Bluebird Nest Box Design and Construction are Important to Alleviate Cold and Heat

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Photos by Leif Marking

Introduction--The Eastern Bluebird breeds throughout the states east of the Rocky Mountains, and their range extends north to the Canadian provinces and south to the Gulf of Mexico (Zeleny 1976). Therefore bluebirds experience a wide variety of temperature and climate. Nesting activities naturally occur earlier in the warmer southern regions and later in the northern states where cold temperatures often persist in April and sometimes in May. In Wisconsin, cold spring temperatures are often responsible for egg hatching failure and mortality of nestlings inside nest boxes. Then, at that same latitude, heat cycles in summer can drive temperatures to 100 degrees F or more, which can threaten heat mortality inside the nest boxes.

Proper incubation of bluebird eggs requires temperatures that range from 95 to 106° F, the temperature range of female bluebirds. Temperatures below this range may slow or impair normal embryonic development, and temperatures of 107° F or higher are considered lethal to eggs and hatchlings (Zeleny 1968; Stokes and Stokes 1991).

The female bluebird develops a brood patch on her breast that is void of feathers and down; this more efficiently transfers her body heat to the eggs for proper incubation and to the newly hatched nestlings to keep them warm. Incubation begins after the last egg is laid and generally requires about 14 days for hatching. Newly hatched nestlings have little down to keep them warm, so the female broods them in cold weather to maintain body temperatures sufficiently to sustain normal metabolism and growth. The nestlings grow fast and develop into fledglings in about 18 days. Therefore, the design and construction of bluebird boxes is important to maintain optimum temperature conditions for incubation of eggs and survival of nestlings despite the adverse weather conditions throughout their extensive breeding range.

Marking, Craig, and Koperski (2006) reported some preliminary results on effects of shade, insulation, and reflective materials on temperatures in cedar nest boxes. Their results suggest that the standard non-vented NABS-style cedar box offers protection from early spring cold temperatures, while the vented box was cooler during cold cycles and significantly cooler during heat cycles. Shade, insulation, and reflective treatments did not significantly decrease temperatures during heat cycles, although slight differences were observable. Furthermore, brown colored paint increased box temperatures significantly over the standard box; dark colors should **never** be used on bluebird boxes. They also concluded that non-vented boxes are satisfactory in northern latitudes, but vented boxes are preferred in hotter climates.

Then Marking, Craig, and Koperski (2007) further investigated different sized shade treatments combined with venting and non-venting of NABS-style bluebird houses. The shade treatments decreased the temperatures only slightly during the four hottest days of July and August; the average decrease was 4.2° F for the standard vented box and 4.8° F for the box with 24 square inches of shade. The vented boxes were consistently cooler than non-vented boxes by an average of about 2° F and by as much as 6° F cooler than ambient during heat cycles in July and August. During the April 16 cold cycle all boxes remained 2 to 3 degrees warmer than ambient temperature and during June heat cycles all boxes remained approximately 3° F cooler than ambient temperature.

Since venting seems to be the most effective and efficient way to alleviate high temperatures in bluebird boxes, this study was designed with replication to verify the significance of venting and non-venting. We collected hourly temperatures for ambient, in four standard boxes, and in four vented boxes for comparison.

Materials and Methods—Nest boxes were constructed from western red cedar lumber that was 7/8 inches thick and rough on one side. All nine boxes were constructed as standard non-vented boxes. They were mounted on 7 foot steel T-type fence posts covered with 5 feet sections of 1 ½ inch PVC pipe for predator control as standard procedure. Houses were mounted to the posts facing east with a single U-bolt and placed about five feet apart in full sunlight in bluebird habitat (Figure 1). Oval entries were covered with1/4 inch-mesh hardware cloth to prevent bird entry. The location of this study was on Marking

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Figure 1. Standard non-vented and vented bluebird houses were placed about five feet apart in bluebird habitat.

Figure 2. The convertible standard box is vented in place by lowering the side panels one half inch.

Ridge at elevation near 1,300 feet above sea level in Hamilton Township of La Crosse County RD S, Holmen, WI.

After mounting, the boxes were assigned numbers to pair the standard boxes and vented boxes. Numbers 2,4,6, and 8 became the standard non-vented boxes while numbers 3,5,7, and 9 became the vented boxes. The vents in those boxes were created by merely withdrawing the screws holding the side panels between the front and back panels, lowering the side panels ½ inch, and replacing the screws to secure the box parts. This convertible box design is especially useful in situations where venting on site may be desired (Figure 2).

Figure 3. HOBO Pendant hourly temperature data logger inside the bluebird nest box.

Number 10 box was vented differently to simulate a procedure for venting existing houses that were not constructed to be convertible. The front roof was pried up ½ inch and secured with 2-inch screws through the top and a pair of ½ inch cedar blocks to ensure the spacing. The rear of the roof remained fastened to the back panel.

Temperatures were recorded hourly from April 15, 2008 to August 31, 2008 in all houses with HOBO Pendent Temperature Data Loggers (Onset Computer Corporation). The ambient temperature was recorded similarly in a 1-½ inch by 12 inch PVC open-ended pipe mounted at the same height as prescribed by the National Weather Service. This ambient temperature setup became the number 1 treatment. Software for data analysis already existed at the La Crosse WI Department of Natural Resources office, so it was used to process the temperature data. The recorders were placed in abandoned bluebird nests in each house to simulate the approximate location of eggs or nestlings (Figure 3). The hourly temperature data graphs display peak cold cycles, such as in April, and peak heat cycles, such as in July and August. The minimum and maximum temperatures recorded during these cycles were used to calculate and compare temperatures in non-vented boxes and vented boxes and the ambient temperature.

Results—The hourly ambient temperature logger recorded over 3,400 data points during the nesting season (Figure 4). The lowest temperature recorded was about 28° F during a cold cycle near the end of April. Many bluebirds had active nests by then, and that low temperature would be lethal to eggs that were not being incubated or to nestlings if they were not brooded constantly. May and June provided temperatures that should not threaten the wellness of bluebird reproduction at any stage of development. July and August had a few heat cycles, but ideally none of the temperatures exceeded 90° F. So these high temperatures were not a threat to bluebirds nesting in vented or non-vented houses this year.

The maximum temperature in April was 76.7° F and temperatures in the vented boxes were very similar to ambient whereas the non-vented boxes were cooler than ambient (Table 1 and Figure 5). The minimum average temperature in April was 28.0° F in the vented house but only about 24.9° F in the non-vented boxes. Apparently, due to air movement restrictions, the standard non-vented box resisted warming and remained cool longer as temperatures increase in April. The temperatures in all boxes in May and June were more similar primarily because the daily temperature changes began to moderate.

In July and August, when heat cycles are common, the average minimum temperatures changed little in standard or vented boxes (Table 1 and Figure 6). However, the peak air temperatures demonstrated differences

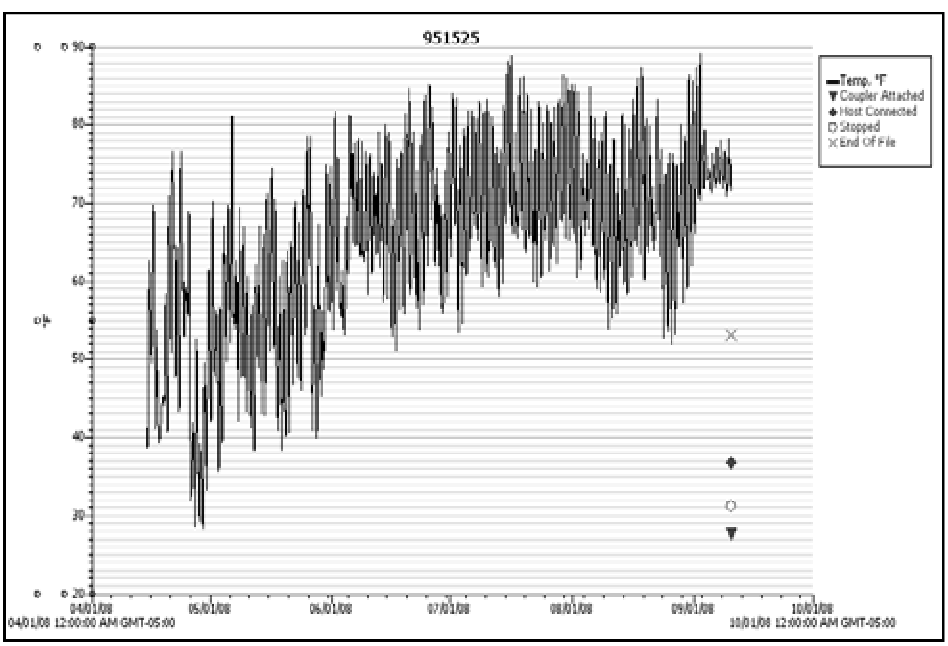

Figure 4. Hourly ambient air temperature data for April 15 to August 31, 2008.

in nest box temperatures. During the hottest day in both July and August, the vented boxes were not only cooler than the non-vented boxes, but also were cooler than the ambient air temperature. The non-vented boxes were hotter than ambient air temperature on August 18, 2008 by an average of 4.8 F. The Number 10 treatment of a single box with expedient partial venting shows nearly the same efficiency as other vented boxes in August.

Discussion and Conclusions—The 2008 nesting season in Wisconsin started with some freezing temperatures in April that undoubtedly caused some egg and nestling mortality. The remainder of the nesting season was temperature favorable for bluebird reproduction with ambient temperatures never reaching 90° F in our study location. This is unusual for Western Wisconsin where heat cycles often reach high 90's or even 100° F each summer. The temperatures in other areas of the state were perhaps a bit warmer. Never the less we did not have high enough temperatures to demonstrate the true effectiveness of vented houses to prevent heat mortality of bluebird nestlings in these type of houses.

We cannot extrapolate our data to simulate the higher temperatures that cause mortality of eggs or nestlings. However, our data verify that temperatures increase in non-vented boxes during heat cycles. Furthermore, vented boxes efficiently decrease box temperatures from ambient and significantly so over non-vented boxes. These studies were conducted in the absence of nestlings in the boxes. Their presence would obviously increase the temperatures inside the boxes. We have experienced some heat mortality with ambient temperatures around 100° F in the past. That suggests that in the presence of nestlings the temperature could increase by as much as 6 or 7° F, and a vented box in this situation may save the nestlings from heat mortality.

Box vents are essential in warmer climates to dissipate nest box heat. This study demonstrated that the internal temperature of vented boxes in summer heat were consistently cooler than both ambient air and in non-vented nest boxes. By contrast, in the cold of spring, the vented boxes closely followed the ambient air temperature while the non-

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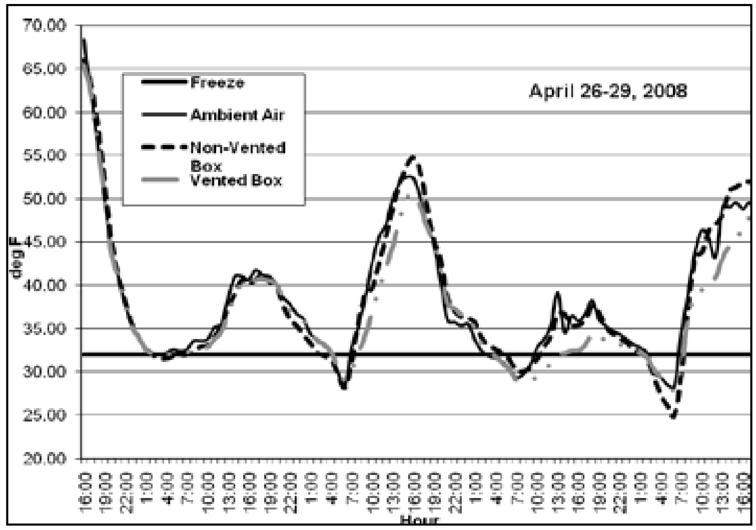

Figure 5. Minimum and maximum temperatures in all treatments during the April cold cycle.

Table 1. Average (n=4) maximum and minimum temperature in standard non-vented and vented bluebird boxes in 2008.

Month	Category	Ambient	Non-vented	Vented
April	Maximum	76.7	76.8	74.7
	Minimum	28.3	24.9	28.0
	Mean	49.9	49.6	48.7
May	Maximum	81.1	81.2	78.1
	Minimum	35.8	36.2	35.8
	Mean	56.2	56.0	55.3
June	Maximum	85.2	87.1	83.8
	Minimum	51.2	50.7	52.7
	Mean	67.8	67.6	66.9
July	Maximum	88.8	91.6	87.4
	Minimum	53.4	53.3	54.5
	Mean	72.2	72.8	71.5
August	Maximum	87.4	92.2	85.6
	Minimum	52.1	52.1	52.8
	Mean	69.6	70.6	69.1

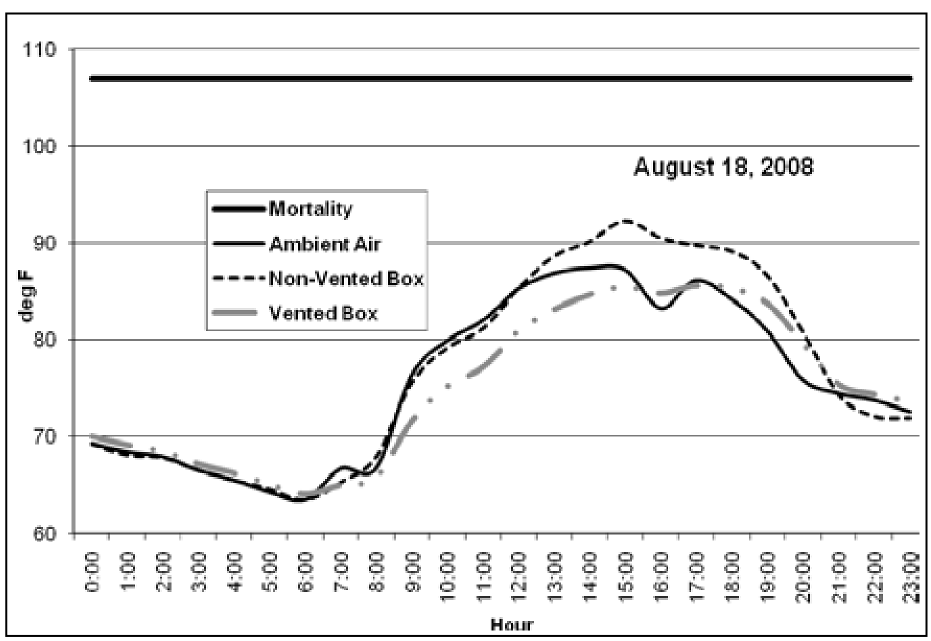

Figure 6. Maximum and minimum temperatures in all treatment during the August heat cycle.

vented boxes were cooler than ambient air and vented nest boxes during warming periods. In Wisconsin the non-vented boxes are desirable in the early spring since rain, sleet, snow and wind can exacerbate any cold temperatures found in vented nest boxes. However, there are some situations where vents would be desirable, especially during summer heat cycles. The convertible boxes used in this study were ideal because ventilation for any house was available as desired.

Zeleny (1968) monitored temperatures in 32 bluebird nest boxes with various treatments to alleviate high temperatures in June and July. Wood construction material was superior to plastic or metal, and thicker wood (3/4 inch) was more efficient than thin wood (3/8 inch) for insulating against high temperatures. Ventilation was effective for decreasing the temperature by 2 to 3° F. He concluded that many bluebird nest failures, especially second and third broods, are probably due to excessive heat resulting from the use of improperly made or improperly located nest boxes.

Members of our Brice Prairie Conservation Association monitor over 900 bluebird boxes annually, and we prefer the NABS-style box that was originally promoted by Lawrence Zeleny (1976) . The original plan included vents. Since cold has proven more destructive than heat in Western Wisconsin, the BPCA altered the original design to create adjustable vents in order to close during cold periods and open during warm periods.

The HOBO data loggers functioned flawlessly throughout the four and one half month study. They are sensitive to one hundredth of one degree and recognize minute changes in temperature. These data loggers are ideal for this kind of study.

Information developed from this study suggests:

- The 2008 nesting season temperatures in La Crosse County were cold (below freezing) in April and caused some impairment of egg development and nestling survival.
- Summer temperatures were ideal for bluebird production and they never exceeded 90 degrees in the study area.
- Non-vented boxes provide more protection from cold temperatures, wind, rain, and other weather conditions in early spring.
- Vented boxes were consistently cooler than non-vented boxes by as much as 7.4 degrees during heat cycles in August.
- The HOBO data loggers functioned flawlessly during the four and one half month study.

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