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RETHINKING YUMA BAT AND LITTLE BROWN BAT FORAGING ENDURANCE

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Introduction

Each spring and summer a large maternity colony of *Myotis* bats roosts in an abandoned railroad pier (Fig. 1) near Olympia, Washington. The bats begin arriving in April, have their young in June, then as the young become volant in early July the colony (now over 3.000) begins a steady decline as the bats disperse (Fig. 2). Nearly all of the bats roosting in the pier have been identified as Yuma bat *(Myotis yumanensis)* or Little brown bat *(M. lucifugus)* (Gaspari 1994; Schirato, pers. comm.; pers. obs.). In the coastal Pacific Northwest these 2 species are extremely difficult to distinguish by morphological features (Harris 1974) and misidentification is common without the aid of genetic analysis (Ormsbee, pers. comm.). Both Yuma bats and Little Brown bats forage in or near riparian areas when they are available, feeding heavily on aquatic emergent insects (Brigham et al. 1992) and use similar resources for maternity roosts (Nagorsen & Brigham 1993).

The landscape consists of saltwater inlets of Puget Sound to the north and east, semi-rural land to the south and west which then transitions into the urban areas 8-10 km from the maternity roost. We expected these bats to forage at the nearest ponds and wetlands, located between 2 and 6 km from the roost and for their nightly activity to alter between bouts of foraging and periods of night roosting, the typical pattern for insectivorous bats. Both of these assumptions proved to be wrong.

Methods

We monitored the maternity colony population with emergenc counts from 23 March to 11 October, 2003. We captured bats leaving the pier with mist nets on 11 nights between 25 April and 21 August, 2003. We attached radio-tags (.37 gr. LB-2N, Holohil Systems) to 1 pregnant, 1 lactating, and 2 post lactating bats to gain insight into their foraging range. Because the flat landscape does not offer vantage points from which to get "line of sight" bearings from distant radio tags, and to allow for intensive monitoring of nightly activities on a fine scale, only one bat was carrying a radio-tag at any time. Tracking was accomplished by outfitting a vehicle with a telemetry receiver, omni-directional antenna, preamplifier, and digital audio processor (to eliminate ignition noise) to first establish vicinity locations. The observer then switched to a handheld 3 element yagi antenna to get directional information and locate the foraging bats. The observer was limited to using public roads since the study area was nearly all rural and urban residential property. When a tagged bat's signal could not be heard, a search pattern was initiated radiating out from the last known location. One of the radio-tags which was deployed was defective and could not be detected further than approximately 100 meters. Only 1 forage location was obtained and 1 commuting location was obtained from this individual.

Several lakes are within the 13 km range from maternity roost .

Figure 5. Capitol Lake, Olympia, Washington. Destination of myotis from Woodard Bay (>12 km)

Results

Two of the radio-tagged bats foraged for long periods without any resting or night roosting. All 4 radio-tagged bats were tracked flying greater than 7 km from their day roost, and 2 of the bats were found foraging at an urban lake (Fig. 5) over 12 km from the maternity roost where they were captured. Two of the bats were tracked to this distant lake on 6 consecutive nights (in July and in August), one traveled directly to the lake from the day roost, foraged up to 5.5 continuous hours at the lake, then traveled back to the roost for a totals of >6.5 hours "on the wing." Our methods allowed a single observer was able to determine the tagged bat's location and activity type approximately 50% of the total night activity period (from emergence at dusk to final return to the day roost).

Discussion

The 12 km (one-way) commute distance is considerably greater than previously reported; studies and surveys for these 2 species indicate distances of <1 km to 8 km between day roosts and foraging areas (Barbour and Davis 1969; Barclay, pers. comm.; Henry et al 2002; Johnson 2002). Because of assumptions about the range for these bats, we did not locate this bat's distant foraging area until the 5th tagged night, searching intensely in the 0 - 7 km range from the roost. Possibly more unusual was the nonstop flying and foraging for up to 6.5 hours. Chruszcz & Barclay (2003) first reported insectivorous bats (Long-eared myotis, *Myotis evotis*) spending 90% of their out-of-roost time foraging. They felt this might be related to the species being near the edge of its range as well as a flexible feeding strategy, gleaning insects from surfaces as well as taking prey aerially. This would allow them to take advantage of the nightly period (between midnight and shortly before dawn) when the aerial insect counts are low (Anthony et al. 1977), but insects on surfaces are still available. Since Little brown and Yuma bats are known only to be hawking (aerial) feeders, emergent aquatic insects were likely available all night at Capitol Lake. These long uninterrupted foraging times may indicate that resources at the distant lake are not all that abundant, as 4.5 - 5.5 hours should be enough time for a Little brown bat to fill its stomach several times (Barclay, pers. comm). It is unknown why these bats are regularly foraging greater distances than previously reported for Little brown or Yuma myotis. Possible explanations include: greater competition for resources by a larger colony; because the distant lake offers superior forage opportunities; or that the fine scale monitoring of individual bats revealed behavior that might have been missed by less intensive methods. The sample size will need to be increased to futher this investigation.

Conclusion

Our work suggests that commonly accepted foraging behavior for small *myotis* bats is not applicable in all landscapes, and they apparently have the physical endurance to sustain long daily commutes with long bouts of foraging without night roosting. Tracki ng radio-tagged bats in an urban landscape offers some unique obstacles such as limited public access within the study area, and decreased signal detection range due to increased electrical interference (from power lines, computers, and strong radio signals) and in flat areas like our study area from the lack of higher vantage points decreases the line-of-sight distance. Because of our experience with a defective tag, we recommend performing distance tests on all radio tags prior to deployment on study subjects.We will continue with similar effort in 2004 to increase the sample size in an attempt to better quantify the foraging range of these bats.

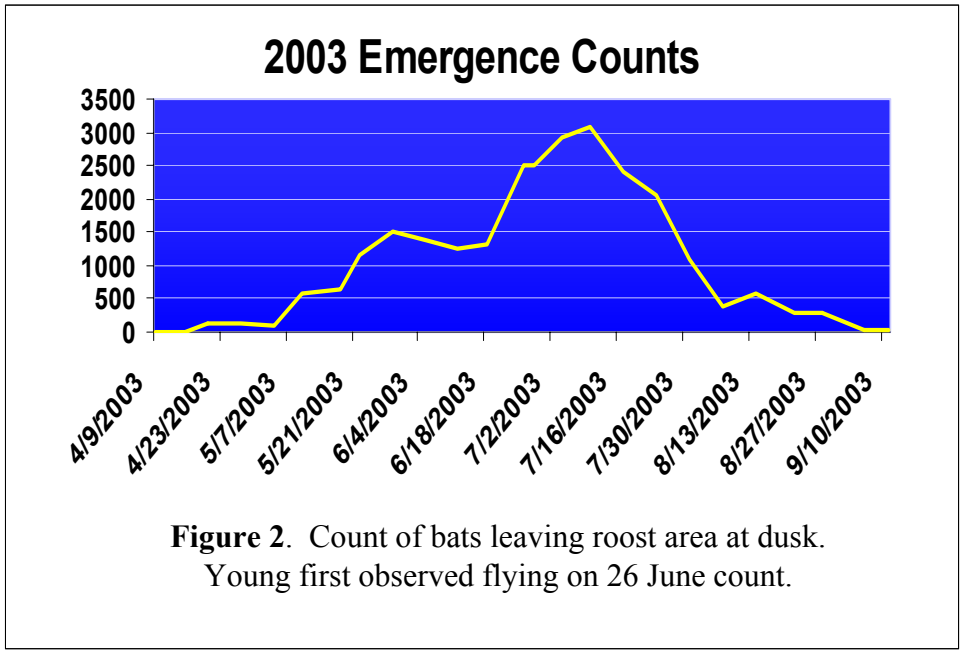

Figure 2. Count of bats leaving roost area at dusk. Young first observed flying on 26 June count.

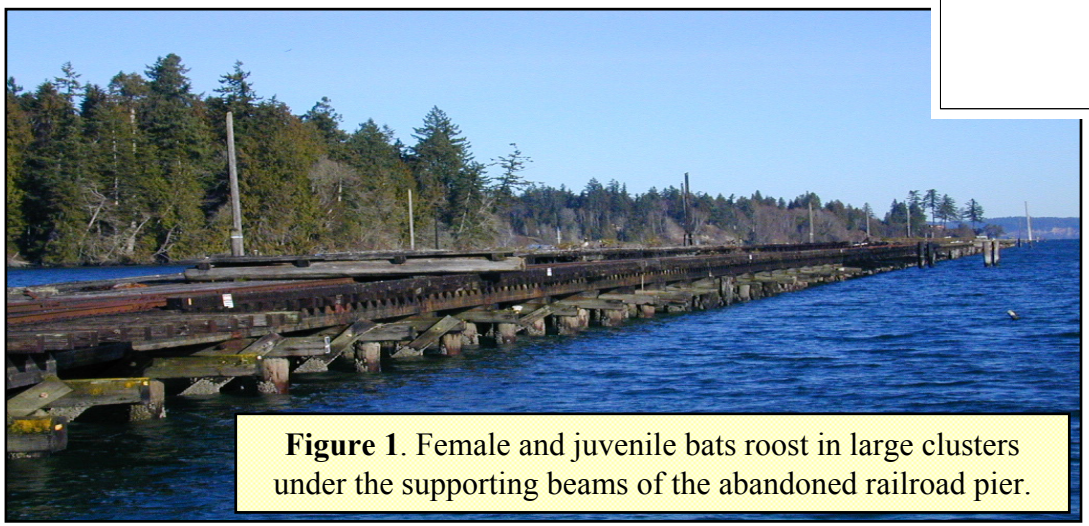

Figure 1. Female and juvenile bats roost in large clusters under the supporting beams of the abandoned railroad pier.

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Do Large Colonies Create Long Commutes? Examining *Myotis* Bat Foraging Distance and Duration

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Introduction

Each spring and summer the largest known bat colony in Washington state, a mixed-species maternity colony of Little brown and Yuma bats (*Myotis lucifugus* and *M. yumanensis*, or "MYYU/LU") roost in an abandoned railroad pier near Olympia, Washington (Figs. 1 & 4). The bats begin arriving in April, have their young in early June. After the young become volant in early July the colony peaks at over 3,000 individuals, then begins a steady decline as the bats disperse only a few remain by September. Based on examination of bats in the the hand, it appears that nearly all of the bats roosting in the pier are Yuma bats or Little brown bats (Gaspari 1994) by examining the skulls of specimens (Schirato 2003, pers. comm) and in 2004 by the author collecting time-expansion calls with a Pettersson D240x ultrasonic detector and analyzing the calls with SonoBat software (Pettersson Elecktronik, Sweden & SonoBat, Arcadia, CA.). In the coastal Pacific Northwest these 2 species are extremely difficult to distinguish by morphological features (Harris 1974) and identification between these two in the hand is unreliable without the aid of genetic analysis or time expansion call analysis (Pat Ormsbee, pers. comm.). Both Yuma bats and Little Brown bats forage in or near riparian areas when they are available, feeding heavily on aquatic emergent insects (Brigham et al. 1992); and this study supports earlier reports that these two species will use similar resources for maternity roosts (Nagorsen & Brigham 1993).

The roost area is bordered by saltwater inlets of Puget Sound to the north and east, semi-rural open and wooded land to the south and west which then transitions into urban areas 8-10 km from the maternity roost. We expected these bats to forage at a series of ponds and wetlands located 2 and 6 km to the south of the roost and for their nightly activity alternate between bouts of foraging and periods of night roosting. This nightly pattern is widely reported for insectivorous bats. Both of these assumptions generally proved to be wrong for this group.

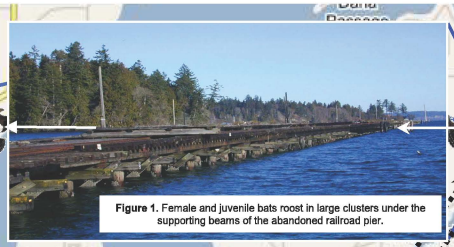

Figure 1. Female and juvenile bats roost in large clusters under the supporting beams of the abandoned railroad pier.

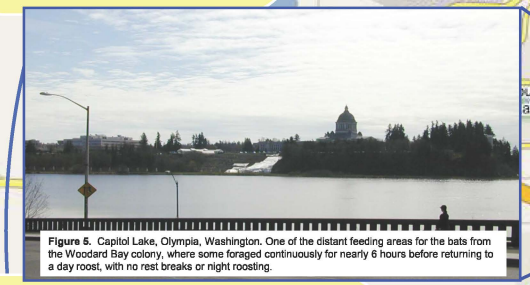

Figure 5. Capitol Lake, Olympia, Washington. One of the distant feeding areas for the bats from the Woodard Bay colony, where some foraged continuously for nearly 6 hours before returning to a day roost, with no rest breaks or night roosting.

Methods

We monitored the maternity colony population with flyout (emergence) counts from late March to early October, 2003 and 2004. We captured bats leaving the pier with mist nets on 16 nights between mid-April and late August both years. We used SkinBond adhesive to attach radio-tags with a 12-day battery life (.36 gram LB-2N, Holohil Systems) to 4 pregnant and 6 post-lactating bats. We gathered an average of over 8 nights of foraging and night roosting behavior per radio-tagged bat. To permit intensive monitoring of the subjects' activities on a fine scale, only one bat was radio-tagged at a time. Tracking was accomplished by first establishing vicinity locations using a vehicle outfitted with a Yaesu FT-817 ham radio (Vertex-Standard, Cypress, CA) , omni-directional gain antenna, low-noise preamplifier, and digital audio processor (to reduce ignition noise) . The observer then switched to a portable telemetry receiver and used a either a 3 or 4-element handheld Yagi antenna to obtain directional information and "walk-in" locations on the bat. When a tagged bat's signal was lost or could not be heard, a search pattern was initiated from its last known location. Re-acquiring a lost signal could sometimes take hours, or not accomplished until he following day. Large movements such as switching day roosts separated by 19 km were successfully tracked, and a single bat crossing 2 Puget Sound inlets (in succession) were successfully tracked.

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Results

Three of the 10 radio-tagged bats foraged for long periods with no night roosting observed, 3 others night roosted only when it started raining while they were involved in feeding, emerging shortly after the rain abated to continue foraging. The remaining 4 routinely roosted 2 or 3 times nightly, close to the foraging area (in all cases a lake, large pond or open wetland) for between 5 and 40 minutes, then emerging to continue foraging in the adjacent areas. All radio-tagged bats were tracked to locations greater than 8 km from their day roost, 7 bats traveled greater than 12 km. Five of the 7 bats tagged at the large Woodard Bay colony commuted to a 250 acre urban lake (Fig. 5) a distance over 13 km from the capture location. Two of these bats were tracked to this distant lake on 6 consecutive nights each (one in July and one in August), and one of these traveled directly to the lake from the day roost, foraged non-stop for 5.75 hours, then traveled back to the roost for a total of 6.75 continuous hours "on the wing."

Discussion

These one-way commute distances ranging between 10 and 15 km are considerably greater than previously reported; studies and surveys for these 2 species indicate distances of <1 km to 8 km between day roosts and foraging areas (Barbour and Davis 1969; Barclay, pers. comm.; Henry et al 2002; Johnston 2002). The non-stop flying for up to 6.75 hours was also unusual. Chruszcz & Barclay (2003) first reported insectivorous bats (Long-eared myotis, *Myotis evotis*) spending 90% of their out-of-roost time foraging. They felt this might be related to the species being near the edge of its range, exercising a flexible feeding strategy as they glean insects from surfaces as well as taking prey aerially. This would allow them to take advantage of the period between midnight and shortly before dawn when aerial insect counts are lower (Anthony et al. 1977), but insects on surfaces are still available for gleaning. However, since Little brown and Yuma bats are thought to be exclusively hawking (aerial) feeders, we expect that emergent aquatic insects are available all night at Capitol Lake during the summer months. Additionally, Little brown and Yuma bats are common in this region and not near the extent of their range. These long uninterrupted foraging times entirely over this one lake may indicate that resources at the site are not all that abundant, as 4.5 - 5.5 hours should be enough time for a Little brown bat to fill its stomach several times (Barclay, pers. comm). The three bats in our study that did night-roost regularly (including non-rainy nights) did so for only 10 to 40 minutes at a time, and rarely more than twice a night. Three bats were never observed night roosting when away from the day roost. It is unknown why these bats were regularly foraging at greater distances than previously reported for Little brown or Yuma myotis. Possible explanations offered have included: greater competition for resources by a larger colony; because the distant lake offers a superior forage opportunities; that the fine scale monitoring of individual bats reveals behavior that might be been missed by less intensive methods.

Figure 2. *Myotis lucifugus* with .37 gram radio tag, ready for release at capture site (in this case the foraging area).

Conclusion

Our results suggest that aspects of the reported foraging behavior for small *myotis* bats is not applicable this landscape, and that these small bats have the metabolic capacity and endurance to regularly make long commutes to feeding areas. Many forage long hours interrupted by little of no night roosting, then commute back to a distant day roost. The hypothesis made in 2003 that the large colony size at Woodard Bay forced these long distances in order to disperse over a larger feeding area was not supported by the 2004 data obtained from "MYLU/YU" bats tagged at Capitol Lake which commuted just as far (up to 15km) to small maternity roosts in entirely different areas (Figure 4). Whether the behavior of these bats is exceptional or if the methods employed facilitated more remote observations that might have been otherwise missed cannot be inferred from this small study, but tracking bats using methods that allow continuous observation of the subject's behavior may help us develop methods for studies with larger sampling effort. Certainly the observation that the "signal was lost" should flag the need to reevaluate the assumptions regarding the range.

Tracking radio-tagged bats in an urban landscape offers some unique obstacles such as limited public access within the study area, and decreased signal detection range due to increased electrical interference (from power lines, computers, and strong radio signals) and in flat areas like our study area, from the lack of elevated vantage points to increase the line-of-sight distance. And because of our experience with a defective tag, we recommend performing distance tests on all radio tags prior to deployment on study subjects. We continue to investigate bat utilization at Capitol Lake using *time expansion* acoustic sampling methods to better identify the species and spatial distribution at this large foraging aggregation.

Figure 4. Map of the area used by the bats under study, encompassing urban Olympia, Washington and the area north and east of Olympia bordered on the north by Puget Sound.

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