Keen's Long-eared Bat, *Myotis keenii*, Confirmed in Southeast Alaska

DOREEN I. PARKER[1] and JOSEPH A. COOK

University of Alaska Museum, 907 Yukon Drive, Fairbanks, Alaska 99775
[1]Current address: Alaska Department of Fish and Game, Division of Wildlife Conservation, P.O. Box 25526, Juneau, Alaska 99802-5526

Parker, Doreen I., and Joseph A. Cook. 1996. Keen's Long-eared Bat, *Myotis keenii,* confirmed in southeast Alaska. Canadian Field-Naturalist 110(4): 611–614.

Myotis keenii is apparently restricted to the Pacific coastal forests of northwestern North America. The only documentation of *M. keenii* in Alaska has been a specimen collected in 1887, causing uncertainty about whether this species normally occurs there. We describe two new records which indicate that *M. keenii* may be a regular member of the Southeast Alaska fauna and we provide measurements and information on diet for this poorly documented species.

Key Words: Keen's Long-eared Bat, *Myotis keenii*, Vespertilionidae, southeast Alaska, temperate rainforest.

Of the five vespertilionid species occurring in Southeast Alaska (MacDonald and Cook 1996), the Keen's Long-eared Bat (*Myotis keenii*) was known from a single specimen taken at Wrangell in 1887 (Miller and Allen 1928). Since then, the possibility persisted that it was an accidental occurrence. The original specimen was preserved in alcohol and the skull was not available to confirm its identification. Consequently, its identity remained uncertain until van Zyll de Jong and Nagorsen (1994) used multiple discriminant analysis of five external measurements to diagnose the specimen as *M. keenii*. Because *M. keenii* is distributed throughout coastal rainforests in the Pacific Northwest (van Zyll de Jong and Nagorsen 1994), extensive timber harvest in Southeast Alaska has increased interest in the status of this species.

Myotis keenii was previously regarded as conspecific with the Northern Long-eared Bat (*M. septentrionalis*), but now is considered a separate species (van Zyll de Jong 1979). These species are difficult to distinguish from each other, and from the Western Long-eared Bat (*M. evotis*), which is sympatric with *M. keenii* in British Columbia and Washington. The three species can be identified by discriminant function analysis of cranial (van Zyll de Jong 1979) or external (van Zyll de Jong and Nagorsen 1994) measurements.

We provide information on two new specimens of this apparently uncommon species in Southeast Alaska including morphological measurements and diet data. Previously, only 59 specimens of *M. keenii* had been collected and deposited in museum collections. Thirty-five are from the Queen Charlotte Islands of British Columbia, nine from other regions of British Columbia, 14 from western Washington, and one from Wrangell Alaska (Figure 1; van Zyll de Jong and Nagorsen 1994). The known range of *M. keenii* is restricted to Pacific coast rainforests (Nagorsen and Brigham 1993; van Zyll de Jong and Nagorsen 1994), and extends over 2000 km from southwestern Washington to Southeast Alaska (Figure 1). The rarity of this species and lack of ecological data have prompted the British Columbia Ministry of Environment to place *M. keenii* on the provincial "red list" of species under consideration for listing as threatened or endangered (Nagorsen and Brigham 1993). The species has no special conservation status in the United States.

Methods

During 18 nights in June, July, and August 1993, mist nets were placed in riparian areas on Prince of Wales and Revillagigedo islands in Southeast Alaska. In 1994 bats were collected from a maternity roost of Little Brown Bats (*M. lucifugus)* at Hoonah on Chichagof Island (58°06′N, 135°26′W; Figure 1). Captured bats were prepared as voucher specimens. Specimens and frozen tissue samples are archived at the University of Alaska Museum. Stomach contents collected in 1993 were preserved in 70% ethanol and analyzed for prey volume. Species identity was determined using cranial measurements (van Zyll de Jong 1985) and verified using multiple discriminant analysis (MDA) of 12 cranial measurements (van Zyll de Jong 1979; van Zyll de Jong and Nagorsen 1994) and 5 external measurements (van Zyll de Jong and Nagorsen 1994) listed in Table 1. Further verification was obtained using MDA of the 7 cranial variables (Table 1) which best discriminate between *M. keenii* and *M. evotis* (van Zyll de Jong and Nagorsen 1994).

Results

On 20 July 1993 an adult male *M. keenii* (UAM 23338) was collected at Turn Creek, in a karst region of northern Prince of Wales Island (56°10′N, 133°18′W), approximately 65 km SW of Wrangell

TABLE 1. Measurements of new *Myotis keenii* specimens.

Measurements (mm)	UAM 23338 from Turn Creek	UAM 29831 from Hoonah	Mean ± 1 SD. *M. keenii**	Mean ± 1 SD. *M. evotis* from British Columbia*
Cranial Measurements:				
Skull length†	14.93	14.38	14.60 ± 0.219	15.45 ± 0.307
Mastoid width†	6.91	6.88	7.43 ± 0.135	7.76 ± 0.167
Orbital width at lacrimal foramina	4.45	4.75	4.30 ± 0.130	4.57 ± 0.130
Rostral width†	2.44	2.50	3.33 ± 0.093	3.63 ± 0.114
Maxillary width at M3†	5.64	5.80	5.52 ± 0.121	5.85 ± 0.128
Palatal width at P2†	3.64	3.65	3.48 ± 0.097	3.66 ± 0.141
Maxillary width at I3	2.51	2.63	2.45 ± 0.074	2.61 ± 0.071
Maxillary tooth row length	5.68	5.63	5.66 ± 0.105	6.11 ± 0.155
Length of P4M3†	3.89	3.98	3.96 ± 0.072	4.33 ± 0.113
Length of M2	1.24	1.26	1.23 ± 0.046	1.37 ± 0.052
Width of M2	1.68	1.48	1.69 ± 0.061	1.85 ± 0.052
Upper canine width at cingulum†	0.69	0.62	0.72 ± 0.026	0.83 ± 0.035
External Measurements:				
Ear length	17	15	18.37 ± 0.491	20.38 ± 0.809
Forearm length	37.28	35.35	36.70 ± 0.986	38.64 ± 1.117
Tibia length	17.00	16.08	16.58 ± 0.659	17.79 ± 0.681
Metacarpal 3 length	31.88	31.98	31.75 ± 0.975	34.16 ± 1.266
Metacarpal 5 length	31.64	29.66	30.99 ± 0.822	33.03 ± 1.142

Measurements are defined in van Zyll de Jong (1979).
*From van Zyll de Jong and Nagorsen (1994).
†measurements which best descriminate between *M. keenii* and *M. evotis* (van Zyll de Jong and Nagorsen 1994).

(Figure 1). This bat was captured in a mist net at 23:20 (2 h 10 min after sunset) within 1 m of a limestone cliff and 1 m above the water. Large Western Hemlock (*Tsuga heterophylla*) and Sitka Spruce (*Picea sitchensis*) dominate this riparian area; blueberry (*Vaccinium* spp.) and Devil's-club (*Oplopanax horridus*) dominate the understory. The stomach of the Turn Creek bat contained 40% Trichoptera, 40% Araneae and 20% Diptera; the first indication of dietary habits.

A second adult male *M. keenii* (UAM 29831) was collected on 11 July 1994 from a *M. lucifugus* maternity roost in the attic of an operating fish cannery at Hoonah, approximately 160 km N of the Wrangell specimen (Figure 1). That site is surrounded by large clearcuts and second-growth forest, as well as forested wetlands and riparian areas.

Body and cranial measurements for both specimens, as well as means (± 1 standard deviation) for *M. evotis* from British Columbia and *M. keenii* are summarized in Table 1. Multiple discriminant analysis (MDA) of 12 cranial measurements (van Zyll de Jong 1979) identified the Turn Creek (UAM 23338) and Hoonah (UAM 29831) specimens as *M. keenii* with probabilities of 88% and 85%, respectively. The MDA of 7 cranial measurements which best discriminate between *M. keenii* and *M. evotis* (van Zyll de Jong and Nagorsen 1994) identified both specimens as *M. keenii* with probabilities of 98%. MDA of the 5 external measurements (Table 1) identified both specimens as *M. keenii* (probability 100%), even though the ear of the Hoonah specimen is > 6 standard deviations smaller than the published mean (van Zyll de Jong and Nagorsen 1994).

Discussion

While only three specimens of *M. keenii* have been recorded in southeast Alaska, little effort has been expended to investigate bat distribution in that region (Parker 1996). *Myotis keenii* may be a year-round resident of Southeast Alaska, although winter records are lacking. All specimens of *M. keenii* have been found in the Pacific Northwest temperate rainforest ecosystem (Walter 1985), a region with relatively mild winters and potentially numerous roost and hibernation sites in caves and trees. Seasonal occurrence of this species, including the documentation of female *M. keenii* and maternity colonies, should be investigated.

Southeast Alaska's temperate rainforests are structurally complex with abundant live trees, snags, and fallen logs of various sizes (Alaback 1991). Such complexity provides loose bark and tree hollows suitable for cavity-roosting species (Bunnell and Allaye-Chan 1984) such as bats (Barclay and Cash 1985; Christy and West 1993; Bradshaw *in press*; Vonhof *in press*). Bats use old-growth forests more frequently than second-growth or clearcut

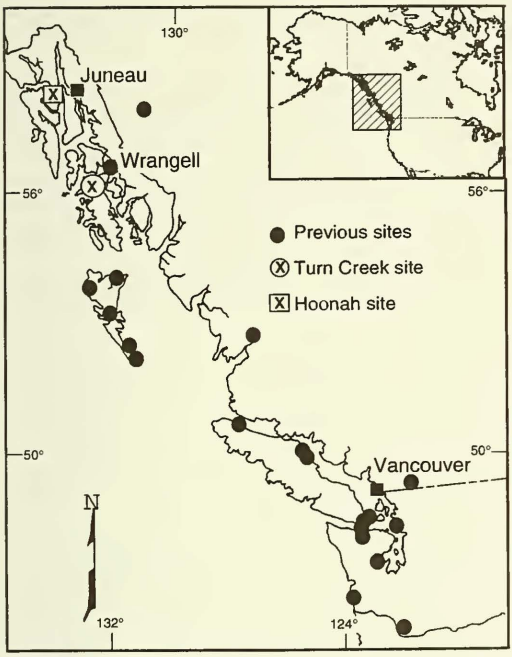

FIGURE 1. Locality records of *Myotis keenii* in the Pacific Northwest. Adapted from data presented by van Zyll de Jong and Nagorsen (1994).

areas in British Columbia, Washington, and Oregon (Barclay and Cash 1985; Lunde and Harestad 1986; Thomas 1988; Christy and West 1993; Bradshaw *in press*; Vonhof *in press*), as well as in Southeast Alaska (Parker et al. *in press*). Caves and crevices are also important bat habitat (Hill and Smith 1984), and over 1769 km^2 of cave and crevice-containing karst underlie Southeast Alaska forests (United States Department of Agriculture 1996). These habitat characteristics may be essential to *M. keenii* as the species appears to be restricted to coastal forests (Firman et al. 1993).

Although limited, our data represent the only diet information available for *M. keenii*. The mixture of flying insects (60%) and nonflying spiders (40%) consumed suggests *M. keenii* has a flexible foraging strategy, pursuing prey in flight and gleaning it from surfaces. Similar foraging behavior has been noted for *M. evotis* (Barclay 1991; Faure and Barclay 1994), a closely related species (van Zyll de Jong and Nagorsen 1994). However, more sampling is required to firmly establish this foraging strategy because bat diets tend to change with season and relative abundance of different prey species (Buchler 1976; Fenton and Morris 1976; Anthony and Kunz 1977). The Turn Creek bat was captured in a riparian area, and its stomach contained a high percentage of Trichoptera, a typically riparian insect. Other prey occur throughout old-growth forests and riparian areas indicating that *M. keenii* forages in those areas.

Roost requirements of *M. keenii* are poorly understood (Nagorsen and Brigham 1993), but it probably uses snags, hollow trees, rock crevices and caves (van Zyll de Jong 1985). The capture of the Hoonah specimen from a maternity roost of *M. lucifugus* in an operating fish cannery indicates that this species will roost in a human-occupied building. *Myotis keenii* roosts in association with *M. lucifugus* under rocks heated by a hot spring on Hot Spring Island in the Queen Charlotte Islands of British Columbia (Nagorsen and Brigham 1993). The Hoonah specimen may have been roosting in the noisy cannery due to a lack of undisturbed roosts in the surrounding area. Nonetheless, this species may tolerate periodic disturbance. Bats at the Hot Spring Island colony must abandon their roost periodically when it floods at high tide (Firman et al. 1993). It is uncertain whether these observations reflect a tolerance of disturbance or lack of alternate, suitable roosts.

Forty-two percent of the highly productive forests in Southeast Alaska were clearcut harvested by 1990 (United States Department of Agriculture 1991; 1993), including over 70% of the karstland forests of Prince of Wales and neighboring islands (Baichtal 1995). These forests contain over 30 000 board feet of useable timber per acre (volume class 6 and 7, approximately 348 m^3 per hectare; Dilworth 1976). Continued clearcut harvesting may alter forest structure important to bats (Thomas 1988). In fact, bat activity is rare in second-growth forests of Southeast Alaska (Parker et al. *in press*). In view of the limited knowledge of the habitat requirements of *M. keenii*, its apparently strong association with old-growth coastal rainforests, and the continuing harvest of these forests in Southeast Alaska, this species and its habitat requirements warrant further and immediate study.

Acknowledgments

We thank the following individuals for their assistance. C. G. van Zyll de Jong examined both specimens described herein, performed multiple discriminant function analysis, and verified species identification. M. Carleton, U. S. National Museum, also verified species identification of the Wrangell specimen. Stomach content analysis was accomplished by J. O. Whitaker, Jr., Indiana State University. M. J. Wike, C. T. Seaton, S. Sevick, and J. R. Demboski assisted with capture and specimen preparation. We sincerely thank D. R. Klein, E. Rexstad, E. W. Lance, M. Ben-David, D. W. Nagorsen, and an anonymous reviewer for their helpful comments on previous drafts of this manuscript.

Literature Cited

Alaback, P. B. 1991. Dynamics of old-growth temperate rainforests in southeastern Alaska. Pages 150–153 *in*

Proceedings of the second Glacier Bay Science Symposium. Glacier Bay, Alaska. *Edited by* A. M. Milner and J. D. Wood, Jr.

Anthony, E. L. P., and **T. H. Kunz.** 1977. Feeding strategies of the little brown bat, *Myotis lucifugus*, in southern New Hampshire. Ecology 58: 775–786.

Baichtal, J. F. 1995. Evolution of karst management on the Ketchikan area of the Tongass National Forest: Development of an ecologically sound approach. Pages 190–192 *in* Proceedings of the 1993 National Speleological Society Cave Management Symposium. *Edited by* D. L. Pate. National Cave Management Symposium Steering Committee. Carlsbad, New Mexico.

Barclay, R. M. R. 1991. Population structure of temperate zone insectivorous bats in relation to foraging behaviour and energy demand. Journal of Animal Ecology 60: 165–178.

Barclay, R. M. R. and **K. J. Cash.** 1985. A non-commensal maternity roost of the little brown bat (*Myotis lucifugus*). Journal of Mammalogy 66: 782–783.

Bradshaw, P. *In press.* Old-growth forest structure and the bat community: The physical nature of vertical forest habitat and its importance in shaping bat species assemblages. *In* Proceedings of the Bats and Forest Symposium 19–21 October 1995. *Edited by* R. M. R. Barclay and R. M. Brigham. Victoria, British Columbia.

Buchler, E. R. 1976. Prey selection by *Myotis lucifugus* (Chiroptera: Vespertilionidae). American Naturalist 110: 619–628.

Bunnell, F. L., and **A. Allaye-Chan.** 1984. Potential of winter range reserves for ungulates as habitat for cavity-nesting birds. Fish and wildlife relationships in old-growth forests, proceedings of a symposium. American Institute of Fishery Research and Biology. Pages 357–365.

Christy, R. E., and **S. D. West.** 1993. Biology of bats in Douglas-fir forests. General Technical Report PNW-GTR-308. United States Department of Agriculture Forest Service Pacific Northwest Research Station. Portland, Oregon. 28 pages.

Dilworth, J. R. 1976. Table 53: Metric system conversion factors. *In* Log scaling and timber cruising. Oregon State University Bookstore, Inc. Corvallis, Oregon.

Faure, P. A., and **R. M. R. Barclay.** 1994. Substrate-gleaning versus aerial-hawking: plasticity in the foraging and echolocation behavior of the long-eared bat, *Myotis evotis*. Journal of Comparative Physiology 174: 651–660.

Fenton, M. B., and **G. K. Morris.** 1976. Opportunistic feeding by desert bats (*Myotis* spp.) Canadian Journal of Zoology 54: 526–530.

Firman, M., M. Getty, and **R. M. R. Barclay.** 1993. Status of Keen's long-eared *Myotis* in British Columbia. Wildlife branch, British Columbia Ministry of Environment, Lands and Parks, Victoria, British Columbia. Wildlife working report WR-59. 22 pages.

Hill, J. E., and **J. D. Smith.** 1984. Bats: A natural history. University of Texas Press. Austin, Texas. 243 pages.

Lunde, R. E., and **A. S. Harestad.** 1986. Activity of little brown bats in coastal forests. Northwest Science 60: 206–209.

MacDonald, S. O. and **J. A. Cook.** 1996. The land mammals of Southeast Alaska. Canadian Field-Naturalist 110(4): 571–598.

Miller, G. S., Jr., and **G. M. Allen.** 1928. The American bats of the genera *Myotis* and *Pizonyx*. United States National Museum Bulletin 144. Washington D. C. 218 pages.

Nagorsen, D. W., and **R. M. Brigham.** 1993. Bats of British Columbia: Royal British Columbia Museum Handbook. University of British Columbia Press. Victoria, British Columbia. 164 pages.

Parker, D. I. Forest ecology and distribution of bats in Alaska. M. S. thesis. University of Alaska Fairbanks. 74 pages.

Parker, D. I., J. A. Cook, and **S. W. Lewis.** *In press.* Effects of timber harvest on bat activity in southeastern Alaska's temperate rainforests. *In* Proceedings of the Bats and Forest Symposium, 19–21 October 1995. Victoria, British Columbia.

Thomas, D. W. 1988. The distribution of bats in different ages of Douglas-fir forests. The Journal of Wildlife Management 52: 619–626.

United States Department of Agriculture. 1991. Environmental effects. *In* Tongass land management plan revision, supplement to the draft environmental impact statement. R10-MB-146. United States Department of Agriculture Forest Service, Juneau, Alaska. Pages 1–765.

United States Department of Agriculture. 1993. Timber supply and demand 1992. Report Number 12, September 1993. United States Department of Agriculture Forest Service, Juneau, Alaska. 40 pages.

United States Department of Agriculture. 1996. Tongass land management plan environmental impact statement. United States Department of Agriculture Forest Service, Juneau, Alaska.

van Zyll de Jong, C. G. 1979. Distribution and systematic relationships of the long-eared *Myotis* in western Canada. Canadian Journal of Zoology 57: 987–994.

van Zyll de Jong, C. G. 1985. Handbook of Canadian mammals, volume 2: bats. National Museum of Natural Science, National Museum of Canada, Ottawa. 212 pages.

van Zyll de Jong, C. G., and **D. W. Nagorsen.** 1994. A review of the distribution and taxonomy of *Myotis keenii* and *Myotis evotis* in British Columbia and the adjacent United States. Canadian Journal of Zoology 72: 1069–1078.

Vonhof, M. *In press.* Roosting ecology and roost-site preference of reproductive *Eptesicus fuscus* and *Lasionycteris noctivagans* in the Pend d'Oreille Valley in southern British Columbia. *In* Proceedings of the Bats and Forest Symposium 19–21 October 1995. *Edited by* R. M. R. Barclay and R. M. Brigham. Victoria, British Columbia.

Walter, H. 1985. Vegetation of the earth and ecological systems of the geo-biosphere. Third edition. Springer-Verlag, New York. Pages 181–187.

Received 16 October 1995
Accepted 5 August 1996