

**ANALYSIS OF THE THERMAL CHARACTERISTICS OF MATERNITY CAVES
AND BAT SPECIES PRESENT AT CRATERS OF THE MOON NATIONAL
MONUMENT, BUTTE COUNTY, IDAHO**

**RESEARCH CONTRACT
with the**

**NATIONAL PARK SERVICE
CRATERS OF THE MOON NATIONAL MONUMENT
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SCOPE OF THE REPORT

Summary of Effort

This report details a summer thermal study and single netting assessment of selected sites in the North Caves Area, Craters of the Moon National Monument, Butte County, Idaho. The study was undertaken to determine if the thermal conditions inside caves, some known to serve as maternity roosts, demonstrate warmer temperatures during the period that pups are reared from June to late July. This research is part of a continuing study where emphasis has been placed on minimal disturbance of bat populations residing at CMNM. Research completed during the two years of field effort are summarized in Keller and Saathoff (1995, 1996).

Taxonomic Placement and Sensitivity of Species

Keller (1985) initially published a key to the bats of Idaho that reviews most of the nomenclature for Idaho species. Evaluation of the nomenclature of species expected in the study area has been assessed from Hall, (1981), Van Zyll de Jong (1984) and Jones, et al., (1992) including species names updated from the nomenclature in Hall (1981) by Frost and Timm (1992) and Tumblison and Douglas (1992). Frost and Timm (1992) restored the traditional generic name of Townsend's big-eared bat from Plecotus to Corynorhinus, a standard used in this report. A key to the bats expected or observed at Craters of the Moon was prepared as an appendix for the current report (see Appendix A). It will be updated periodically as additional species are identified at CMNM. Silver-haired bats (Lasionycteris noctivagans) and Big-brown bats (Eptesicus fuscus, uncommon or found near coniferous trees, have not been captured to date. They have been documented using caves on the Idaho National Engineering and Environmental Laboratory, however (Keller, Bosworth and Doering, 1993).

New bat species have been added to the Conservation Data Center, Idaho Department of Fish and Game Sensitive Species list and Groves, et al. (1997) have recently added global rankings (Master, 1991) to document the status of Idaho bats. These rankings, developed after the 1996 elimination of the "C" series classification for vertebrate species by the U.S. Fish and Wildlife Service, need to be considered when assessing potential disturbance to bats located at Craters of the Moon National Monument. In Idaho, Townsend's Big-eared bat, (Corynorhinus townsendii), is listed as an S2 (imperiled because of rarity), species but remains unprotected (Groves, et al. 1997). Alternatively, Long-eared Myotis (Myotis evotis) and Long-legged Myotis (M. volans) are listed as Idaho S3 species (rare or uncommon). The latter species two species are currently listed G5 globally, suggest they are demonstrably widespread, abundant, and secure nationally.

Corynorhinus townsendii, listed as a G4 species, and M. evotis are not common at CMNM. Consequently, both should be considered sensitive and their habitats extensively studied prior to undertaking any action that may eliminate local populations. Other species expected in caves or trees in the study area, as assessed from Hall (1981), on the basis of specimens held in museum collections containing Idaho bats, or on the basis of a previous studies at the Idaho National Engineering Laboratory are detailed in Keller and Saathoff (1996), and appear secure.

METHODS

Field Assessment of Bat Populations

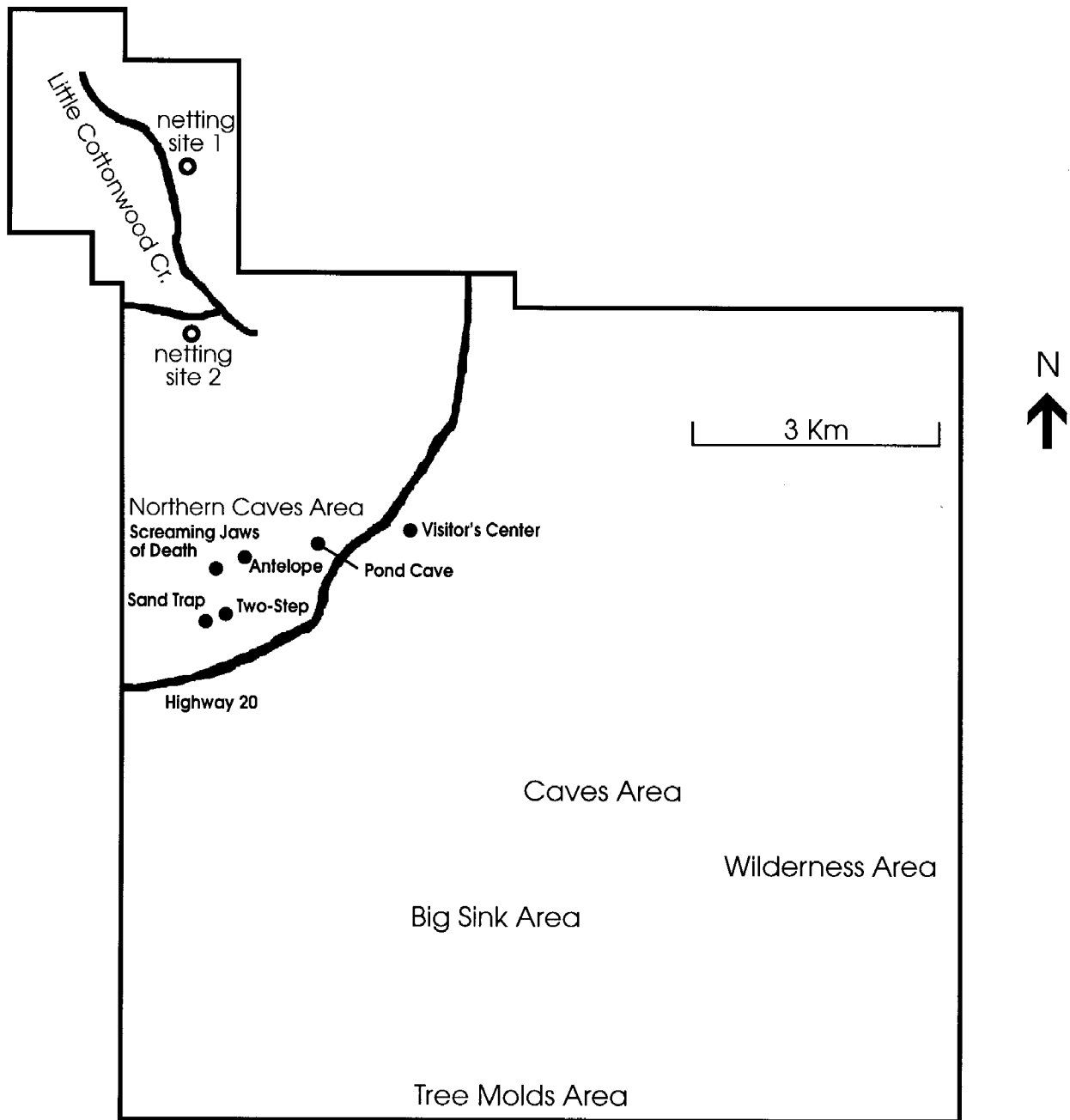
Locations of sites studied during this year are shown in Fig.1. Summer sampling was limited to a re-assessment of bat species using a single cave, hence forth to be referred to as Pond Cave, NW1/4, sec 35, T2N, R24E. A limited survey, conducted in 1995, indicated that this cave was used by at least three species of bats (Keller and Saathoff, 1996). On 15 August 1996, Pond Cave was netted over the largest of its two openings with a single four shelf 2.6 m high and 60 mm (110d 2 ply 2 and 3/8 inch) mesh black nylon mist net from 9:02 to 10:30 p.m. Captured individuals were sexed, aged, weighed with a Pesola scale, and the right forearm was measured with a Fowler Ultra-cal digital caliper. Two bats were fitted with Buchler (1978) light tags to determine direction of flight upon release. During summer placement of temperature logging equipment (see below) in caves, limited searches for bats were completed excepting at Screaming Jaws of Death Cave, which had not been documented to serve as a maternity roost for C. townsendii.

A daylight evaluation of winter use of four caves, Two Step, Sand Trap, and Upper and Lower Antelope, as hibernial sites was completed for a second winter, without success, on 15 March 1997, as all potential hibernacula were completely closed by snow and the entrances could not be located. Cold weather access subsequently was obtained on April 19, when the snowpack permitted locating cave entrances sealed by deep snow during the winter 1996/97. All entrances were still partially sealed with drifted snow or contained internal cones of snow that partially blocked openings on April 19. Two caves, Screaming Jaws of Death and Pond Cave were also checked for hibernial activity on this date. No hibernating bats were located in a single unnamed dome cave entered March 15, 1997.

Temperature Analysis of Caves

Three caves, Two Step, Sand Trap, and Antelope, considered important potential maternity colony sites, were

Figure 1. Craters of the Moon sites investigated for bats from 1994-1996 (see Keller and Saathoff 1995,1996). The 1996 research was concentrated in the Northern Caves Area.



Bat Research Locations Craters of the Moon, North Section

equipped with Onset Computer Corporation (Pocasset, MA) thermal temperature loggers on 11 June, 1997 (Table 1). Loggers were suspended by wire from an Orjan cement-wall picture hook containing four 5 mm stainless steel pins that were driven into a location near the ceiling of each cave. Assessment of internal temperatures was completed with three Hobo-temp loggers programmed to read at 48-minute intervals in the upper or lower chamber of Two Step Cave. Single loggers were placed in the twilight areas of Sand Trap Cave and Upper Antelope on the same date. Caves were not disturbed further as a result of potential use by females until July 21, when several loggers were exchanged for downloading to a spreadsheet and Lower Antelope and Screaming Jaws were equipped with loggers with external probes placed approximately 15 cm from the ceiling. Loggers were then re-checked for proof of operation on August 8. A logger at Two Step and Sand Trap had failed and were replaced. As a result of consultation with Onset Computer and similar problems encountered in a study of the thermal profile of mines in northern Idaho (Keller, 1997), it was determined that the moisture present in these caves was leading to chip failure in loggers. Consequently, assessment was terminated until 15 April 1997, when caves were accessible and could be equipped with waterproof Optic StowAway 32K loggers that could be read on site with either a lap-top computer or an optic shuttle, a hand-held data transporter which can be used to read and launch loggers on location. The number of loggers was reduced to a single device in all but Screaming Jaws of Death Cave which now contains three StowAway devices (Table 2). Pond Cave, a site designated for research during the summer of 1997, and one new cave, discovered and logged March 15, were added as assessment sites.

RESULTS

Field Assessment of Bats

Pond Cave, which is unmapped, has two entrances. Only the larger single entrance was netted as a result of the larger number of bats that used this route to access the cave for water. A single pond, located in a separate partially enclosed area on the left side of this oblong cave, appears to be deep and permanent. It is likely maintained by significant snow cones produced in one or both openings each winter. The pond did not appear to contain ice on 19 April 1997, when a logger was attached to the ceiling above the entrance to the room containing the pool, a condition presumably produced by its large thermal mass and isolation. However, the floor of the cave was covered with ice and ice may have existed under the surface of the pond. No hibernating bats were found inside on this date. When netted on 15 August 1996, 3 long-eared *Myotis*, 2 western small footed *Myotis*, 12 little-brown

Table 1. Sample location and 1996 dates of data collection for lava-tube caves in the North Caves Area, Craters of the Moon National Monument. Temperature range of each logger is shown under location. Sampling intervals vary due to logger failures and settings available for specified sample settings.

Cave Name	Location	Sampling Period	Set Sample Interval	Logger s/n#	Attachment and condition
Two Step	rear wall upper level Craters 6 Hobo-temp -5 to +37C	6/11 to 8/8	60d @48min	19853	taped to wall removed working 8/8
Two Step	upper twilight area Craters 5 Hobo-temp -5 to +37C	6/11 to 7/21	60d @48min	19850	ceiling hook removed, read
Two Step	lower chamber level Craters 7 Hobo-temp -5 to +37C	6/11 to 8/10	60d @48 min	19851	wall hook; data read by Onset
Two Step	twilight area at opening Craters 3 Hobo XT=p -5 to +37C	7/21 to 9/4	45d @36min	18044	ceiling hook replaces 19850
Sand Trap	twilight area at opening Craters 2 Hobo-temp -37 to +46C	6/11 to 7/25	60d @48min	72896	ceiling hook failed early removed 8/8
Sand Trap	twilight area at opening Craters 1 Hobo-temp -37 to 46C	8/8 to 9/22	45d @36min	72900	ceiling hook replaces 72896

Upper Antelope	on roof dome, twilight Craters 1 Hobo-temp -37 to +46C	6/11 to 7/21	60d @48min	72900	ceiling hook removed, read
Upper Antelope	on roof dome, twilight Craters 4 Hobo XT=p -5 to +37C	7/21 to 9/04	45d @36min	18041	ceiling hook replaces 72900
Lower Antelope	suspended near roof Craters 8 Hobo XT+p -37 to +46C	7/21 to 9/04	45d @36min	79993	ceiling hook
Screaming Jaws	at throat, upper chamber Craters 7 Hobo XT+p -37 to +46C	7/21 to 7/23	45d @36min	79996	upper wall hook Probe wire cut by rodent?

Table 2. Optic StowAway temperature logger locations for 1997 research in progress at Craters of the Moon National Monument. Loggers were placed in service on 19 April. Interval between samplings is every 6 minutes 24 seconds, in continuous service for 144 days. These waterproof loggers are read by computer optically. One separate logger (see*) was placed in service on March 15, inside an accidentally discovered dome cave. It was attached to the ceiling.

Cave Name	Logger location	Logger s/n#	Title	Comments
Two step	upper chamber, twilight zone suspended on hook	109856	two step #1	
Sand trap	upper chamber, twilight zone suspended on hook	103439	sand trap	
Upper Antelope	upper chamber, twilight zone suspended on hook	109760	special #1	
Lower Antelope	near ceiling just inside entrance near downfall	103434	antelope lower	
Screaming Jaws	in mouth area, upper chamber, left side throat	103457	screaming jaws #1	
Screaming Jaws	middle lava tube, half way into the long tube	109857	screaming jaws #2	new logger site
Screaming Jaws	lower chamber just inside throat	103461	special #2	new logger site
Pond Cave	on ceiling, at entrance to	109761	pond cave	new logger; new cave site
* unknown	on ceiling, will read as incorrect cave name.	unknown	unknown	discovered by accident

Myotis, and 3 long-legged Myotis (*M. volans*), a new species for CMNM, were collected as a subsample of a significant number of bats attempting entrance but avoiding collection as a result of difficulties incurred netting the irregular opening to the cave. The large number of individuals observed or collected indicate that this cave serves as a significant source of water for a number of species (Table 3). The forearm measurements on three little-brown Myotis exceeded the range published for this bat, a condition suggesting that an extension of the study reported by Adams (1997), who analyzed the size of wings and foraging habitats of little-brown Myotis, could be undertaken as a graduate thesis at CMNM. Light-tagged long-eared Myotis flew toward a Douglas fir forested area located on Grassy Cone. The use of this area by bats will be studied more intensively during the summer, 1997.

Winter assessment of Screaming Jaws of Death was initiated during 1997. Between the mouth and the lower chamber, which are connected by a "throat tube", a long downward-slanting tube runs from the throat under the upper chamber. Unfortunately, this tube has not been surveyed in previous samplings, especially winters. When checked on 15 April 1997, 5 *Corynorhinus townsendii* were found still hibernating in this tube. This record constitutes the first evidence that hibernation occurs in the North Caves Area. Significant cold air flow was detected in this tube which likely connects to another portion of the cave that I was unable to reach. Screaming Jaws Cave contains highly significant variation in microclimates available for use by bats. Consequently, three loggers (see below) were immediately established in the mouth, throat tube adjacent to a hibernating bat, and in the lower chamber. It is unknown how normal thermal patterns or bat movements change when the cave space is disconnected from the outside environment, a condition that occurred as a result of deep snow during the winter of 1996/97. If this cave is snow sealed during 1997/98, entrance will be sought by digging through the snow covering the opening to count bats.

Temperature Analysis

Two Step Cave

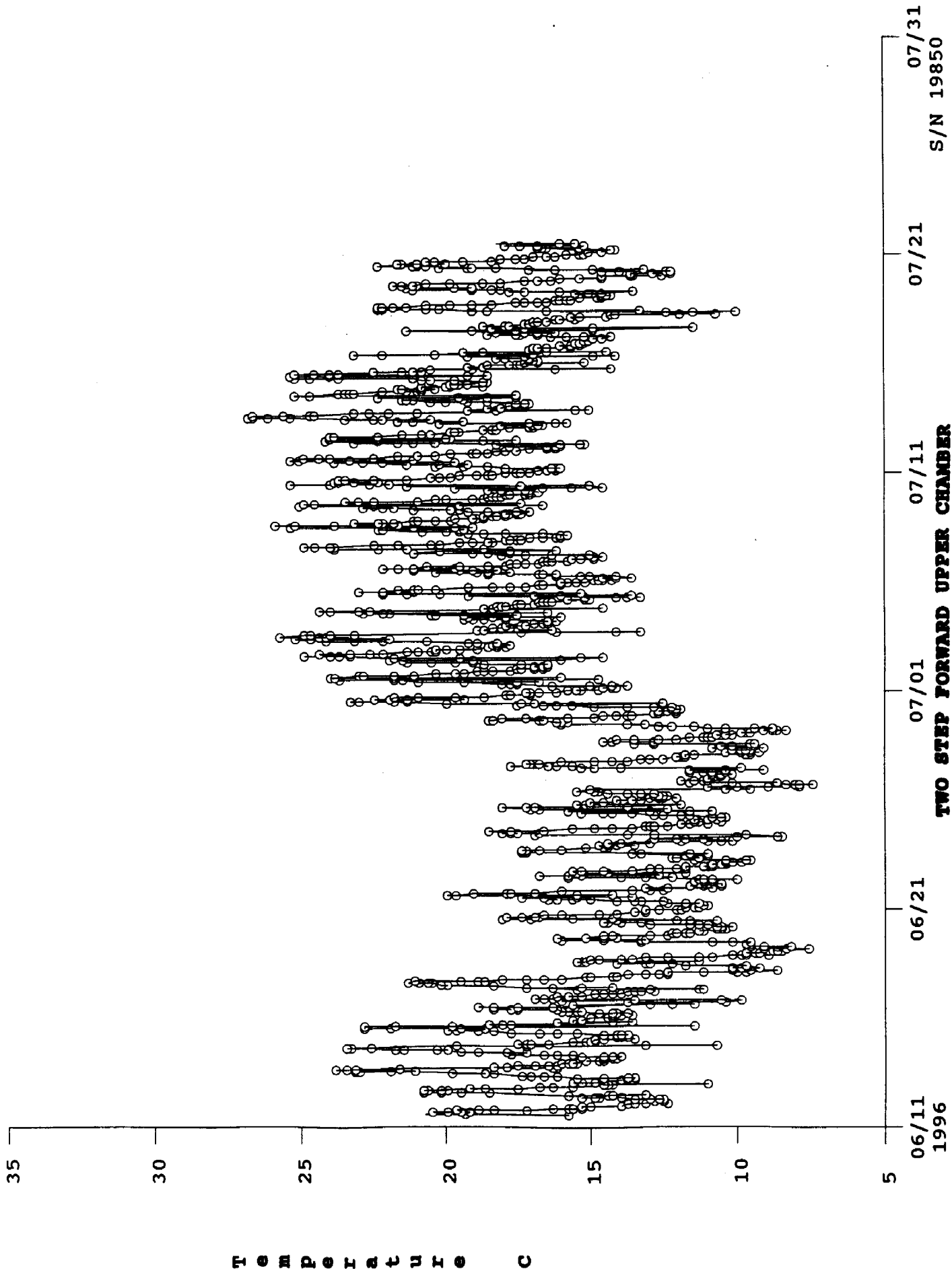
Figures 2 and 3 show the thermal profile of the upper chamber of Two Step from June 11 through September 4. A basic trend is apparent for lower temperatures during June, prior to the period when females would select a maternity site at this cave. During June, the upper thermal levels rarely exceed 20C (=68F) and commonly declined to 11C (=52F), a range that likely would require clustering to keep pups alive. July temperatures appear less erratic. The upper limits cluster around 25C (=77F), the low around 15C (=59F). An unexplained wave function pattern is apparent in the data from July 21 to

Table 3. Captured and released bats on August 15, 1996 at Pond Cave, Craters of the Moon National Monument.

Species	Common name	Sex	Age	Forearm length(mm)	Weight (grams)	Comment
<u>Myotis evotis</u>	Long-eared Myotis	M	A	39.9	5.4g	
<u>Myotis evotis</u>	Long-eared Myotis	F	A	37.6	5.4g	
<u>Myotis evotis</u>	Long-eared Myotis	M	A	38.6	6.0g	
<u>Myotis ciliolabrum</u>	Western Small-footed Myotis	F	A	41.9	7.0g	
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	38.4	n/a	
<u>Myotis volans</u>	Long-legged Myotis	F	A	43.4	7.2g	
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	42.3	6.4g	large forearm
<u>Myotis lucifugus</u>	Little Brown Myotis	F	A	41.1	6.6g	
<u>Myotis lucifugus</u>	Little Brown Myotis	F	A	38.3	6.4g	
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	42.2	8.0g	large forearm
<u>Myotis volans</u>	Long-legged Myotis	F	A	39.6	6.8g	nursing
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	43.3	6.0g	large forearm
<u>Myotis lucifugus</u> ?	Little Brown Myotis	F	A	39.0	8.0g	collected
<u>Myotis ciliolabrum</u>	Western Small-footed Myotis	M	A	40.0	6.4g	

<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	39.9	7.8g
<u>Myotis volans</u>	Long-legged Myotis*	M	A	42.0	7.8g
<u>Myotis lucifugus</u>	Little Brown Myotis	F	A	40.5	7.2g
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	40.3	7.0g
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	40.5	6.0g
<u>Myotis lucifugus</u>	Little Brown Myotis	M	A	40.1	6.8g

Figure 2. Thermal profile developed from Hobo-temp data logger #19850, attached adjacent to the ceiling in the upper chamber twilight zone at Two Step Cave, June 11 to July 24, 1996.



September, when the upper boundary is around 29C (=84F), conditions too hot for bat survival (Fig 3). Consequently, the data support the general observation that females could raise pups in warm locations but likely move to other sites or to deeper levels of caves in the summer after the pups are weaned. A logger established in the single lower chamber of this cave demonstrates a consistent evening temperature from 5C to 6C with upward fluxes during daylight hours for the period of mid-June to mid-August (Fig.4), conditions favorable for rapid cooling following evening foraging. Thus, this cave shows varied microclimates are available to nursing females in the middle of the season, and good roosting conditions for bats during all portions of the summer.

C. townsendii were not present during daylight hours on July 21 at Two Step, but were discovered in Screaming Jaws during the evening of August 8. Because only the upper chamber of this cave was checked on July 21, it is highly probable that females had moved to the middle chamber of Screaming Jaws cave as summer heat levels increased. Figure 5 displays data from the rear of the upper chamber for Two Step. The logger was permanently removed on August 8 from this location. The pattern of data is very similar to the information developed by the frontal logger. Temperatures trend to be 1 or 2 degrees centigrade cooler.

Sand Trap Cave

Figure 6 and 7 exhibit the thermal profiles in the upper chamber of Sand Trap Cave from June 11 to September 22, excepting several days where the first logger employed, failed. This cave was cold, averaging around 9C (=48F) low to 18C (=64F) high during June. The lower temperature profile trends upward toward 13C (=55F) during July, but the upper bound failed to change until August (Fig. 7), when the temperature range reached a level that could support a maternity colony, ranging between 14C (=57F) and 23C (=73F). Unfortunately, as a result of the decision to prevent disturbance to maternity sites, this cave was not checked for bats during this period.

Upper and Lower Antelope

Upper and Lower Antelope caves are connected but differ significantly in configuration, exposure, and aspect. Lower Antelope is accessed through a large opening approximately 6m below the smaller opening of Upper Antelope. Figure 8 exhibits a lower boundary of 8C (=46F) and an upper boundary of 15C to 20C (=59-68F) during June for Upper Antelope Cave. July temperatures increased to an upper boundary of 25C (=77F) and a common lower boundary of 14C (=57F) during July. A second unexplained cycle of temperature variation is shown for August in Figure 9. The bounds of this variation appear to be

Figure 3. Thermal profile developed from a Hobo XT with probe data logger #18044, attached adjacent to the ceiling in the upper chamber twilight zone at Two Step Cave, July 21 to September 4, 1996.

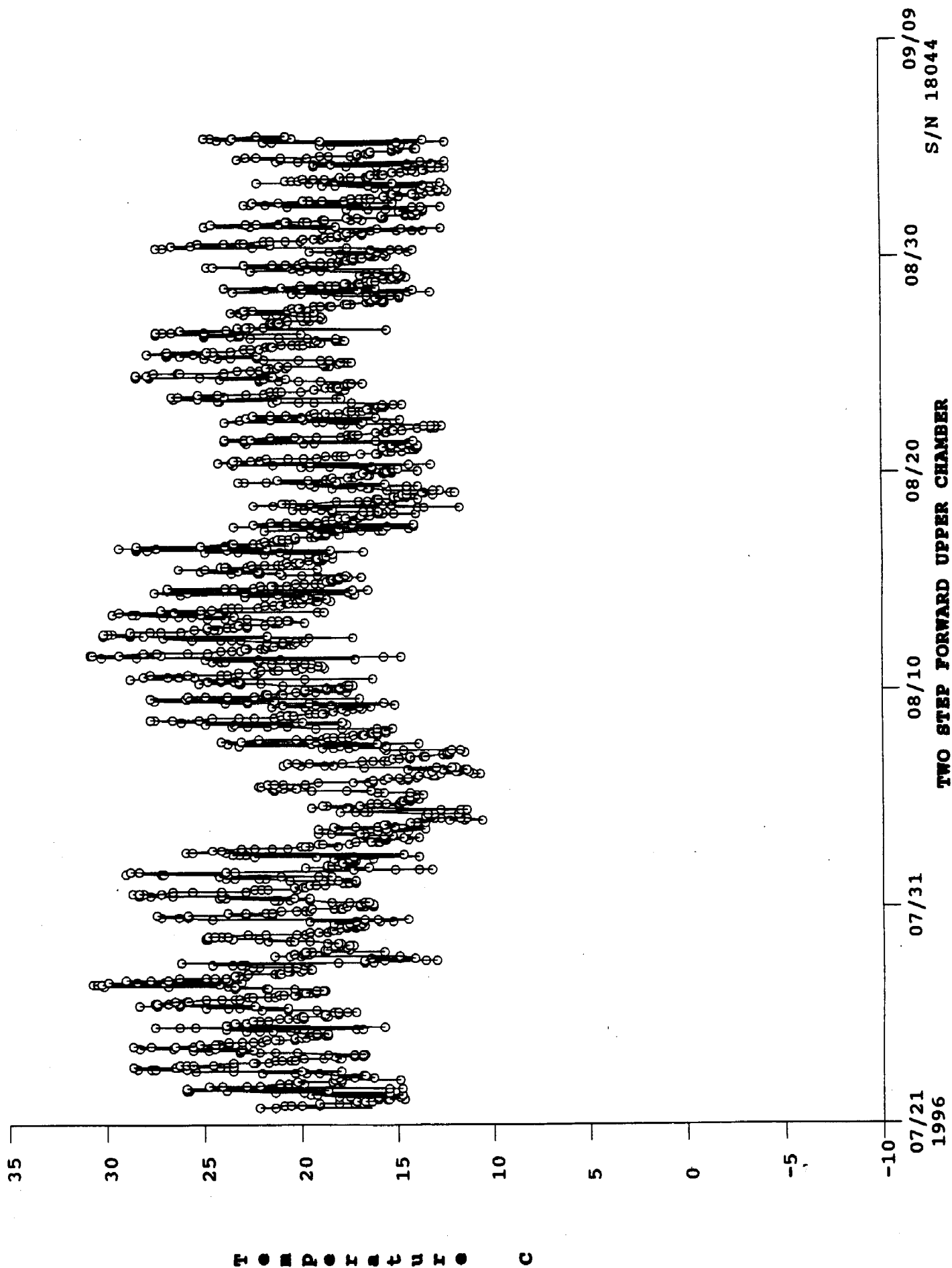


Figure 4. Thermal profile developed from Hobo-temp data logger #19851, attached to the wall in lower level chamber at Two Step Cave, June 11, to August 10, 1996.

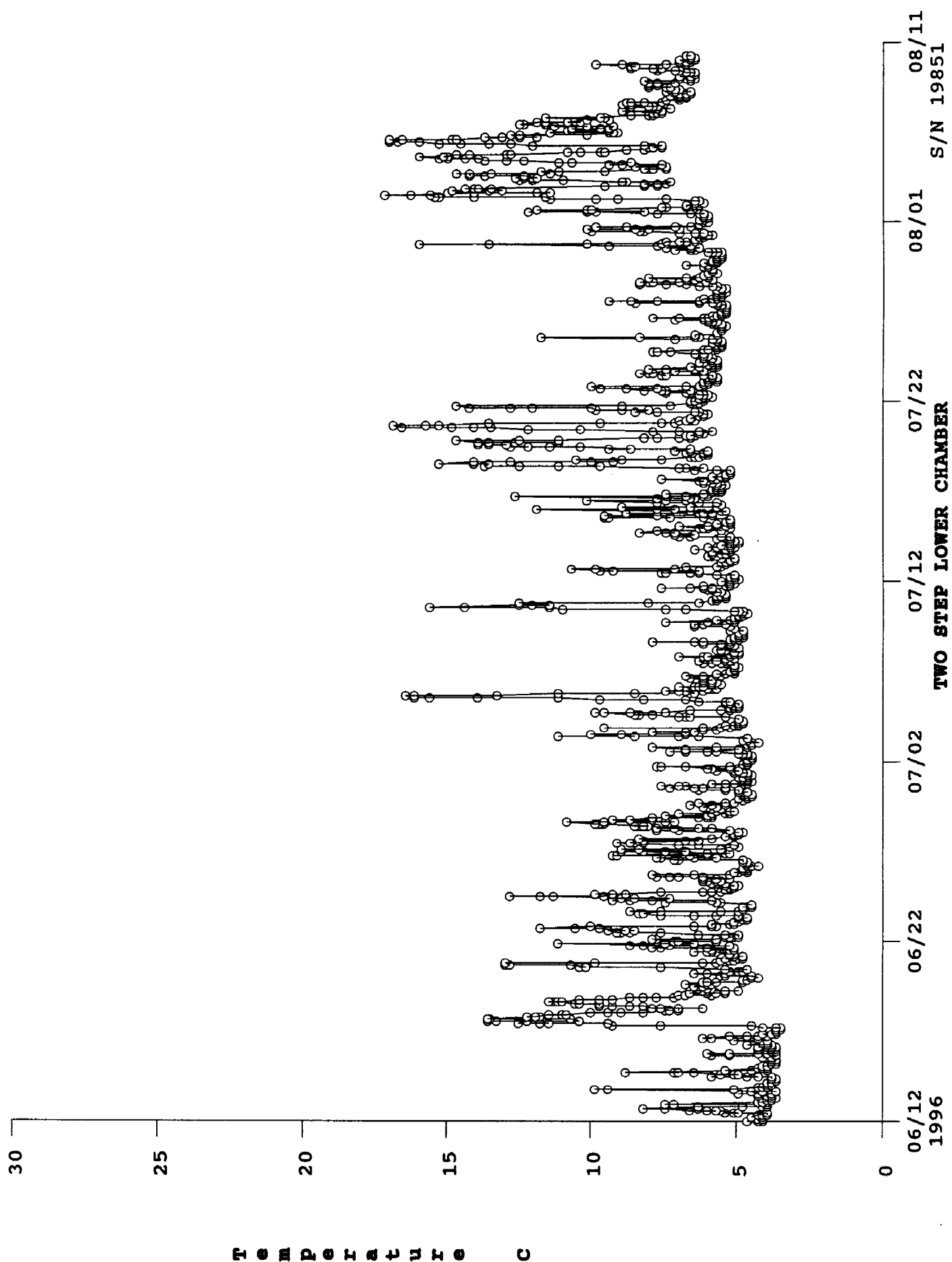


Figure 5. Thermal profile developed from Hobo-temp data logger #19853, attached to the rear wall in the upper chamber twilight zone at Two Step Cave, June 11, to August 8, 1996.

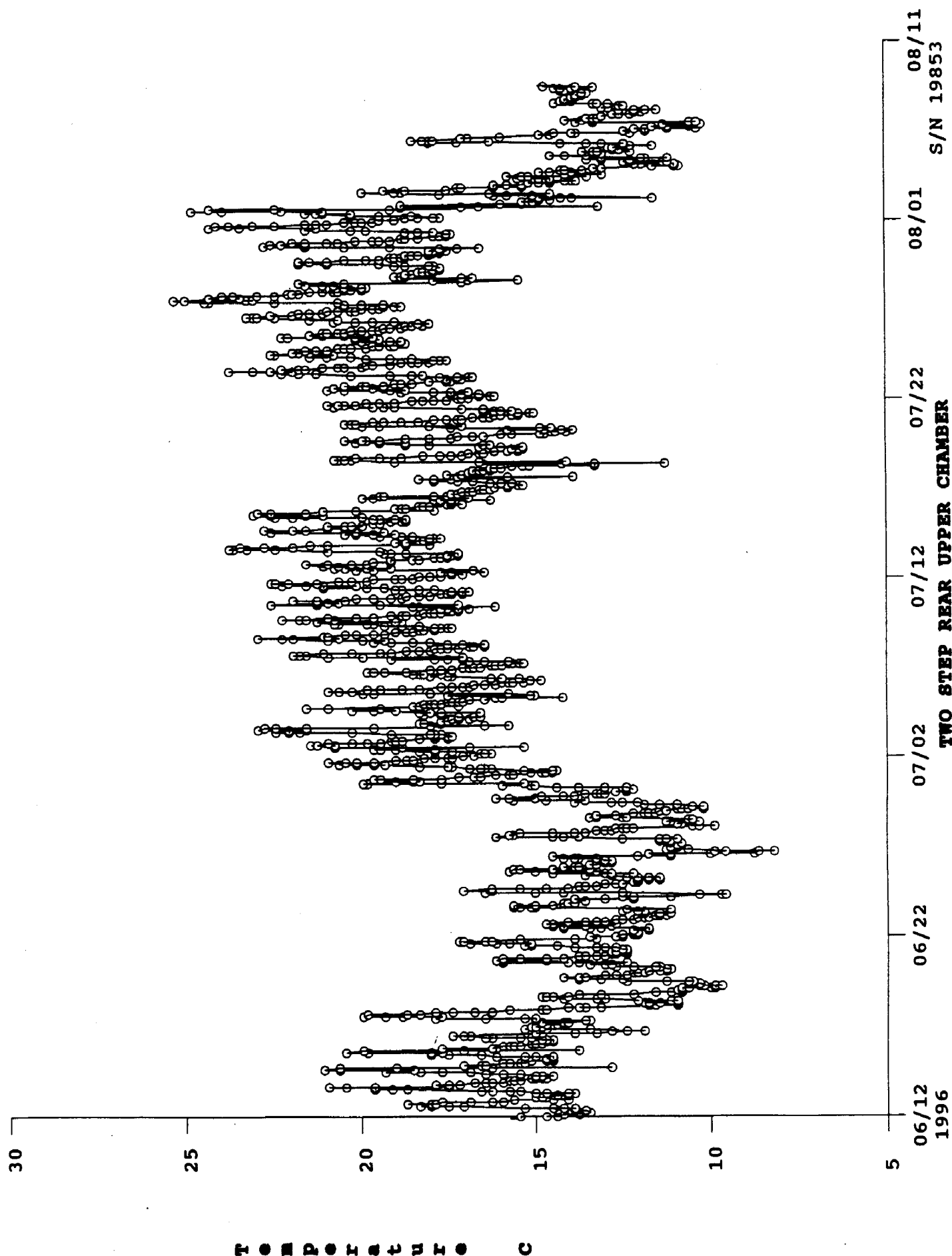


Figure 6. Thermal profile developed from Hobo-temp data logger #72896, attached adjacent to the ceiling in the upper chamber twilight zone at Sand Trap Cave, June 11, to July 25, 1996.

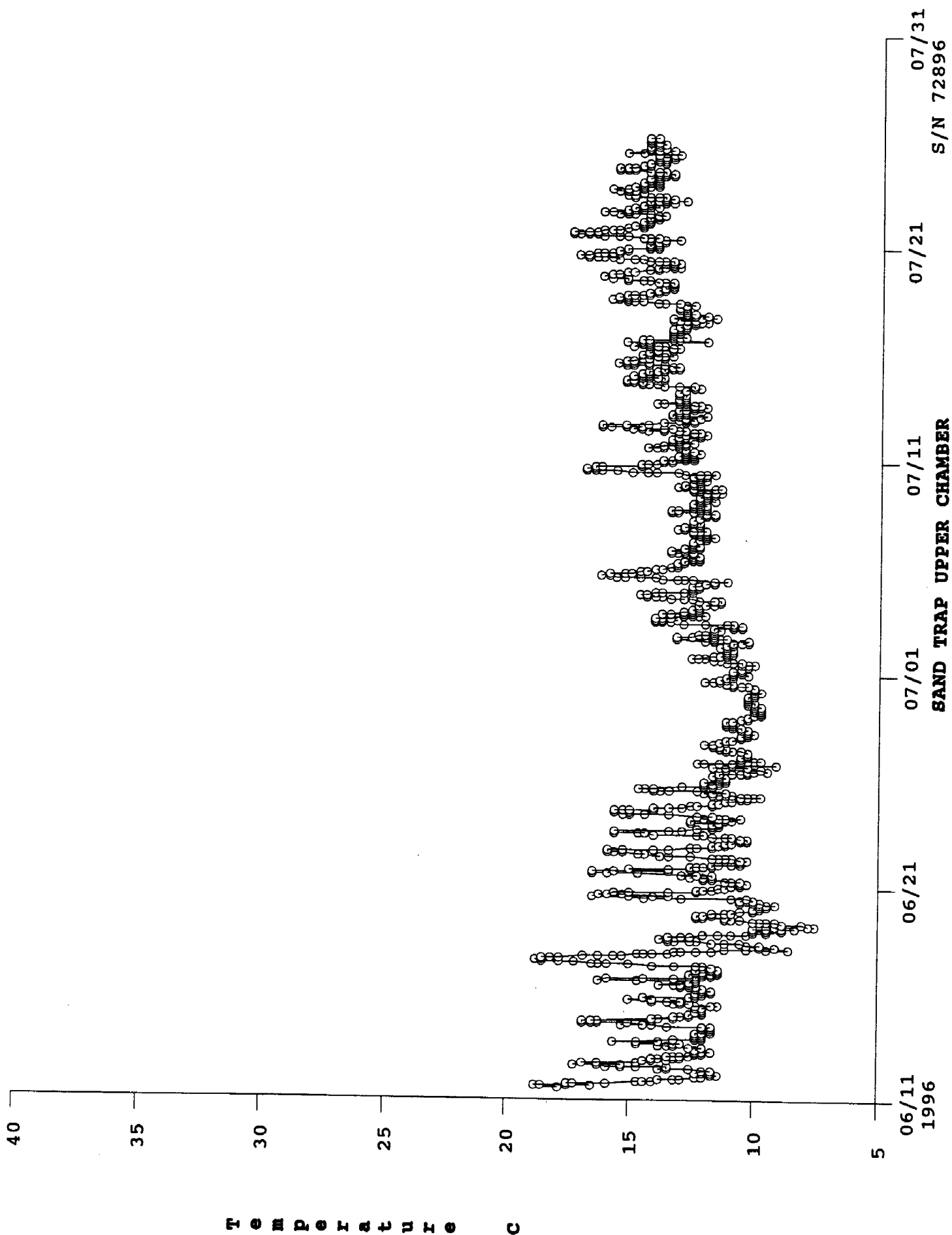


Figure 7. Thermal profile developed from Hobo-temp data logger #72900, attached adjacent to the ceiling in the upper chamber twilight zone at Sand Trap Cave, August 8 to September 22, 1996.

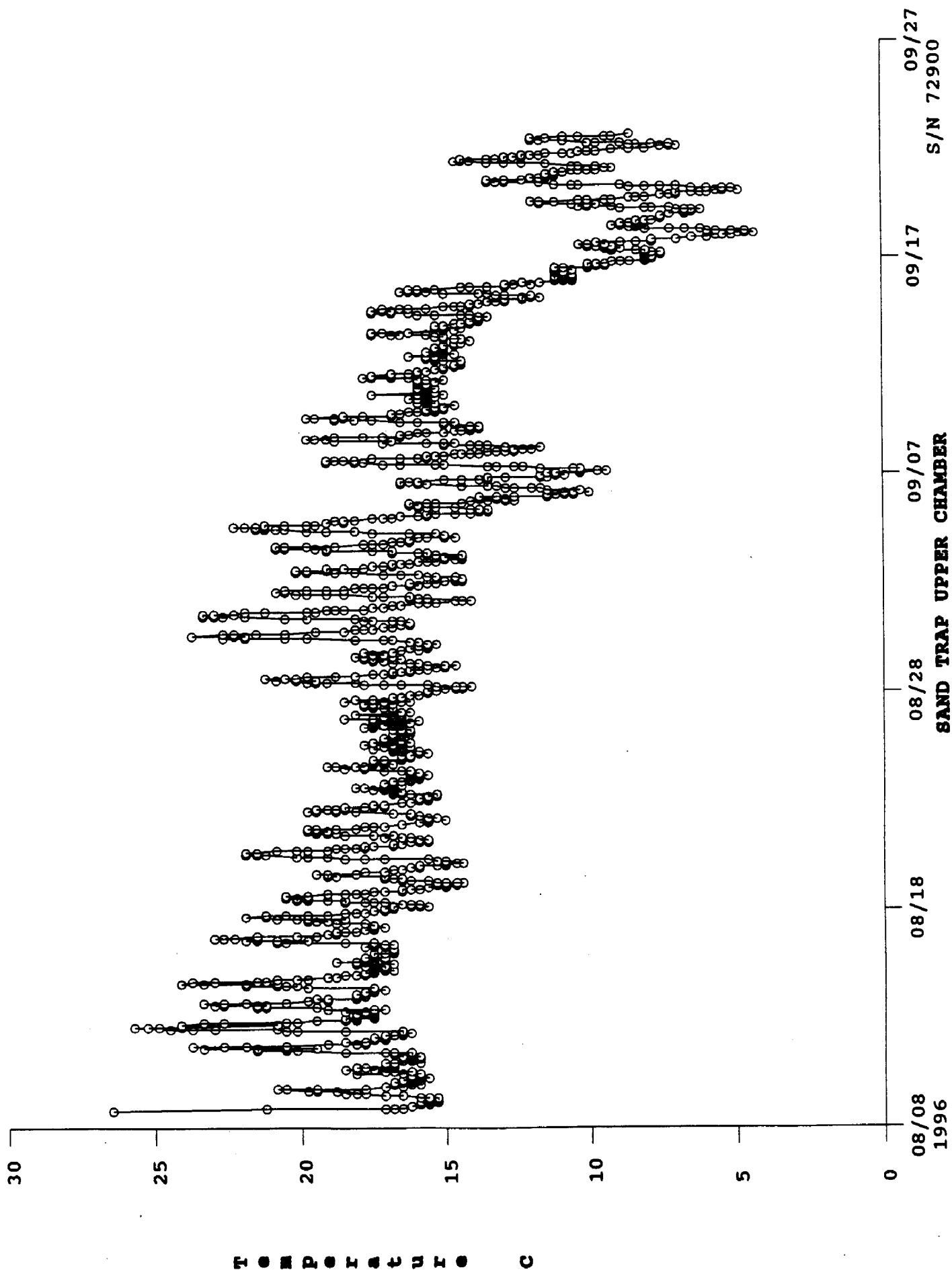


Figure 8. Thermal profile developed from Hobo-temp data logger #72900, attached adjacent to the ceiling in the upper chamber twilight zone at Upper Antelope Cave, June 11 to July 21, 1996.

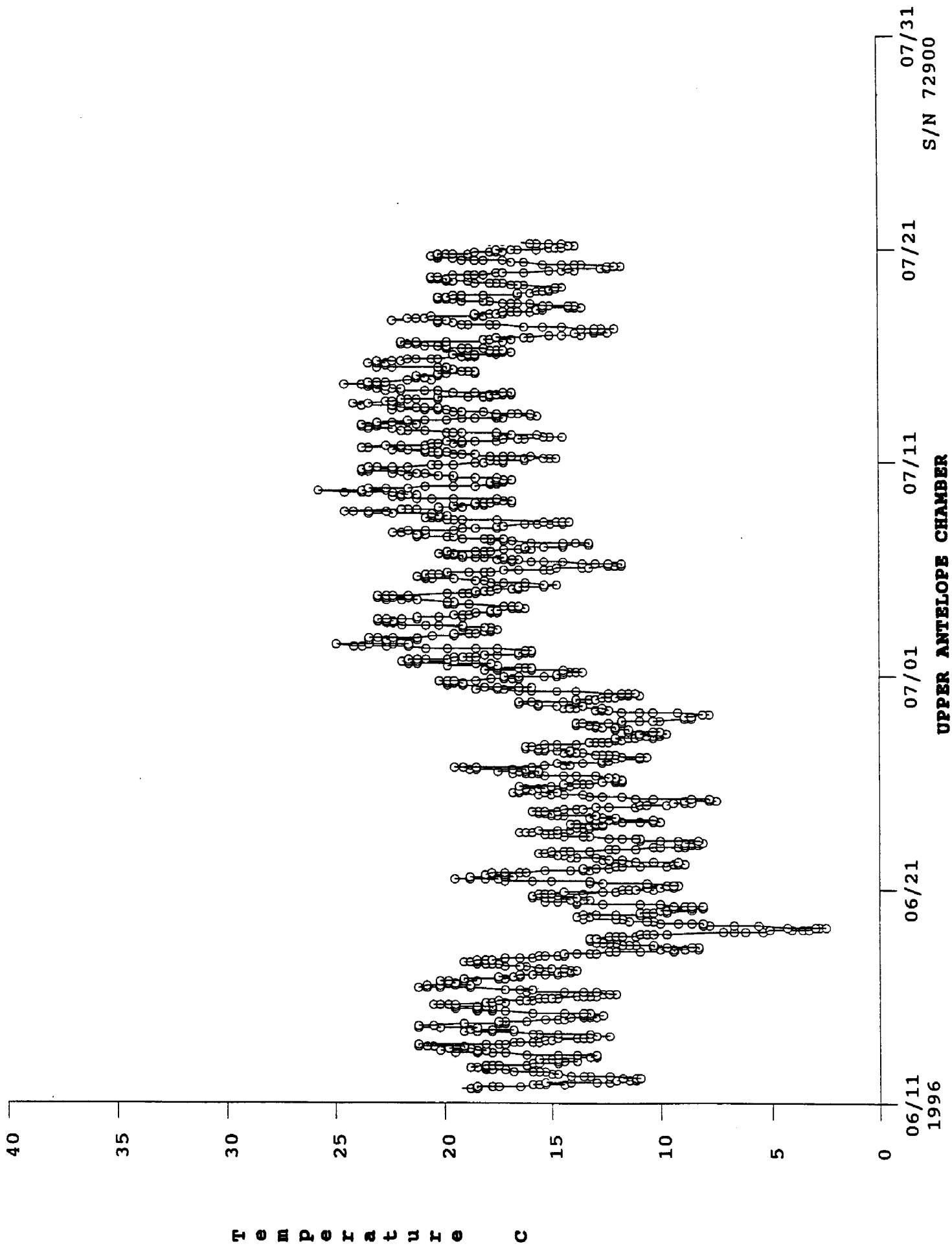
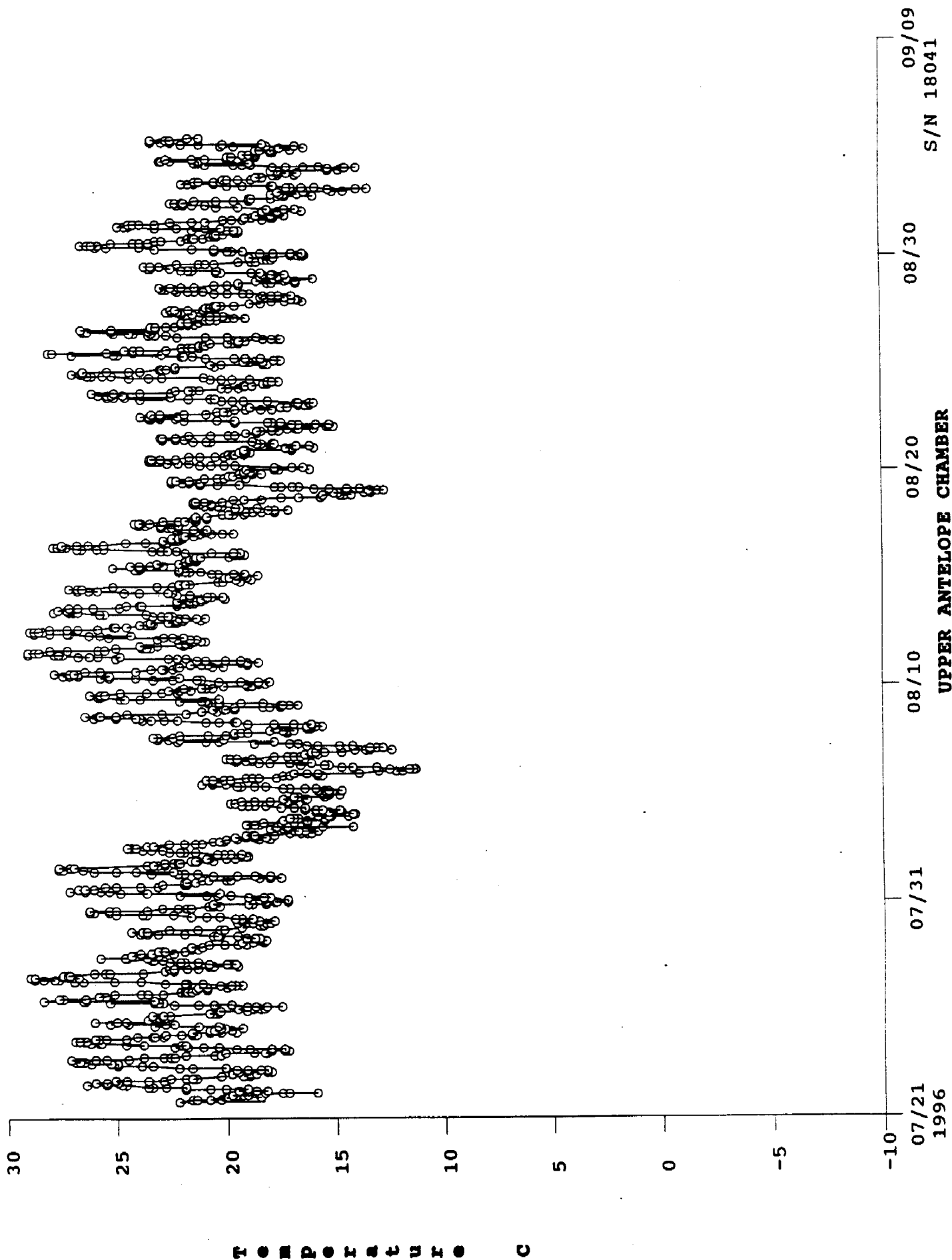


Figure 9. Thermal profile developed from a Hobo-XT with probe, logger #18041, attached adjacent to the ceiling in the upper chamber twilight zone at Upper Antelope Cave, July 21 to September 4, 1996.



similar to the pattern established in August for Two Step (compare Figs. 3 and 9). By contrast, the late July to early September temperature profile for Lower Antelope Cave (Fig. 10) tends to be significantly cooler ($15^{\circ}\text{C}=59^{\circ}\text{F}$). Bats have not been observed in these caves during winter or daylight hours. However, Saathoff netted bats using the lower opening as a night roost in 1995 (Keller and Saathoff, 1996).

Screaming Jaws of Death

This cave system has not been observed to support a maternity colony. A logger was established on July 21, 1996 in the upper rear dome area known as the "mouth" adjacent to a tube area leading downward, similar to a throat. The operation of this logger was not verified on August 8 as a result of discovery of Corynorhinus exiting the lower chamber during evening. The only logger established during 1996 had a probe that was destroyed by a rodent, rendering it inoperable several days after installation. The upper bounds of the period for which data are available (Fig. 11) indicate that the mouth area was very warm ($29-30^{\circ}\text{C}$ ($=84$ to 86°F), likely because the chamber lies just under the lava which covers it.

DISCUSSION

To evaluate the habitat requirements of bats within natural maternity sites, data are needed on thermal variables at two levels. First, caves should be equipped with thermal sensors set to continuously monitor changes in the thermal envelope available to bats. Sensors at Two Step Cave thus were positioned to assess general horizontal and vertical trends in the cave space. Second, periodic manual data collection at the location of individuals and unoccupied sites are needed. Unfortunately, human intrusion into the cave would disturb females and their young, likely causing them to abandon the cave. Consequently, only logger data were collected at Two Step to describe the thermal envelop for contrast against other sites. Because Onset loggers have not been employed in similar studies elsewhere, the initial field work has yielded preliminary data on site variability that is marginally impacted as a result a logger failures. The new loggers being employed in Screaming Jaws of Death should rectify this problem providing data for a longer period of time. Additionally, next year, a hand-held "thermal gun" will be tested for use to estimate thermal temperatures adjacent to any bats located. These data will then permit contrast against logger information. The integration of these two methods will allow a more thorough description of the thermal envelope of caves and permit investigating the significance of temporal and spacial variability of the small caves in the North Caves Area. Winter thermal information developed by Bosworth (1994) and Doering (1996) and Wackenhut (1990) for

Figure 10. Thermal profile developed from a Hobo-XT with probe, logger #79993, attached adjacent to the ceiling in the lower chamber opening in the twilight zone, Lower Antelope Cave, July 21 to September 4, 1996.

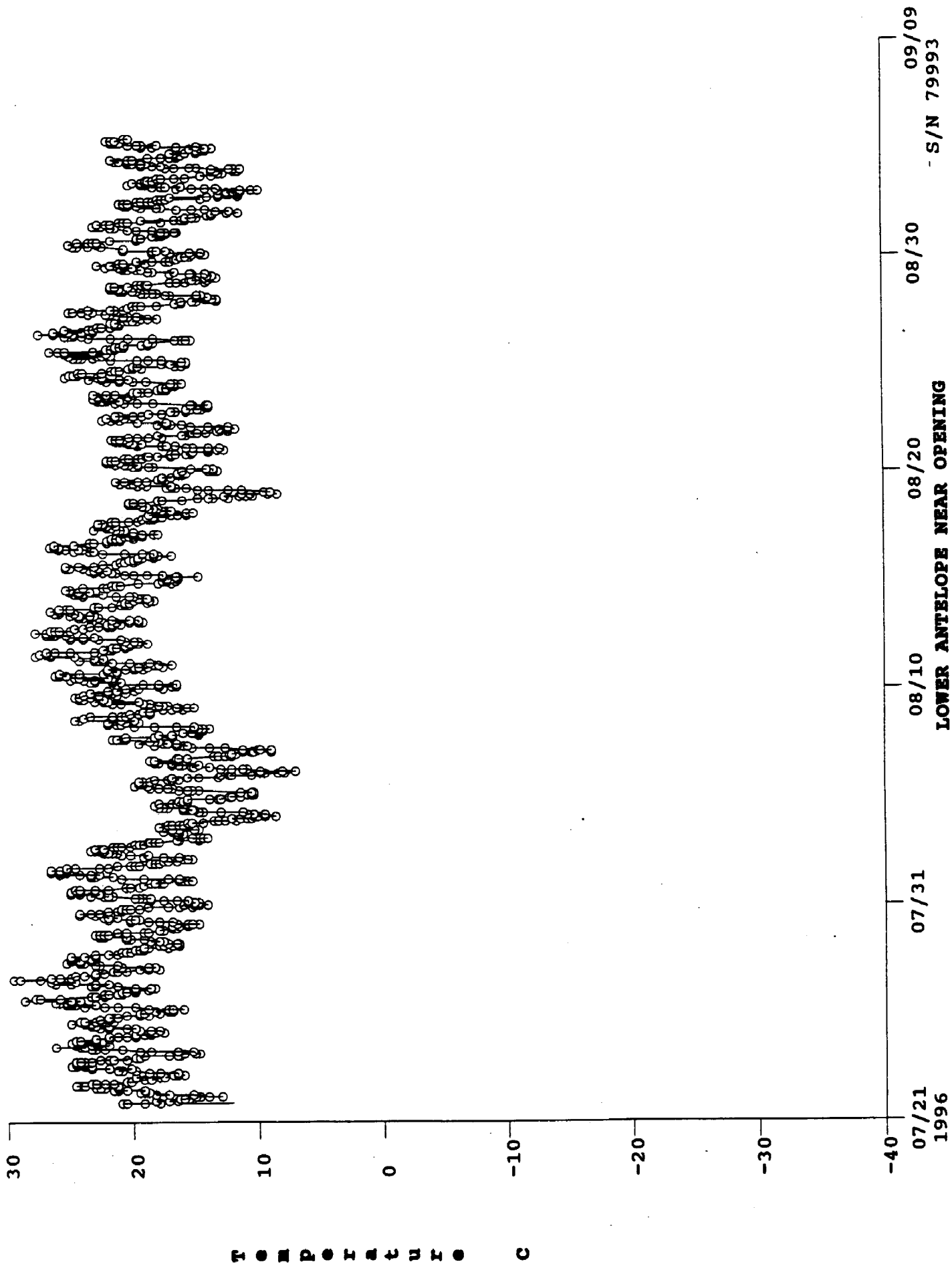
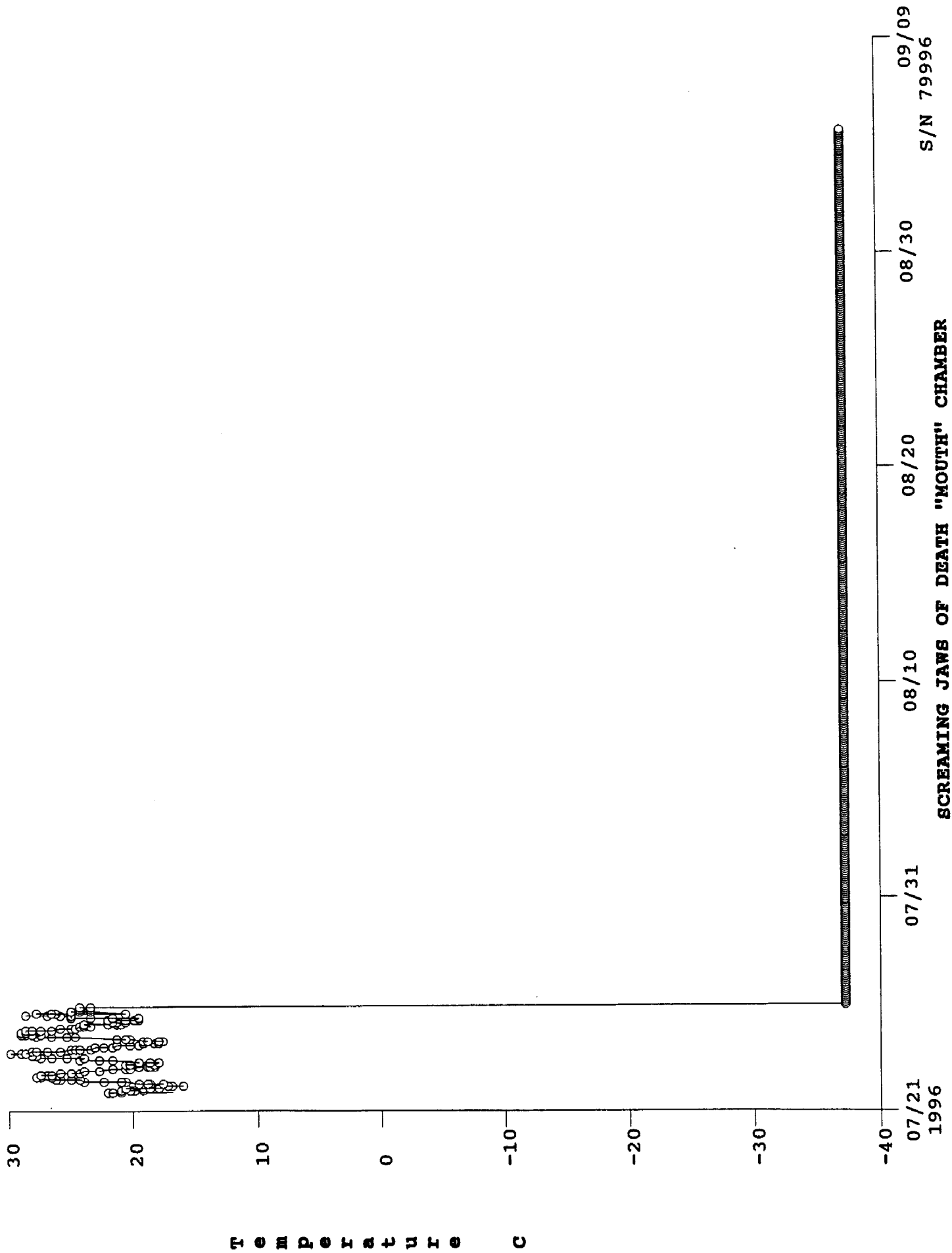


Figure 11. Thermal profile developed from a Hobo-XT with probe, logger #79996, attached adjacent to the ceiling in the rear upper chamber (=mouth) area of Screaming Jaws of Death Cave, July 21 to July 23, 1996. This logger failed as a result of the cutting of the probe wire cord, likely by a rodent.



large hibernaculum caves on the INEEL can also be contrasted against the data collected in CMNM caves during winter. It appears likely that Screaming Jaws of Death may be found to be one of the most important winter bat hibernacula in the North Caves Area and information obtained from this cave may be useful in making this contrast.

Studies completed at Craters suggest that both the environment of roosts and the thermal physiological needs of young pups and/or pregnant female bats undergo seasonal patterns of change. On the basis of the data collected this past year, I suspect that CMNM maternity colonies move to caves containing more optimal thermal envelopes as they change during summer periods. Thus, absence at a site one year does not suggest that the site was abandoned. Rather, as a result of variation in time when a cave is checked, the presence of a colony may have been missed. A life-history strategy of movement would likely be of selective advantage by lessening the probability of extinction of either pups or females as a result of natural disaster, sudden thermal inconsistencies, or discovery and predation. In sum, success of rearing young in small desert caves may require season movement among optimal thermal envelopes, a condition that would make finding maternity colonies difficult. To test this hypothesis, a major full-summer study of the North Caves Area will be required. It would not be feasible to do such a study unless all the caves are mapped by GIS location so that an investigator can locate caves rapidly at night. **Daylight GIS locations of these sites, without cave intrusion, could be produced by summer personnel working at CMNM.** I strongly recommend that this task be undertaken and completed as quickly as possible.

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Appendix A. Taxonomic key to the bats of Crater's of the Moon. Species with a (*) are confirmed residents. Three species, the Hoary Bat, the Silver-Haired Bat, and the Big-brown Bat have not been collected, but are confirmed uncommon bats on the INEEL. Bolded letters in a couplet represent distinguishing characteristics for a given species. The dental formula, represented to the far left of each taxon, provides the number of upper and lower teeth sequentially as: incisors, canines, premolars and molars. The dental formula can be used to distinguish skulls of bats excepting members of the genus Myotis.

**KEY TO THE BATS OF
CRATERS OF THE MOON NATIONAL MONUMENT**

1a. UPPER SURFACE of INTERFEMORAL MEMBRANE AT LEAST WELL-FURRED OVER HALF OF SURFACE to tip of tail.

. . . Go to 2

1b. Upper surface of interfemoral membrane not well-furred over half of surface.

. . . Go to 3

2a. Upper interfemoral membrane furred to tip of tail; Body YELLOWISH to brownish with white-tipped hairs producing a FROSTED appearance; TAN THROAT PATCH; EARS with BLACK RIMS.

1 1 2 3 =32
3 1 2 3

Lasiurus cinereus
Hoary Bat
134-54-12-16
total length, 134-140
length of tragus, 9
forearm, 46-55
g.lgth.sk1., 17.0-18.5
wt., 21-42g

2b. Upper interfemoral membrane heavily furred outward from body for slightly more than 1/2 of its length; BODY VERY DARK BROWN OR BLACKISH WITH SILVERY-WHITE TIPS TO THE HAIRS GIVING A FROSTED APPEARANCE.

2 1 2 3 = 36
3 1 3 3

Lasionycteris noctivagans
Silver-haired Bat
93-39-8-6
total length, 92-115
length of tragus, 8
forearm, n/a
g.lgth.sk1., n/a
wt., 8-11g

3a. GLANDULAR LUMPS on FACE BETWEEN NOSTRILS and EYES; upper fur brownish to grayish-brown, underparts sooty; EARS, LONG (to 35mm), BROWN and MAY be FOLDED or COILED AGAINST BODY.

2 1 2 3 = 36
2 1 3 3

Corynorhinus townsendii *
Townsend's Big-eared Bat
95-46-9-35
total length, 90-112
length of tragus, 15
forearm, 39.2-47.6
g.lgth.sk1., 15.2-17.2
wt., 9-14

3b. No glandular lumps on face between nostrils and eyes

. . . Go to 4

4a. TIP of TAIL EXTENDS UP TO 4mm BEYOND INTERFEMORAL MEMBRANE; upper fur chocolate brown or reddish-brown, underparts paler; size relatively large, forearm usually more than 45mm; wing span may exceed 32cm.

2 1 1 3 = 32
3 1 2 3

Eptesicus fuscus
Big Brown Bat
115-46-12-14
total length, 87-138
length of tragus, 9
forearm, 39-53.6
g.lgth.skl., 15.1-23.0
wt., 14-21g

4b. Tip of tail does not extend much beyond interfemoral membrane; color variable; forearm less than 45mm.

. . . Go to 5

5a. DISTINCT BLACK MASK ACROSS MUZZLE AND FACE to ears; ears blackish; upper fur color variable brown to yellowish; calcar keeled.

2 1 3 3 =38
3 1 3 3

Myotis ciliolabrum *
Western small-footed Myotis
79-36-7-13
head-body, 34.4-48.0
length of tragus, n/a
forearm, 29.6-36.0
g.lgth.skl., 13.1-14.7
wt., n/a

5b. No distinct mask across muzzle and face to ears; ears blackish or brownish; upper fur color variable brown.

. . . Go to 6

6a. TIPS of HAIRS IMPARTING INCONSPICUOUS BRONZE TONE, especially when fur ruffled; yellowish to olive-brown fur on back appears long and glossy; calcar not keeled.

2 1 3 3 =38
3 1 3 3

Myotis lucifugus *
Little Brown Myotis
85-36-11-13
head-body, 41-54
length of tragus, 8
forearm, 33.0-41.0
g.legth.skl., 14.0-16.0
wt., 7-9g

6b. Tips of hairs not imparting inconspicuous bronze tone; color variable, but dull.

. . . Go to 7

7a. Upper fur brownish, dark at base, underparts buffy; BLACK EARS, LONG, CAN BE EXTENDED BEYOND TIP OF NOSE, AND WIDE, 9-10mm ACROSS at BASE; TRAGUS MORE THAN 1/2 LENGTH of EAR.

2 1 3 3 = 38
3 1 3 3

Myotis evotis *
Long-eared Myotis
88-41-8-20
head-body, 41.6-56.0
length of tragus, 9
forearm, 35.5-41.0
g.lgth.skl., 15.0-16.4
wt., 5g

7b. Body cinnamon to brownish above and buffy to light brown below; membranes and short rounded ears dark; FUR ON UNDERSIDE OF WING MEMBRANE EXTENDING FROM THE BODY TO A LINE JOINING THE ELBOW AND KNEE.

2 1 3 3 = 38
3 1 3 3

Myotis volans *
Long-legged Myotis
91-42-11-14
head-body, 43-54
length of tragus, 5
forearm, 35.2-41.2
g. length skl., 12.2-15.0
wt., unknown