USE OF TORPOR IN A HIGH- AND MID-ELEVATION HUMMINGBIRD SPECIES IN SOUTHEASTERN ARIZONA

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INTRODUCTION
Studies have shown that hummingbirds enter nocturnal torpor when energy reserves fall below specific “threshold” levels (Hainsworth et al. 1997). Thus any ecological or physiological change that increases a hummingbird’s energy costs could push energy reserves past their threshold requiring that torpor be used to balance their energy budget (e.g. Carpenter and Hixon 1988; Hiebert 1993; Powers et al. 2003).

Climate change has occurred in hummingbird habitats and recent studies suggest that these changes pose challenges that will likely increase hummingbird daily energy costs (La Sorte & Thompson 2007; Paesan 2006). Because hummingbirds are sensitive to environmental change and must respond quickly to address their energetic needs they are good candidates to be pioneer indicators to climate change (La Sorte 2009). If climate-induced increases in energy costs frequently push hummingbirds past their energy-storage thresholds then their first response might be increased torpor use (Powers et al. 2003).

To determine if climate change has made energy-budget management more problematic for hummingbirds we studied the frequency of torpor use by free-living broad-billed hummingbirds (Cyananthus latirostris; mid-elevation) and broad-tailed hummingbirds (Selasphorus platycerus; high elevation) from populations within their historical range. No baseline data exists for “normal” torpor use in hummingbirds (La Sorte & Thompson 2007) and we predicted that access to a good quality food source might eliminate the need for torpor altogether.

METHODS
Study Sites & Species. We studied two hummingbird species at two sites in southeastern Arizona during June 2012. Broad-tailed hummingbirds (Selasphorus platycerus; BTLH; Mₚ=3.12-4.16 g; N=7) were captured on Mt. Lemon (high-elevation ~3,000 m) and broad-billed hummingbirds (Cyananthus latirostris; BBLH; Mₚ=3.42-3.65 g; N=8) were captured along Harshaw Creek in the Patagonia Mountains (mid-elevation ~1,300 m). Since measurements were made during breeding season, only males were used.

RESULTS
Minimal VO₂ measurements for BTLH. Green circles indicate normothermic measurements, while blue circles are birds presumed to be in torpor. Most birds (50%) entered torpor at 25 °C, approximately 3 hours into the metabolic trial. Torpor VO₂ begins to increase between 10 and 15 °C suggesting minimum Tₜ is in this range (similar to the 12 °C minimum Tₜ for BTLH; Bucher and Chappell 1989).

CONCLUSIONS
- Metabolic patterns during torpor suggest that minimum torpor Tₜ in BBLH is between 10 and 15 °C which is similar to that reported for BTLH (Bucher & Chappell 1989).
- Both high- and mid-elevation species regularly entered torpor at Tₜ below 25 °C. Consistent use of torpor at these relatively mild temperatures suggests that maintaining energy balance is a challenge for these species. Possible impact of climate change?
- Both species used torpor more frequently than expected. This might suggest that frequent use of nocturnal hypothermia by hummingbirds does not result in the physiological consequences seen in some mammals (Roth et al. 2010).

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