State Wildlife Grants Program
Division of Ecological Services
Minnesota Department of Natural Resources

Timing and Pattern of Bat Activity at Soudan Underground Mine

Final Report to the
State Wildlife Grants Program

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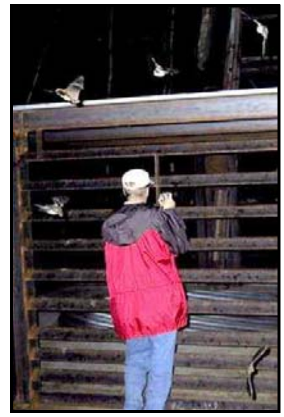
MNDNR Biological Report No. 88
June 2006

Acknowledgements

We wish to thank the Minnesota State Wildlife Grants Program for providing matching funds to the Minnesota County Biological Survey (MCBS), Division of Ecological Resources, and the Division of Parks and Recreation (Parks), Minnesota Department of Natural Resources. These funds were crucial to the completion of this project.



Special recognition goes to Dave Olfelt, formerly co-project leader and Northeast Region Parks Resource Specialist for his contribution to this project, as well as others involving bats at state parks in northern Minnesota. His long-standing concern for the protection of the bats at Soudan Underground Mine and support of efforts to better understand and appreciate the importance of this site to bats will be recognized for years to come.

Without the substantial assistance from staff at Soudan Underground Mine State Park, this project would not have been possible. Jim Essig, Park Manager, and Paul Wannarka, former Park Manager, offered important advice in detector placement and timing of trips underground. Tony Zaoudnik, Lyle Mattson, Jim Sunsdahl, Allen Kosir, James Pointer, and others, provided essential assistance — accompanying us underground, running the hoist, and offering electrical advice. The support and camaraderie of all park staff made trips to the mine a welcome reward after a long drive north.

Appreciation is extended to Aren Gunderson, former MCBS Animal Survey Specialist, who provided indispensable assistance with the initial preparation of equipment and data collection at the beginning of this project.

Preface

The development of electronic monitoring devices that run continuously has enabled the collection of data that would have been unattainable in the past. Over 1,600,000 call files and 80,000 environmental readings were recorded during this project. Although the bat detectors and data loggers reduce time needed in the field, the immense amounts of data collected by these devices substantially adds to the data processing and analysis time. The information presented in this report summarizes the major observable trends. However, the data contains much more information on the behavior of the bats at Soudan Mine. Hopefully, in the future, we will be able to look at these data more closely and perhaps conduct additional follow-up work when MCBS returns to conduct surveys in this area. This information, combined with the long-term data that has been collected on the bats in the mine, will build a more complete picture of the role Soudan Underground Mine and adjacent open pits play in the life cycle of bats in this region. This report is only the first chapter to that story.

Cover Photo: View of main frame and engine house from across the main pit.
Top Photo: Dave Olfelt at Alaska Shaft.

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Introduction

An estimated 10,000 bats use Soudan Underground Mine as a hibernaculum (or winter roosting site). The majority of bats found hibernating at the mine are Little brown myotis (*Myotis lucifugus*) and at least 2,000 are Northern myotis (*Myotis septentrionalis*), a state special concern species (Figure 1a, b). Not only is this the largest hibernating colony of Northern myotis in Minnesota, but Soudan Underground Mine also supports the largest total number of over-wintering bats in the state. The second largest is Mystery Cave in southeastern Minnesota, where approximately 2,300 bats hibernate. Big brown bats (*Eptesicus fuscus*), a common hibernator in Minnesota have not been documented in Soudan Underground Mine, but another state special concern species, the Eastern pipistrelle (*Pipistrellus subflavus*), occasionally hibernates here (Figure 1c). This is the northernmost record of this species known for Minnesota. Clearly, this mine is a vital resource to bat populations in the state. Activities that impact the survival of this over-wintering colony will have far reaching implications to the status of bat populations in the Upper Midwest.

In addition to its value as an essential resource to hibernating bats, it is one of the state's more unusual parks – Soudan Underground Mine State Park – where an estimated 40,000 visitors tour the mine and surface features annually. It also is the site of a number of long-term, international physics studies (refer to http://www.physics.umn.edu/outreach/soudantour/). Others have found the mine an important resource for conducting research and testing. The timing and intensity of activities associated with these research projects and the operation and maintenance of the mine as a state park have the potential of negatively impacting the hibernating bats by forcing them to arouse frequently during hibernation or by changing the hibernating environment in ways that are detrimental to the health of hibernating bats. During winter, bats rely solely on their fat reserves to sustain them and hibernating is a behavioral mechanism that reduces their energy consumption. Unnecessary arousals during this time increase depletion of these energy reserves, resulting in reduced survival. The challenge before park staff is to allow legitimate activities within the mine, while minimizing their impact to the hibernating bats.

Background Information about Soudan Mine

Located in the iron-rich Soudan Formation of the Vermillion Range, Minnesota's first iron ore was shipped from an open pit mine at the Soudan site in 1884. Seven open pits were mined in the area before operations shifted underground in the early 1890s. There were indications that these seven areas were linked to a main ore body. As part of the underground efforts, several vertical shafts were sunk at intervals along the surface with underground horizontal tunnels or drifts extending toward the ore bodies (*Eliseuson, M. 1976. Tower Soudan...the state park down under. Minnesota State Park Heritage Series, No. 1: 1 – 36*). Commercial mining operations ended in 1962. In 1965, U. S. Steel Corporation donated the mine and adjacent lands to the state.

The main underground mine extends vertically 714 meters to the 27^{th} level, with 19 horizontal drifts, some extending for more than 1500 meters (Figures 2, 3). Drifts typically are 2.5 meters high, vertically separated by 30 or 60 meters of Ely Greenstone, and interconnected by shafts and raises. Stopes (areas where ore has been excavated) are distributed throughout the mine, some of which are quite large – over 30 meters long and 15 meters high. A rough estimate of total length of vertical and horizontal passages in the mine is over 80 kilometers. Two shafts remain open to the surface; Shaft No. 8 is the primary access shaft that connects with all levels of the mine and extends to Level 27. The Alaska Shaft, approximately 520 meters east of Shaft No. 8, ends at Level 12. Anecdotal evidence indicates that as mining activity extended to deeper levels, bats began to occupy the upper abandoned levels.

Soudan Underground Mine serves as an important physics research laboratory, operated by the University of Minnesota's School of Physics and Astronomy and other affiliated institutions. The first of these physics laboratories (Soudan I) was constructed in 1980 in an existing drift on the 23^{rd} level. Although bats had been present in the mine long before the physics research, this was the first time that their presence was made known to bat researchers, when Dr. Marvin Marshak commented during an interview that the bats clustered outside the laboratory.

Subsequent expansion of the physics laboratories involved considerable alteration of the mine. In 1984, excavation of a larger physics laboratory (Soudan II) began on Level 27. Construction, including blasting and hauling of rock, continued round-the-clock until 1986, resulting in a chamber 70 meters long, 14 meters wide, and 12 meters high. This laboratory has been in continuous operation ever since (refer to http://www.hep.umn.edu/soudan/brochure.html#top). Like the first laboratory, a sizeable number of bats were observed roosting in and near the laboratory. During 1989, out of concern for the high bat mortality in these areas, Department of Natural Resources' Division of Parks and Recreation (DNR Parks) drafted a bat management plan that attempted to exclude bats from the physics area and reduce the effects of temperature, humidity, and air flow in the adjacent drifts.

An additional chamber twice the size of Soudan II was constructed on the 27th level from 1999 until 2002. During planning for construction of the new MINOS laboratory, the impact of these activities to the bats figured prominently in discussions between UM Physics and the DNR. Assessments of the number and locations of hibernating bats were made prior, during, and after construction, and annual winter bat counts continue to the present day.

The Alaska Shaft, long recognized as an important entrance to the mine for bats, underwent renovation in 2001, to make it safe for visitors while keeping it accessible to bats. Through a cooperative effort between DNR Parks and Bat Conservation International, Inc., the shaft was reinforced and a bat-friendly cage was installed over the entrance (Figure 4).

Project Objectives

Bat research at the Soudan Underground Mine had been conducted sporadically since 1983 and included winter and summer bats counts, bat banding, and surface bat activity.

Based on this information and observations made by park staff, specific questions about the bats at Soudan were identified and became the focus of the project proposal submitted to the Minnesota State Wildlife Grants Program (SWG). These initial objectives were later expanded, as was the project timeline, when preliminary data revealed bat behaviors that were not anticipated at the time the proposal was prepared. The project objectives, listed below, reflect the modified proposal resubmitted to SWG, December 2004.

1. ***To document the timing of spring emergence, fall return, and winter activity by bats from Soudan Underground Mine during 2004 and 2005.***

2. ***To correlate above and below-ground bat activity during spring emergence and fall return, with changes in surface weather patterns, temperature, relative humidity, and barometric pressure at Soudan Underground Mine during 2004 and 2005.***

Documentation of the timing of spring emergence (the period beginning when bats start shifting roost positions in the mine until most bats have left) and fall return (the period beginning when "swarming" activity increases outside the mine until surface activity largely ceases and most of the bats have returned to the mine) had not been conducted in detail for the bats in the Soudan Underground Mine. Not only would this information add to our knowledge of the phenology of bat activity in the mine, but also to the general timing of bat activity in northern Minnesota. A better understanding of when bats are out of the mine would assist park staff determine the best time to conduct activities that could be potentially disruptive to hibernating bats.

What factors determine when bats leave and return to their hibernacula are not fully known, however, environmental changes may play a role. Changes in weather, temperature, relative humidity, and barometric pressure at the mine would be compared with changes in bat activity.

3. ***To determine if open pits are used as secondary access locations to the mine during spring emergence and fall return, and whether these pits serve as hibernacula.***

The No. 8 Shaft and the Alaska Shaft are the primary, and perhaps only, points of access for bats into and out of Soudan Underground Mine. However, there are a number of open pits and associated drifts that may be connected to the mine and could be used by bats as alternate exits. Recording bat activity at some of these pits would document whether or not bats use these locations as hibernacula and or as secondary entrances. Such information would be useful when evaluating future activities in the mine that involve closure of one or both of the shafts or exclusion of bats from these shafts.

4. ***To identify the species and sex composition of bats clustering on Level 12 and their eventual hibernating sites.***

5. ***To document survival of bats on Level 27 through the hibernating period.***

Park staff have commented on the seasonal clustering of bats on Levels 12 and 27, however, the exact timing and duration of this clustering activity has not been well documented. In addition, the composition by species and sex are not known, nor is it understood if these bats eventually hibernate on the same level or distribute themselves throughout the mine during winter.

Bats have been observed to roost in or near the physic laboratories, a warm and dry environment that is not suitable for hibernation. In addition, late summer bat die-offs have been recorded on Level 27. Why bats apparently select this unsuitable area is not understood.

Methods

1. ***To document the timing of spring emergence, fall return, and winter activity by bats from Soudan Underground Mine during 2004 and 2005.***

The primary tool used to estimate bat activity and to identify bat species at Soudan was the ANABAT II® bat detecting system, developed by Titley Electronics Pty Ltd (Figure 5). This detector was used to record the ultrasonic calls generated by bats as they echolocate. Each recording setup was composed of an ANABAT II bat detector connected to an ANABAT CF Storage ZCAIM (or Zero Crossings Analysis Interface Module). The bat detector received the ultrasonic calls and recorded them, via the ZCAIM, onto compact flash (CF) cards. These permanent data files were later downloaded, reviewed, and analyzed on computer (Figure 6).

Levels 12 and 27 were selected for underground placement of the bat detectors because they represented the range of hibernating conditions in mine. Level 12, one of the uppermost levels that can be safely accessed, is 365 meters below the surface and open to both the Alaska and No. 8 shafts. Level 27, the lowermost level, is 714 meters below the surface and open only to the No. 8 shaft. In addition, previous bat studies had been conducted on these levels. Two locations were initially selected on Level 12 and one on Level 27. Each ANABAT and ZCAIM was placed in a protective box and powered from the mine's electrical supply. The bat detectors were run 24 hours/day. Compact flash cards were changed weekly from April through November 2004, then bi-monthly from December 2004 through April 2005. Information on detector checks was entered onto a Palm® PDA and later incorporated into an activity log.

Level 12 – Main (Figure 7, 8): Set at the south end of the Pump Room pointing towards the main shaft. The detector was run from 7 April until 6 May 2004, but was removed after a month due to acoustic interference caused by the cage traveling up and down the shaft.

Level 12 – Alaska (Figures 7, 9): Set on an ore car beyond a wooden wall north of the Pump Room. The detector faced east down the drift toward the Alaska Shaft. The detector was run from 7 April 2004 until 27 April 2005.

Level 27 (Figures 10, 11): Set in the east drift on a stack of wooden timbers, a short distance past a dividing wall. The detector faced eastward down the drift, and was operated from 7 April 2004 until 27 April 2005.

To assess the relative use of the two mine shafts by bats as entry and exit locations, bat detectors were placed at the surface next to the shafts. One was set in the Manway next to the No. 8 Shaft and another besides the bat cage over the Alaska Shaft (Figure 12). A second bat detector was placed with the Alaska Shaft detector to record bat activity in the open area adjacent to the shaft. Each detector was housed in a protective box and mounted on a tripod. With the exception of the Manway location, which was run on the mine's electrical supply, the bat detectors were powered by 12-volt sealed batteries (Ẁerker®, WKA 12-12F2).

From April through December 2004, detectors were operated beginning a half hour before sunset and ending a half hour after sunrise. During this time, detectors were visited weekly to replace compact flash cards and batteries.

Manway (Figure 13): Set inside the Manway House, facing west through the access window and tilted down into Shaft No. 8. The detector was powered by the mine's electrical supply and operated from 7 April through 13 December 2004.

Alaska – Shaft (Figure 14): Set outside the bat cage of the Alaska Shaft, facing east and tilted down into the shaft. The detector was battery-powered and operated from 7 April to 10 May and from 13 – 20 October 2004.

Alaska – Open (Figure 14): Set outside the bat cage of the Alaska Shaft, facing west and tilted up toward a forest opening. The detector was battery-powered and operated from 7

April through 13 October and from 20 October through 13 December 2004.

2. ***To correlate above and below-ground bat activity during spring emergence and fall return, with changes in surface weather patterns, temperature, relative humidity, and barometric pressure at Soudan Underground Mine during 2004 and 2005.***

Three data loggers (MadgeTech® PRTEMP101) were placed underground and on the surface to record temperature, relative humidity, and barometric pressure. Two were placed next to the bat detectors on Level 12 (Alaska) and Level 27 and housed in protective boxes to reduce condensation on the data loggers (Figure 11). Another was placed on the surface, atop of the Alaska Shaft cage, in a weather station housing (Figure 15). The data loggers were set to record readings every 15 minutes from 7 April to 13 December 2004. Data were periodically downloaded using Palm® PDA recorders. Data loggers were removed, batteries replaced, and reset to record every 30 minutes from 23 February to 27 April 2005.

Weather conditions during the study were obtained from the Weather Underground website (www.wunderground.com) for Ely, Minnesota. Information collected from daily weather summaries included precipitation (rain < 1 inch or > inch; occurrence of thunderstorms or snow), wind (10 – 20 mph or >20 mph), and the time and duration of these events.

3. ***To determine if open pits are used as secondary access locations to the mine during spring emergence and fall return, and whether these pits serve as hibernacula.***

Three open pit mines near the underground mine were selected for placement of bat detectors. From April through December 2004, detectors were operated beginning a half hour before sunset and ending a half hour after sunrise. During this time, detectors were visited weekly to replace compact flash cards and batteries (Figure 16a; see Butte, below, for modifications to this procedure). Information on detector checks was entered onto a PDA.

Main Pit (Figure 16a, b): Set at the upper edge on the south side of the pit, facing north and tilted down toward the bottom of the pit. The detector was battery-powered and operated from 7 April through 13 December 2004.

West Tower (Figure 17): Set underneath the boardwalk at the top of the west edge of the West Tower Pit, facing east and tilted down into the pit. The detector was battery-powered and operated from 7 April through 13 December 2004.

Butte (Figure 18): Set at the edge on the north side of the pit, facing south and tilted down into the pit. The detector was battery-powered and operated during the night from 7 April through 13 December 2004. Because bats appeared to remain active at the pit into the fall, the detector was set to run 24 hours/day from 13 December 2004 until 27 April 2005. A solar panel was installed to maintain a charge in the battery and prevent it from freezing during the winter (Figure 19a). Compact flash cards were replaced bi-monthly during this time (Figure 19b).

4. *To identify the species and sex composition of bats clustering on Level 12 and their eventual hibernating sites.*

5. *To document survival of bats on Level 27 through the hibernating period.*

During each visit underground to replace the CF cards in the bat detectors, counts were made of the number of bats roosting in selected locations on Level 12 and Level 27. Photographs also were taken of the areas. The Level 12 count area included a large pocket and smaller drill hole made in the ceiling and wall, plus the adjacent wooden wall to the right of the doorway (Figures 20a, b). The Level 27 count area included a portion of a cinder block wall enclosed by fencing (Figures 21a, b). Counts of the bats were made from 7 April 2005 until 27 April 2005.

Also during each visit, all dead bats were removed and identified. On Level 12, the area searched included the passage way from the shaft to the wooden wall. On Level 27, the initial search area included the hallway behind the shaft and in front of the MINOS laboratory. This area was counted until June, when the area was routinely cleaned of all bats in preparation for tours to the laboratory. We then shifted the count area to the hallway in front of the Soudan II laboratory and continued counts in this new area through 27 April 2005.

Based upon our observations about when roosting bats were greatest on these levels, we returned in summer and fall 2005 to band a sample of the bats and collect species and sex information from these clusters.

Results and Discussion

1. ***To document the timing of spring emergence, fall return, and winter activity by bats from Soudan Underground Mine during 2004 and 2005.***

3. ***To determine if open pits are used as secondary access locations to the mine during spring emergence and fall return, and whether these pits serve as hibernacula.***

A total of 1,620,792 files were recorded from the nine bat detector locations, 729,699 files from the three open pits (Table 1). Clearly, bats use these pits and are likely present in other pits in the area. Based upon the placement of the detectors and the timing of the calls at the pits, these bats were exiting from the pits and not arriving to them from elsewhere. However, whether they were moving from the Soudan Mine and exiting from the pits, or if they actually hibernate in the pits and associated drifts, could not be determined.

Bat activity was estimated by counting the number of call files recorded during a period of time. This method provided only a rough approximation of activity because the detector could not distinguish between several bats passing the detector once each or a single bat passing back and forth several times. Also, some call files contained a short sequence of calls from a single bat, while other files contained long sequences of calls from several individuals.

All files from surface locations were reviewed to remove those that contained no bat calls. These typically were created during rain events, strong winds, and when the detector was checked each week. After reviewing a sample of files from the underground locations, it was decided that the number of "noise" files in relation to the huge number of bat calls was too few to significantly affect the bat activity estimates.

To directly compare bat activity among all sites, the same time period was selected for estimating activity. The underground bat activity was so great at times that the 64 MB compact flash card filled up in as few as 29 hours. Table 2 shows the run time for the bat detector at Level 12 – Alaska. Normally, 160 – 190 hours would lapse between weekly checks. Run times less than that were due either to power outages or especially high bat activity. During these times, which include mid-April to early June, mid-July to mid-August, and early September, bats were continuously flying up and down the drifts. Only a single night might be recorded before the compact flash card filled. Thus, the first night of recording for each week was used to compare bat activity at each location.

Figures 22-24 and Table 3 show the nighttime bat activity estimates for all bat detector locations during the 2004 recording period. Surprisingly, bats were active in the pits from the beginning of the recording period (7 April 2004). Also unexpected was the lack of a definite departure and return time for the underground locations. Evidently, bats are present in the mine year-round.

All locations showed a steep increase in activity near the beginning of May, followed by an equally steep drop in activity around the end of June. The June drop in activity corresponds to the time when female bats are giving birth. At this time they select warm environments, such as attics or loose tree bark, that would not be present in the mine. The highest levels of activity were attained during late August – early September. By this time, the young are volant and may accompany the females to the hibernaculum. Fall also is the time when mating takes place and bats "swarm" at the entrances to hibernacula. By mid-October, activity was greatly reduced and remained at low levels into December.

The pattern of activity at the different types of locations -- the underground sites (Figure 22), the shaft entrances (Figure 23), and the open pits (Figure 24) -- showed similarities among themselves, but differed from the other locations. The bat activity at the open pits showed high, sustained activity during late spring and summer (Figure 24), while the shaft entrances and underground locations appear to reflect waves of activity during this time (Figures 22, 23). The shaft entrance activity generally resembled the activity levels recorded underground. However, during the spring departure period, more bats appeared to use the No. 8 Shaft as an exit, while during the fall return period more activity was recorded at the Alaska Shaft (Figure 23). One possible explanation for higher activity at the Manway could be the level of human activity at that time. Among the underground sites, Level 27 had substantially lower activity in the spring as compared to Level 12 (Figure 22). This may be due, in part, to fewer bats being present on Level 27. It also may reflect the gradual shift of bats from lower levels of the mine to upper levels and eventually to the surface.

The underground bat detectors, which were run continuously, enabled a comparison of daytime versus nighttime activity (Figure 25, Table 4). During the spring departure period, activity levels during day and night were the same. However, during the fall return period, the bats were much more active at night than during the day.

Bats were found to be active well into winter. Because of this, detectors at the two underground locations and the detector at the Butte Pit were allowed to continue running, 24 hours per day, from 14 December 2004 until 27 April 2005. Figure 26 and Table 5 summarize the bat activity during that time. Unlike the previous recording period, bat activity on Level 27 was consistently higher than that on Level 12 (compare Figure 26 with Figure 22). This higher activity on Level 27 could be associated with construction activities, such as installation of an elevator on that level. More remarkably, active bats were recorded at the Butte Pit throughout the winter, albeit at a much lower level than at the underground locations. Also, notable was the dramatic increase in activity at the Butte Pit in late March.

Big brown bats, while never recorded inside the mine, were found in all three open pits. This species typically selects colder temperatures that hover close to freezing. None of the accessible portions of the Soudan Mine have temperatures near freezing, although it is possible that such conditions might exist in the upper levels. However, no Big brown bats were recorded exiting the Alaska Shaft or Manway. The deep, open pits have much colder conditions; snow was observed at the base of West Tower Pit well into June. Drifts or excavations at the base of these pits may offer suitable habitat to Big brown bats.

Call files at the Butte Pit were examined throughout the recording period to determine whether the observed bat activity during winter was due to Big brown bats (Table 6). The percent of Big brown bat calls (*Eptesicus*) compared to those of Little brown myotis and Northern myotis (*Myotis* spp.), ranged from 1 to 51 percent. Surprisingly, in the middle of winter, the majority of bat calls belonged to one the *Myotis* species, rather than the more weather-hardy Big brown bat.

2. *To correlate above and below-ground bat activity during spring emergence and fall return, with changes in surface weather patterns, temperature, relative humidity, and barometric pressure at Soudan Underground Mine during 2004 and 2005.*

The three data loggers collected a total of 80,858 readings of temperature, relative humidity, and barometric pressure between 7 April 2004 and 27 April 2005 (Table 7). These data are summarized for the period from 7 April until 13 December 2004, when recordings were taken every 15 minutes in Tables 8 – 10, for the Alaska Shaft, Level 12, and Level 27 locations, respectively. Values for temperature and barometric pressure are graphed for the Alaska Shaft in Figures 27 and 28, for Level 12 in Figures 29 and 30, and for Level 27 in Figures 31 and 32.

Temperature at the three locations varied considerably, reflecting the different environments above and below ground. Compared to a temperature variation at the surface of 52.8 °C, temperatures on Level 12 and Level 27 varied 3.0 and 0.6 °C, respectively. Level 12 showed a seasonal rise and fall of temperatures, similar to the surface readings, but at a much lower amplitude. Level 27 temperatures basically remained unchanged at 10 °C. The relative depth of the two levels can explain much of the difference in underground temperatures. In addition, exposure of Level 12 to both the No. 8 Shaft and the Alaska Shaft results in greater air flow from the surface through the drifts.

Relative humidity varied on the surface from 22.5% to 100%. Underground, the data loggers registered 100% humidity throughout the recording period. The data logger was unable to distinguish minor fluctuations in humidity at near saturation levels.

The variation in barometric pressure was closely similar for all three locations, 1.49, 1.42, 1.51 inches Hg for Alaska Shaft, Level 12, and Level 27, respectively. Differences in absolute pressure reflected the increase in atmospheric pressure associated with greater depth underground (highest readings were 28.76, 29.72, and 31.39 inches Hg, respectively).

While changes in temperatures are dampened underground, barometric pressure changes are not. Thus, if bats receive environmental signals while hibernating in the mine, it seems logical that barometric pressure changes could play a role. In regional caves, bats have been observed to move from lower, deeper portions of the cave to areas closer to the entrance. Here, changes in temperature would be more variable. It is likely that bats at Soudan Mine behave in a similar manner. When 100 barometric pressure readings, exhibiting the highest decreases and highest increases in pressure change, were examined for their time of occurrence, most appeared in April and May (Tables 8-10) and to a lesser extent in August through October. These time periods correspond to spring and fall weather changes, but also correlate to increased bat activity at the mine and pits. Information on other weather conditions, such as rain, wind, precipitation, and storms, was collected from the Ely weather station (posted on the Weather Underground website and summarized in Appendix 1). Although they may affect bat activity on an hourly or nightly basis, the estimates of bat activity used in this report could not distinguish any influence.

The observed levels bat activity during the winter months was unexpected, particularly bats flying in the pits at below-freezing temperatures. At this time of year, their insect prey is not available, plus flying in such cold temperatures is energetically costly and injurious to thin wing membranes and ears. A number of bats found hibernating in the mine show evidence of freezing injury and occasionally one becomes frozen to the Main

Frame. It is known that bats periodically arouse during hibernation to drink water and get rid of body wastes. This probably explains much of the activity observed in the mine during winter, however, the relatively frequent excursions outside remain a question.

To see if outside temperature influenced the timing and level of bat activity at the Butte Pit during winter 2004 – 2005, minimum and maximum surface temperatures were compared with bat activity from 15 January – 15 February 2005 (Figures 33 and 34, Table 11; readings were taken from the Ely weather station because the data loggers were not operating over that entire interval). There appeared to be a strong correlation between bat activity and warmer temperatures, but particularly warmer minimum temperatures. Another potential factor affecting bat activity could be the pits, themselves, that may act as heat sinks during sun days (Figure 35). The tall, south-facing wall of the Butte Pit may absorb sufficient solar energy during the day to ameliorate nighttime temperatures in the pit.

4. *To identify the species and sex composition of bats clustering on Level 12 and their eventual hibernating sites.*

5. *To document survival of bats on Level 27 through the hibernating period.*

Figure 36 and Table 12 summarize the bat clustering data collected on Level 12 and Level 27, Appendices 2 and 3 are thumbnails of the photographs taken of the cluster count area. The temporary clustering of bats at the two locations differs both in the timing and the behavior of the bats. The clustering on Level 12 peaked in early May and again in early June. The bats clustering at these times were very active, moving over one another and vocalizing. By comparison, the bats on Level 27 during May appeared to be in torpor and did not show a second wave of clustering in June.

On Level 27, the highest number of clustering bats occurred in September, when few or no bats were present on Level 12. Banding and examination of the clustering bats, conducted in June and September 2005, further supported the hypothesis that bats are clustering at the two levels for different reasons. Table 13 summarizes the banding results and shows that on Level 12, in both June and September, the ratio of males to females was heavily skewed to males (94:6 and 95:5, respectively). Conversely, the sex ratio of the Level 27 cluster was predominantly female (21:79, male:female). The fall clustering on Level 27 may correlate with the time that females return to the hibernaculum with the young-of-the-year. However, by this time it is very difficult to distinguish young from adults.

During the fall clustering period on Level 27, park staff have reported a substantial increase in the number of dead bats around the physics laboratories. Bat carcasses were collected on Level 12 and Level 27 throughout the recording period (Figure 37, Table 14). On Level 27, the highest number of dead bats retrieved per visit occurred when the cluster counts also were greatest. However, the sex ratio of the dead bats was close to equal (48:52, male:female), unlike the composition of the cluster at that time. The number of dead bats retrieved on Level 12 was consistently low throughout the collection period.

It has been suggested that dead bats occur on Level 27 because they are lost and unable to get outside to feed. Although the weights of the dead bats were quite low, it may have been due more to desiccation in the relatively hot, dry environment of the physics area. Autopsies performed by the Veterinary Diagnostics Laboratory at the University of Minnesota, St. Paul, found no evidence of rabies, West Nile, or other illnesses. In addition, one bat, banded on Level 27, was found on Level 12 during annual bat counts, conducted in February 2006, indicating that at least one bat was able to move from Level 27 to Level 12.

This project has revealed unexpected, and perhaps unique, aspects about the importance of the Soudan Underground Mine and the surrounding open mine pits to bats in the region. Further analysis of these data may provide additional insight, as well as point to future research directions, to better understand the interaction of bat and mine.

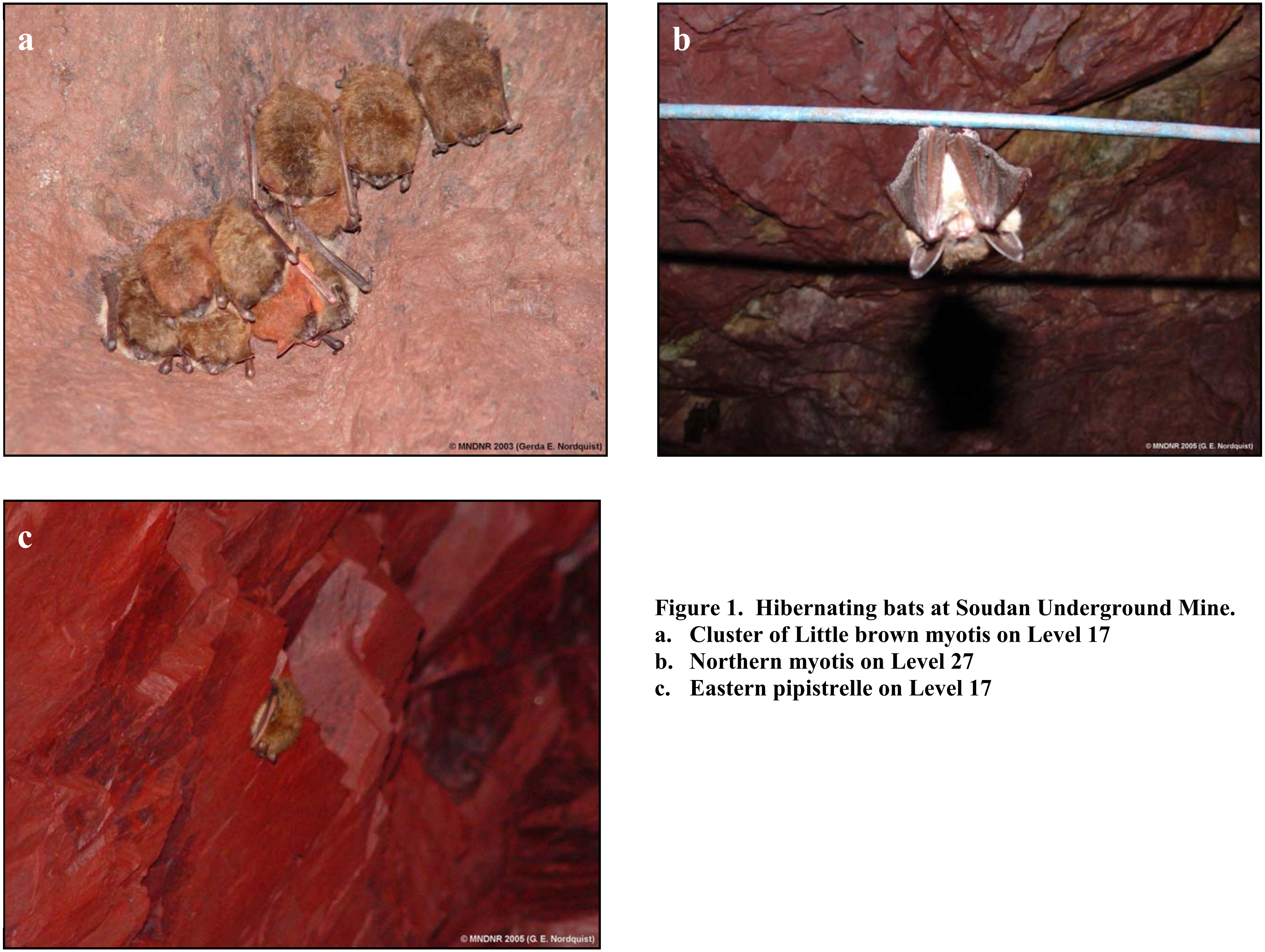


Figure 1. Hibernating bats at Soudan Underground Mine.
a. Cluster of Little brown myotis on Level 17
b. Northern myotis on Level 27
c. Eastern pipistrelle on Level 17

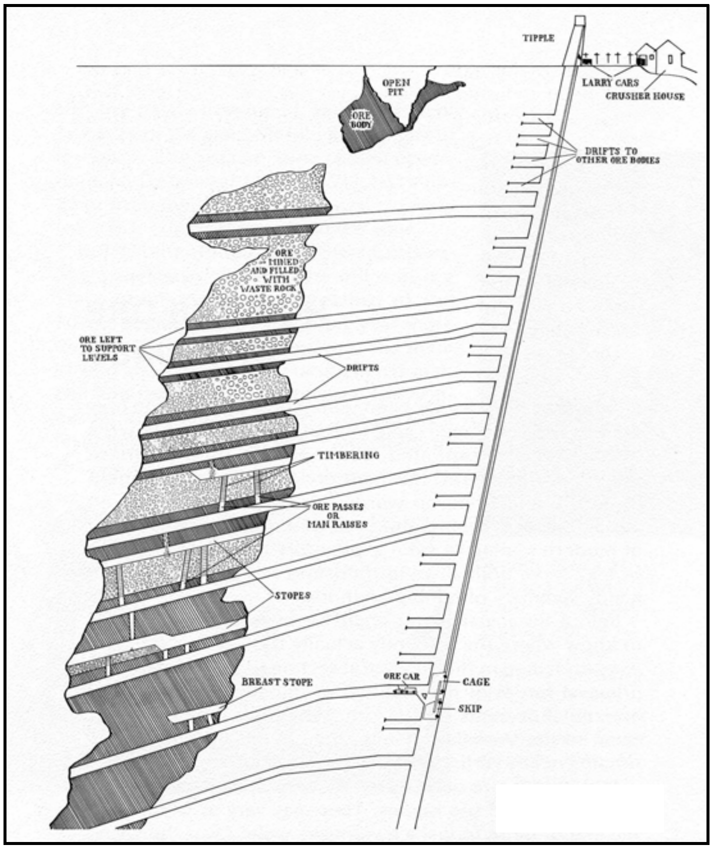


Figure 2. Diagram of Soudan Underground Mine (from Eliseuson, 1976).

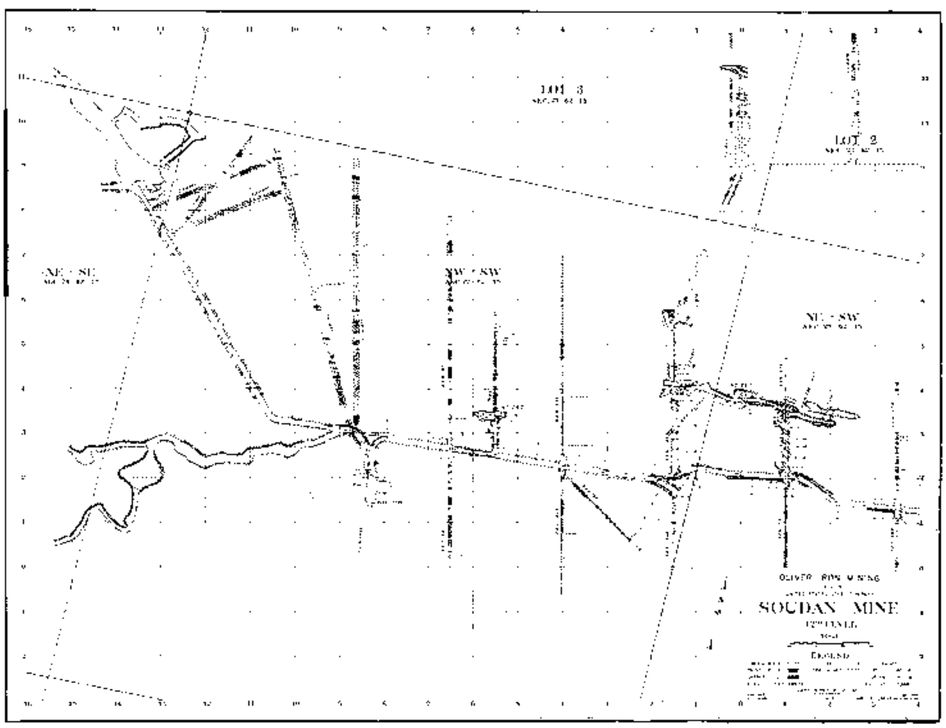


Figure 3. Map of Level 12 near Shaft No. 8.

a

b

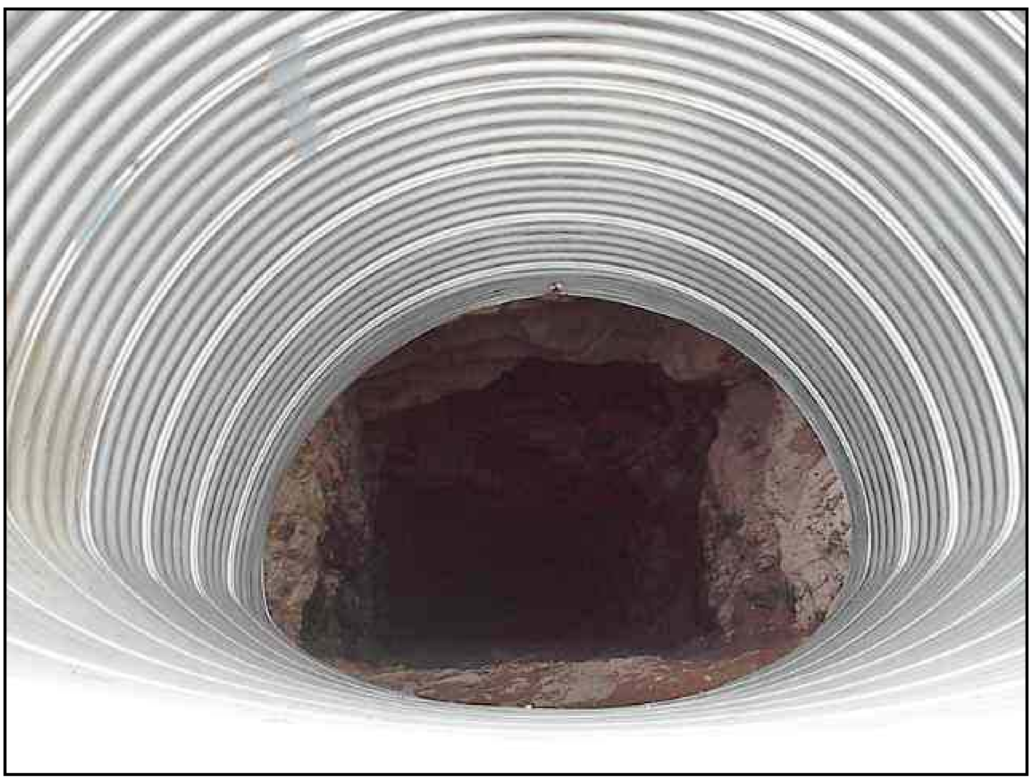


Figure 4. Bat-friendly cage over the Alaska Shaft.
a. Protective cage; spacing of the bars allows bats to exit and enter shaft.
b. Looking down culvert into the Alaska Shaft.

Figure 5. ANABAT II® bat detecting system in protective box.

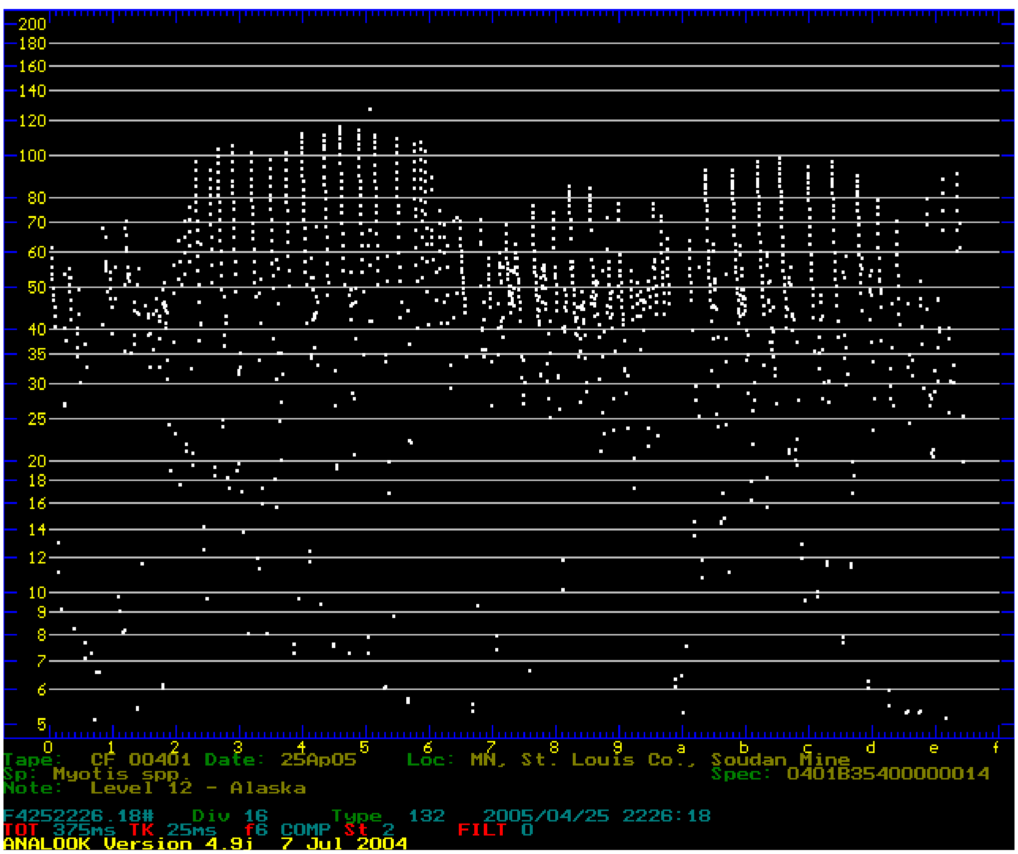


Figure 6. Example of bat calls recorded by ANABAT on Level 12.

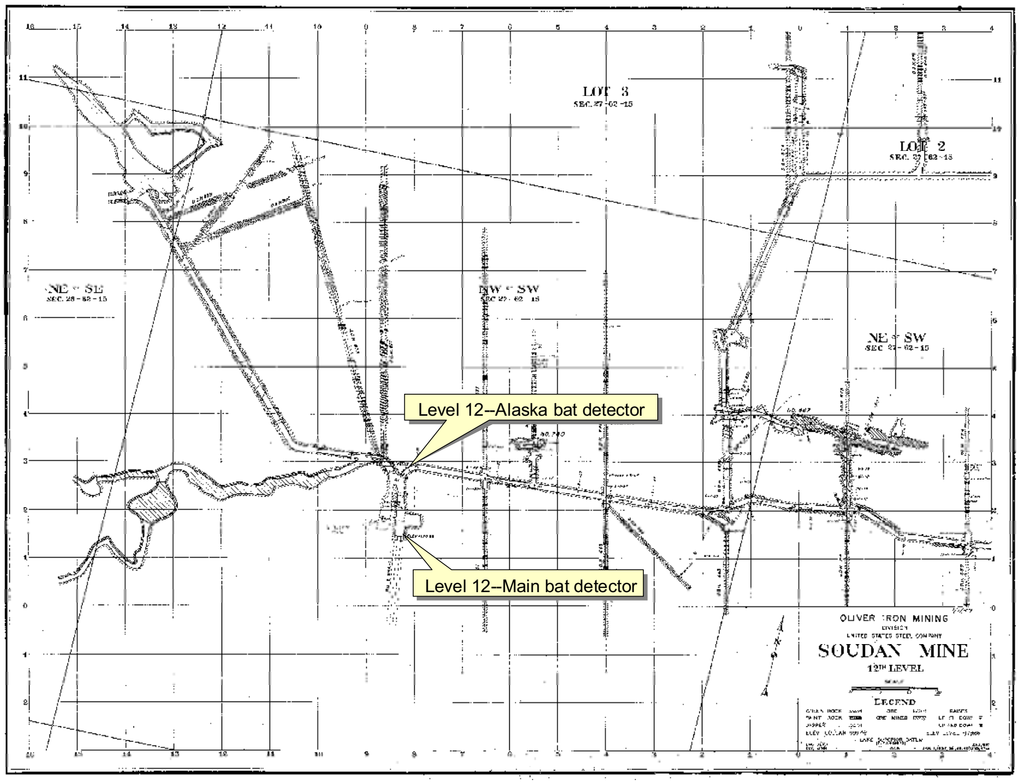


Figure 7. Map of Level 12 showing locations of bat detectors.

Figure 8. Level 12—Main bat detector.

Figure 9. Setting up Level 12—Alaska bat detector.

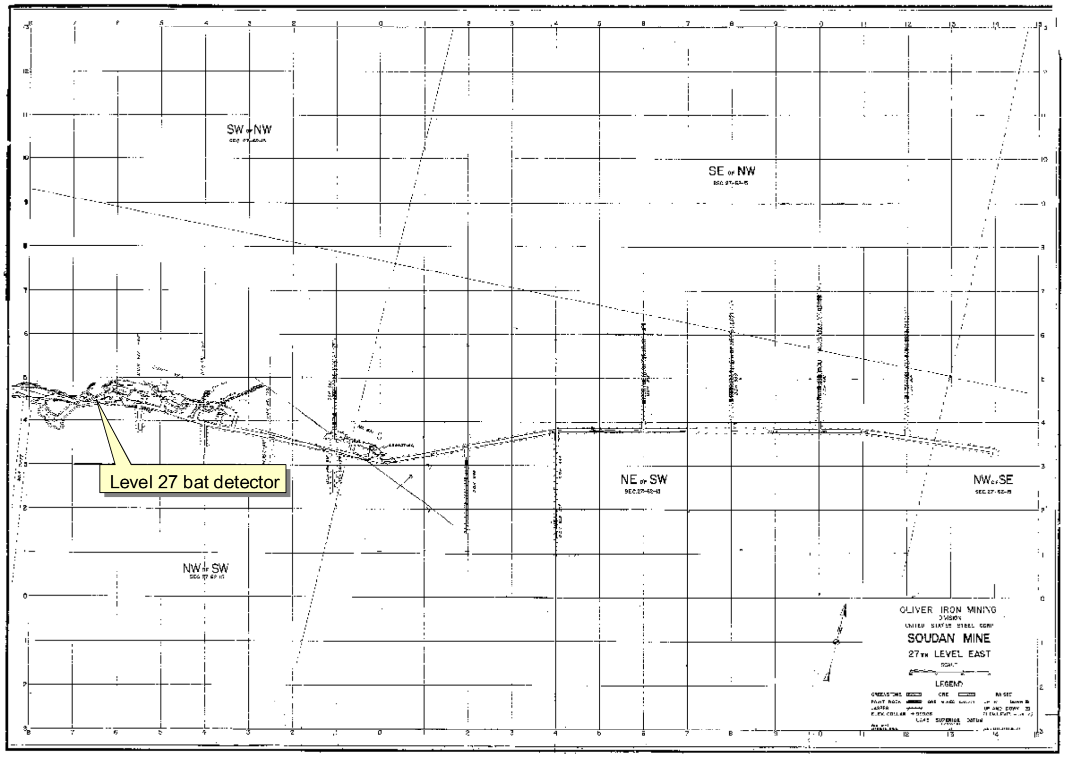


Figure 10. Map of Level 27 showing location of bat detector.

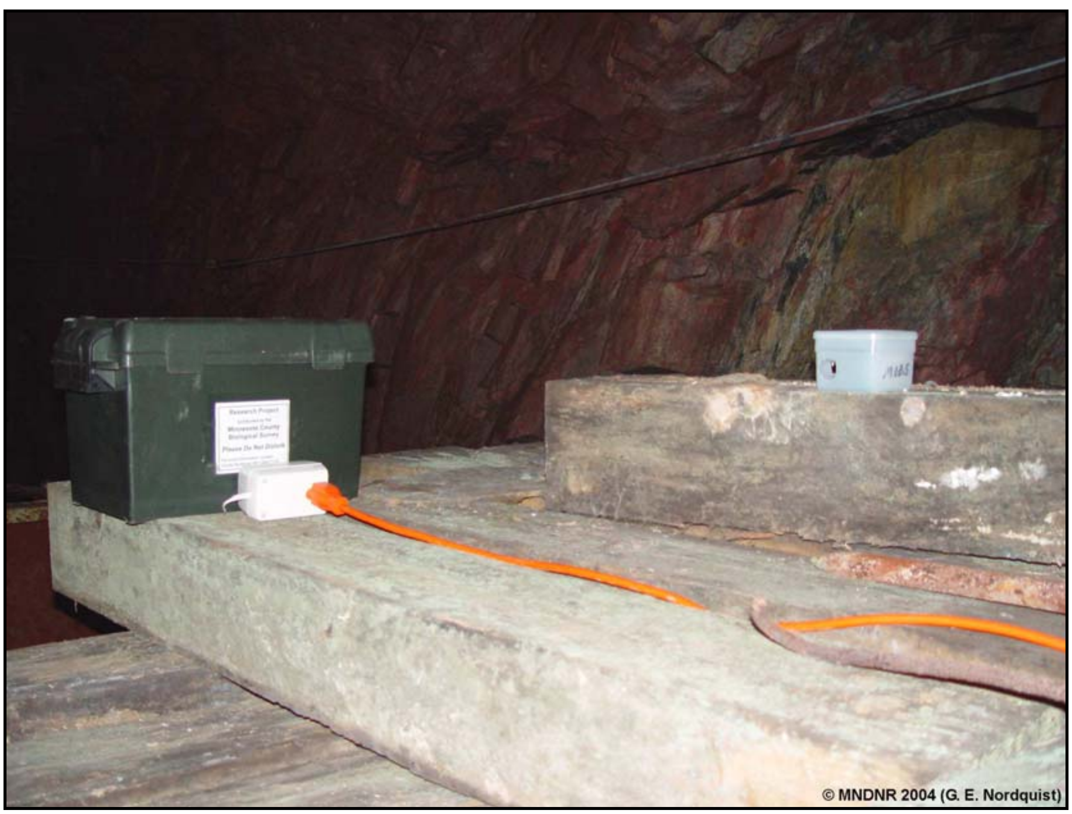


Figure 11. Level 27 bat detector (left) and data logger (right).

Figure 12. Locations of surface bat detectors at Soudan Mine.

Figure 13. Manway bat detector.

Figure 14. Alaska Shaft bat detectors (Alaska—Open visible, Alaska—Shaft facing cage).

Figure 15. Setting up surface data logger on Alaska Shaft cage.

a

b

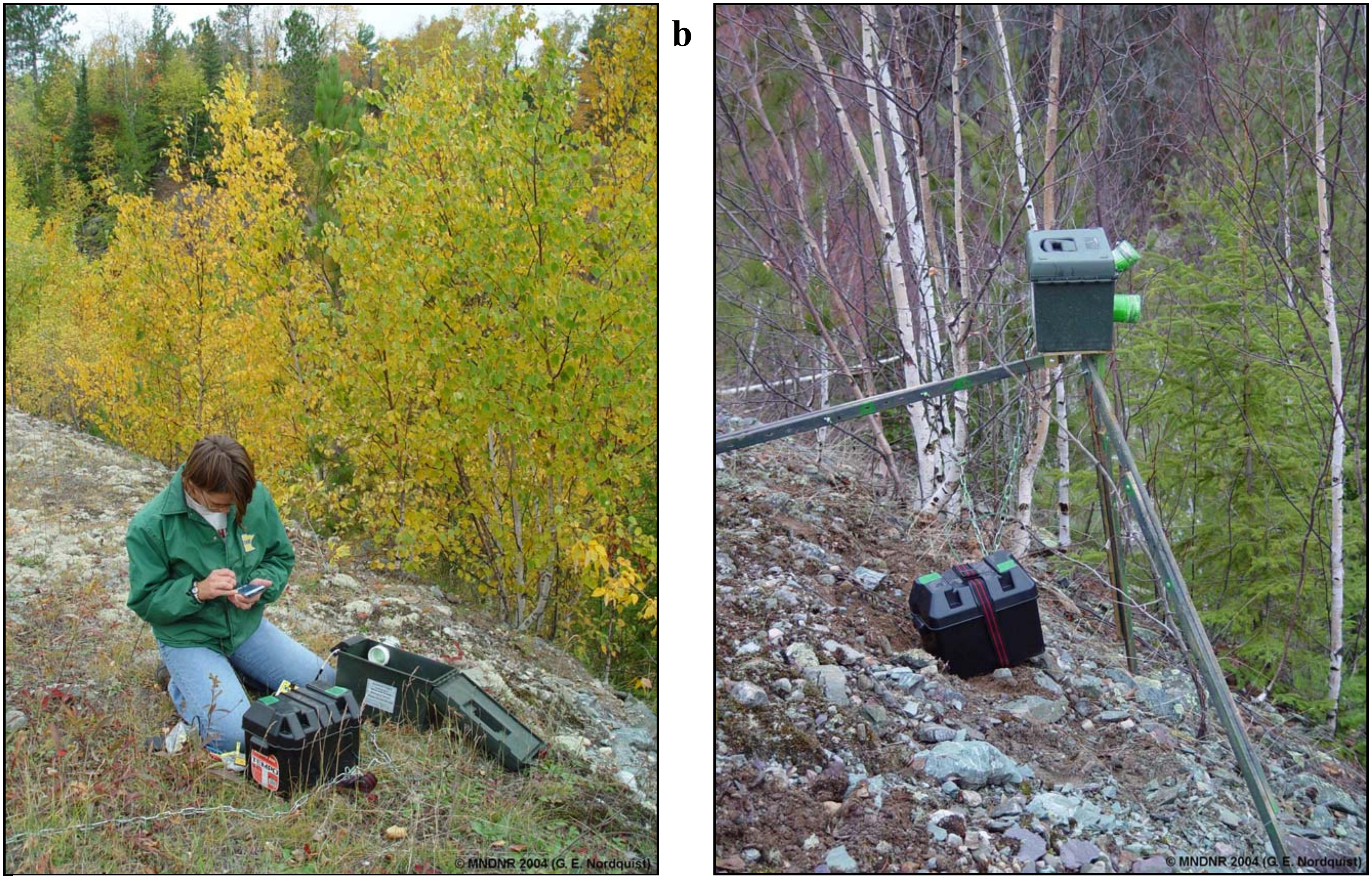


Figure 16. Main Pit bat detector.
a. Entering data, replacing compact flash card and battery.
b. Main Pit set-up.

Figure 17. West Tower Pit bat detector.

Figure 18. Butte Pit bat detector.

Figure 19. Butte Pit detector during winter 2004-05.
a. Solar panel connected to battery.
b. Checking bat detector with safety harness.

a

b

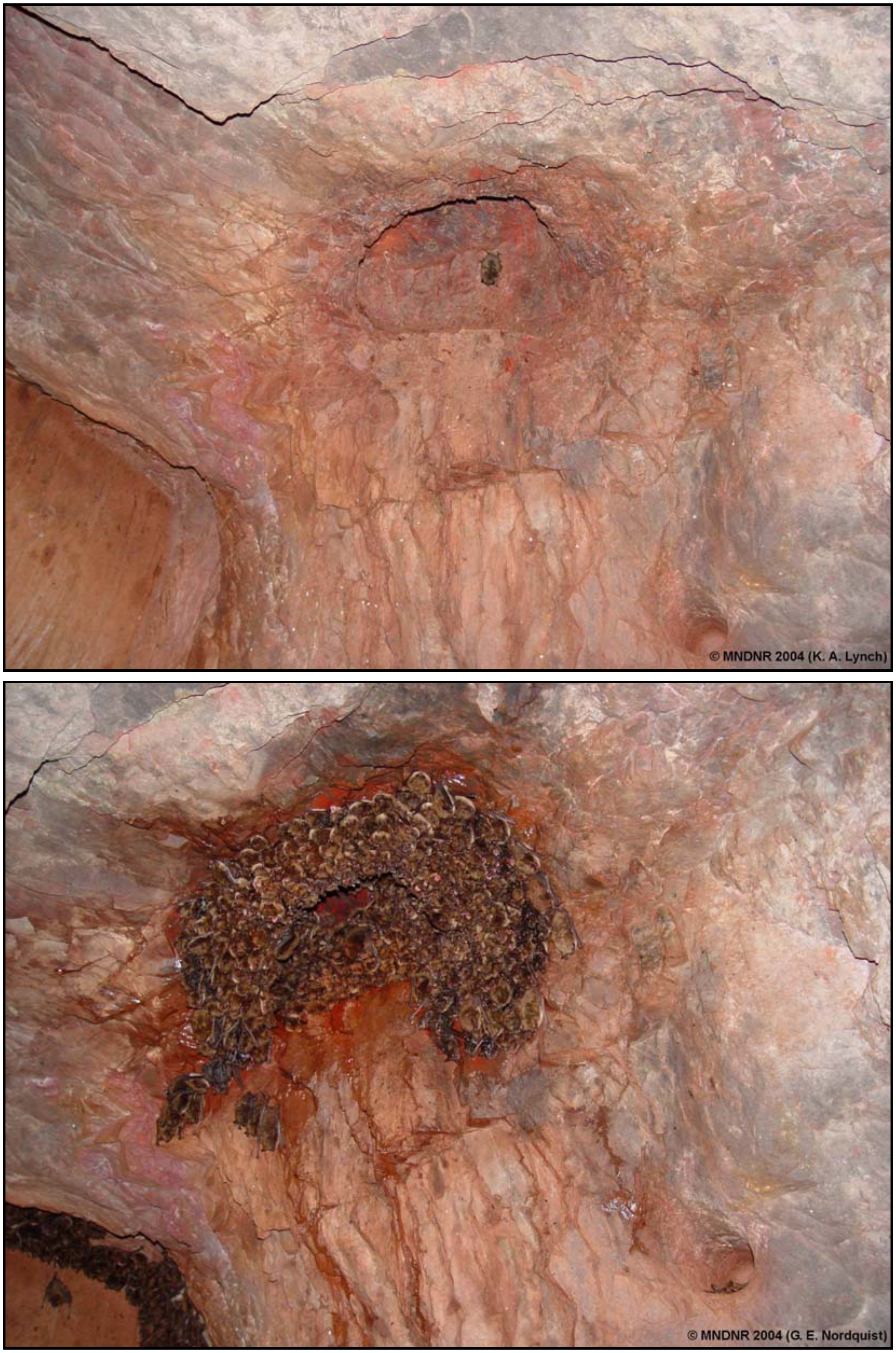


Figure 20. Bat count area on Level 12.
a. 30 September 2004.
b. 6 May 2004.

a

b

Figure 21. Bat count area on Level 27.
a. 21 June 2004.
b. 30 September 2004.

Figure 22. Bat call files/hour at Level 12 and Level 27 during night, 7 April—13 December 2004.

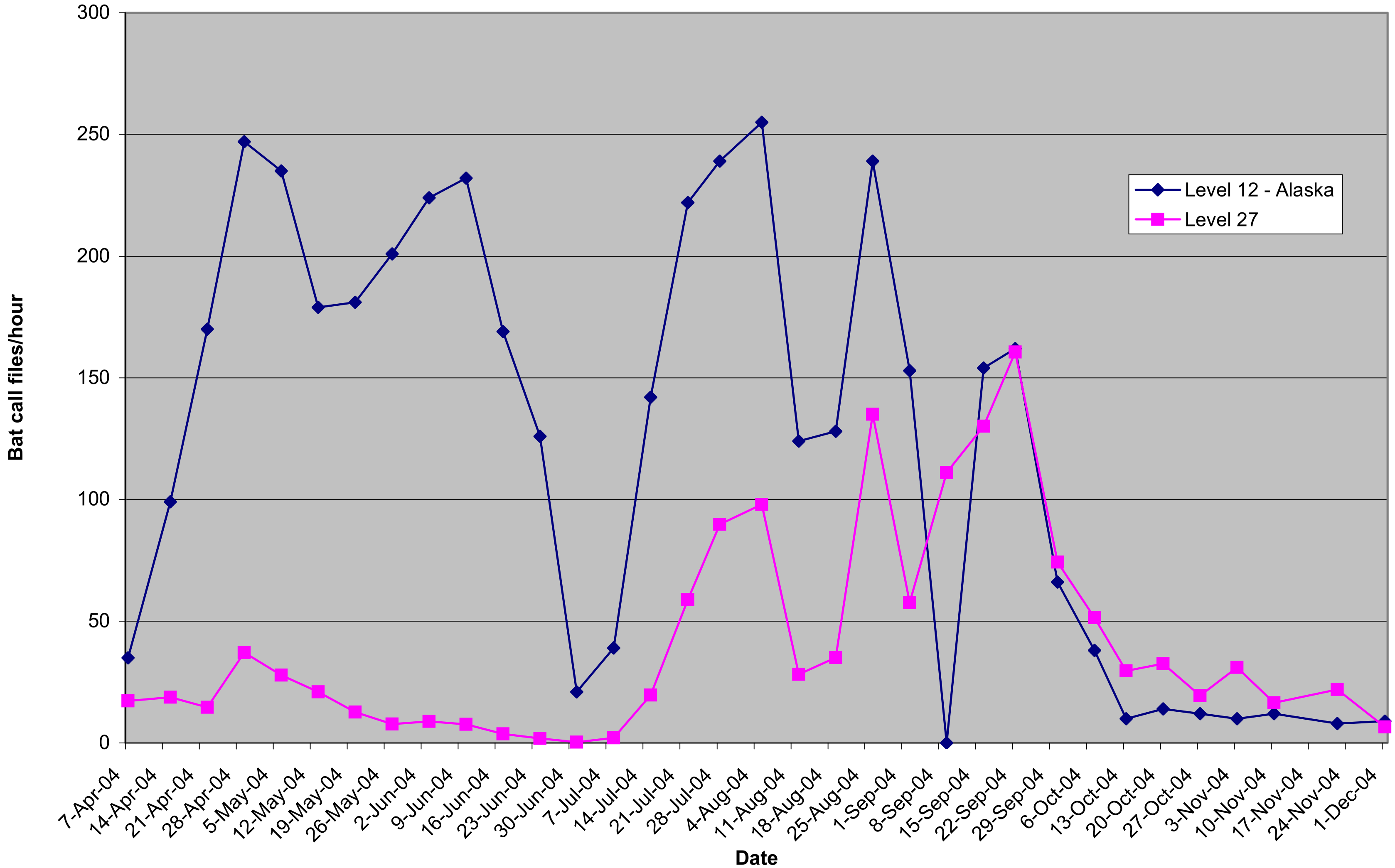


Figure 23. Bat call files/hour at the shaft entrances during night, 7 April—13 December 2004.

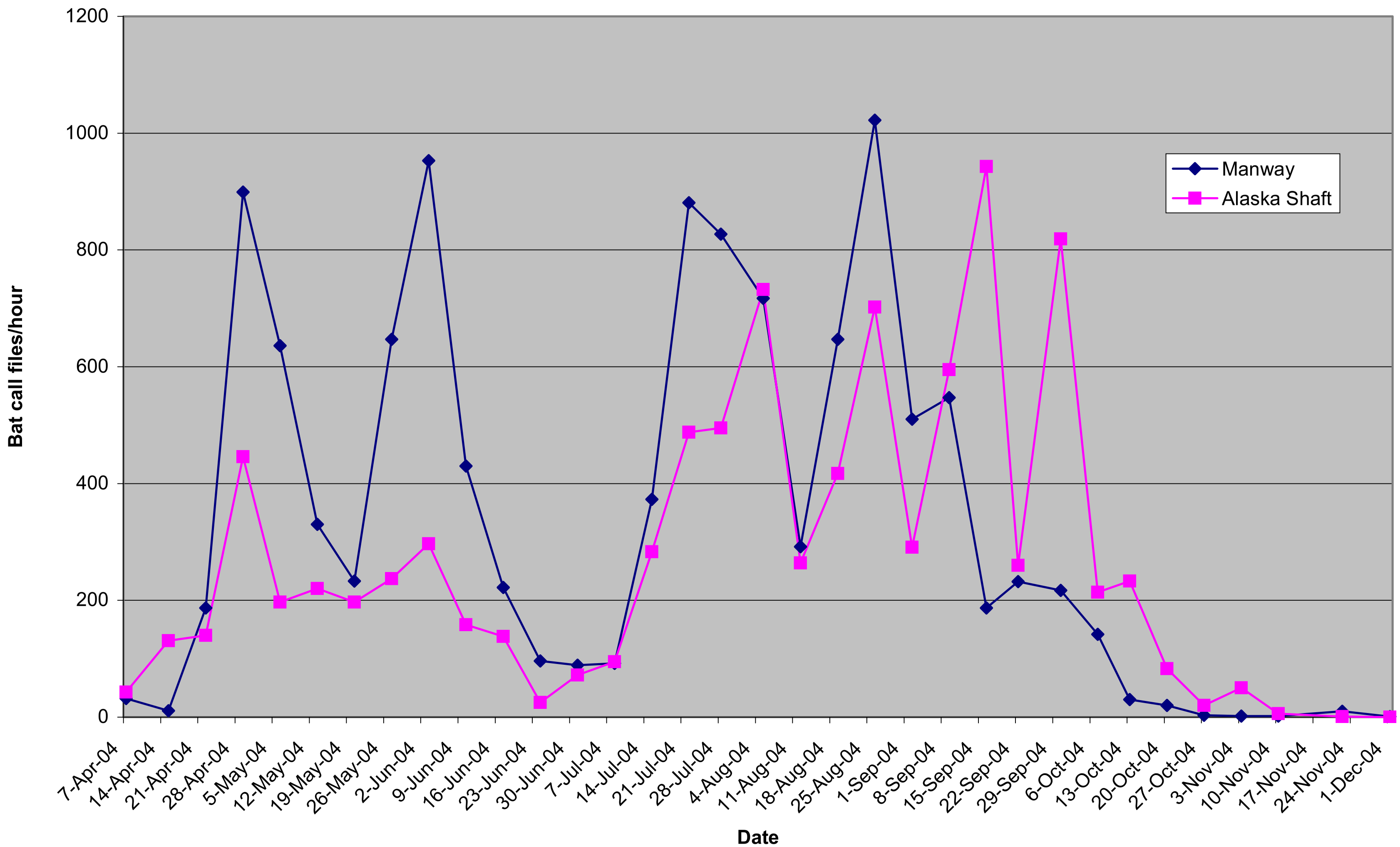


Figure 24. Bat call files/hour at the open pits during night, 7 April—13 December 2004.

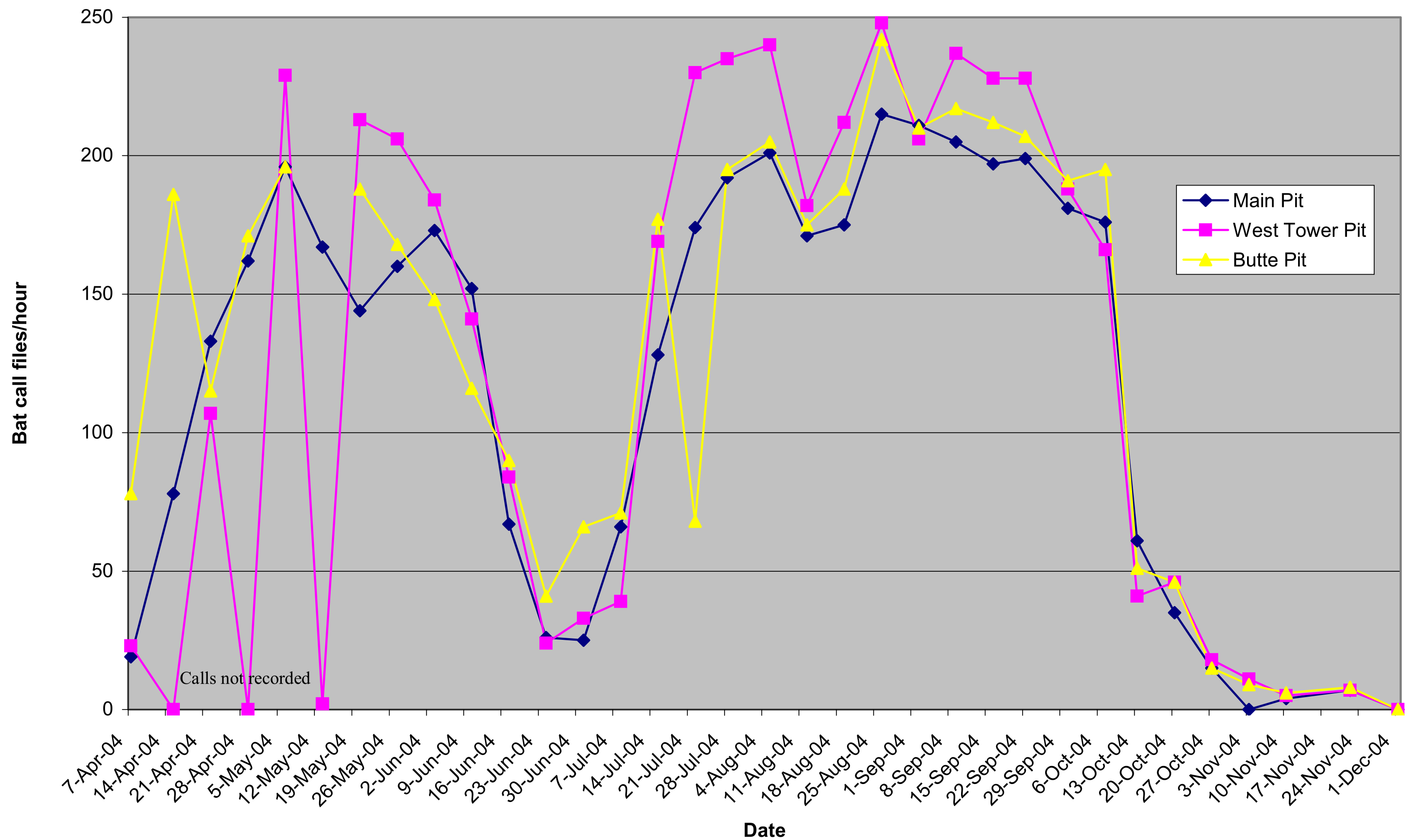


Figure 25. Call files/hour on Level 12 and Level 27 during day and night, 7 April—13 December 2004.

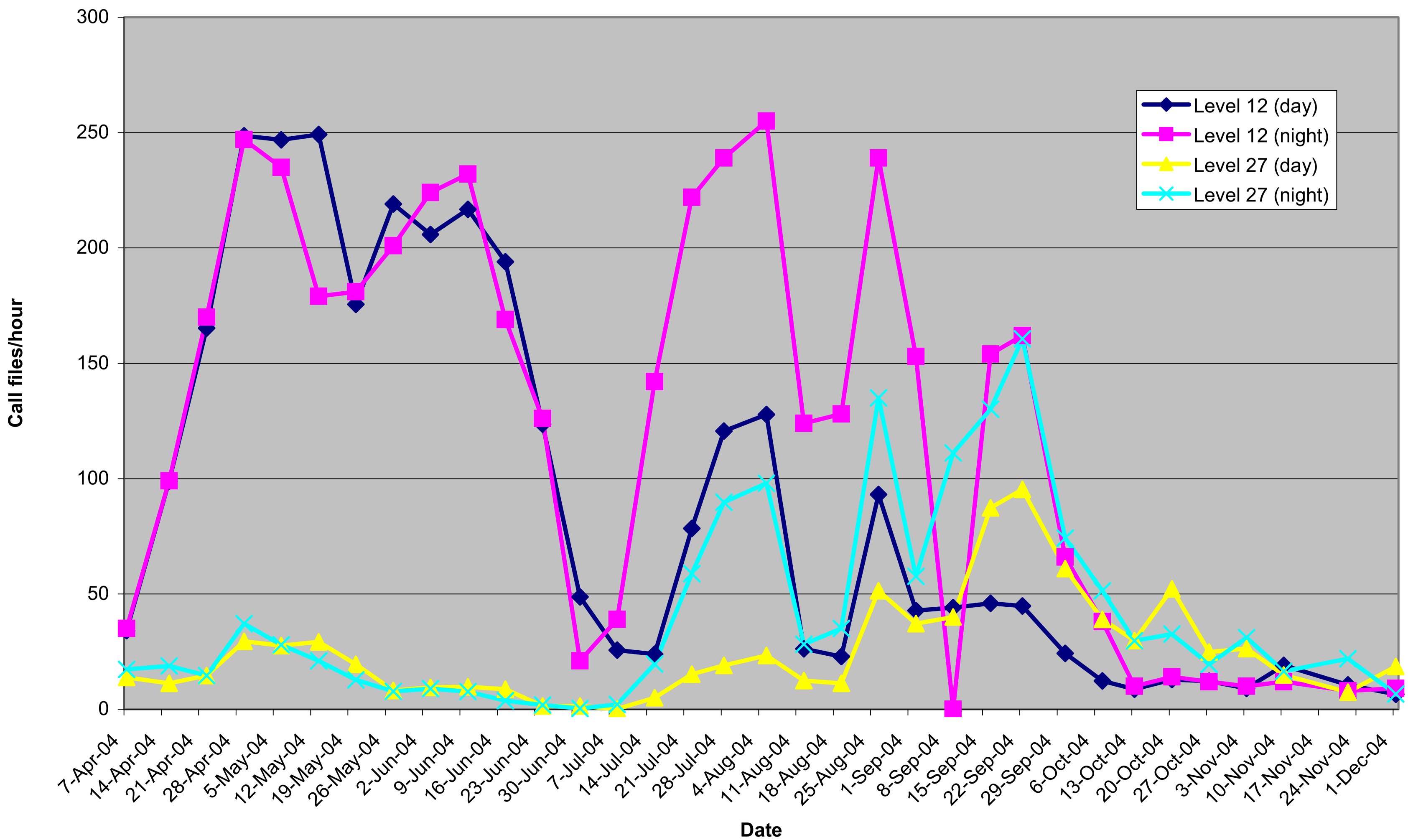


Figure 26. Bat call files/hour at Level 12, Level 27, and Butte Pit, 14 December 2004—30 March 2005.

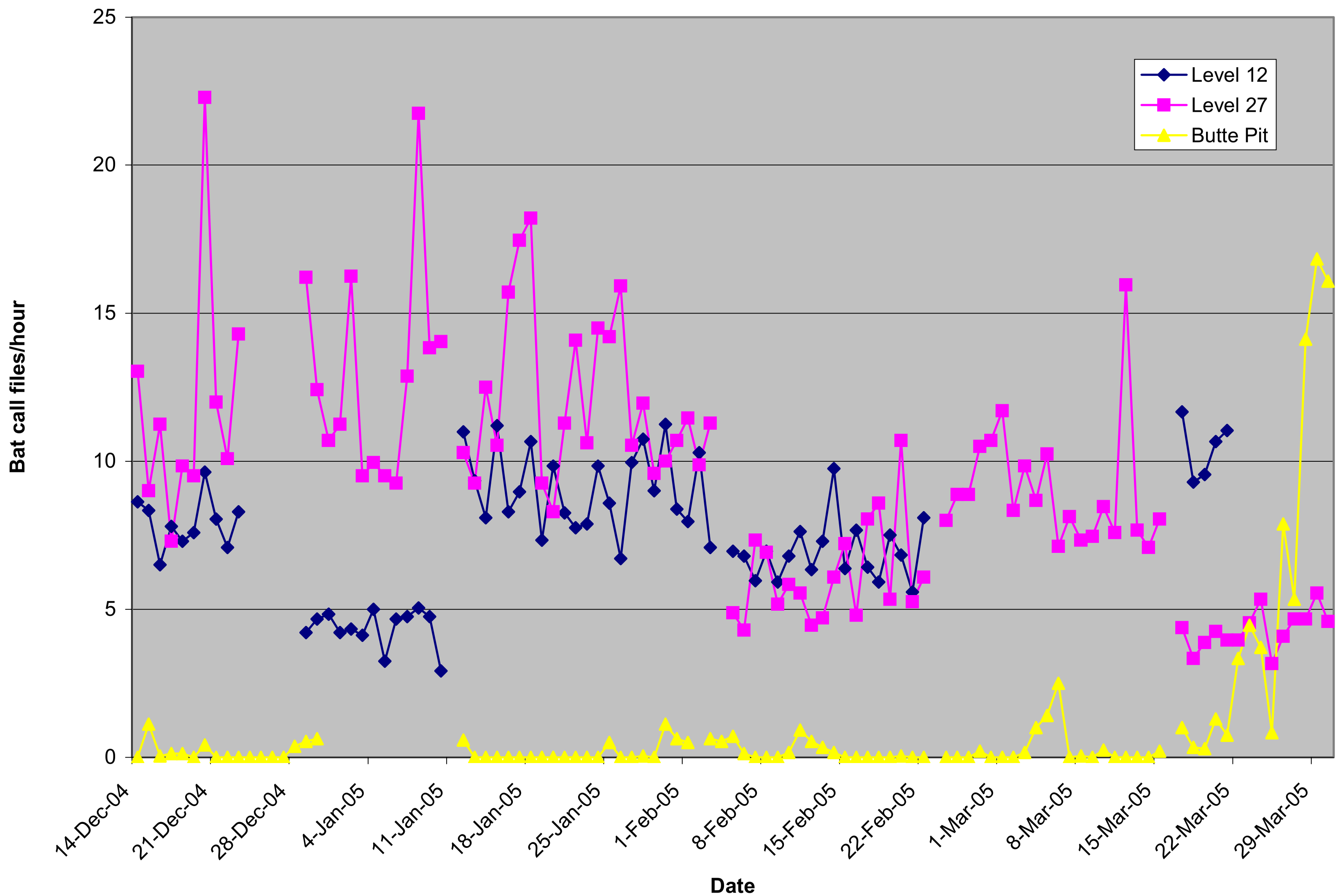


Figure 27. Temperature readings for Alaska Shaft data logger, 4 April—13 December 2004.

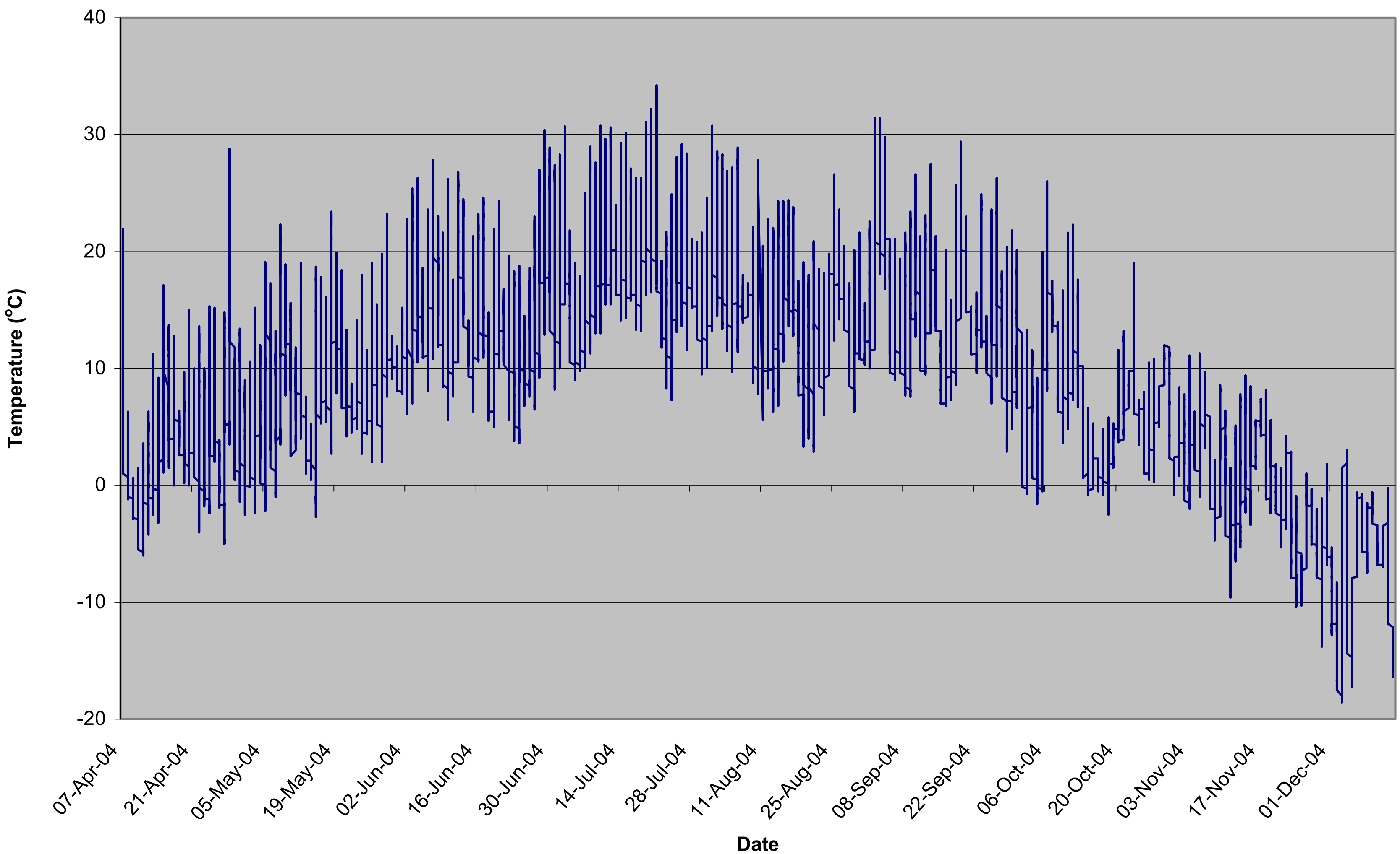


Figure 28. Barometric pressure readings for Alaska Shaft data logger, 4 April—13 December 2004.

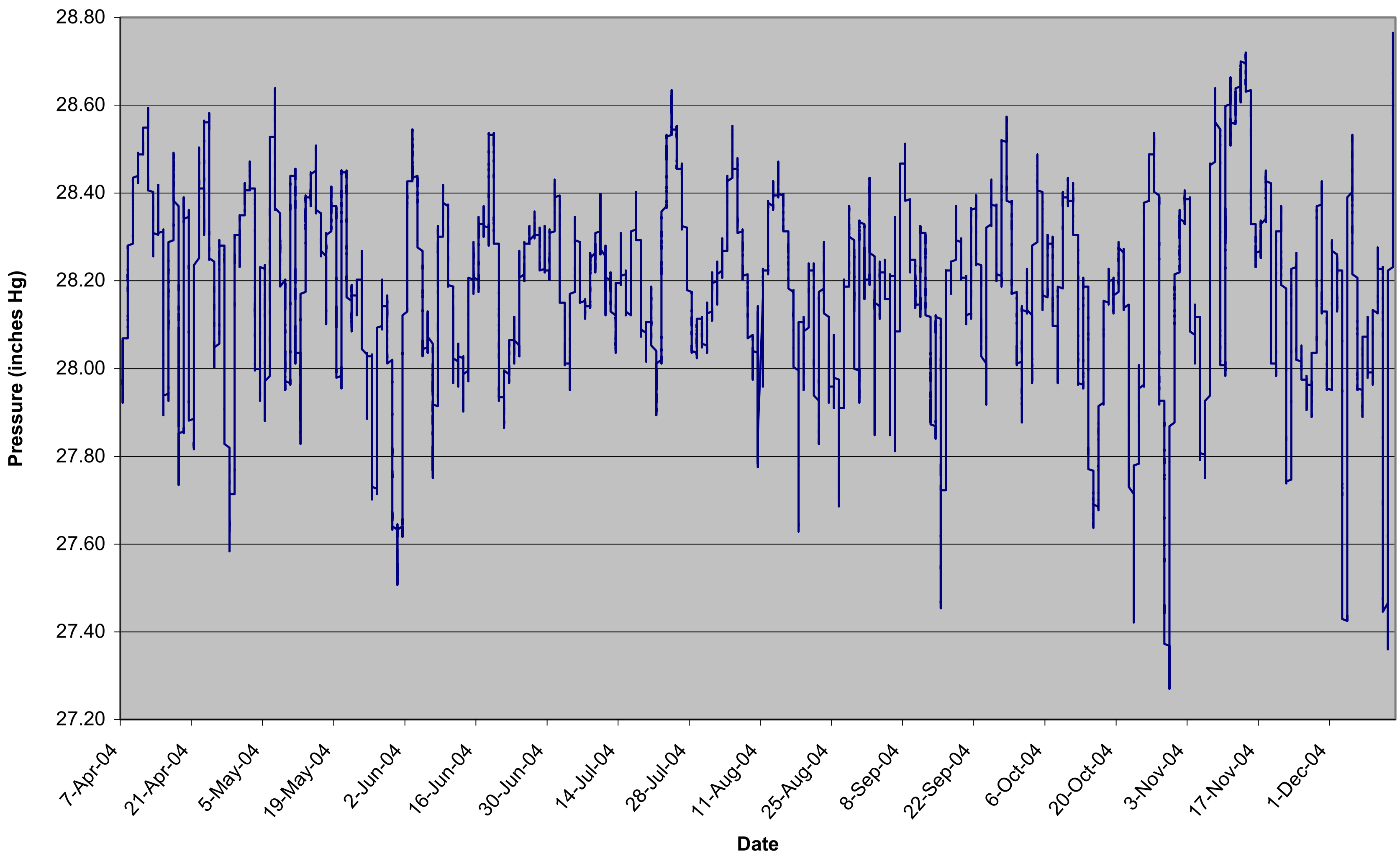


Figure 29. Temperature readings for Level 12 data logger, 4 April—13 December 2004.

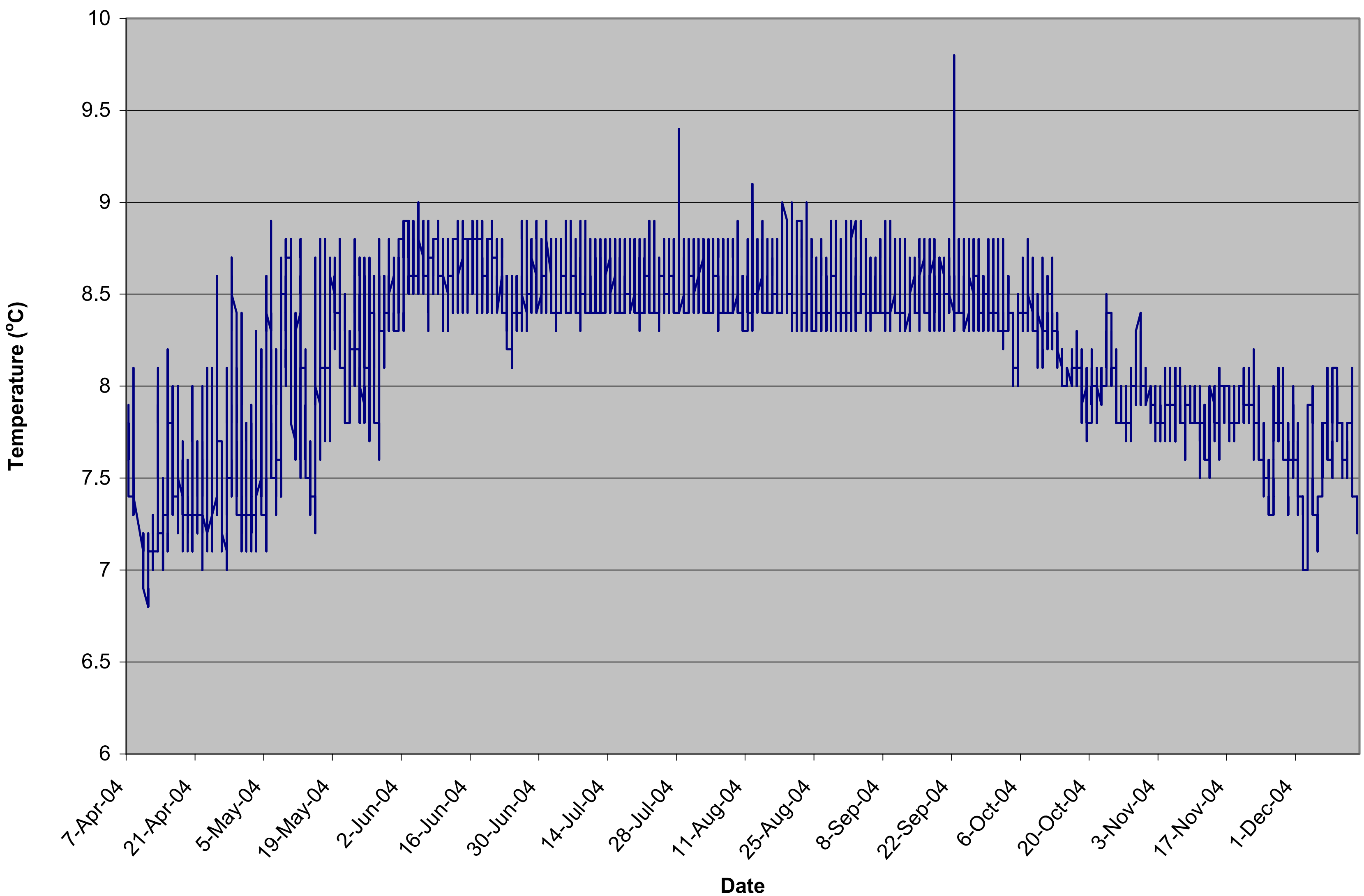


Figure 30. Barometric pressure readings for Level 12 data logger, 4 April—13 December 2004.

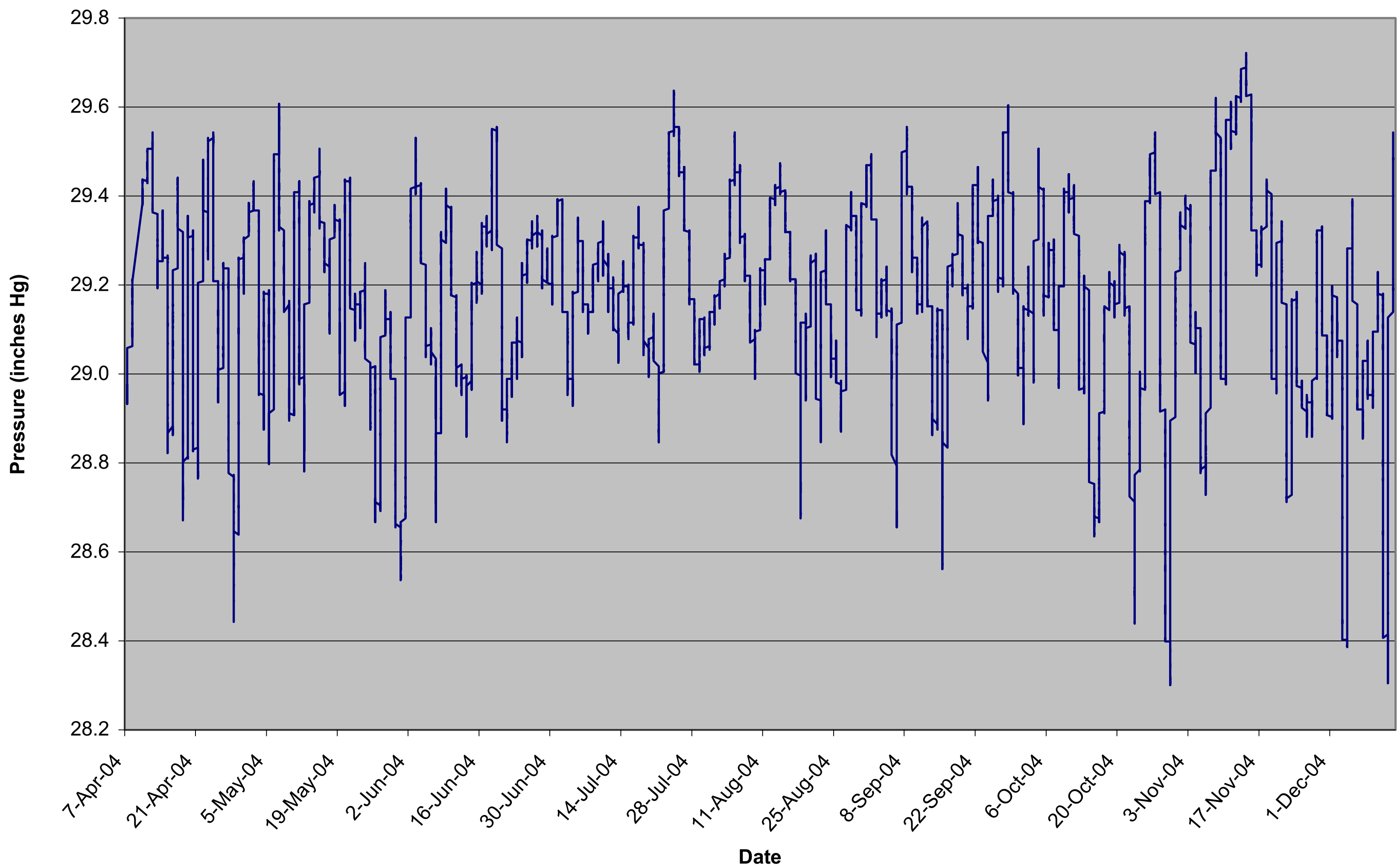


Figure 31. Temperature readings for Level 27 data logger, 4 April—13 December 2004.

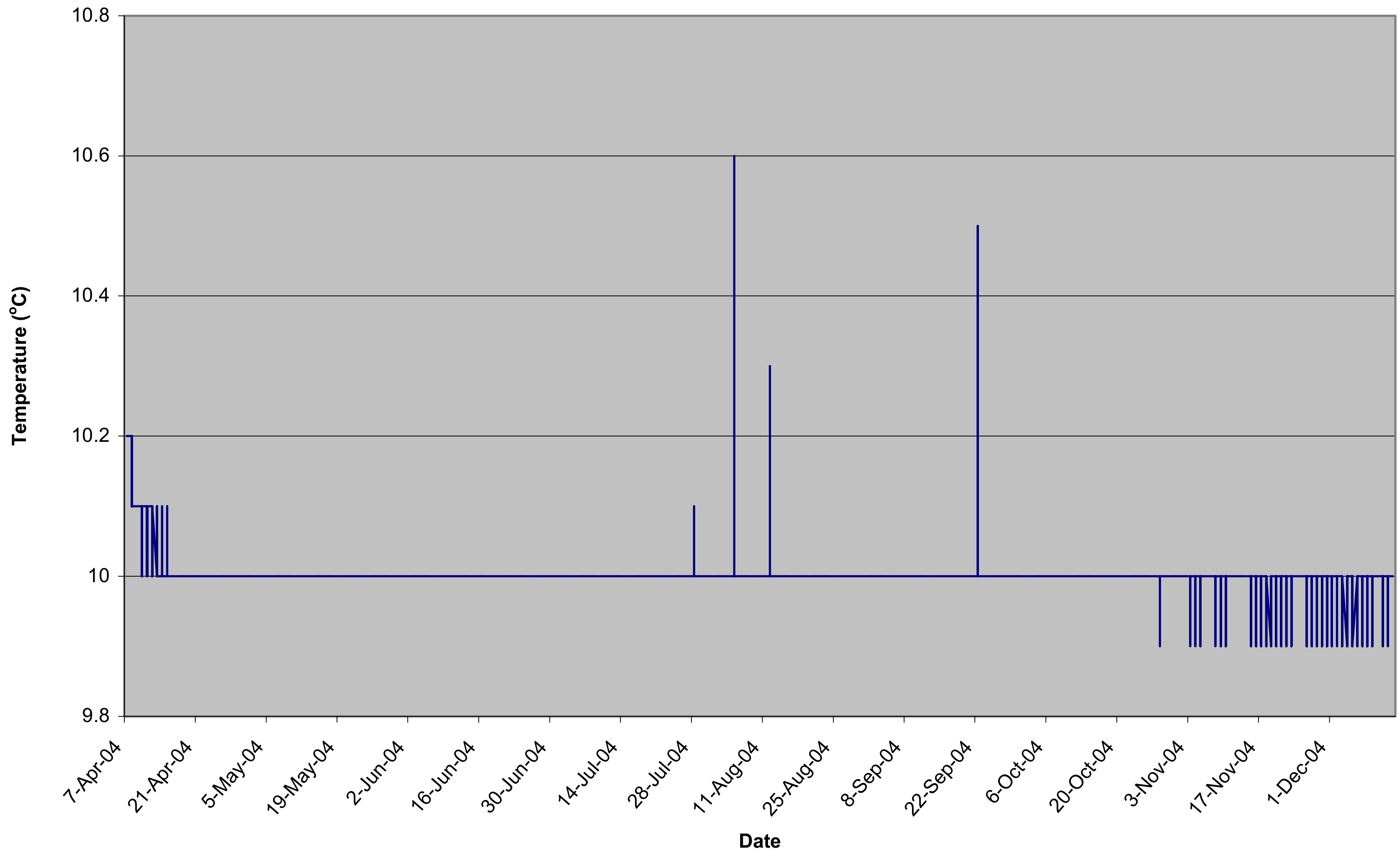


Figure 32. Barometric pressure readings for Level 27 data logger, 4 April—13 December 2004.

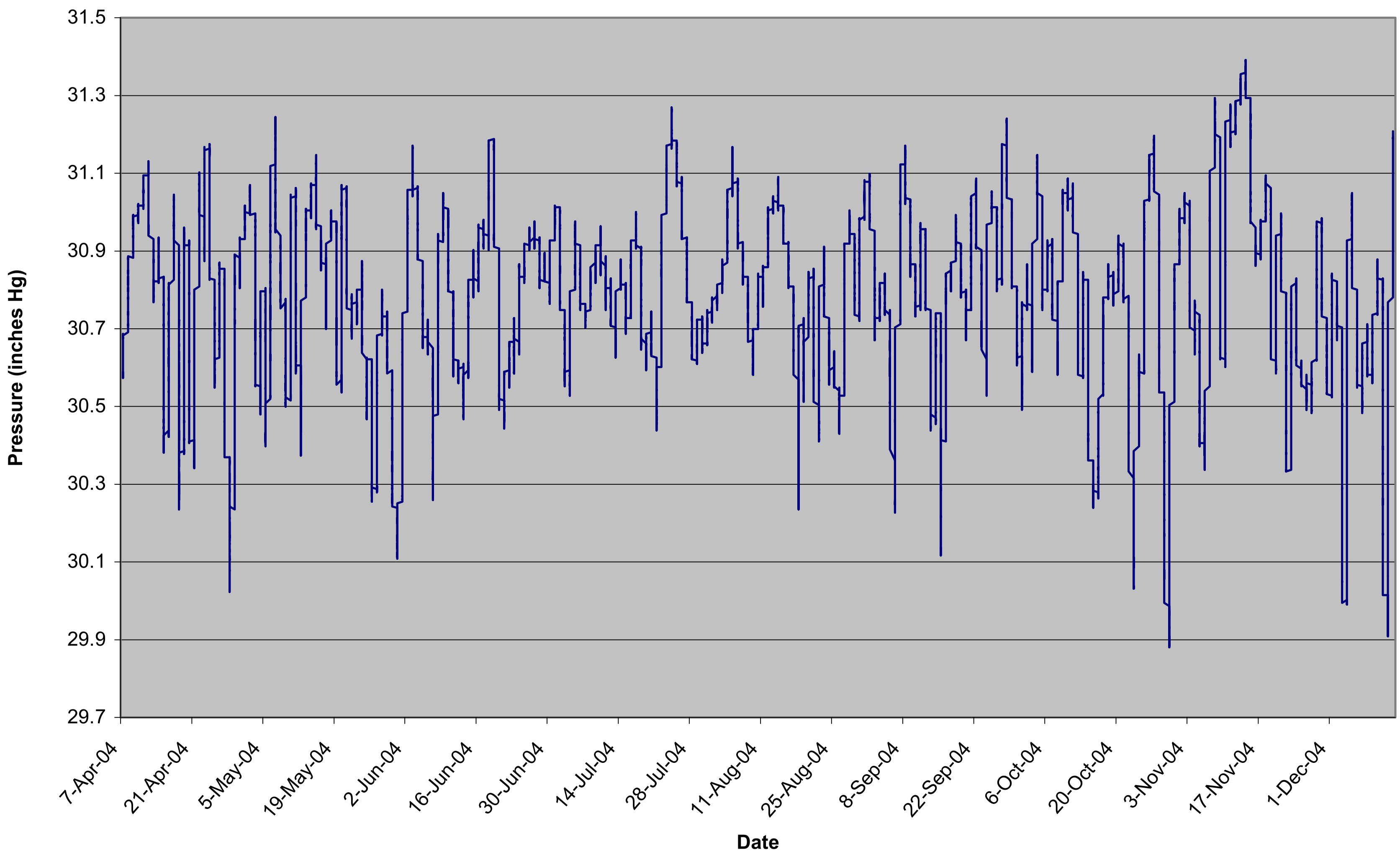


Figure 33. Bat activity at Butte Pit, 15 January—15 February 2005.

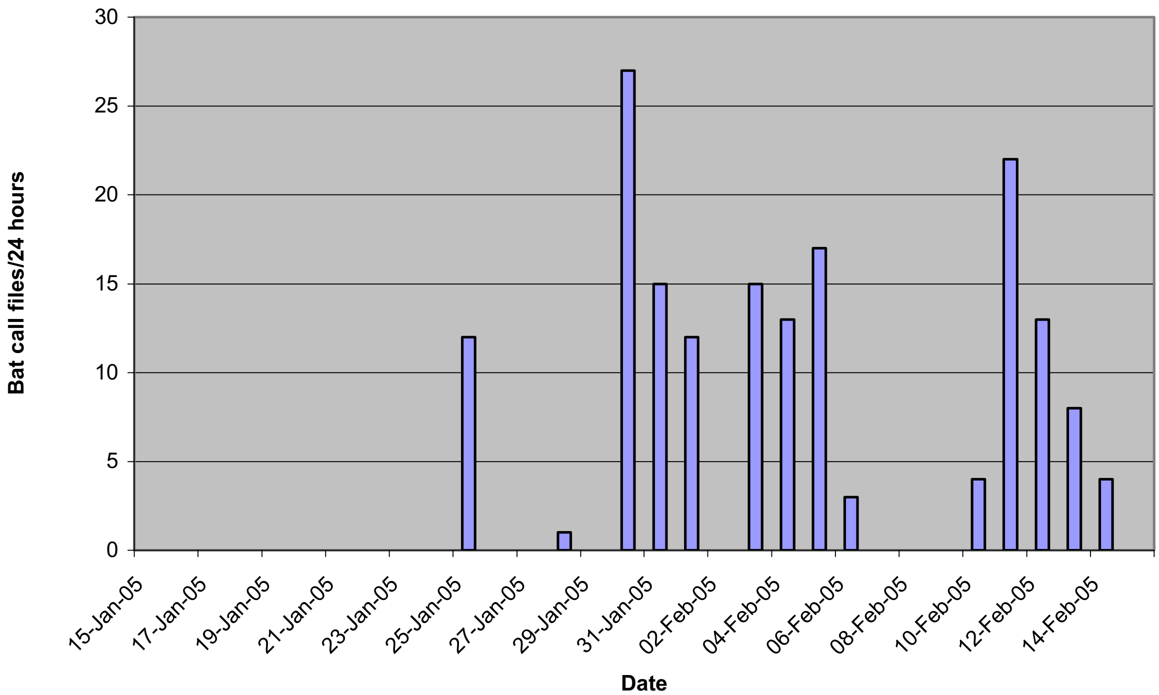
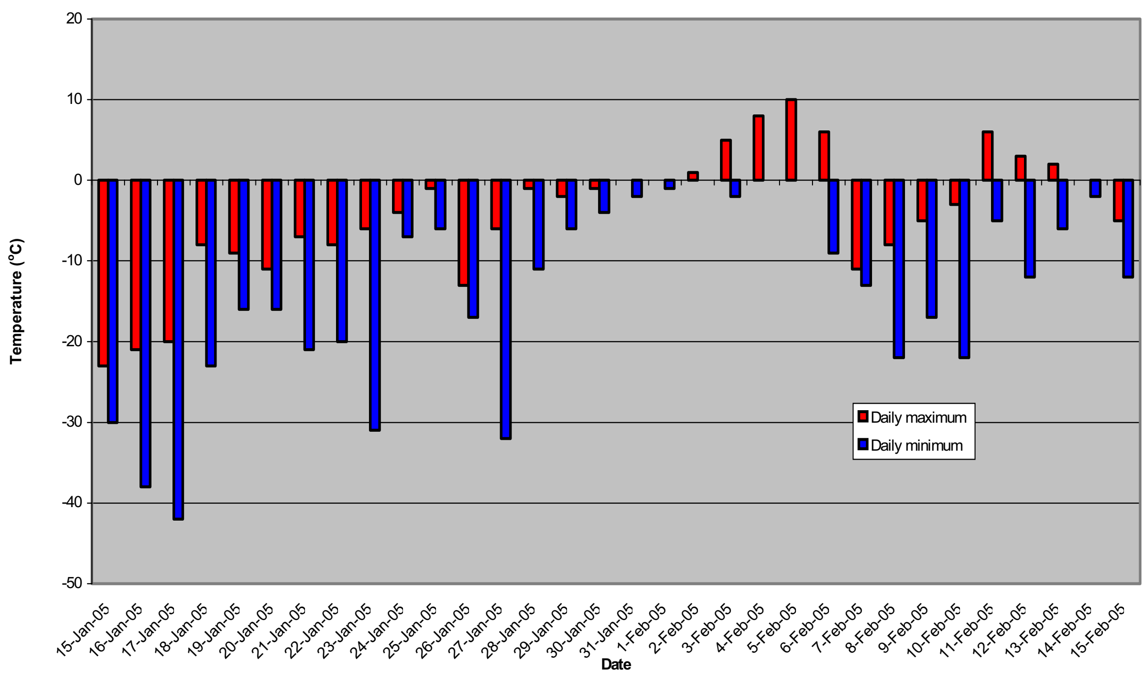


Figure 34. Daily maximum and minimum temperatures at Ely, 15 January—15 February 2005.



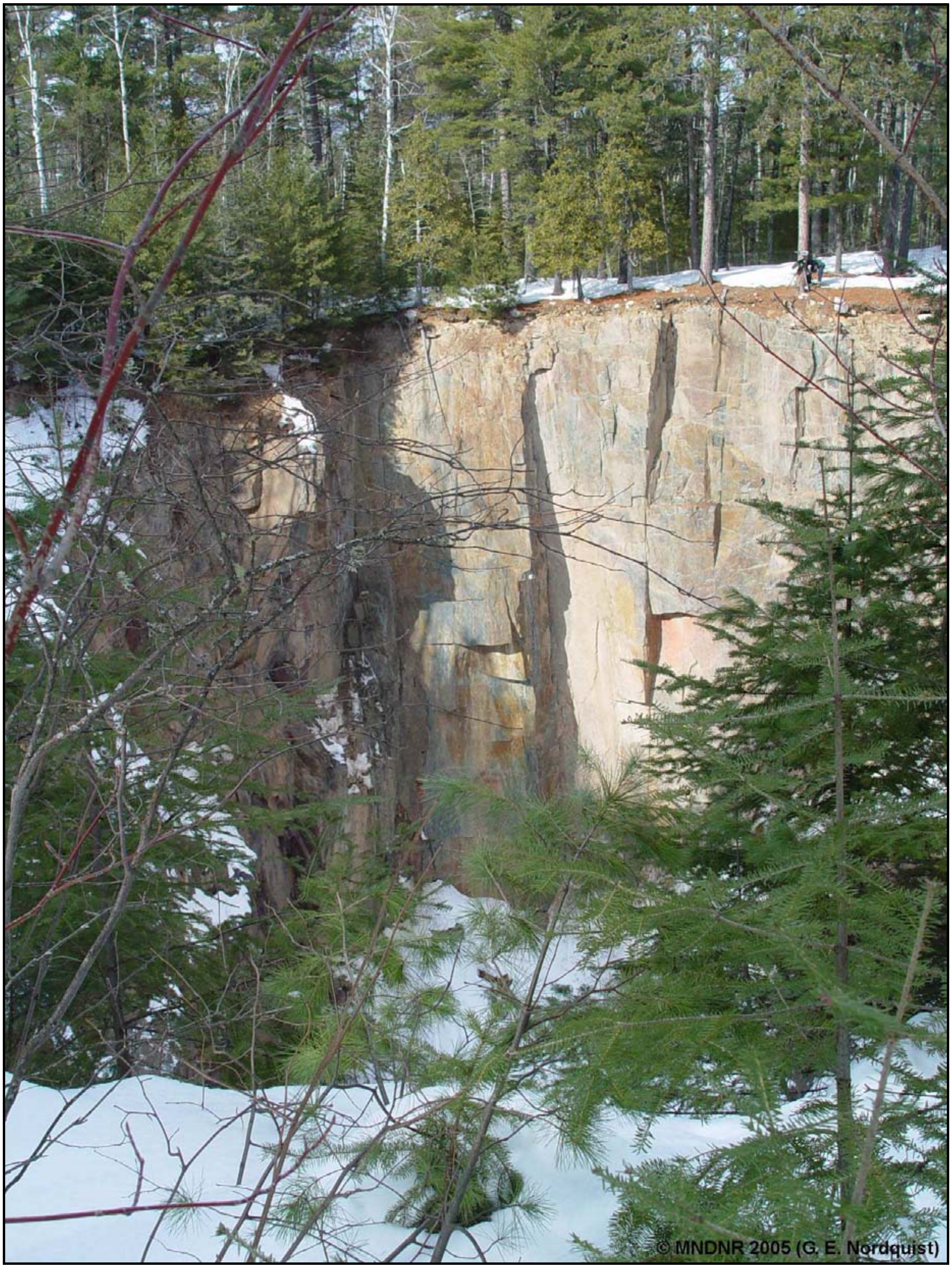


Figure 35. South-facing wall of Butte Pit below bat detector, winter 2005.

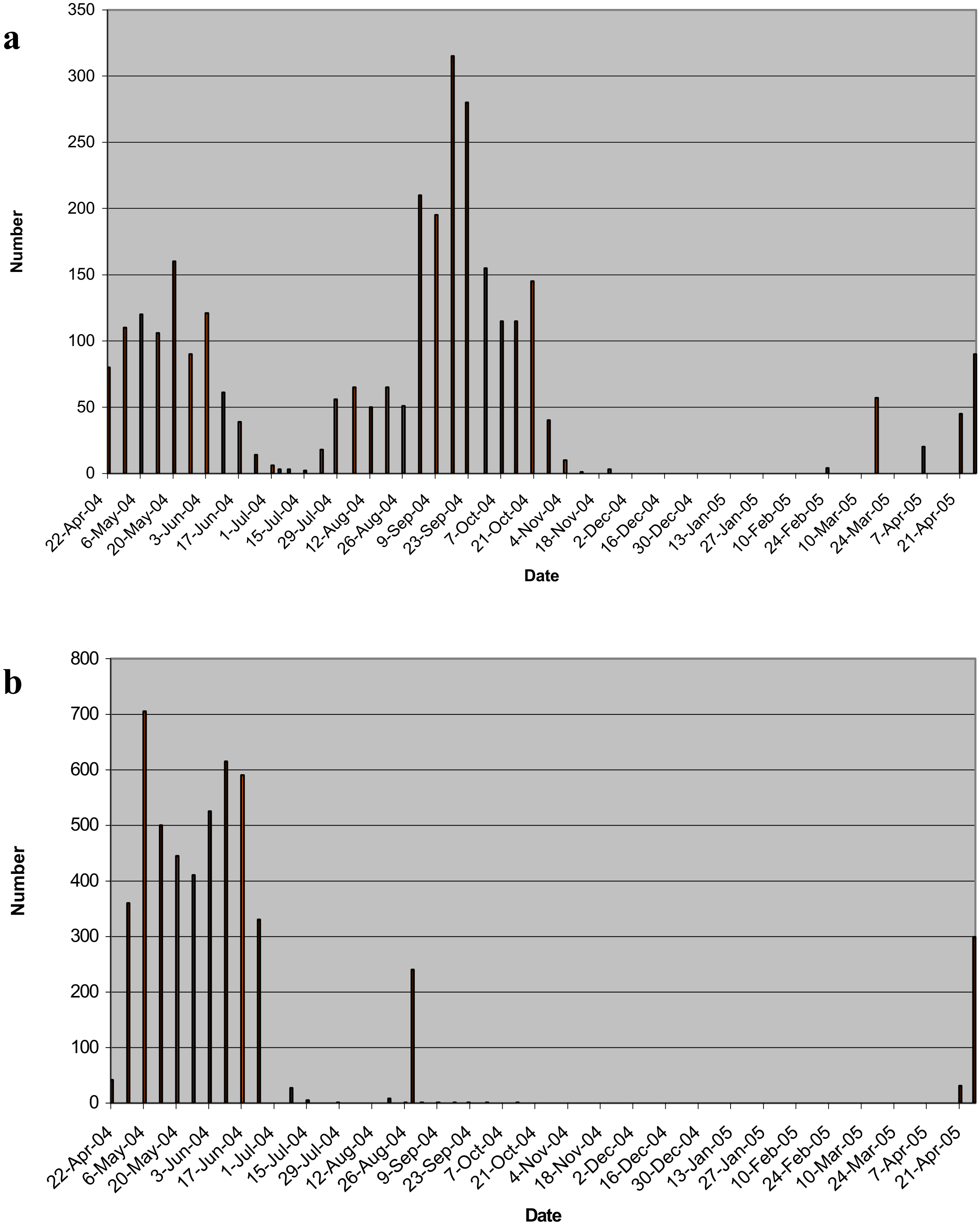


Figure 36. Timing of bat clustering on Level 12 (a) and Level 27 (b), 22 April 2004 — 27 April 2005.

Figure 37. Dead bat counts on Level 12 and Level 27, 4 April 2004—11 January 2005.

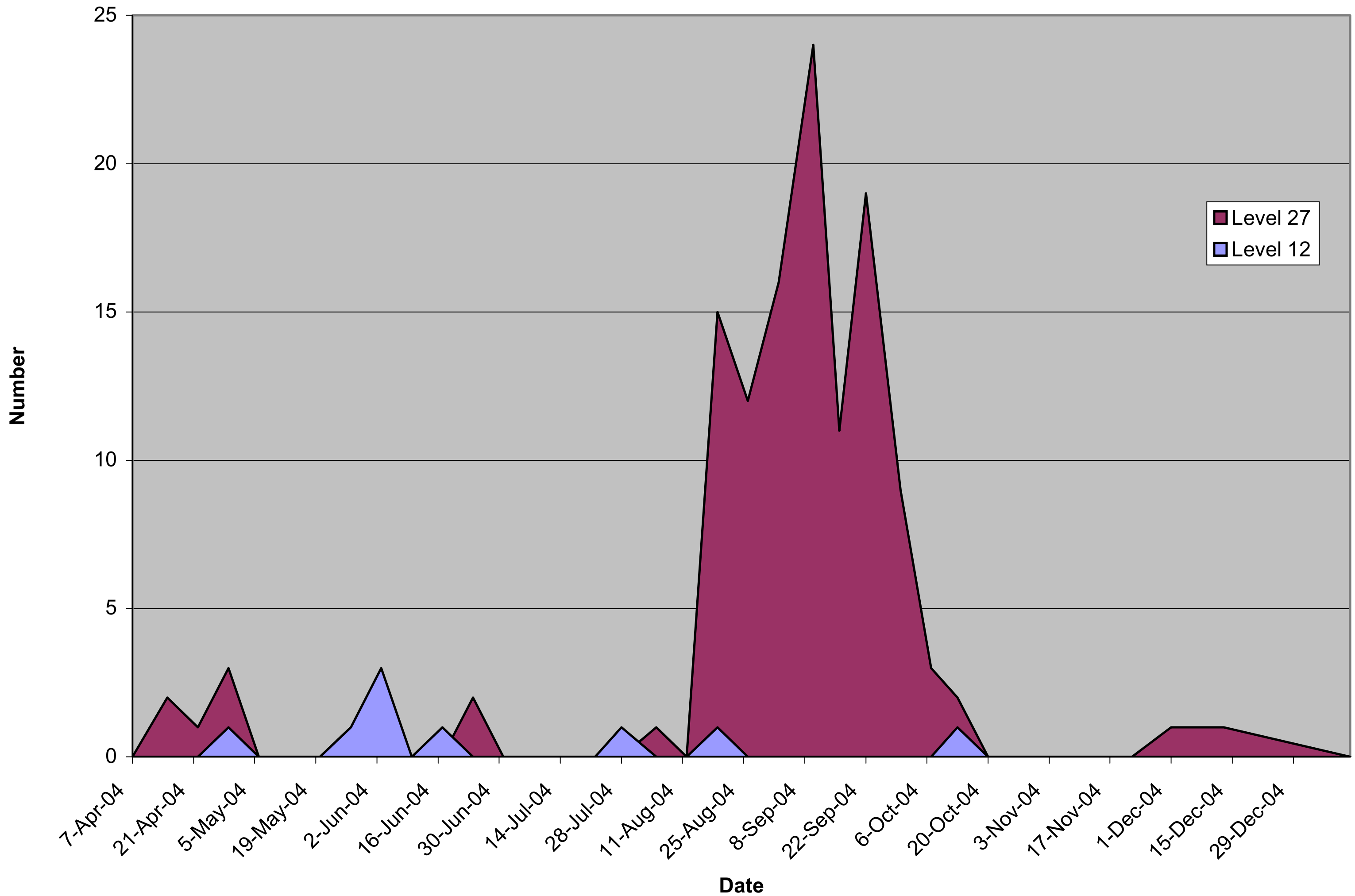


Table 1. Number of files recorded at Soudan Mine bat detector locations.

Detector location	Files recorded	
	7 Apr – 13 Dec 2004	13 Dec 2004 – 27 Apr 2005
Level 12 - Alaska	365,716	33,817
Level 12 – Main	58,027	
Level 27	153,280	31,084
Alaska - Open	126,294	
Alaska - Shaft	19,567	
Manway	130,308	
Butte Pit	244,140	29,153
Main Pit	233,443	
West Tower Pit	222,963	
TOTAL (1,620,792)	**1,526,738**	**94,054**

Table 2. Bat detector run times for Level 12 - Alaska, 2004.

First call (day, hour)	Last Call (day, hour)	Run hours	KB/hour	Comments
7-Apr 16:31	15-Apr 22:51	192	128	
15-Apr 21:59	22-Apr 16:55	168	221	
22-Apr 15:40	25-Apr 10:49	68	923	CF full
29-Apr 3:18	30-Apr 21:16	42	1485	CF full
6-May 6:19	11-May 19:28	133	472	power cut
13-May 15:14	14-May 20:27	29	2146	CF full
20-May 17:57	24-May 9:46	88	713	CF full
27-May 21:37	3-Jun 6:46	153	362	
3-Jun 9:14	6-Jun 8:25	71	884	CF full
10-Jun 13:33	11-Jun 4:46	15	757	power cut
17-Jun 9:47	23-Jun 13:46	148	424	CF full
24-Jun 11:28	1-Jul 13:28	170	199	
1-Jul 13:38	8-Jul 12:56	167	32	
8-Jul 12:48	13-Jul 3:54	111	64	power cut
15-Jul 13:32	22-Jul 13:05	168	205	
22-Jul 13:05	27-Jul 2:23	109	576	CF full
28-Jul 10:40	30-Jul 21:45	59	1064	CF full
5-Aug 13:31	7-Aug 13:29	48	1307	CF full
12-Aug 14:16	17-Aug 1:37	107	582	CF full
19-Aug 14:05	26-Aug 15:01	169	129	
26-Aug 15:04	2-Sep 13:27	166	195	
2-Sep 13:28	6-Sep 22:37	105	598	CF full
9-Sep 15:12	12-Sep 21:56	78	805	CF full
16-Sep 14:55	22-Sep 14:39	144	185	
22-Sep 14:42	30-Sep 14:56	192	139	power cut
30-Sep 14:57	7-Oct 15:05	169	34	
7-Oct 15:08	13-Oct 14:16	143	39	
13-Oct 14:17	20-Oct 14:19	168	15	
20-Oct 14:20	27-Oct 12:40	166	18	
27-Oct 12:41	3-Nov 14:45	170	12	
3-Nov 14:46	10-Nov 15:40	169	17	
10-Nov 14:44	22-Nov 12:05	286	6	
22-Nov 12:07	1-Dec 12:54	216	10	
1-Dec 12:54	13-Dec 14:04	290	9	

Table 3. Number of bat call files/hour during night, 7 April - 13 December 2004.

Date	Level 12-Alaska	Level 27	Manway	Alaska Shaft	Alaska - open	Main Pit	West Tower Pit	Butte Pit
7-Apr-04	35	17	32	40	43	19	23	78
15-Apr-04	99	19	11	176	131	78	0	186
22-Apr-04	170	15	187	732	140	133	107	115
29-Apr-04	247	37	899	446		162	0	171
6-May-04	235	28	636		197	196	229	196
13-May-04	179	21	330		220	167	2	
20-May-04	181	13	233		197	144	213	188
27-May-04	201	8	647		237	160	206	168
3-Jun-04	224	9	953		297	173	184	148
10-Jun-04	232	8	430		158	152	141	116
17-Jun-04	169	4	222		138	67	84	90
24-Jun-04	126	2	96		25	26	24	41
1-Jul-04	21	0	89		72	25	33	66
8-Jul-04	39	2	92		95	66	39	71
15-Jul-04	142	20	373		283	128	169	177
22-Jul-04	222	59	881		488	174	230	68
28-Jul-04	239	90	827		495	192	235	195
5-Aug-04	255	98	717		732	201	240	205
12-Aug-04	124	28	292		264	171	182	175
19-Aug-04	128	35	647		417	175	212	188
26-Aug-04	239	135	1022		702	215	248	242
2-Sep-04	153	58	510		291	211	206	210
9-Sep-04	0	111	547		595	205	237	217
16-Sep-04	154	130	187		943	197	228	212
22-Sep-04	162	161	232		260	199	228	207
30-Sep-04	66	74	217		819	181	188	191
7-Oct-04	38	51	142		214	176	166	195
13-Oct-04	10	30	30	233		61	41	51
20-Oct-04	14	33	20		83	35	46	46
27-Oct-04	12	19	3		20	15	18	15
3-Nov-04	10	31	2		50	0	11	9
10-Nov-04	12	16	2		6	4	5	6
22-Nov-04	8	22	10		1	7	7	8
1-Dec-04	9	7	1		0	0	0	0

Table 4. Number of bat call files/hour during day and night for Level 12 and Level 27.

Date	Level 12 - Alaska		Level 27	
	Day	Night	Day	Night
7-Apr-04	34	35	14	17
15-Apr-04	99	99	11	19
22-Apr-04	165	170	15	15
29-Apr-04	249	247	29	37
6-May-04	247	235	28	28
13-May-04	249	179	29	21
20-May-04	176	181	20	13
27-May-04	219	201	8	8
3-Jun-04	206	224	9	9
10-Jun-04	217	232	10	8
17-Jun-04	194	169	9	4
24-Jun-04	124	126	1	2
1-Jul-04	49	21	1	0
8-Jul-04	26	39	0	2
15-Jul-04	24	142	5	20
22-Jul-04	78	222	15	59
28-Jul-04	121	239	19	90
5-Aug-04	128	255	23	98
12-Aug-04	26	124	12	28
19-Aug-04	23	128	11	35
26-Aug-04	93	239	51	135
2-Sep-04	43	153	37	58
9-Sep-04	44	0	40	111
16-Sep-04	46	154	87	130
22-Sep-04	45	162	95	161
30-Sep-04	24	66	61	74
7-Oct-04	12	38	39	51
13-Oct-04	9	10	30	30
20-Oct-04	13	14	52	33
27-Oct-04	12	12	25	19
3-Nov-04	9	10	26	31
10-Nov-04	19	12	15	16
22-Nov-04	11	8	7	22
1-Dec-04	6	9	19	7

Table 5. Bat call files/hour at Level 12, Level 27, and Butte Pit, 14 December 2004 -- 21 April 2005.

Day	Location		
	Level 12	Level 27	Butte
14-Dec-04	8.6	13.0	0.0
15-Dec-04	8.3	9.0	1.1
16-Dec-04	6.5	11.3	0.0
17-Dec-04	7.8	7.3	0.1
18-Dec-04	7.3	9.8	0.1
19-Dec-04	7.6	9.5	0.0
20-Dec-04	9.6	22.3	0.4
21-Dec-04	8.0	12.0	0.0
22-Dec-04	7.1	10.1	0.0
23-Dec-04	8.3	14.3	0.0
24-Dec-04			0.0
25-Dec-04			0.0
26-Dec-04	power outage		0.0
27-Dec-04			0.0
28-Dec-04			0.4
29-Dec-04	4.2	16.2	1
30-Dec-04	4.7	12.4	0.6
31-Dec-04	4.8	10.7	
1-Jan-05	4.2	11.3	
2-Jan-05	4.3	16.3	
3-Jan-05	4.1	9.5	
4-Jan-05	5.0	10.0	
5-Jan-05	3.3	9.5	wires broken by marten
6-Jan-05	4.7	9.3	
7-Jan-05	4.8	12.9	
8-Jan-05	5.0	21.8	
9-Jan-05	4.8	13.8	
10-Jan-05	2.9	14.0	
11-Jan-05	equipment change		
12-Jan-05	11.0	10.3	0.6
13-Jan-05	9.3	9.3	0.0
14-Jan-05	8.1	12.5	0.0
15-Jan-05	11.2	10.5	0.0
16-Jan-05	8.3	15.7	0.0
17-Jan-05	9.0	17.5	0.0
18-Jan-05	10.7	18.2	0.0
19-Jan-05	7.3	9.3	0.0
20-Jan-05	9.8	8.3	0.0
21-Jan-05	8.3	11.3	0.0
22-Jan-05	7.8	14.1	0.0
23-Jan-05	7.9	10.6	0.0
24-Jan-05	9.8	14.5	0.0
25-Jan-05	8.6	14.2	0.5
26-Jan-05	6.7	15.9	0.0
27-Jan-05	10.0	10.5	0.0
28-Jan-05	10.8	12.0	0.0
29-Jan-05	9.0	9.6	0.0
30-Jan-05	11.3	10.0	1.1
31-Jan-05	8.4	10.7	0.6
1-Feb-05	8.0	11.5	0.5
2-Feb-05	10.3	9.9	change
3-Feb-05	7.1	11.3	0.6
4-Feb-05	equipment change		0.5
5-Feb-05	7.0	4.9	0.7
6-Feb-05	6.8	4.3	0.1
7-Feb-05	6.0	7.3	0.0
8-Feb-05	7.0	6.9	0.0
9-Feb-05	5.9	5.2	0.0
10-Feb-05	6.8	5.8	0.2
11-Feb-05	7.6	5.5	0.9
12-Feb-05	6.3	4.5	0.5
13-Feb-05	7.3	4.7	0.3
14-Feb-05	9.8	6.1	0.2
15-Feb-05	6.4	7.2	0.0
16-Feb-05	7.7	4.8	0.0
17-Feb-05	6.4	8.0	0.0
18-Feb-05	5.9	8.6	0.0
19-Feb-05	7.5	5.3	0.0
20-Feb-05	6.8	10.7	0.0
21-Feb-05	5.6	5.3	0.0
22-Feb-05	8.1	6.1	0.0
23-Feb-05	equipment change		
24-Feb-05		8.0	0.0
25-Feb-05		8.9	0.0

Table 5. continued.

Day	Location		
	Level 12	Level 27	Butte
26-Feb-05	calls not recorded	8.9	0.0
27-Feb-05		10.5	0.2
28-Feb-05		10.7	0.0
1-Mar-05		11.7	0.0
2-Mar-05		8.3	0.0
3-Mar-05		9.8	0.2
4-Mar-05		8.7	1.0
5-Mar-05		10.3	1.4
6-Mar-05		7.1	2.5
7-Mar-05		8.1	0.0
8-Mar-05		7.3	0.0
9-Mar-05		7.5	0.0
10-Mar-05		8.5	0.3
11-Mar-05		7.6	0.0
12-Mar-05		16.0	0.0
13-Mar-05		7.7	0.0
14-Mar-05		7.1	0.0
15-Mar-05		8.0	0.2
16-Mar-05	equipment change		
17-Mar-05	11.7	4.4	1.0
18-Mar-05	9.3	3.3	0.3
19-Mar-05	9.5	3.9	0.3
20-Mar-05	10.7	4.3	1.3
21-Mar-05	11.0	4.0	0.8
22-Mar-05	CF card full	4.0	3.3
23-Mar-05		4.5	4.5
24-Mar-05		5.3	3.7
25-Mar-05		3.2	0.8
26-Mar-05		4.1	7.9
27-Mar-05		4.7	5.3
28-Mar-05		4.7	14.1
29-Mar-05		5.5	16.8
30-Mar-05		4.6	16.1
5-Apr-05	37.9	10.3	30.8
21-Apr-05	137.2	17.5	35.6

Table 6. Percent of *Myotis* spp. and *Eptesicus* calls at Butte Pit.

Date	Percent	
	Myotis spp.	*Eptesicus*
15-Apr-04	75	25
17-Jun-04	49	51
19-Aug-04	95	5
16-Sep-04	99	1
8-Dec-04	62	39
2-Feb-05	63	37
16-Mar-05	94	6

Table 7. Number of readings recorded at Soudan Mine data logger locations.

Data logger location	Reading recorded (temperature, relative humidity, barometric pressure)	
	7 Apr - 13 Dec 2004 (15 minutes)	23 Feb - 27 Apr 2005 (30 minutes)
Alaska Shaft	24,011	3,029
Level 12	23,848	3,028
Level 27	23,919	3,023
TOTAL (80,858)	**71,778**	**9,080**

Table 8. Summary of data logger readings at Alaska Shaft.

Recording period: 7 April - 13 December 2004
Number of readings (every 15 minutes): 24,011

Temperature (^oC)

minimum		maximum	
-18.6	3-Dec-04	34.2	21-Jul-04

lowest (100)	Month	highest (100)
0	Apr	0
0	May	0
6	Jun	0
65	Jul	0
5	Aug	0
24	Sep	0
0	Oct	0
0	Nov	0
0	Dec	100

Change in temperature (^oC)

largest decrease		largest increase	
-20.5	11-Aug-04	14.6	10-Aug-04

largest decrease	Month	largest increase
11	Apr	10
15	May	15
21	Jun	24
22	Jul	11
17	Aug	23
9	Sep	9
4	Oct	3
1	Nov	5
0	Dec	0

Table 8. continued.

Relative humidity (%)

lowest		highest		
22.5	7-May-04	100	21%	4,958 readings

lowest (100)	Month	100% RH/month
43	Apr	106
43	May	293
0	Jun	172
2	Jul	322
12	Aug	758
0	Sep	816
0	Oct	1019
0	Nov	692
0	Dec	780

Change in relative humidity (%)

largest decrease		largest increase	
-36.5	10-Aug-04	33	1-Sep-04

largest decrease	Month	largest increase
5	Apr	12
21	May	25
25	Jun	22
9	Jul	9
26	Aug	21
5	Sep	6
5	Oct	3
4	Nov	2
0	Dec	0

Table 8. continued.

Barometric pressure (inches Hg)

lowest		highest	
27.27	30-Oct-04	28.76	13-Dec-04

lowest (100)	Month	highest (100)
0	Apr	0
0	May	0
0	Jun	0
0	Jul	0
0	Aug	0
0	Sep	0
65	Oct	0
0	Nov	88
35	Dec	12

Change in barometric pressure (inches Hg)

largest decrease		largest increase	
-0.50	6-Sep-04	0.34	10-Aug-04

largest decrease	Month	largest increase
20	Apr	21
24	May	14
10	Jun	12
7	Jul	3
10	Aug	18
13	Sep	14
8	Oct	8
1	Nov	3
7	Dec	7

Table 9. Summary of data logger readings on Level 12.

Recording period: 7 April - 13 December 2004
Number of readings (every 15 minutes): 23,848

Temperature (^oC)

minimum		maximum	
6.8	11-Apr-04	9.8	22-Sep-04

lowest (100)	Month	highest (100)
100	Apr	0
0	May	0
0	Jun	6
0	Jul	2
0	Aug	74
0	Sep	18
0	Oct	0
0	Nov	0
0	Dec	0

Change in temperature (^oC)

largest decrease		largest increase	
-0.6	22-Sep-04	1.0	22-Sep-04

Relative humidity (%)

After intial 2 days of adjustment, remained at 100%

Change in relative humidity (%)

After initial adjustment, no change

Table 9. continued.

Barometric pressure (inches Hg)

lowest		highest	
28.30	30-Oct-04	29.72	14-Nov-04

lowest (100)	Month	highest (100)
0	Apr	0
0	May	0
0	Jun	0
0	Jul	0
0	Aug	0
0	Sep	0
53	Oct	0
0	Nov	100
47	Dec	0

Change in barometric pressure (inches Hg)

largest decrease		largest increase	
-0.17	18-Apr-04	0.18	10-Apr-04

largest decrease	Month	largest increase
18	Apr	25
30	May	18
13	Jun	11
5	Jul	5
4	Aug	3
12	Sep	14
9	Oct	10
2	Nov	4
7	Dec	10

Table 10. Summary of data logger readings on Level 27.

Recording period: 7 April - 13 December 2004
Number of readings (every 15 minutes): 23,919

Temperature (^oC)

minimum		maximum	
9.9	136*	10.5	22-Sep-04

* readings

lowest (136)	Month	highest (100)
0	Apr	91
0	May	0
0	Jun	0
0	Jul	1
0	Aug	5
0	Sep	3
1	Oct	0
84	Nov	0
51	Dec	0

Change in temperature (^oC)

largest decrease		largest increase	
-0.1	12-Apr-04	0.3	12-Apr-04

Excluded dates/times when changing equipment

Relative humidity (%)

After intial 2 days of adjustment, remained at 100%

Change in relative humidity (%)

After initial adjustment, no change

Table 10. continued.

Barometric pressure (inches Hg)

lowest		highest	
29.88	30-Oct-04	31.39	14-Nov-04

lowest (100)	Month	highest (100)
1	Apr	0
0	May	0
0	Jun	0
0	Jul	0
0	Aug	0
0	Sep	0
55	Oct	0
0	Nov	0
44	Dec	100

Change in barometric pressure (inches Hg)

largest decrease		largest increase	
-0.18	18-Apr-04	0.09	10-Nov-04

largest decrease	Month	largest increase
23	Apr	33
25	May	17
15	Jun	12
6	Jul	6
4	Aug	3
12	Sep	9
7	Oct	10
2	Nov	3
6	Dec	7

Table 11. Bat activity at Butte Pit and daily temperatures at Ely, 15 January - 15 February 2005.

Date	Bat calls/24 hours	Ely daily temperature (^oC)	
		maximum	minimum
15-Jan-05	0	-23	-30
16-Jan-05	0	-21	-38
17-Jan-05	0	-20	-42
18-Jan-05	0	-8	-23
19-Jan-05	0	-9	-16
20-Jan-05	0	-11	-16
21-Jan-05	0	-7	-21
22-Jan-05	0	-8	-20
23-Jan-05	0	-6	-31
24-Jan-05	0	-4	-7
25-Jan-05	12	-1	-6
26-Jan-05	0	-13	-17
27-Jan-05	0	-6	-32
28-Jan-05	1	-1	-11
29-Jan-05	0	-2	-6
30-Jan-05	27	-1	-4
31-Jan-05	15	0	-2
1-Feb-05	12	0	-1
2-Feb-05		1	0
3-Feb-05	15	5	-2
4-Feb-05	13	8	0
5-Feb-05	17	10	0
6-Feb-05	3	6	-9
7-Feb-05	0	-11	-13
8-Feb-05	0	-8	-22
9-Feb-05	0	-5	-17
10-Feb-05	4	-3	-22
11-Feb-05	22	6	-5
12-Feb-05	13	3	-12
13-Feb-05	8	2	-6
14-Feb-05	4	0	-2
15-Feb-05	0	-5	-12

Table 12. Bat cluster counts at Soudan Underground Mine, 4 April 2004 - 27 April 2005.

Date	Level 12				Level 27			
	Hole	Wall	Total	Photo	Block	Fence	Total	Photo
22-Apr-04	42	0	42	DSC01234, 35	80		80	DSC01236
29-Apr-04	300	60	360	DSC01257	110		110	DSC01256
6-May-04	600	105	705	DSC01262, 63	120		120	DSC01264, 65
13-May-04	385	115	500	DSC01266	60	46	106	DSC01267, 68
20-May-04	295	150	445	DSC01286	90	70	160	DSC01287, 88
27-May-04	250	160	410	DSC01289	90		90	DSC01290
3-Jun-04	370	155	525	DSC01303, 04	90	31	121	DSC01305-07
10-Jun-04	415	200	615	DSC01314	61		61	DSC01315
17-Jun-04	355	235	590	DSC01428, 29	31	8	39	DSC01430, 31
24-Jun-04	195	135	330	DSC01484, 85	14	0	14	DSC01487, 88
8-Jul-04	19	8	27	DSC01521, 22	6	0	6	
15-Jul-04	5	0	5	DSC01535, 36	3	0	3	SET 5_01, 06
22-Jul-04	0	0	0	DSC01543	3	0	3	DSC01523
28-Jul-04	1	0	1	DSC01545	2	0	2	DSC01537
5-Aug-04	0	0	0	DSC01696	18	0	18	DSC01544
12-Aug-04	0	0	0	DSC01700	55	1	56	DSC01546-48
19-Aug-04	6	2	8	DSC01605-07	65	0	65	DSC01597, 98
26-Aug-04	1	0	1	DSC01619, 20	50	0	50	DSC01699
29-Aug-04	150	90	240	Set 6_01, 02	40	25	65	DSC01608, 09
2-Sep-04	0	1	1	DSC01640, 41	35	16	51	DSC01622, 23
9-Sep-04	0	1	1	DSC01659, 60	145	65	210	DSC01642, 43
16-Sep-04	1	0	1	DSC01692, 93	130	65	195	DSC01657, 58
22-Sep-04	1	0	1	DSC01701	285	30	315	DSC01694-96
30-Sep-04	1	0	1	DSC01712, 13	255	25	280	DSC01702-04
7-Oct-04	0	0	0	DSC01736-38	140	15	155	DSC01715-17
13-Oct-04	1	0	1	DSC01745, 46	90	25	115	DSC01732-35
20-Oct-04	0	0	0	DSC01761-63	100	15	115	DSC01747-49
27-Oct-04	0	0	0	DSC01768-70	120	25	145	DSC01757-60
3-Nov-04	0	0	0	DSC01782-84	35	5	40	DSC01771-75
10-Nov-04	0	0	0	DSC01793, 94	10	0	10	DSC01785, 86
22-Nov-04	0	0	0	DSC01800-02	1	0	1	DSC01798, 99
1-Dec-04	0	0	0	DSC01806-08	3	0	3	DSC01803-05
13-Dec-04	0	0	0	DSC01821, 22	0	0	0	DSC01812-14
11-Jan-05	0	0	0	DSC01851, 52	0	0	0	DSC01823, 24
4-Feb-05	0	0	0		0	0	0	DSC01853, 54
23-Feb-05	0	0	0		4	0	4	DSC01922, 23
16-Mar-05	0	0	0		50	7	57	DSC01982-85
5-Apr-05	0	0	0		15	5	20	DSC02006-08
21-Apr-05	30	1	31		40	5	45	
27-Apr-05	260	39	299	DSC02020-22	75	15	90	DSC02032-34

Table 13. Sex ratio of Little brown myotis banded on Level 12 and Level 27.

Date	Number			Percent	
	Total	♂	♀	♂	♀
Level 12					
2-Jun-2005	84	79	5	94.1	6.0
20-Sep-2005	19	18	1	94.7	5.3
Level 27					
20-Sep-2005	62*	13	49	21.0	79.0

* 2 Northern myotis also banded on Level 27

Table 14. Summary of dead bats collected on Level 12 and Level 27, 7 April 2004 - 11 January 2005.

Date	Level 12										Level 27									
	Total	Distribution by species and sex									Total	Distribution by species and sex								
		Myotis lucifugus			*M. septentrionalis*			*Myotis* spp.				*Myotis lucifugus*			*M. septentrionalis*			*Myotis* spp.		
		♂	♀	Unk	♂	♀	Unk	♂	♀	Unk		♂	♀	Unk	♂	♀	Unk	♂	♀	Unk
SUMMARY	**9**		**4**		**1**	**1**				**3**	**123**	**54**	**58**	**2**		**1**				**7**
7-Apr-04		area cleared of dead bats										removed all dead bats from count area								
15-Apr-04	0										2	2								
22-Apr-04	0										1									1
29-Apr-04	1									1	3									3
6-May-04	0										0									
13-May-04	0										0									
20-May-04	0										0									
27-May-04	1									1	1									1
3-Jun-04	3		2			1					0									
10-Jun-04	0										0									
17-Jun-04	1		1									shifted to new count area, removed all dead bats								
24-Jun-04	0										2		2							
1-Jul-04	0											bats not counted								
8-Jul-04	0										0									
15-Jul-04	0										0									
22-Jul-04	0										0									
28-Jul-04	1				1						0									
5-Aug-04	0										1			1						
12-Aug-04	0										0									
19-Aug-04	1		1								15	9	5							
26-Aug-04	0										12	4	8							
2-Sep-04	0										16	4	12							
10-Sep-04	0										24	14	9	1						
16-Sep-04	0										11	3	8							
22-Sep-04	0										19	11	8							
30-Sep-04	0										9	4	4			1				
7-Oct-04	0										3	1	2							
13-Oct-04	1									1	2	2								
20-Oct-04	0										0									

Table 14. continued.

Date	Level 12										Level 27									
	Total	Distribution by species and sex									Total	Distribution by species and sex								
		Myotis lucifugus			*M. septentrionalis*			*Myotis* spp.				*Myotis lucifugus*			*M. septentrionalis*			*Myotis* spp.		
		♂	♀	Unk	♂	♀	Unk	♂	♀	Unk		♂	♀	Unk	♂	♀	Unk	♂	♀	Unk
27-Oct-04	0										0									
3-Nov-04	0										0									
10-Nov-04	0										0									
22-Nov-04	0										0									
1-Dec-04	0										1									1
13-Dec-04	0										1									1
11-Jan-05	0										0									

Appendix 1. Weather conditions recorded at Ely weather station, 7 April - 13 December 2004.
Data obtained from Weather Underground website (www.wunderground.com)

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
7-Apr-2004	X				1915 on	light rain/ snow
8-Apr-2004	X		X		until 0430	light rain/ snow
9-Apr-2004			X		2030 on	light snow
10-Apr-2004			X		until 1000	light snow
11-Apr-2004					0215-0430	light snow
12-Apr-2004			X			
13-Apr-2004			X			
14-Apr-2004						
15-Apr-2004	X		X		2115 on	light rain/ thunderstorm
16-Apr-2004			X			
17-Apr-2004						
18-Apr-2004	X			X	0600-1700	rain/ thunderstorm
19-Apr-2004			X		0130-1230	light rain/ snow
20-Apr-2004			X			
21-Apr-2004	X				until 1500	light rain/ drizzle
22-Apr-2004			X			
23-Apr-2004			X			
24-Apr-2004			X			
25-Apr-2004	X			X	0200-1400	light rain/ drizzle
26-Apr-2004	X		X		0330-1215	light snow
27-Apr-2004	X		X		1900	drizzle
28-Apr-2004	X		X		until 0500, 1930-2030	light rain/ thunderstorm
29-Apr-2004			X			
30-Apr-2004				X		
1-May-2004			X			
2-May-2004			X			
3-May-2004	X		X		1830-2100	light rain/ drizzle
4-May-2004			X			
5-May-2004				X		
6-May-2004			X			
7-May-2004	X		X		2130 on	light rain
8-May-2004						
9-May-2004	X		X		2015	rain
10-May-2004				X		
11-May-2004				X	1400-1800	rain
12-May-2004		X	X		0615-1730	rain
13-May-2004	X		X		0630-1530	light rain/ drizzle
14-May-2004			X			
15-May-2004			X			
16-May-2004	X		X		0600-0800, 1930 on	light rain/ drizzle
17-May-2004		X	X		until 1230	rain
18-May-2004			X			
19-May-2004	X		X		1730-1900	light rain
20-May-2004			X			
21-May-2004			X			
22-May-2004			X		1715-1900	light rain

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
23-May-2004				X		
24-May-2004	X		X		1730-2330	light rain/ drizzle
25-May-2004	X				until 0800, 1830-2200	light rain/ drizzle
26-May-2004	X		X		1800 on	rain/ thunderstorm
27-May-2004	X				until 0500	light rain/ drizzle
28-May-2004						
29-May-2004	X			X	1900-2100	light rain
30-May-2004	X			X	on and off until 1830	rain
31-May-2004	X		X		until 0830	rain
1-Jun-2004	X		X		until 0800	light rain/ drizzle
2-Jun-2004						
3-Jun-2004			X			
4-Jun-2004			X			
5-Jun-2004						
6-Jun-2004			X			
7-Jun-2004	X		X		until 0700, 1730-2230	light rain/ drizzle
8-Jun-2004	X		X		1900 on and off	light rain
9-Jun-2004						
10-Jun-2004			X			
11-Jun-2004	X			X	2100-2300	rain/ heavy thunderstorm
12-Jun-2004			X			
13-Jun-2004	X			X	0500-0800, 1715	light rain
14-Jun-2004			X			
15-Jun-2004	X		X		1700 on and off	light rain
16-Jun-2004	X		X		until 0200	light rain
17-Jun-2004			X			
18-Jun-2004	X			X	1900	light rain
19-Jun-2004			X			
20-Jun-2004	X			X	2300-2355	light rain
21-Jun-2004	X			X	1830-1930	light rain
22-Jun-2004				X		
23-Jun-2004	X		X		1600-1930	light rain/ drizzle
24-Jun-2004	X		X		0530-0800	light rain/ drizzle
25-Jun-2004	X		X		until 1930	light rain/ drizzle
26-Jun-2004			X			
27-Jun-2004	X		X		1800-1900	light rain/ drizzle
28-Jun-2004			X			
29-Jun-2004				X	1830-1900	light rain
30-Jun-2004			X			
1-Jul-2004			X			
2-Jul-2004						
3-Jul-2004			X			
4-Jul-2004		X	X		variable	light rain
5-Jul-2004			X			
6-Jul-2004			X			
7-Jul-2004						
8-Jul-2004			X			

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
9-Jul-2004			X			
10-Jul-2004		X	X		2235 and on	thunderstorms
11-Jul-2004		X			0000-0800	thunderstorms
12-Jul-2004						
13-Jul-2004	X			X	0415	light thunderstorms
14-Jul-2004			X			
15-Jul-2004		X	X		2100	thunderstorms
16-Jul-2004						
17-Jul-2004						
18-Jul-2004			X			
19-Jul-2004	X		X		1430-1530	thunderstorms
20-Jul-2004	X		X		1100-1150	light rain
21-Jul-2004	X			X	2135	light rain
22-Jul-2004	X		X		AM	light rain
23-Jul-2004			X			
24-Jul-2004			X			
25-Jul-2004			X			
26-Jul-2004			X			
27-Jul-2004			X			
28-Jul-2004	X		X		2235 and on	light rain
29-Jul-2004	X		X		0115	light rain
30-Jul-2004	X				2315	light rain
31-Jul-2004						
1-Aug-2004			X			
2-Aug-2004						
3-Aug-2004						
4-Aug-2004			X			
5-Aug-2004						
6-Aug-2004			X			
7-Aug-2004	X		X		throughout day	light rain
8-Aug-2004	X				0000-0100, 2200-0000	light rain/ thunderstorm
9-Aug-2004	X		X		0000-0030, 2000-0000	light rain/ drizzle
10-Aug-2004	X		X		throughout day	light rain
11-Aug-2004	X				0000-0600	light rain
12-Aug-2004						
13-Aug-2004						
14-Aug-2004			X			
15-Aug-2004			X			
16-Aug-2004	X				2300	light rain
17-Aug-2004			X			
18-Aug-2004	X			X	on and off throughout day	light rain
19-Aug-2004	X			X	1900-2030	light rain
20-Aug-2004			X			
21-Aug-2004			X			
22-Aug-2004	X		X		on and off throughout AM	rain
23-Aug-2004			X			
24-Aug-2004						

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
25-Aug-2004	X				2330-0000	light rain
26-Aug-2004	X		X		0000-0300	light rain
27-Aug-2004			X			
28-Aug-2004						
29-Aug-2004	X		X		2100-0000	light rain
30-Aug-2004	X		X		0000-0130	light rain
31-Aug-2004						
1-Sep-2004			X			
2-Sep-2004			X			
3-Sep-2004			X			
4-Sep-2004			X			
5-Sep-2004	X		X		0230-0600, 2100-0000	rain/ thunderstorm
6-Sep-2004	X			X	0000-0500, 2115	rain
7-Sep-2004	X			X	0330-0530	light rain
8-Sep-2004			X			
9-Sep-2004			X			
10-Sep-2004			X			
11-Sep-2004	X		X		0500-0600	rain
12-Sep-2004			X			
13-Sep-2004	X			X	1900, on and off throughout night	light rain
14-Sep-2004	X		X		on and off throughout AM	light rain
15-Sep-2004		X	X		began at 0700	heavy rain
16-Sep-2004				X		
17-Sep-2004	X		X			
18-Sep-2004			X			
19-Sep-2004			X			
20-Sep-2004	X		X		began at 1800	rain
21-Sep-2004	X		X		on and off throughout AM	rain
22-Sep-2004						
23-Sep-2004	X		X		1900-2100	rain
24-Sep-2004	X		X		on and off throughout AM	rain
25-Sep-2004			X			
26-Sep-2004			X			
27-Sep-2004			X			
28-Sep-2004						
29-Sep-2004			X			
30-Sep-2004			X			
1-Oct-2004		X	X		rain in AM starting at 0300	rain
2-Oct-2004				X		
3-Oct-2004	X		X		1900 on	light rain/ snow
4-Oct-2004			X			light snow
5-Oct-2004			X			
6-Oct-2004			X			
7-Oct-2004			X			
8-Oct-2004	X			X	evening	light rain/ drizzle
9-Oct-2004			X			
10-Oct-2004			X			

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
11-Oct-2004			X			
12-Oct-2004			X			
13-Oct-2004	X		X		0300-1200	rain
14-Oct-2004			X			
15-Oct-2004	X				2030-2100	rain
16-Oct-2004			X			light snow
17-Oct-2004			X			
18-Oct-2004			X			
19-Oct-2004			X			
20-Oct-2004			X			
21-Oct-2004			X			
22-Oct-2004	X		X		2215 on	light rain
23-Oct-2004		X	X		AM and 1915	heavy rain/ rain
24-Oct-2004	X		X		2030-2300	light rain/ drizzle
25-Oct-2004	X		X		AM	light rain/ drizzle
26-Oct-2004						
27-Oct-2004			X			
28-Oct-2004	X				early AM and 2130 and on	light rain/ drizzle
29-Oct-2004	X		X		AM and 2200 and on	light rain/ drizzle
30-Oct-2004		X	X		on and off all day	rain
31-Oct-2004			X			
1-Nov-2004						
2-Nov-2004	X				AM	light rain/ drizzle
3-Nov-2004			X			
4-Nov-2004	X		X		0330-0600	light rain/ drizzle
5-Nov-2004			X			
6-Nov-2004						
7-Nov-2004				X		light snow
8-Nov-2004			X			
9-Nov-2004			X			
10-Nov-2004			X			
11-Nov-2004			X			
12-Nov-2004			X			
13-Nov-2004			X			
14-Nov-2004			X			
15-Nov-2004			X			
16-Nov-2004			X			
17-Nov-2004						
18-Nov-2004			X			
19-Nov-2004	X		X		1700 on	light rain/ drizzle
20-Nov-2004	X				0000-0700	light rain/ drizzle
21-Nov-2004			X			
22-Nov-2004			X			
23-Nov-2004				X	AM	light snow
24-Nov-2004			X		PM	light snow
25-Nov-2004					AM	light snow
26-Nov-2004					PM	light snow

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
27-Nov-2004			X		AM	light snow
28-Nov-2004			X		PM	light snow
29-Nov-2004			X		AM	snow
30-Nov-2004			X			
1-Dec-2004			X		AM	light snow
2-Dec-2004					AM	light snow
3-Dec-2004			X		PM	light snow
4-Dec-2004	X				0030-0100	light rain
5-Dec-2004			X		2130	lgith snow
6-Dec-2004			X		all day	light snow
7-Dec-2004					0530-0800	light snow
8-Dec-2004						
9-Dec-2004			X			
10-Dec-2004			X		0430-0600	light snow
11-Dec-2004					1600 on	light snow
12-Dec-2004				X	all day	light snow
13-Dec-2004			X		AM	light snow
14-Dec-2004						
15-Dec-2004			X			
16-Dec-2004	X		X		AM-1930	light snow
17-Dec-2004			X		on and off	light snow
18-Dec-2004			X			
19-Dec-2004			X		2000 on	light snow
20-Dec-2004			X		0000-0300	light snow
21-Dec-2004			X		0515-0930	light snow
22-Dec-2004			X			
23-Dec-2004			X		2200-2300	light snow
24-Dec-2004					0100-0200	light snow
25-Dec-2004						
26-Dec-2004						
27-Dec-2004					0630-1100	light snow
28-Dec-2004			X			
29-Dec-2004						
30-Dec-2004	X		X		1700-2000	light rain/ drizzle
31-Dec-2004	X			X	all day	light drizzle/ light snow
1-Jan-2005			X		0000-0100, 1235 on	light snow
2-Jan-2005				X		
3-Jan-2005						
4-Jan-2005			X		0300-0900	light snow
5-Jan-2005						
6-Jan-2005						
7-Jan-2005					all day	light snow
8-Jan-2005					on and off	light snow
9-Jan-2005			X		0800 on	light snow
10-Jan-2005			X		until 0130	light snow
11-Jan-2005						
12-Jan-2005			X		0600 on	light snow

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
13-Jan-2005				X	until 0600	light snow
14-Jan-2005				X		
15-Jan-2005			X		0330-0400	light snow
16-Jan-2005			X			
17-Jan-2005						
18-Jan-2005			X		0900 on	light snow
19-Jan-2005	X		X		all day	light snow
20-Jan-2005			X		until 1330	light snow
21-Jan-2005			X		0315 on	light snow
22-Jan-2005			X		until 0800	light snow
23-Jan-2005				X	0315-0500	light snow
24-Jan-2005			X		AM	light snow
25-Jan-2005			X		0030-0330, 2030-0000	light snow
26-Jan-2005			X		until 0300	
27-Jan-2005			X		0600-0800	light snow
28-Jan-2005			X		1900 on	light snow
29-Jan-2005					until 0300	light snow
30-Jan-2005			X			
31-Jan-2005			X			
1-Feb-2005			X			
2-Feb-2005			X			
3-Feb-2005			X			
4-Feb-2005						
5-Feb-2005			X			
6-Feb-2005			X		1315 on	light snow
7-Feb-2005					until 1000	light snow
8-Feb-2005						
9-Feb-2005					0415 on	light snow
10-Feb-2005			X		1700-1930	light snow
11-Feb-2005				X		
12-Feb-2005						
13-Feb-2005			X		2030-2230	light snow
14-Feb-2005			X		until 1030	light snow
15-Feb-2005				X	0130-1030	light snow
16-Feb-2005			X		0715-1315	light snow
17-Feb-2005			X			
18-Feb-2005			X		1515-2130	light snow
19-Feb-2005						
20-Feb-2005			X		0415 on	light snow
21-Feb-2005			X		until 1200	light snow
22-Feb-2005					0400-1900	light snow
23-Feb-2005			X		0400-1015	light snow
24-Feb-2005					2330 on	light snow
25-Feb-2005					until 1000	light snow
26-Feb-2005			X		0500-0730	light snow
27-Feb-2005			X		0830 on	light snow
28-Feb-2005			X		until 1730	light snow

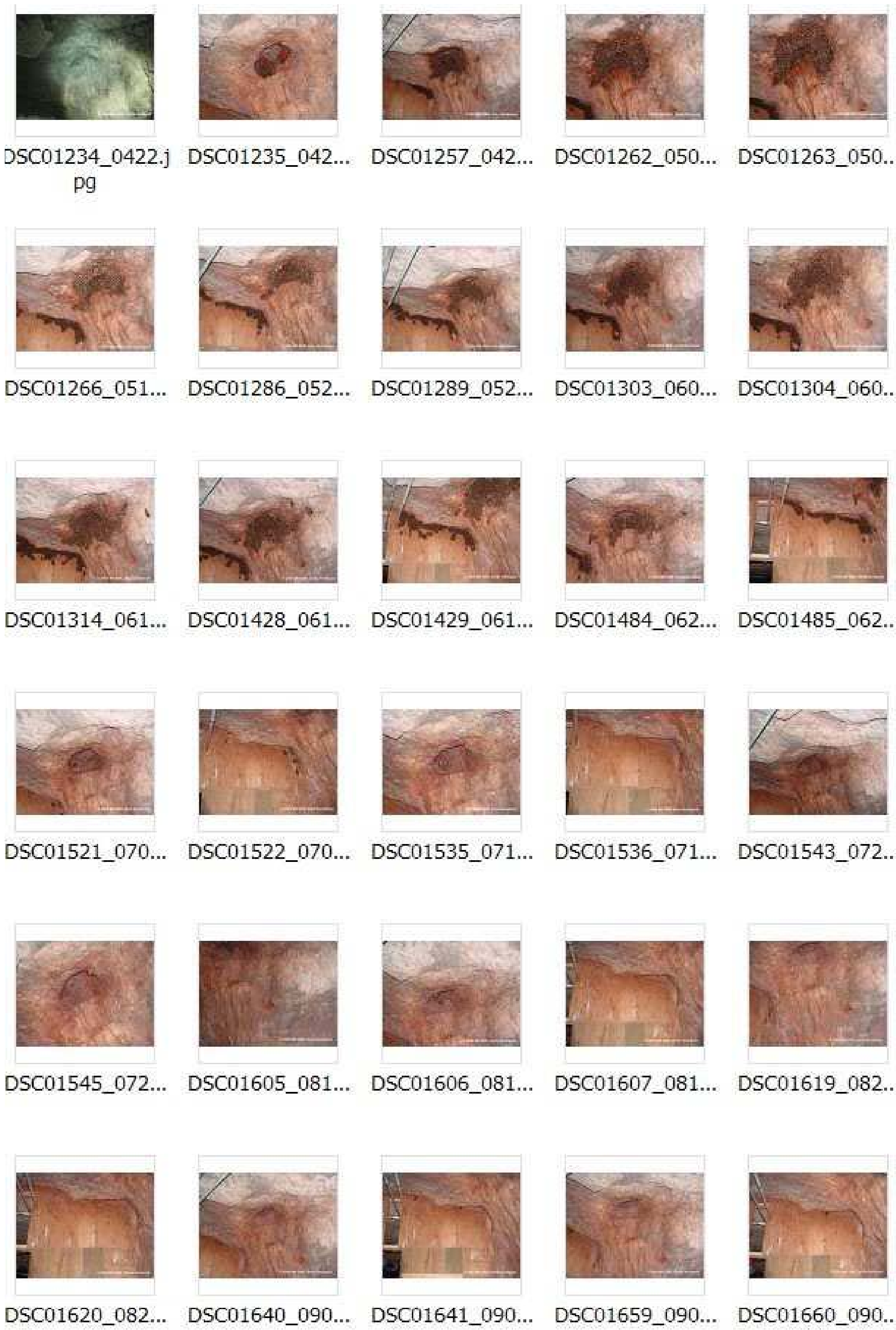
Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
1-Mar-2005						
2-Mar-2005						
3-Mar-2005			X			
4-Mar-2005					0200-0500	light snow
5-Mar-2005			X			
6-Mar-2005			X		2330 on	light snow
7-Mar-2005			X		until 0530	light snow
8-Mar-2005			X			
9-Mar-2005			X			
10-Mar-2005			X		until 1030, 2330 on	light snow
11-Mar-2005				X	until 1530	light snow
12-Mar-2005			X			
13-Mar-2005			X		0600-0730, 1900 on	light snow
14-Mar-2005					0515-0715	light snow
15-Mar-2005					0230-1730	light snow
16-Mar-2005					2130-2355	light snow
17-Mar-2005						
18-Mar-2005						
19-Mar-2005			X			
20-Mar-2005						
21-Mar-2005						
22-Mar-2005						
23-Mar-2005			X			
24-Mar-2005			X		0415-1030	light snow
25-Mar-2005			X			
26-Mar-2005			X			
27-Mar-2005			X			
28-Mar-2005						
29-Mar-2005				X		
30-Mar-2005	X		X		0815-2200	light rain
31-Mar-2005	X		X		0130-0430	light rain
1-Apr-2005			X			
2-Apr-2005						
3-Apr-2005						
4-Apr-2005				X		
5-Apr-2005	X		X		1730-1900	thunderstorm
6-Apr-2005	X		X		0615-1200	drizzle
7-Apr-2005						
8-Apr-2005			X			
9-Apr-2005			X			
10-Apr-2005	X		X		0315-0730	light rain/ thunderstorm
11-Apr-2005	X			X	1730-2000	light rain
12-Apr-2005			X			
13-Apr-2005			X			
14-Apr-2005			X			
15-Apr-2005			X			
16-Apr-2005			X			

Appendix 1. continued.

Date	Rain		Wind		Weather event	
	< 1 inch	> 1 inch	10-20 mph	>20 mph	Time period	Event
17-Apr-2005			X			
18-Apr-2005				X		
19-Apr-2005	X		X		1900-2030	rain
20-Apr-2005						
21-Apr-2005			X			
22-Apr-2005	X		X		0515-0800	light rain/ drizzle
23-Apr-2005			X			
24-Apr-2005			X			
25-Apr-2005			X		0215 on	light rain/ snow
26-Apr-2005			X		all day	light snow
27-Apr-2005			X		until 0500	light snow

Appendix 2. Thumbnails of photographs of bat cluster count area on Level 12.



Appendix 2. continued.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DSC01700_081...


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DSC01712_093...


DSC01713_093...


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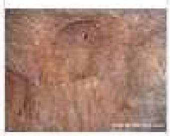
DSC01738_100...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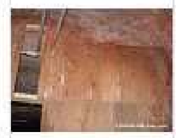
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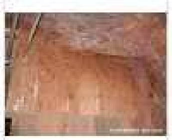
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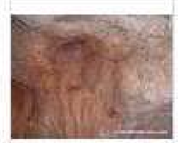
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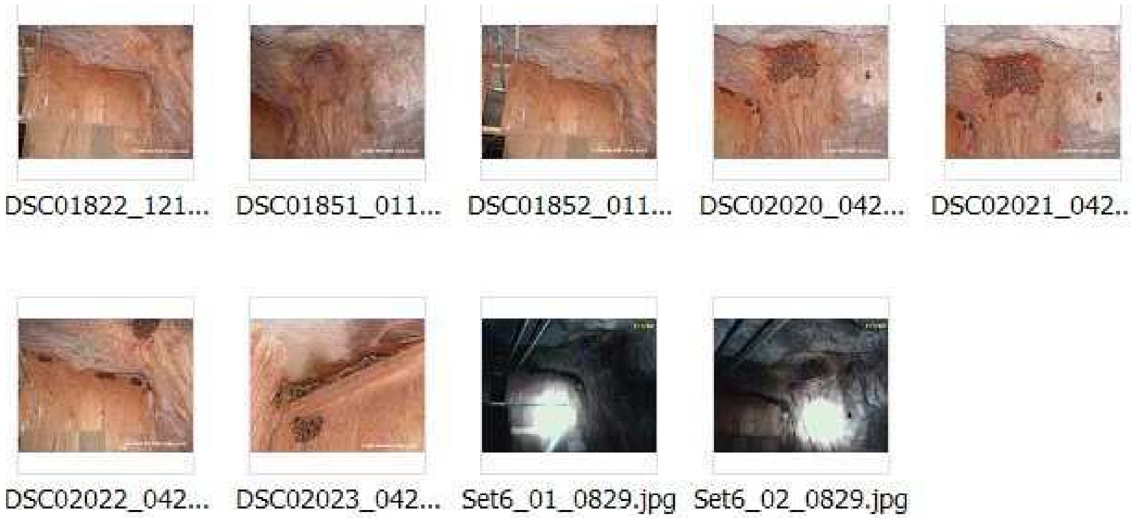
Appendix 2. continued.



Appendix 3. Thumbnails of photographs of bat cluster count area on Level 27.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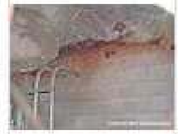
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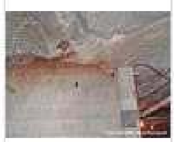
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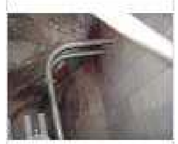
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DSC01622_082...


DSC01623_082...


DSC01642_090...


DSC01643_090...

Appendix 3. continued.


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DSC01694_091...


DSC01695_091...


DSC01696_091...


DSC01697_080...


DSC01698_080...


DSC01699_081...


DSC01702_092...


DSC01703_092...


DSC01704_092...


DSC01715_093...


DSC01716_093...


DSC01717_093...


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DSC01733_100...


DSC01734_100...


DSC01735_100...


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DSC01749_101...


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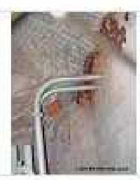
DSC01759_102...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DSC01775_102...


DSC01785_110...

Appendix 3. continued.


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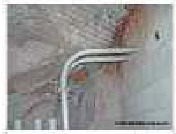
DSC01798_111...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DSC01812_1201.jpg


DSC01813_120...


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DSC01824_121...


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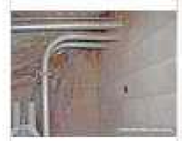
DSC01985_031...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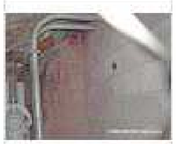
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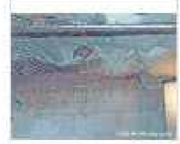
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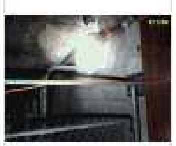
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