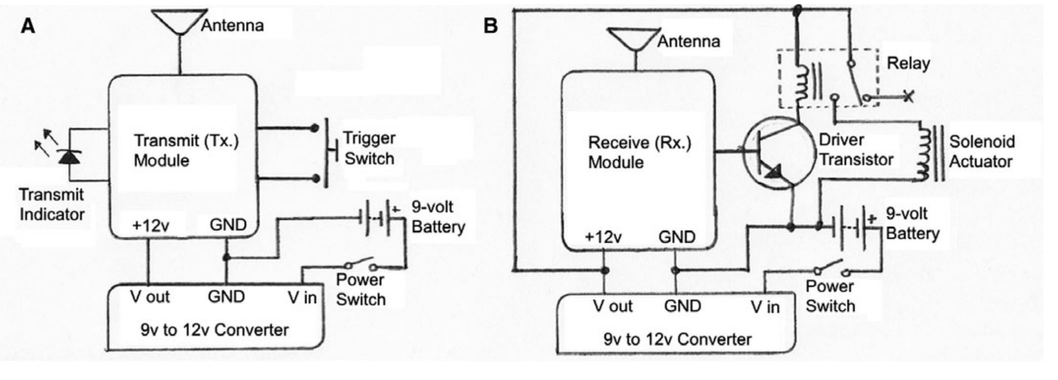

Fig. 3. Electronic schematics for building our remote-controlled traps (also see https://www.youtube.com/watch?v=Fys-OZnUw9s and Supporting Information). (A) Transmitter, and (B) Receiver.

to operate both the receiver circuitry and solenoid actuator. The decision to use a standard 9-volt battery was also made to reduce replacement frequency. Briefly, A23 cells typically have a capacity in the range of tens of milliampere-hours (mAh), whereas a typical 9-volt alkaline battery has many hundreds of mAh capacity and can, therefore, function adequately for a greater number of uses before requiring replacement or recharging.

To operate the unit, the main battery switch is closed (i.e., turned on) on both the transmitter and the receiver, providing standby current to the relevant circuitry (Figs. 2 and 3; https://youtu.be/ghzg6Kz_wR8 and https://www.youtube.com/watch?v=Fys-OZnUw9s). When the transmitter trigger switch is closed, the transmitter produces a modulated signal that encodes an ID unique to it. The receiver it is paired with is receptive only to signals with that unique ID and, upon detecting it, activates the electromechanical relay connected to it. This closes the circuit between the power source and the solenoid coil, retracting the core. This allows the flap to swing down under spring tension, sealing off the nest-box entrance from inside. The transmitter and receiver then return to standby mode. To remove a unit from a box after deployment, the transmitter trigger switch is activated again, and the door flap pushed manually in and up toward the ceiling until it contacts the base plate of the receiver mechanism. At this point, the transmitter trigger can be released, locking the door flap in the inactive position. The receiver mechanism can then be removed. We field-tested units in 2017 and 2018 and compared our results with prop-trap data collected from 2013 to 2018.

Statistical analyses were run in SAS (SAS Institute, Cary, NC, USA). We used chi-square tests to compare rates of capture between prop and remote traps, and general linear models (GLMs) to compare times needed to capture adults. Sexes were tested separately.

RESULTS

We found no difference between trap types in the likelihood of capturing female Tree Swallows ($\chi^2_1 = 1.1$, $P = 0.30$), capturing 56 females in 131 attempts (42.7%) with prop traps and 14 females in 26 attempts (53.8%) with remote-controlled traps. In contrast, we were significantly more likely to capture male Tree Swallows with remote-controlled traps ($\chi^2_1 = 6.3$, $P = 0.01$), capturing 16 males in 30 attempts (53.3%) compared to 41 in 139 attempts (29.5%) for prop traps. An average of 45.4 ± 32.8 (SD) min was required to capture females ($N = 77$) with prop traps (summed for multiple capture attempts), whereas 20.6 ±14.2 min was required to capture females ($N = 14$) with our remote-controlled trap (GLM, $R^2 = 0.08$, $F_{1,89} = 7.7$, $P = 0.007$). For males, averages were 53.4 ± 35.6 min with prop traps ($N = 93$) and 29.4 ±15.3 min with the remote-controlled trap ($N = 20$; $R^2 = 0.07$, $F_{1,111} = 8.7$, $P = 0.004$).

DISCUSSION

Our remote-controlled traps did not increase the likelihood of capturing female Tree Swallows, but did improve the likelihood of capturing males. Moreover, and perhaps more importantly, our remote-controlled traps required about half as much of time as prop traps to capture adults. This had the additional ethical advantage of reducing the amount of time that nestlings were not being fed.

Our remote-controlled trap can be installed in a nest box in a few seconds. Although our trap requires a specific type of nest box, investigators can, prior to construction, modify the trap's design to suit other box types. The electronic sub-systems of the transmitter and receiver would not require modification, nor would the general design of the door-flap mechanism. The dimensions of the base plate of the receiver mechanism would, however, need to be sized according to the dimensions of nest boxes. The door-flap dimensions of the mechanism may also need modifying to adequately cover the box entrance. This would not add significant extra cost to the construction of the device because the mechanisms would be built to work with a particular box design.

Simple prop traps (Magnusson 1984, Stutchbury and Robertson 1986) can be constructed at minimal cost, as can Friedman et al.'s (2008) horizontal prop trap. The trap described by Lombardo and Kemly (1983) cost less than \$200 USD at the time their paper was published, but we do not know the current cost of a trap of similar design. For our trap, parts were easily obtained (Supporting Information); total cost of parts to make a transmitter and receiver was ~ \$60 USD, and time required to build a trap was between 2 and 3 h (Fig. 2, Appendix S1).

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's web-site.

Fig. S1. Installation of the trap in a nest box.

Fig. S2. Transmitting unit plans.

Fig. S3. Transmitting unit electronics.

Fig. S4. Receiving unit.

Fig. S5. Receiving unit door.

Fig. S6. Receiving unit electronics.

Appendix S1. Materials needed to construct the trap.

Video S1. Simulated field deployment and operation of the remote-controlled nest-box trap.

Video S2. Design, assembly, and explanation of the remote-controlled nest-box trap.