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AN OPTIC DEVICE TO INSPECT NEST BOXES FROM THE GROUND

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Abstract.—Nest boxes used to manage and study some species of owls, American kestrel (*Falco sparverius*), and flying squirrels (*Glaucomys sabrinus*) are most effective when hung high on the boles of trees. Monitoring these boxes by tree climbing is time consuming, may damage the trees, and presents a safety risk. An optic device was developed to peer into large nest boxes hung up to 10.5 m above the ground. The device (nest box checker) consists of a periscope-like head with light source, which is raised to the nest box on a 10.5-m telescoping pole. Unused boxes could be distinguished from boxes with lichen, owls or residual nesting material by viewing the box interior using binoculars. Monitoring boxes with this device took less ($\bar{x}$ = 6.4 ± 1.04 min, range 2.7–13.5) time than climbing to inspect each box ($\bar{x}$ = 7.5 ± 0.98 min, range 2.8–15.0).

UN INSTRUMENTO ÓPTICO PARA INSPECCIONAR CAJAS DE ANIDAMIENTO DESDE EL SUELO

Sinopsis.—Las cajas de anidamiento que por lo general se utilizan para manejar o estudiar algunas especies de buhos, falcones y ardillas, son más efectivas cuando se colocan a gran altura en los árboles. El examinar estas cajas, trepando a los árboles, consume mucho tiempo, puede dañar la vegetación y en ocasiones es peligroso. Se desarrolló un instrumento óptico para examinar cajas a alturas hasta de 10.5 m. El llamado "examinador de cajas" consiste en una cabeza tipo periscopio con una fuente de luz, que es elevado hasta la caja con una vara telescópica. Las cajas utilizadas pueden ser diferenciadas de las no utilizadas, por la presencia de líquenes, o residuos de anidamiento, al poderse observar la caja con la ayuda de binoculares. El examinar estas cajas con este instrumento tomó menos tiempo ($\bar{x}$ = 6.4 ± 1.04 min, alcance 2.7–13.5) que el trepar a los árboles ($\bar{x}$ = 7.5 ± 0.98 min, alcance 2.8–15.0).

For years, nest boxes have been used to manage and study cavity nesting bird populations. Individuals and management agencies maintain systems of nest boxes to supplement natural cavities for passerines, ducks and owls (Mitchell 1988). Nest boxes have also been employed as a research tool to investigate nest-site selection, population biology, demography, mating systems and life history strategies in cavity nesting birds (e.g., Carlsson et al. 1987, Finch 1989, Korpimaki 1988, VanCamp and Henny 1975).

As concern for cavity-nesting species increases, nest boxes will be employed to an even greater extent in both management and research. In the past 3 yr, 50–450 nest boxes have been hung in each of six National Forests in Idaho, Montana, and Oregon (total of 1440 boxes) to monitor and manage the Boreal Owl (*Aegolius funereus*). Monitoring occupancy and productivity of wildlife using large systems of nest boxes requires

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several weeks of field work from skilled field personnel. As nest boxes for Boreal Owls, Saw-whet Owls (*A. acadicus*), flying squirrels (*Glaucomys sabrinus*), and other wildlife must be hung over 4 m high on the bole of trees in regions that receive deep winter snowfall, field personnel checking nest boxes must be skilled tree climbers.

Depending on the method used, repeatedly climbing trees to inspect nest boxes may injure or kill trees (pers. obs.), and presents a safety risk for field workers. During our evaluation of nest boxes as a tool to monitor Boreal Owls (Hayward et al. 1992) we sought a method to inspect nest boxes from the ground, eliminating the need to climb to many of the nest boxes. DeWeese et al. (1975) and Moriarty and McComb (1982) described instruments to peer into small nest cavities after climbing to the hole. In cooperation with the College of Engineering, University of Idaho, we designed a tool to inspect nest boxes hung up to 10.5 m above the ground.

DESCRIPTION OF DEVICE

We designed a "nest-box checker" (NBC) scaled to facilitate inspection of nest boxes hung for our studies of Boreal Owls (Hayward et al. 1992). Our box design followed Korpimaki (1985). Inside box dimensions were: bottom, 20 × 20 cm; front height, 46 cm; back height, 51 cm; and cavity diameter, 9 cm. We constructed nest boxes from rough cut, 3-cm pine and fir. Two to five centimeters of wood chips and saw-dust were placed in the bottom of each box.

Our NBC consists of a periscope-like head (hereafter, header), with light source, which fits on the end of a 10.5-m telescoping pole (Fig. 1, Table 1). To operate the NBC an observer turns on a halogen light in the front of the header, extends the telescoping pole, and inserts the header through the nest box entrance. Brackets on the header align the scope at the proper depth in the nest box. After securing the telescoping pole, the observer is free to release his grip on the pole and peer into the box with the aid of 7–9 power binoculars. After viewing, the header is slipped from the box, telescoping pole collapsed, and the header brought to the ground where the light is turned off.

The header consists of an aluminum mount that attaches the header to an insert in the top of the telescoping pole and an aluminum cross member from which the mirrors, batteries and light source are hung (Fig. 2, Table 2). A tubular shield, made from 22-gauge steel sheet metal, with elliptical openings for light transfer, surrounds the cross member to protect the mirrors and light. The header-pole angle can be adjusted to accommodate different viewing positions from the ground.

Two mirrors transfer the image of the box interior to the observer on the ground. The inner mirror is slightly convex (cut from a convex, replacement, side-mirror for an automobile). The outer mirror is flat. This arrangement permits viewing of about 60% of the bottom of a 20 × 20-cm nest box. By gently turning the telescoping pole while viewing the box, an observer can inspect the entire box bottom. A 6.3 V, 0.15 A,

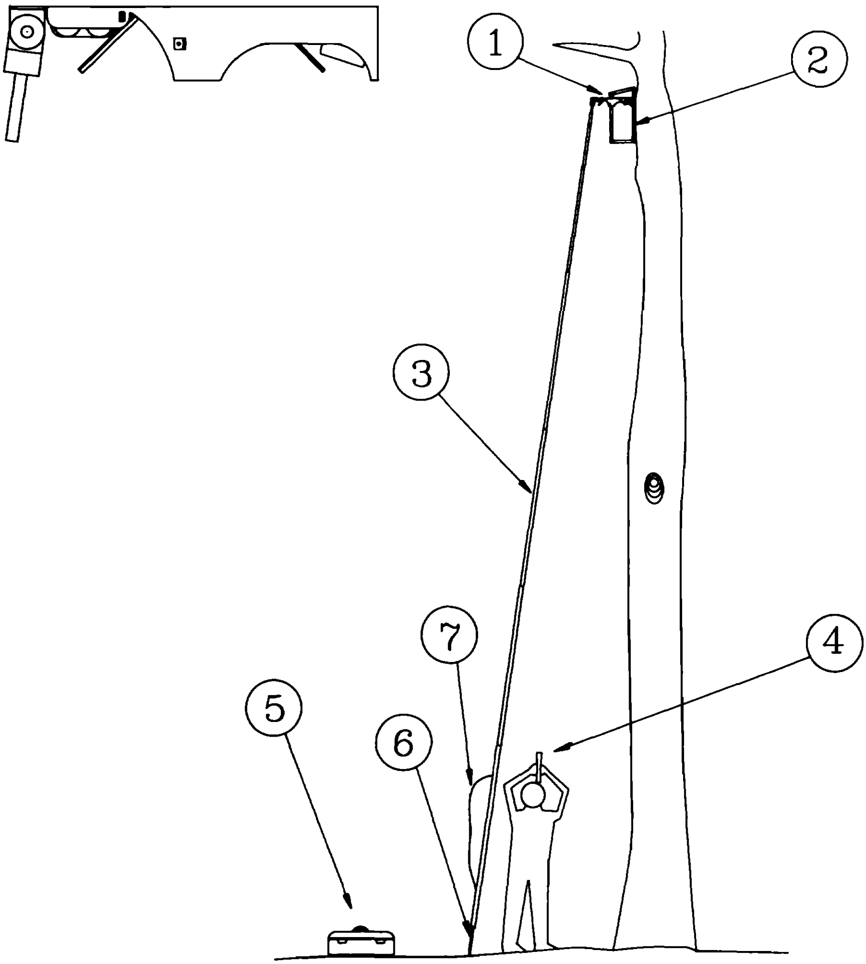

FIGURE 1. Overview of 'box checker' used to peer into large nest boxes.

halogen light bulb is necessary to provide sufficient illumination to distinguish nest contents. The bulb is powered by two, D-size, lithium batteries (Eternacel, by Power Conversion, Inc., available from Recreational Equipment Inc., Seattle, Washington 98138 USA), which weigh less than alkaline batteries but produce 2.9 V each. The lamp set holding the light bulb (item 16 on Fig. 2) may be any available flashlight head that will hold the halogen bulb and illuminate a 15-cm diameter surface when held about 30 cm from the surface.

In 1989, it cost $110.15 (US) for the parts and materials necessary to build the header (including lithium batteries and halogen bulb). An aluminum 10.5 m telescoping pole cost $177.64. Poles ranging from 4.5 to

TABLE 1. Material list corresponding to numbered parts on nest box checker shown in Figure 1.

Part #	Part title	Description
1	Header	Mirror, battery and light unit
2	Nest Box	Existing nest box being checked
3	Telescoping Pole	Tucker 10.5 m pole, Tucker Mfg. Inc., Cedar Rapids, Iowa 52046 (319)365-3591
4	Binoculars	9× binoculars
5	Carrying Box	ToolMaster tool box, Model TM2695, Southern Case, Inc., 2315 Laurelbrook St. Raleigh, North Carolina 27604
6	Spike	Steel spike to secure pole in ground
7	Carrying Strap	Optional nylon strap to aid in transporting pole

13.5 m long may be purchased from Tucker Manufacturing (P.O. Box 848, Cedar Rapids, Iowa 52406 USA). Quality binoculars are also necessary to use the tool at distances greater than 3 m. We recommend purchasing a 29 × 66 × 24-cm tool box and cutting a soft foam insert to protect the header when transporting it with other field gear during extended trips in a vehicle. The header is durable, however, and can be left attached to the telescoping pole during daily field work. (More complete plans for building the NBC can be obtained from GDH.)

TEST OF EFFICIENCY AND ACCURACY

In 1989 we checked over 200 nest boxes for Boreal Owls on the Idaho Panhandle National Forests using the NBC. Compared to monitoring boxes by scaling trees with climbing spurs, operating the NBC resulted in less fatigue. We could distinguish between a box with only wood chips inside (bedding provided when boxes were hung) and boxes in which owls nested. Boxes containing lichen (*Bryoria* spp.) caused problems because the dark lichen could not be distinguished from the dark appearance of a box containing feces and other remains from previous use by owls.

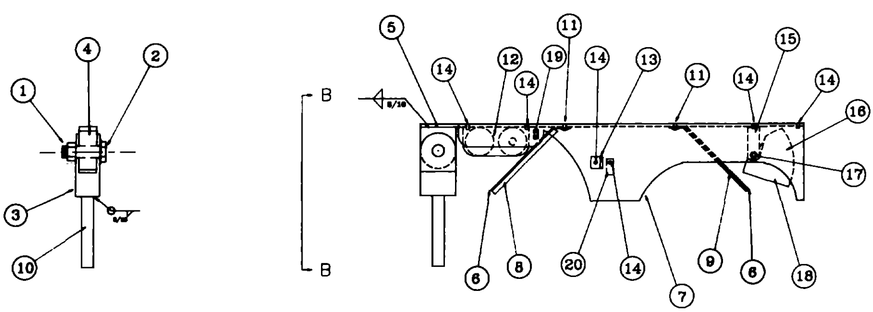

FIGURE 2. Detail of header portion of 'box checker.'

TABLE 2. Material list corresponding to numbered parts on header (and header mount) shown in Figure 2. Part dimensions are in English units.

Part #	Part title	Description
1	Nut	1/2″–20 UNF: Use lock washer with nut
2	Steel Bolt	1/2″–20 UNF: Steel bolt
3	Pole Pin Connector	Machined aluminum
4	Header Pin Connector	Machined aluminum
5	Cross Member	0.125″ thick sheet aluminum
6	Mirror Bracket	Sheet aluminum
7	Tube	22 gauge sheet steel housing
8	Outside Mirror	1/8″ flat mirror
9	Inside Mirror	1/8″ convex mirror
10	Pole Rod	1/2 × 3″ aluminum rod
11	Screw	8-32 × 3/16″ from VSI Fasteners, Inc.
12	Battery Pack	Archer Cat. No. 270-386, 2 D-cell holder
13	Stops	Machined stops
14	Pop Rivet	
15	Light Bracket	Sheet aluminum
16	Light	Cat Eye Battery Lamp Set, Tsuvama Mfg. Co. LTD
17	Light Mount Screw	From Cat Eye Light Assembly kit
18	Light Bulb	Archer Cat. No. 272-1128, Tandy Corp. Fort Worth, Texas 76102. 6.3 V, 0.15 A, E-10 base.
19	Light Switch	Archer Cat. No. 275-635, Tandy Corp. (off-on toggle)
20	Wire Clip	Clip made of 22 gauge sheet steel bent to form loop to enclose wire

On the basis of these observations and after encouragement from a reviewer we designed a test to determine the efficiency of the device compared to climbing trees.

Methods

In 1991 we tested the reliability and efficiency of the NBC through a series of field trials. Reliability was measured by whether the user could distinguish between a nest used by owls and one which was not. Efficiency was measured by the time necessary to check nest boxes using the NBC compared with climbing. We tested the hypothesis that checking the contents of nest boxes using the NBC takes the same amount of time and is equally reliable as climbing trees and inspecting contents visually. For the test we used two sets of trials consisting of 40 different boxes per trial and employing two observers (total of 80 boxes). In the first set of trials (n = 40), one observer checked and recorded the contents of boxes using the NBC, and another observer verified the results by climbing. In the second set of trials, boxes were checked only by climbing (n = 40). For each set of trials (NBC and climbing), each of two observers checked 20 nest boxes in two groups of 10. Trial routes were selected at random and observers alternated methods for groups of 10 boxes. For each nest box visit, we recorded the elapsed time for the first observer to make the round trip from the vehicle to the tree, check the box, and walk back to the vehicle.

When monitoring boxes with the NBC, it is necessary to climb to boxes that need repair or must be cleaned. Therefore, during trials involving the NBC, recorded elapsed time included the time necessary to climb to, and work on, boxes needing repair or cleaning. Boxes containing owls (which required capture, measuring and banding) were not included in the samples.

In any monitoring program field crews should be trained prior to initiating field work. Therefore, prior to beginning the trials each observer checked at least 10 boxes by each method and felt comfortable operating the equipment.

In our analysis we compared the mean elapsed time for checking boxes with the NBC versus climbing to examine efficiency, and evaluated the accuracy of classification of nest box contents to examine reliability of the NBC. We used ANOVA to compare statistically the efficiency of the monitoring methods. Our ANOVA model included two main effects, method (NBC vs. tree climbing), and observer (two technicians), and one interaction, method × observer. Prior to running the model we transformed the response variable, elapsed time to check each box, to ranks (Conover and Iman 1981). We calculated power for the overall model and for the individual terms using JMP statistical software (JMP, SAS Institute Inc., Cary, North Carolina 27513). We report 95% confidence limits.

Results

Reliability.—We considered the NBC reliable if the contents of nest boxes could be identified accurately enough so that an observer always climbed to a box when it contained an active owl or squirrel nest, or needed to be cleaned. A box needed cleaning if it contained lichen, grass or remains of a former owl nest (e.g., feathers, pellets). Presence of only wood chips indicated the observer did not need to climb to the box.

In 40 trials using the NBC, contents of nest boxes 5–10 m above the ground were misclassified once. In this case the remains of an old owl nest (brick of matted feces, hair and bones) was identified as lichen. The tree would have been climbed whether the box contained lichen or nest remains, so the misclassification was not considered a functional error. During our field season in 1991, on 10 NBC box visits owls were present in the box. In each case we immediately recognized that the box needed to be inspected by climbing.

Efficiency.—Results of our trials indicate that checking nest boxes with the NBC required less time than climbing. Despite the necessity of climbing trees when boxes needed cleaning, mean elapsed time using the NBC was 6.4 (±1.04 SE, range 2.7–13.5) min, whereas the mean elapsed time of climbing trials was 7.5 (±0.98, range 2.8–15.0) min. For the two observers, mean elapsed time for trials using the NBC were 7.1 (±1.38) and 5.5 (±1.54) min and for climbing trials were 7.7 (±1.55) and 7.3

TABLE 3. Results of ANOVA (n = 80) testing effects of monitoring method (NBC vs. climbing) and observer (two technicians) on elapsed time to check nest boxes. The response variable was transformed to ranks because of nonnormal distributions of errors (Conover and Iman 1981).

Source	df	Sum of squares	F	P
Method	1	2610.1	5.0556	0.0274
Observer	1	2453.1	4.7514	0.0323
Observer•Method	1	754.8	1.4620	0.2303
Error	77	40,270.3		

Power Details

Model Component	α	Power
Method	0.05	0.60
	0.10	0.72
	0.20	0.83
Observer	0.05	0.58
	0.10	0.70
	0.20	0.81
Observer•Method	0.05	0.22
	0.10	0.33
	0.20	0.47

($\pm$1.41) min. ANOVA demonstrated the significance of differences in elapsed time between monitoring methods and observers while testing the interaction of observer with monitoring method (Table 3). We found no significant interaction of observer by method but the power of this test was less than tests of main effects.

DISCUSSION

Our results demonstrated a difference in elapsed time between methods (NBC and climbing) and observers but failed to demonstrate an interaction among these main effects. The lack of a significant interaction indicates that the superior efficiency of the NBC relative to monitoring boxes by climbing with spurs is consistent across observers. The difference between observers was likely due to their body stature and their physical condition. As with most physical tasks, we expected differences between observers in the elapsed time but were encouraged that both observers checked boxes more rapidly using the safer monitoring technique.

Our experiences indicate that the NBC can serve as an efficient and reliable aid in monitoring nest box use by wildlife. With a moderate amount of experience (training on 10 nest boxes) the NBC can be used effectively and reduce damage to trees induced by climbing spurs. Furthermore, the NBC improves worker safety by reducing the overall time climbing and offers an alternative method for checking boxes on dead and dying trees.

In addition to reducing the need to climb trees to check nest box contents, the NBC facilitated trapping owls. Brooding, adult, Saw-whet and Boreal Owls were entrapped in the nest box when the header was inserted through the box entrance, preventing the owls escape while we climbed to capture them.

The NBC is designed specifically to check the large nest boxes used by Boreal Owls. Similar large nest boxes are frequently hung for ducks, American Kestrels, (*Falco sparverius*) and other owl species (e.g., McCamant and Boen 1979, Mitchell 1988, VanCamp and Henny 1975, Willner et al. 1983). The NBC could be adapted to use with these species by changing the diameter of the header to match the entrance on the box and adjusting the placement of the brackets, which control the depth to which the header enters the box. If the device is adapted for use with passerines or other small cavity nesters, however, the reliability of results should be retested.

When the NBC is used to aid in monitoring nest boxes, we suggest that observers climb to inspect boxes where there is any doubt of the box contents. There is an incentive to find that "all is well" with a nest box when using the NBC because the tree, then, does not need to be climbed. Only clear evidence that the box is empty (clean bedding or box bottom) should be used to decide that direct inspection is not needed. Even with this strict rule we found that over 45% of the boxes checked in trials did not need inspection by climbing.

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