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BAT BOX SUB-COMMITTEE (of WNS CRWG)

- 59 members from across the US and Canada – outline developed by group and knowledge gaps identified
- Work collaboratively on Best Management Practices (BMP) -Webinars and in person workshop (NASBR 2019)
- Share existing data on microclimates in relation to occupancy and context – for bat boxes and bat condo.
- Conduct research to *fill critical knowledge gaps* needed to inform BMP development – this field study addresses an important knowledge gap:

BUILDINGS VS. BAT BOXES

- Buildings used by some synanthropic species to raise young[1].
- Boxes used as mitigation for loss of roosts[2] or as habitat enhancement

BUT…do they offer the same energetic and reproductive benefits as the original building roost over the entire maternity season?

RESEARCH QUESTIONS:

1. How do microclimates (temperature, humidity) differ in occupied anthropogenic roost structure types?
2. Is overheating (heat stress = temp*humidity) more common in bat boxes (Fig. 1) than in building roosts?
3. For mixed *Myotis lucifugus* and *M. yumanensis* colonies in bat boxes and building roosts are there differences in:
   a) Reproductive rates and/or;
   b) Juvenile growth rates?

Figure 1. Bats in a box show signs of heat stress; adult females (pale fur) and pups (dark fur) can be seen crowding at the entrance of the box in mid-afternoon during a heat wave. *Photo S. Latour.*

METHODS

- Focal taxa *Myotis lucifugus* and *M. yumanensis*.
- Primary study area within the Kootenay region, Canada (Fig. 2): Seven sites comprising six bat boxes, one bat condo and three building roosts.
- Temperature and relative humidity (RH) for ambient conditions and within roost structures.
- Microclimate profiles compared between boxes and buildings in relation to ambient conditions.
- Observations of heat stress in bats recorded.
- Occupancy data for each roost type.
- Reproductive status of adult females and juvenile growth measurements.
- Four sites in the Okanagan region, Canada: 22 maternity bat boxes (microclimate and occupancy data only).

Figure 2. Clockwise from left: map of study sites near Creston, British Columbia; bat box data logger install prior to bat return; and building roost. *Photo credits: J. Hobbs; S. Dulc*

PRELIMINARY RESULTS

1. **Microclimate comparison (of *occupied* roosts)**
   - Daily maximum temperatures in boxes were 20 – 25 °C greater than ambient conditions (Presence of bats increased temperatures within occupied chambers of boxes by 24.4°C).
   - Maximum and minimum daily RH frequently 100% in boxes (Box 2: 78%, *n*=115) (Fig. 3).
   - Maximum daily RH in buildings exceeded 80% only 3% of the time (Bldg 2: *n*=157).

Figure 3. Minimum daily relative humidity for occupied chambers of a bat box (red) and a building roost (dark green) compared to ambient conditions at each site (orange and light green, respectively).

PRELIMINARY RESULTS

2. **Overheating events**
   - See Case Example Box (at bottom)

3. **Reproductive success****
   a) **Reproductive rates**
   - Buildings had higher pregnancy rates than all boxes in early season (χ_2, $p<0.001$).
   - Post-parturition reproductive rates were also different but did not correlate with structure type (χ_2, $p<0.002$).
   - 68-82% of adult females showed signs of pregnancy.

   b) **Juvenile growth****
   - No significant difference in average juvenile mass for paired date comparisons between boxes and buildings – except for two sites at end of August (Fig. 4). Larger sample size (2021 data) pending.

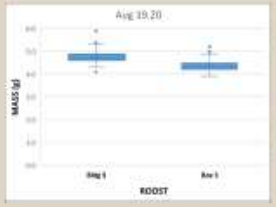

Figure 4. Mean mass (g) of juvenile bats captured at Building (Bldg) 3 and Box 3 August 19-20, 2019. Difference in means was significant ($p<0.001$) for this late August capture date; Bldg 3 $\bar{x}$ = 4.76 g (n=55), Box 3 $\bar{x}$ = 4.40 g (n=69).

CONCLUSIONS – Preliminary

- Extremes in microclimate conditions (temperature and particularly humidity) occur much more frequently in boxes than in buildings.
- Buildings offer greater temperature stability than boxes.
- Advanced gestation in building roosting females (i.e., earlier parturition) -- may benefit survival of young, enhancing reproductive success.
- Juvenile mass higher in some building vs bat boxes -- bat pups in buildings may have better body condition, advantageous for first hibernation.

Two Case Examples of Overheating Events in B.C.

Overheating events were observed and documented with installed microclimate dataloggers at 2 sites:

#1. Mixed *Myotis lucifugus* and *M. yumanensis* colony (~600 bats) in Greater Vancouver (Leah Rensel, Univ. of B.C. Okanagan, unpub. data)

- colony uses identical, south-facing, 7-chambered bat boxes -- built to replace a lost adjacent building roost -- to raise young in an area where few buildings and trees exist.
- summer heat wave (July 2018) -- adults and juveniles fell out of boxes (box reached 46°C), and ~75 died (J. Saremba, Burke Mountain Naturalists, pers. comm.).

#2. *M. yumanensis* colony (~300 individuals) in Creston, British Columbia, Canada (part of this study)

- colony uses a single multi-chambered bat box erected near a building from which they were evicted – raising young in this box throughout the summer, suggesting no alternative roosts
- pregnant females with urine-soaked fur (to facilitate evaporative cooling) -- observed crowding at entrance mid-day June 2019, and several fled to shaded adjacent trees.
- box 40.7°C and 100% humidity (ambient temp. 31.7°C)

Take-home: Unusual heat waves that are not anticipated by bats may be partially to blame. It is possible that the fewer roosts options available to a colony raising young, the higher the risk of unsuitability that could lead to heat stress or mortality.

** Capture was suspended in 2020 so no data are available to assess these parameters. Capture has been approved for 2021 and is currently underway. These parameters will be assessed and compared to 2019 data and results.

BAT BOX BEST MANAGEMENT PRACTICES

A draft BMP has been developed*. In the next stage it will circulate to the full committee for review. **What are the *real* problems with bat boxes? Likely *none*, as long as they are used *correctly*.**

Draft Guidance Key Points

I. **Bat boxes *can* be a useful tool to replace lost building or natural roosts, but they must be seen for what they are – a box – skin to a single tree or rock crevice roost, therefore:**
   - Expectation of 'one box does all' is not realistic – maternity colonies in natural roosts switch crevice roosts often for thermoregulation, energy-savings, reducing predation risk, social networking, and more.
   - One tree or rock crevice will not meet the needs of a colony throughout the summer, so we should not expect a bat box to either.
     - ✓ E.g., a light-coloured box is less likely to overheat in summer, but more likely to be unsuitably cool in spring, delaying gestation

II. **A single bat box -- even a four-chambered one – could become an ecological trap[3] because:**
   - Bats have high fidelity – once evicted, they stick around.
   - If there are no suitable alternate roosts nearby, bats may:
     - Not reproduce to full potential– a single bat box cannot provide full range of thermal conditions needed by a maternity colony throughout entire season (though a building roost can)
     - Be unable to switch roosts for safety (e.g., predation risk, overheating)

III. **Growing concern with climate change – some bat boxes overheat[4] (see Case Example Box)**
   - *Natural roosts overheat too* -- bats switch roosts to avoid heat stress.
   - Mortality events resulting from overheating may reflect limited roost availability rather than inherent flaws in boxes, such as particular designs.
     - ✓ Problem planning/placements, not problem boxes per se

IV. **Solutions:**
   - Consider the big picture -- the *roosting area* for a maternity colony.
     - ✓ Mimicking a natural roosting area requires accommodating requisite roost switching.
   - **Goldilocks Approach** – give bats choices to find the 'just right roost' when they need it.
     - ✓ Install *multiple* bat boxes with *varied* and *nearby* placements to offer thermal options (and safe refuge).
     - ✓ Build other artificial roosts too e.g., tree manipulations, bark mimics
   - Engage and educate citizens
     - ✓ e.g., Urban Planning for Bats; Community Bat Programs

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