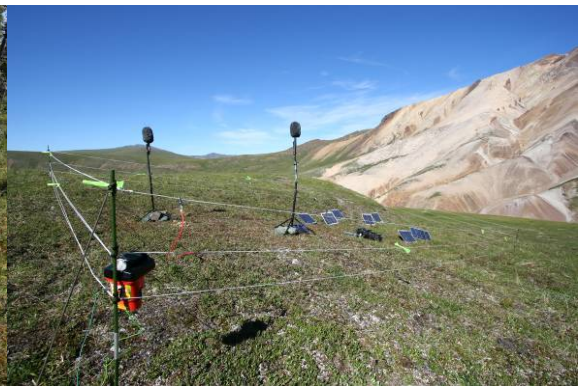
Denali National Park & Preserve

Soundscape Annual Report 2005

Boulder

Lower East Fork Toklat

McKinley Bar Trail



Upper East Fork Toklat

Toe of the Tokositna Glacier

Denali National Park & Preserve
Soundscape Annual Report 2005

December, 2005

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BACKGROUND

The ever-increasing human-generated sounds at Denali National Park and Preserve (Denali) have become an important resource issue because of their detrimental impact on the natural soundscape and visitor experience. The Denali Backcountry Management Plan (BCMP) has been revised and was opened for public comment during the summer 2005. In the BCMP, soundscape measurements have been identified as an important indicator of the level of human impact on park resources. Soundscape measurements are objective with methods that are easily reviewed by the public, which will provide strong support for future management decisions. Park planners have increasingly expressed a desire for more soundscape data so that they can make informed decisions about the sound level standards that will be set in the BCMP. Without these data the park will have little information to make management guidelines or support management decisions that may affect the quality of the Park's soundscape.

The initial push for Denali to begin soundscape inventories began with Director's Order 47 (DO-47). Robert Stanton issued the order in 2000 directing park managers to identify baseline soundscapes and related measures. DO-47 states that "natural sounds are intrinsic elements of the environment that are often associated with parks and park purposes…They are inherent components of 'the scenery and the natural and historic objects and the wild life' protected by the NPS Organic Act." DO-47 directed park managers to "(1) measure baseline acoustic conditions, (2) determine which existing or proposed human-made sounds are consistent with park purposes, (3) set acoustic management goals and objectives based on those purposes, and (4) determine which noise sources are impacting the park and need to be addressed by management." Furthermore, it requires park managers to "(1) evaluate and address self-generated noise, and (2) constructively engage with those responsible for other noise sources that impact parks to explore what can be done to better protect parks."

The primary purpose behind the Denali soundscape study has been to measure the level of influence overflight traffic and snowmachine traffic has on the Park's soundscape. Understanding the natural soundscape is important to evaluate the levels of impacts human-generated sounds may have on this important resource. Different habitats have specific soundscape characteristics that are an important attribute of the natural system, with distinct impacts on the human perception of the environment. The natural soundscape is generally comprised of two main sound categories, physical and biological. Physical sounds are created by physical forces (wind, rock fall, rivers, etc.), whereas biological sounds are created by organisms (birds, frogs, plants, etc.). The presence and abundance of sounds from these two categories is used to characterize different habitats. Impacts on the natural soundscape and on visitor experiences come from human-generated sounds.

Equipment used

Denali has been working closely with the National Park Service Soundscape Program Center developing soundscape monitoring techniques and applications. Automated acoustic data loggers, designed by Skip Ambrose at the NPS Natural

Soundscape Program Center, collect one-second decibel data as well as digital recordings using a systematic sampling scheme (5 seconds every 5 minutes), and 10 second recordings of sound events exceeding a user-defined threshold (usually 55dBA) and duration (usually 5seconds). Calibrated Type 1 Larson-Davis Model 824 sound level meters, Type 1 Larson-Davis PRM902 microphone preamplifiers, and Type 1 G.R.A.S. 40AE microphones, with windscreens, are used to collect 33 one-third octave band frequency (12.4-20,000Hz) sound pressure levels each second of the sampling period. Sound Monitor™ (Far North Aquatics, Fairbanks, Alaska) software, running on a Windows™ - based Panasonic™ CF-45 laptop computer, control and store the acoustical data. Each system collects CD quality digital recordings (44.1KHz, 16-bit) using an external sound card. The acoustic data loggers, contained within weatherproof containers, are powered by 12 volt battery and photovoltaic charging systems. The system can operate continuously for long periods, provided there is enough sunshine.

Specific methodologies and protocols for equipment type, microphone type, microphone placement and height, and other factors are described in the guidelines in the Draft Programatic Soundscape Management Plan (NPS, 2005). These protocols were developed following guidance of Ambrose and Burson (2004) and were based on American National Standard Institute S12.9 (1992), Federal Aviation Administration's "Draft Guidelines for the Measurement and Assessment of Low-level Ambient Noise" (Fleming et al. 1998), and "Methodology for the Measurement and Analysis of Aircraft Sound Levels within National Parks" (Dunholter et al. 1989).

The equipment used for monitoring the soundscape is shown in Figures 1 and 2. Detailed equipment lists used at each location sampled can be found in Appendix C. The equipment is described below:

- **Data Logger (Laptop).**
  - *Panasonic Toughbook* running *Windows 2000* or greater and using *SoundMonitor™* software developed by *Far North Aquatics*, Fairbanks, AK.
- **Sound Level Meter (SLM) and Microphone**
  - *Larson-Davis 824* Type 1 Sound Level Meter (SLM). Type 1 microphone and preamp with both a *Larson-Davis* foam and *Rycote* (fuzzy) windscreen.
- **High Quality Digital Sound Card and Omnidirectional Microphone**
  - *M-Audio MobilePre* USB powered external sound card with 48V Phantom microphone power for a *Sennheiser ME 62* omnidirectional microphone or, *G.R.A.S. 40AE* Type 1 omnidirectional microphone with *G.R.A.S. 26CA* Pre-amp.
- **Power Supply**
  - At the high latitudes of Denali with the system currently used (1.0 Amps), a minimum of 160 Watts of solar panels are necessary for summertime applications. Wintertime applications require up to 2000Watts of solar panels.
  - 140 Amp hours worth of deep cycle batteries are generally sufficient for retaining enough power during summertime applications. The battery power must be ample enough to last between solar charges that may be insufficient for weeks at a time due to cloud cover.

The equipment is secured in a way that there is no self-induced noise (e.g., from loose wires). The equipment is protected from animal mischief through the use of conduit, strong containers for the digital equipment, and in some cases, using an electric fence. The Draft Programmatic Soundscape Management Plan (NPS, 2005) has extensive protocol instructions that were developed by the National Park Service Soundscapes Program Center for using the equipment and measuring sound in national parks.

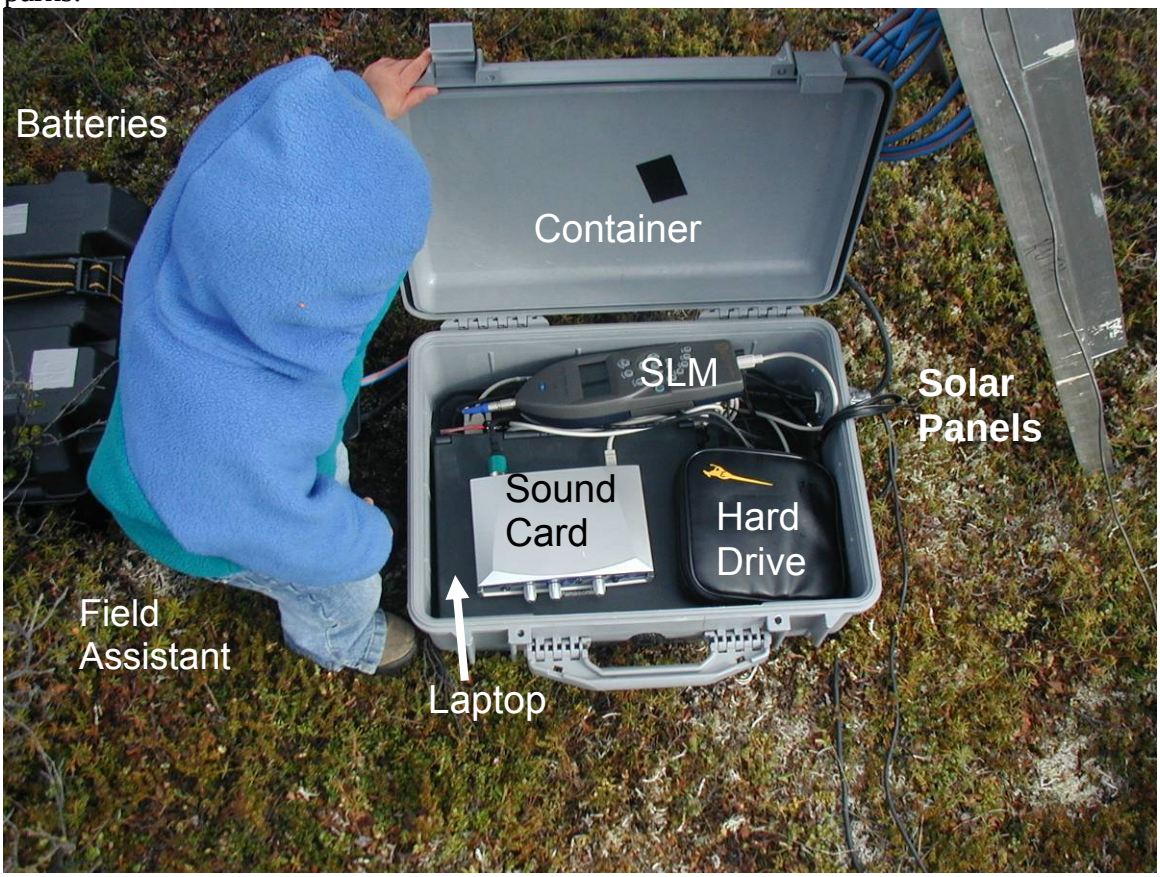

Figure 1. Photograph of the inner workings of a sound station. Sound stations run off solar panels and batteries. They contain a laptop, external sound card, external hard drive, and a sound level meter, which are all contained in a *Pelican* Case.

Figure 2. Photograph of the microphones used for audio recordings and measuring sound pressure levels.

Data collected

Two types of data are collected at a sound station: audio recordings and sound pressure levels. Two types of audio recordings are made; one type at user defined time intervals and the other triggered at user defined sound levels. Sound pressure levels are taken every second. The data collected are:

- **Events** - audio recordings that are triggered by loud sounds at user defined exceedance levels. The user defined exceedance levels traditionally used at Denali have been sounds greater than 55dBA for 5 or 10 seconds and 90dBA for one second. An audio recording of an event is made during the event for 5 seconds before and after the event.
- **Audibility Audio Recordings** - made at user-defined intervals. Traditionally, at Denali, audio clips recorded for 5 seconds every 5 minutes have been sufficient for identifying sound sources. This data is used to calculate the percent time and number of times sound sources are audible throughout the day.
- **Sound Levels** - taken every second. Recorded are the overall A-weighted Leq, and the Flat Weighted Leq of each third octave. Leq is the energy equivalent sound level, which is the level of a constant sound over a specific time period that has the same sound energy as the actual (unsteady) sound over the same period. The A-weighted sound pressure level (dBA) is weighted based on limits of human hearing.

2005 SUMMARY

The primary focuses for 2005 were to collect data for supporting the development and implementation of the BCMP and to develop a sampling plan that will take the program through to 2008 and beyond. The station locations up to 2004 were selected primarily for support of specific projects with specific focus areas. Outside entities and Denali managers recognized the importance of implementing a statistically supportable sampling plan throughout the entire park. Through collaboration with Western EcoSystems Technologies Inc. a random sampling plan for the entire park has been developed.

2005 Sound Station locations

The focus of the soundscape study in 2005 was divided between two priorities; to collect data from the Old Park for support of the BCMP and to collect data from the Toklat Basin. Five locations were sampled during 2005, which increases the total number of locations sampled to 18 (Figure 3). The following is a summary of the station data collection successes and issues.

The time period sound stations were in place during 2005 and the amount of usable data collected are shown in Figure 4. There were five stations placed during the 2005 field season:

McBAR - located along the McKinley Bar Trail;
UEFK - located in the Upper East Fork River Valley 4mi south of Sable Pass;
LEFK - located along the East Fork River north of the Lower East Fork Cabin;
TOKO - located at the toe of the Tokositna Glacier;
BLDR - located along the foothills between the Bull and Cantwell Rivers.

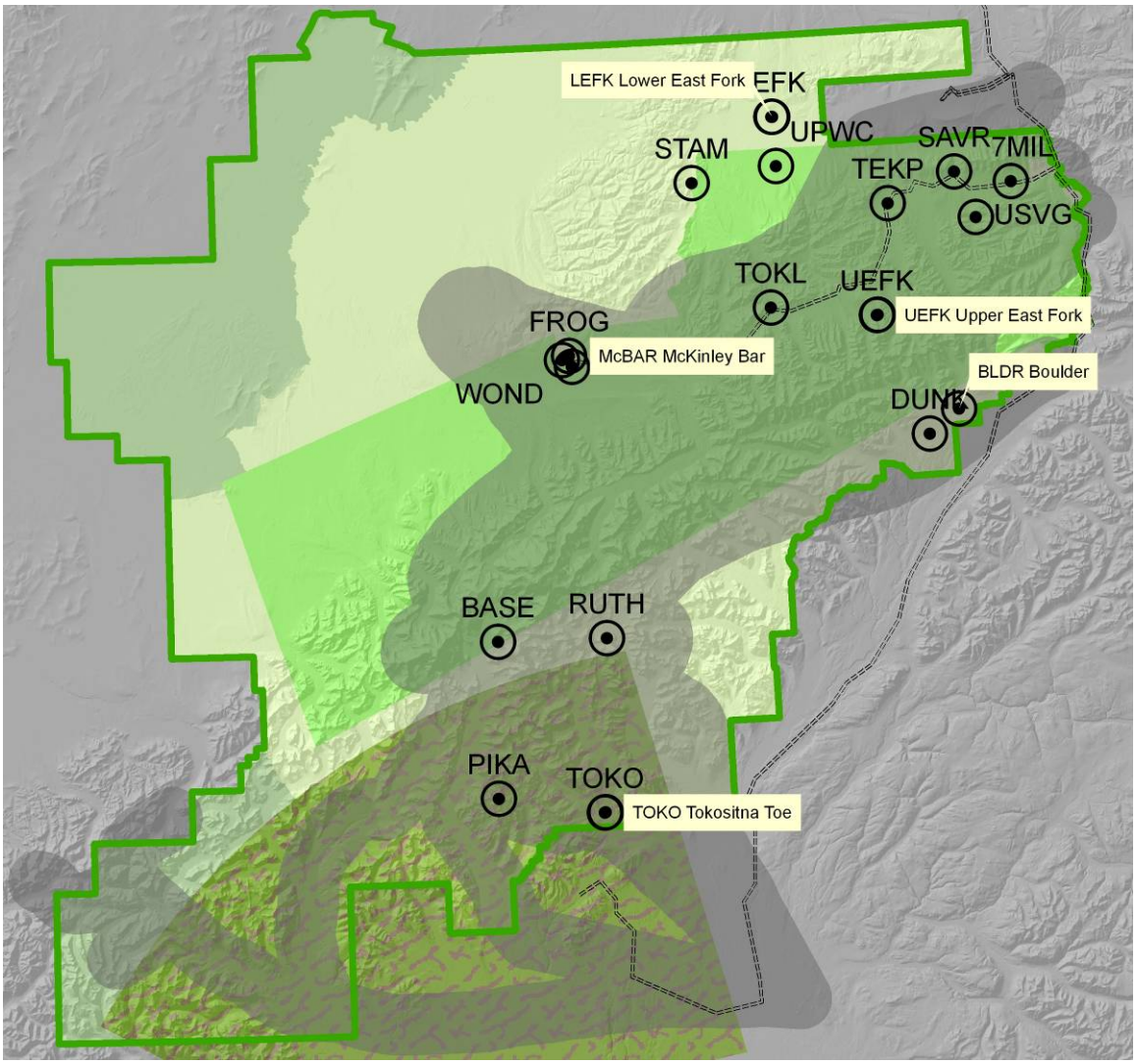

Figure 3. Map showing the sound station locations placed from 2001-2005. 2005 sound station locations are indicated by the yellow callouts. Common flightseeing paths footprints are shaded in grey. The Military Operating Area is shown in Camouflage.

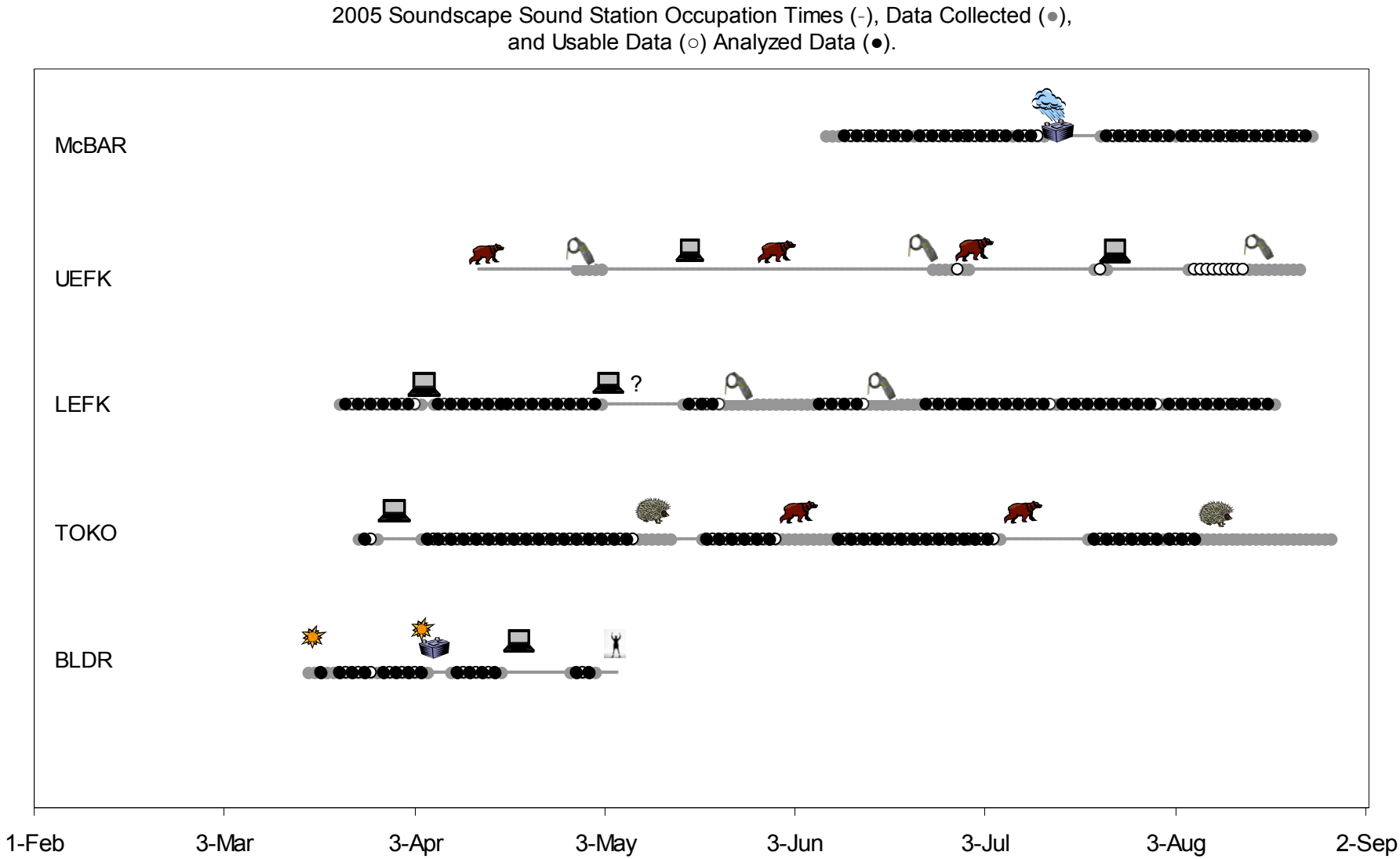

Figure 4. Chart showing the 2005 sound station occupation times, data collected, and usable data analyzed (for station locations refer to map in Figure 3). Small characters indicate reasons for loss of data. Characters are: bear attack; porcupine attack; computer malfunction; with battery overcast weather; sound level meter malfunction; sun with battery overloaded solar controllers; human error.

2005 Data Collection and Analysis

Many malfunctions caused disruptions in data collection. The types of malfunctions are represented by characters in Figure 4. The types of malfunctions included bear attacks, porcupine attacks, computer malfunctions, sound level meter malfunctions, and weather related malfunctions. For the 2005 field season the proportion of usable data (293days) to the number of days each station was located and available to collect data (569days) was 51.5%. Though this number is low, it is greater than the 2004 proportion which was 30%. The strongest influence driving down the success rate was the UEFK location (Fig. 3) where bear problems were frequent. The second most influential cause of disruption was multiple incidences of sound level meter malfunctions. As a solution, a portable electric fence manufactured by UDAP™ was installed around the station in August. The sound level meter problem is a mystery but tests will be done before the 2006 season to discover the cause. The cause may be either a glitch in the sound level meter firmware, a glitch in the communication commands sent by the Sound Monitor software, or a power failure. To solve two of the problems the firmware will be re-installed, and batteries will always be kept in the sound level meter. A computer software problem is trickier to figure out. Details of the successes, failures, and brief summaries of the data collected for each station follow.

The purpose of the McBAR location (Fig. 3) was to collect data from within the boreal forest acoustical zone. The location was selected as part of a draft stratified sampling plan randomly selecting stratified long-term ecological monitoring (LTEM) grid points. LTEM grid point #142 was stratified as a hikable boreal forest location and randomly selected from all hikable boreal forest locations.

The only problem incurred at the McBAR location was a period of overcast weather during mid-July (Fig. 4). The problem could have been remedied by using more solar panels so at sites where weight is not a factor more solar panels will be deployed. We are continuing the search for a a lower power unit.

Wind, birds, and insects, in descending order, dominated the soundscape at the McBAR location. The number of motorized sounds heard per day averaged from 10 in June to 30 in August, gradually increasing throughout the summer (see Appendix E). Some or most of the wind sounds may have been the McKinley River, but during site visits the river was never heard. The dull roar heard throughout all the recordings was most likely the wind through the trees. Most if not all the unidentified motorized sounds were vehicles on the park road. Some days the weather was just right so that the motorized sounds were very clear. In addition, some days a park-operated backhoe could be heard operating on the park road.

The purpose of the UEFK location (Fig. 3) was to collect data from within the Old Park away from the road and under the popular north side scenic flight paths. The location was chosen from the hikable LTEM grid points (#156) but not randomly selected. The location was attempted during the 2004 season but was only successful

during late August and September of that year. The site was attempted again to capture the busy June-July tourist season but with no success.

The problems incurred at the UEFK location were primarily from computer and sound level meter malfunctions and bear troubles. As seen in Figure 4, there were five incidences of computer or sound level meter malfunctions and three bear events. Most of the data collection time lost was due to bears chewing on microphones, because there was a time when there was no available spare to replace the destroyed microphone. The microphone had to be sent in for repairs, which took three weeks. A portable electric fence was purchased to solve the problem. The three sound level meter malfunctions are a mystery but may be related to firmware or power failures, which will be fixed by re-installing the firmware and placing batteries in the sound level meters. The first computer malfunction was caused by a hardrive failure and the second is unknown. Since the only usable data was collected for a week during August and this period was captured during the 2004 season, the data was not analyzed.

The purpose of the LEFK location (Fig. 3) was to collect data from the Toklat Basin at an LTEM grid point. The site was established during the 2004 season but had no success until September. The station was started in March in order to capture snowmachine traffic.

The problems incurred at the LEFK location during the 2004 season were primarily due to a bad battery. The station was successful during September 2004 but the data was not collected until the first visit in Spring 2005 (Fig. 4). The station incurred two computer malfunctions and two sound level meter malfunctions (Fig. 4). Both types of malfunctions are a mystery but the sound level meter problem may be related to firmware or power glitches so the firmware will be replaced and batteries will be kept in the sound level meters.

Wind, rain, bugs, and birds, in descending order, dominated the soundscape at the LEFK location (see Appendix E). The number of motorized sounds heard per day at the LEFK location ranged from 2-20 with the highest portion caused by prop planes with a nearly even but lesser proportion being jets. The only snowmachine traffic captured was on 03/23/2005, which was me checking the station to see if it was running the day after it was started.

The purpose of the TOKO location (Fig. 3) was to measure the late winter through summer soundscape south of the Alaska Range. The specific site was chosen because it is located at a small airstrip and is a corridor for both snowmachine and flightseeing traffic. The site was sampled during mid-July to the end of August 2001. The 2001 recordings were set at such a high gain that it was not possible to tell if wind or river noise was causing a constant roar in the 2001 audio recordings (Hults, 2004). Planners also wanted baseline data for the level of snowmachine use in the area to compare with future levels that could be potentially impacted by southside development scenarios.

The problems incurred at the TOKO location were primarily caused by porcupine and bear attacks with, surprisingly, only one computer malfunction (see Figure 4). A porcupine was heard chewing on the Pelican case from May 20 - May 30. The porcupine(s) chewed completely through the Pelican case (Fig. 5). Most likely, the porcupine chewed through a microphone cord on May 9 and August 8 (Fig. 4). To keep critters away from the station mothballs were placed in the Pelican case, around the Pelican case, and in the microphone covers. This method kept critters from chewing the pelican case and bears from molesting the station but did not keep a critter from chewing through another microphone cable. Mothballs are not recommended because working with the equipment later in the office is not conducive to positive working relationships with fellow office mates. A portable electric fence manufactured by UDAP™ is preferable for future installations in critter country.

The soundscape at the TOKO location was dominated by the Tokositna River, Birds, Rain, and aircraft overflights (see Appendix E). The dominate sound sources were wind and rain during March and April, but after the Tokositna River broke up, sometime during April 20 or 21, then the river sounds drowned out the wind. Rain events combined with the constant river sound caused very high numbers of physical sounds throughout the summer. During the spring (March-April) the number of motorized sounds heard per day ranged from 4-38, with the relative proportions declining from prop planes, snowmachines, to jets. During the summer, the number of motorized sounds heard per day consistently ranged from 5-65, with a higher proportion prop planes and a lesser proportion jets.

Figure 5. Toe of the Tokositna site (TOKO) Pelican case that was completely chewed through most likely by a porcupine and later molested by a bear.

The purpose of the BLDR location (Fig. 3) was to measure late winter sound levels in an area with frequent visitor use. The specific site was chosen because it is a popular snowmachine use area.

The problems incurred at the BLDR location were primarily due to too much sunshine overloading the solar controller (i.e. the solar controller chosen could not handle the number of amps produced by the solar panels with the combined sun and snow reflection). The initial result of this problem produced a buzz in the audio recordings. The solar controller was replaced and a couple solar panels were removed. The buzz stopped due to this action. The computer malfunctioned once for no known reason. The batteries were wired incorrectly once, which caused the station to run off of onlyone battery, so during cloudy weather the station died on May 2.

The soundscape at the BLDR location was dominated by motorized sounds and secondly by wind (see Appendix E). This was the first site measured that was dominated by motorized sounds, which is a result of it being within line of site of the Parks Highway and within a popular sowmachine area. The sounds identified as “unknown motorized” were most likely all vehicle traffic along the highway. The sounds of road traffic were so faint that a positive identification could not be made. The train, which is slightly farther from the site than the highway, was also audible at this site. Snowmachine traffic was heard during nine of the fourteen days analyzed. The number of recording clips per day that snowmachines were audible ranged from 10-60.

PLANS FOR FUTURE STUDY: SAMPLING PLAN

The soundscape program has secured funding for 2006 through 2008 from the Concessions Franchise Fee program (PMIS 110798) and a Regional Natural Resources Grant (PMIS 110731). The following abstract from the Regional Natural Resources Grant proposal states clearly the focus of the next three years of study:

Understanding baseline soundscape conditions using statistically valid sample schemes and techniques are a necessity for properly characterizing the soundscape of Denali and for abiding by Alaska National Interest Lands Conservation Act (ANILCA) requirements (Gibert, 2004). We propose to complete a stratified random sampling plan, based on acoustical zones and management zones, randomly sampling grid points of the Long Term Ecological Monitoring (LTEM) park-wide systematic grid. Although Denali has been working on three smaller soundscape studies over the last three years, the primary purpose of these studies was to inventory targeted areas for impact levels of motorized vehicles. Sampling locations selected thus far were selected based strictly on specific project needs and cost of access. Although this data may be used as an initial measure of these targeted areas, by statistical design, the data cannot accurately be extrapolated over the entire area of Denali.

With the assistance of Trent McDonald, a statistician from Western EcoSystems Technology Inc., a sampling plan has been worked out through the 2005 season to get a leg up on the 2006 field season. The sampling plan went through many stages of complexity of stratification but came back around to a very simple plan.

The first step in designing a sampling plan is to identify the driving factors. The primary driving factor behind the sampling plan design is to quantify the motorized sounds and compare these motorized sounds to the natural soundscape. A second driving factor considered was the benefit that the audio recordings taken at each location could be analyzed for identification of birdcalls (Daw and Ambrose, 2003). With this in mind, the soundscape sampling design could include co-locating sound stations where traditional bird counts are made. Since the bird crew and vegetation crews are utilizing the LTEM grid, to standardize long-term monitoring projects in the park, it was decided that the soundscape sampling plan would also utilize the LTEM grid as the basis of the sampling plan. The third driving factor behind the sampling plan design is the total number of stations that a single soundscape program manager can maintain during a summer field season. After considering the last five years of experience, the maximum estimated number of stations one person can maintain is five stations (one more than the current number of four stations). The fourth driving factor behind the sampling plan design is the return cycle for a long-term monitoring plan. The vegetation and bird sampling plans are both on a ten-year cycle, which seems applicable for a soundscape sampling plan.

After identifying the driving factors behind the sampling plan design a level of practicality and efficiency had to be devised. Through discussions with the CAKN managers during the soundscape scoping meeting held on November, 29 2004, the consensus was that the sampling plan would be most efficient and best extractable if it

was stratified. The first drafts of the sampling plan stratified the LTEM grid points into four strata:

1. Acoustical zone
    a. Boreal Forest
    b. Alpine Tundra/Scrub
    c. Non-Vegetated/Alpine
    d. Riparian
2. BCMP Zones
    a. High
    b. Medium
    c. Low
3. Within / Outside the footprint of common flightseeing routes (see Fig. 6) and the SW Military Operation Area.
4. Hikable / Non-hikable

After developing a complex stratified sampling plan Trent McDonald suggested it was not necessary. What we noticed when we simply looked at the spatial extent of each of the strata was that their components were nearly equal in area. For example, there are 121 LTEM grid points that fall within the footprint of common flightseeng routes and the SW Military Operation Area, whereas114 LTEM grid points fall outside the footprint. Since the LTEM grid points are divided nearly 50/50 it makes no sense to stratify the points by the flight footprint. The same pattern exists when the acoustical zone stratification is made and when the BCMP zones are applied. In the end, a coarse grid was agreed upon that would provide the most statistically robust and spatially diverse sampling plan.

The final sampling plan is designed using a coarse grid made up of the LTEM grid. The number of points in the coarse grid is driven by the number of stations available per year (5) and the length of time each station should be established at each location. To properly characterize the natural soundscape, stations should be established throughout the entire field/tourist season from July to the end of August (one station may be established during the winter months during some years and the shoulder seasons will be attempted at limited locations). To maximize the spatial coverage with only five stations we decided it was best to sample four locations through the entire field season and rotate the fifth station through three locations, one month each. Two of the month-long stations would be established for the coarse sampling grid with one month free to allow management to choose a desired/imperative location. In the end, during each year there will be six locations sampled of a coarse sampling grid. For a ten year return cycle that means there are sixty locations to be sampled. A coarse grid of 60 points was made up of the LTEM grid (Figure 6).

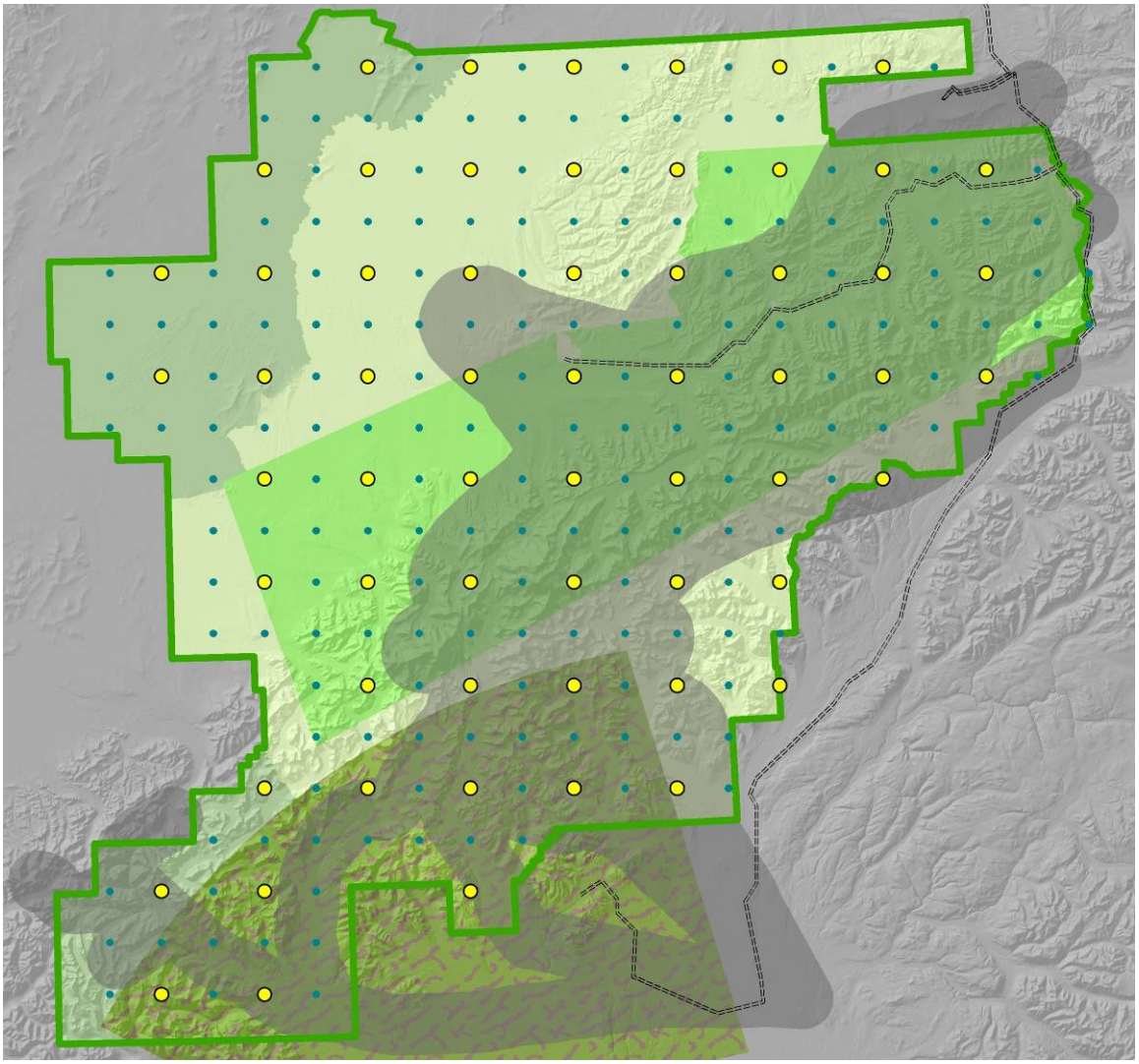

Figure 6. Map showing the coarse grid of sixty points to be sampled. The coarse grid was made up from the finer LTEM grid. Also shown in the map is the footprint of the common flight seeing paths (grey) and the SW military operation area (camouflage).

The final step was to select which six sites would be sampled each year. To keep each year spatially spread out a systematic selection was chosen over a pure random selection (which results in clustering during some years). The technique used is similar to choosing players for ten hokey teams from a group of children. Having the children count off from one to ten starting from one corner. A similar technique was done by labeling the coarse grid from one to ten starting at the SE corner in order of the numbering system of the LTEM grid points. The first round resulted in diagonal lines of nearby points selected for each year, which is a poor spatial arrangement. The count off was done again from the new list of points. All the points were sorted by year then re-numbered one to ten. The result was a satisfactory spatial arrangement for each year. Figure seven shows the coarse grid of sixty points labeled by year to be sampled starting in 2006. Note that for each year the points are spread out spatially. One other important note is that nearly every year has a location that is hikable, which originally was the most

limiting stratifying category. With this systematic sample design the soundscape of the park can be adequately represented with a statistically sound sampling plan.

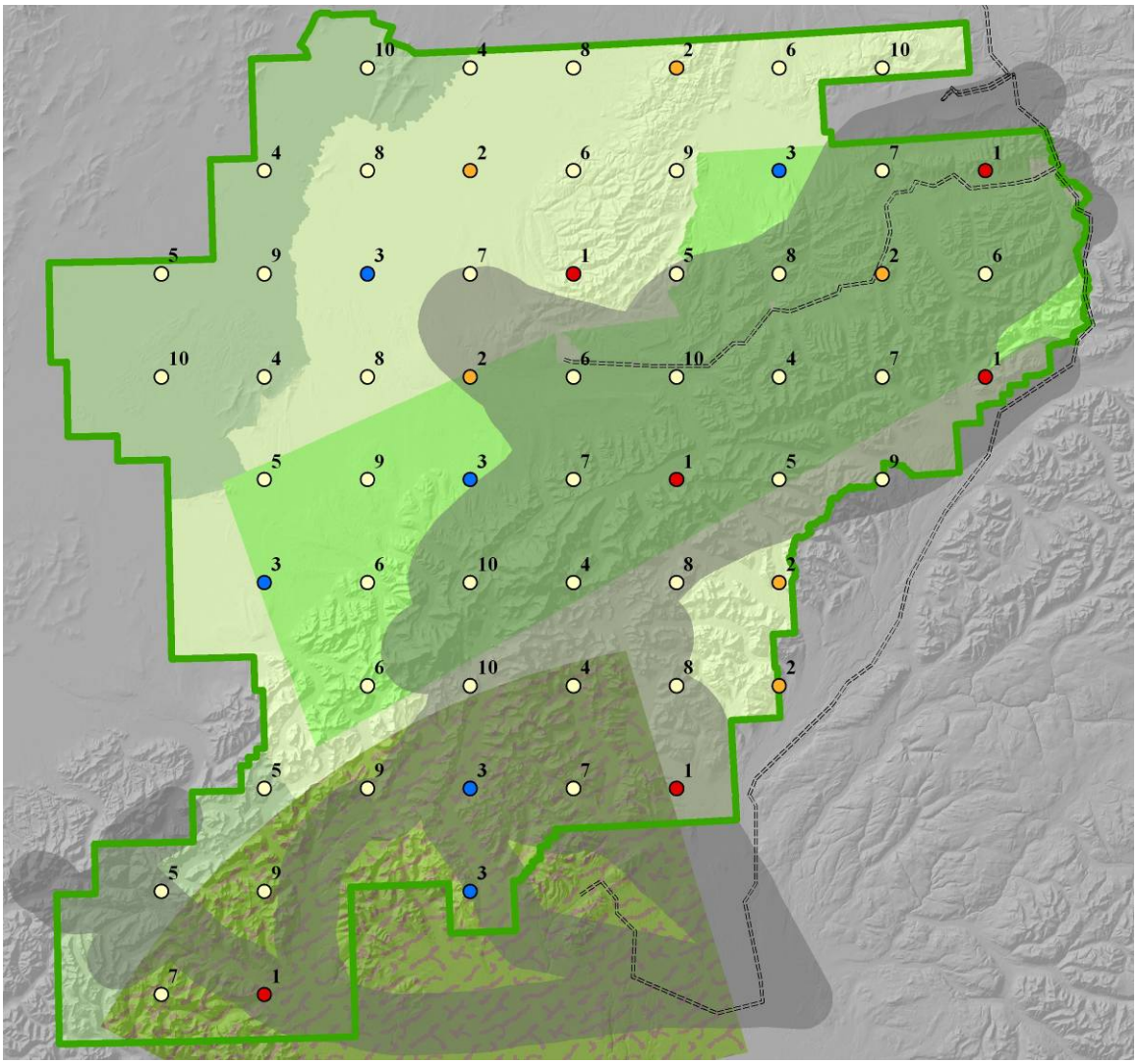

Figure 7. Map showing the coarse grid of sixty points to be sampled labeled by the year to be sampled (starting year 1 in 2006). Also shown in the map is the footprint of the common flight seeing paths (grey) and the SW military operation area (camouflage).

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APPENDIX A: Funding and Personnel

The Soundscape study for 2005 was funded out of the base Denali operating budget. The soundscape program has secured funding for 2006 through 2008 from the Franchise Fee Demo program and a Regional Resources Block Grant. These funds will be used to continue inventorying the soundscape in Denali by implementing a random sampling plan.

Personnel

- $48441.29 Soundscape Program Manager: Chad Hults GS-9 Term with 3Mo Furlough
- $1977.60 Larissa Yocum – analyzed data from sites with snowmachines.

Aviation

- $4628.64 Helicopter and Fixed-wing

Supplies

- $12519.19

CAKN Soundscape Scoping Meeting

- $1125.00 Cross and Associates Meeting Facilitator
- $2500.00 Wyle Labs Chris Hobbs Sound Engineer
- $2808.82 Travel for WRST Folks and Shan Burson
- $635.03 Supplies/Conference Room

APPENDIX B: Publications, Presentations, and Trainings

Permits

- DENA-2001-SCI-0026 "Soundscape Study of Denali National Park and Preserve." Valid April 16, 2001 to December, 31, 2008.

Education/Presentations/Public Outreach (by Chad Hults)

- 05/11/2005 Presented “Soundscape Monitoring in Alaskan National Parks” to the Wrangell St Elias National Park and Preserve staff.
- 05/25/2005 Presented “Soundscape Monitoring in Alaskan National Parks” to a UAF natural resource management field class.
- 06/22 and 06/24/2005 Introduced soundscapes to kids of the Denali Discovery Field Camp.
- 07/20/2005 Southside Denali Discovery Field Camp.

Reports

- 2005 Annual Report
- Introduction to Soundscape Monitoring in Alaskan National Parks
- Denali Soundscape Study Fact Sheet
- Alaska Park Science Denali Issue (projected for spring 2006) Denali Soundscape Article

Training (Chad Hults)

- B3 online refresher
- GIS training presented by AKRO
- GIS online-training through ESRI Virtual Campus

APPENDIX C: Equipment Lists

Station Location	**Equipment List (see below)**
<u>2005</u>	
McBAR	Ps
UEFK	Pg
LEFK	Ks, Kg
TOKO	Ps
BLDR	Ps

Equipment List K (Audio through a *Sennheiser* mic and *MoblilePre* soundcard)

K = Knaack Box 2032 **s = Sennheiser mic, g = G.R.A.S Mic**

#/Station Item

- 2-5 *Kyocera* 85W Solar Panels
- 0-2 *Kyocera* 35W Solar Panels
- 1-4 Angle Aluminum Solar Panel Frames
- 3-5 Batteries 100Ah Gel Cell
- 1 30A *Trace Engineering* Solar Controller
- 1 Laptop (*Panasonic Toughbook CF-45*) with 40Gb HD and Win XP, 192Mb RAM.
- 2 *Bogen* Tripods (Microphone Stands)
- 6 Microphone Stand Anchor Screws
- 1 Lock *MasterLock*

Larson-Davis SLM:

- 1 *Larson Davis 824* SLM
- 1 *Larson Davis PRM 902* Type 1 mic Pre-amp
- 1 *G.R.A.S. 40AE* Type 1 microphone
- 1 *Larson Davis* Microphone Cable 25'
- 1 *Larson Davis* Environmental Kit (mic tube, foam windscreen, bird spike)
- 1 *Rycote Windjammer* "Fuzzy" Windscreen
- 1 *Larson Davis* SLM to Computer Serial Cable
- 1 Desiccants

Audibility Recordings:

- 1 External *MobilePre* Soundcard

  Setup g
  - 1 G.*R.A.S. 26CA* Pre-amp
  - 1 *G.R.A.S. 40AE* Microphone
  - 1 BNC Cable *Belden* (25')
  - 1 BNC Female-XLR female connector

  Setup s:
  - 1 *Sennheiser K6P* Power Module

- 1 *Sennheiser ME62* Microphone Capsule
- 1 XLR Cable (25')

- 1 Home Rigged Environmental Kit (PVC mic tube, cloths hanger bird spike, duct seal)
- 1 *Larson Davis* Foam Windscreen
- 1 *Rycote Windjammer* "Fuzzy" Windscreen

Equipment List P (Audio through a *Sennheiser* mic and *MoblilePre* soundcard)

P = Pelican Case 1520 **s = Sennheiser mic, g = G.R.A.S Mic**

#/Station Item

- Solar Panel setups
  - McBAR, BLDR – 8 *Solarex MSX Lite* 20W
    - 4 - 6'x1 ½"x1/8" aluminum angles, 4 – 6'x1"x1/8" aluminum angles, 2-4'x1"x1/8" aluminum angles
  - UEFK – 6 *Solarex MSX Lite* 20W, 1 Kyocera 35W
    - 16 Tent Stakes for Solar Panels
    - 16 Aluminum Rods to raise top edge of Solar Panels (1/4" x 18")
  - TOKO – 2 Solarex 50W, 2 Solarex MSX Lite 20W
    Changed To, 3 Kyocera 35W, 2 Solarex MSX Lite 20W
    - 4- 6'x1 ½"x1/8" aluminum angles, 2 - 34"x1"x1/8" angle aluminum angles
- 4 Batteries 35Ah (TOKO – 2 100Ah)
- 1 10A *Sun Saver* 10 Solar Controller
- 1 Laptop (*Panasonic Toughbook CF-45*) with 40Gb HD and Win XP, 192Mb RAM.
- 1 Duct Seal for microphone cables
- UEFK
  - 2 - *Bogen 3372* Light Stands (Microphone Stands)
  - 6 - Microphone Stand Mesh bags for Weight
- McBAR, BLDR, LEFK, TOKO
  - 2 - *Bogen* Tripods (Microphone Stands)
  - 6 - Microphone Stand Anchor Screws
- 1 *Pelican Case* 1520
- 1 Lock (P-1 from B&U)

Larson-Davis SLM:

- 1 *Larson Davis 824* SLM
- 1 *Larson Davis PRM 902* Type 1 mic Pre-amp
- 1 *G.R.A.S. 40AE* Type 1 microphone
- 1 *Larson Davis* Microphone Cable 25'
- 1 *Larson Davis* Environmental Kit (mic tube, foam windscreen, bird spike, duct seal, straw)
- 1 *Rycote Windjammer* "Fuzzy" Windscreen
- 1 *Larson Davis* SLM to Computer Serial Cable

- 1 Desiccants

Audibility Recordings:

- 1 External *MobilePre* Soundcard
- 1 Home Rigged Environmental Kit (PVC mic tube, cloths hanger bird spike, duct seal)
- 1 *Larson Davis* Foam Windscreen
- 1 *Rycote Windjammer* "Fuzzy" Windscreen

  Setup g
  - 1 G.*R.A.S. 26CA* Pre-amp
  - 1 *G.R.A.S. 40AE* Microphone
  - 1 BNC Cable *Belden* (25')
  - 1 BNC Female-XLR female connector

  Setup s:
  - 1 *Sennheiser K6P* Power Module
  - 1 *Sennheiser ME62* Microphone Capsule
  - 1 XLR Cable (25')

APPENDIX D: Percent Exceedence (L_x)

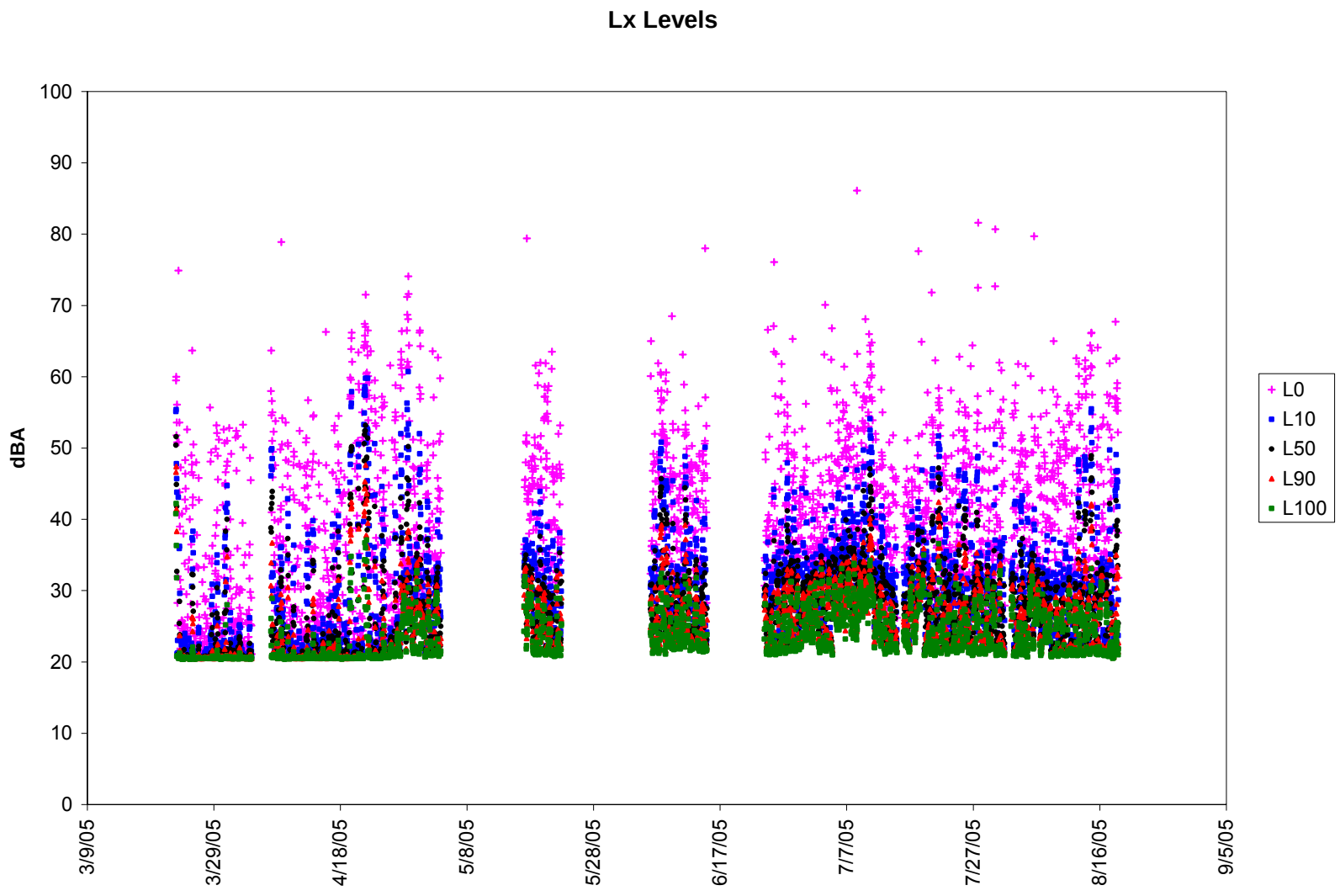
The charts on the following pages represent the Percent Exceedence levels (Lx, see definition below) for all locations sampled during the 2005 season. Percent exceedence levels are calculated for each hour. Each point on the charts is a percent exceedence level calculated for one hour. The first chart for each location shows percent exceedence levels of L_{100}, L_{90}, L_{50}, L_{10}, and L_0. L_{100} is the minimum sound level measured during the hour and the L_0 is the maximum sound level measured during the hour. The second – fourth charts show the L_{10}, L_{50}, and L_{90} values respectively.

Percent Exceedence (L_X)

These metrics are the sound levels (L), in decibels, exceeded x percent of the time. The L50 value represents the sound level exceed 50 percent of the measurement period. L50 is the same as the median. The L90 value represents the sound level exceeded 90 percent of the time during the measurement period. For natural ambient environments, these levels generally differ by less than 3 to 5 dB because natural levels usually do not vary much over short periods of time (e.g., during an hour or two, unless there are highly variable conditions). L50 and L90 are useful measures of the natural sounds because in wildland situations, away from developed areas, they are less likely to be affected by non-natural sounds. Put another way, non-natural sounds in many wildland areas are likely to affect the measured sound levels for less than 50% of the time, and almost certainly for less than 90% of the time. L50 is used when there is high certainty that no non-natural sounds affect the measurements. L90 is used when non-natural occur during measurements.

Adapted from: Ambrose, S., Donaldson, M. (In Press). Sound Levels In and Near the YUKON Military Operations Areas, Alaska, 1999-2003 (Draft). NPS Internal Report, 78pp.

The data for the charts below were compiled using a new macro developed in December 2005 by Chad Hults. The macro was created using Visual Basic for Applications in Excel. The macro grabs the L_X values L_{100}, L_{90}, L_{50}, L_{10}, L_0 from the SPL*.xls files created by the ConvertSPLtoXLS macro that was created in 2004, which is contained in the SPL Macr.xls file. There is a ReadMe file for all the macros created within the folder containing the macros.


Lx Levels
dBA
100
90
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
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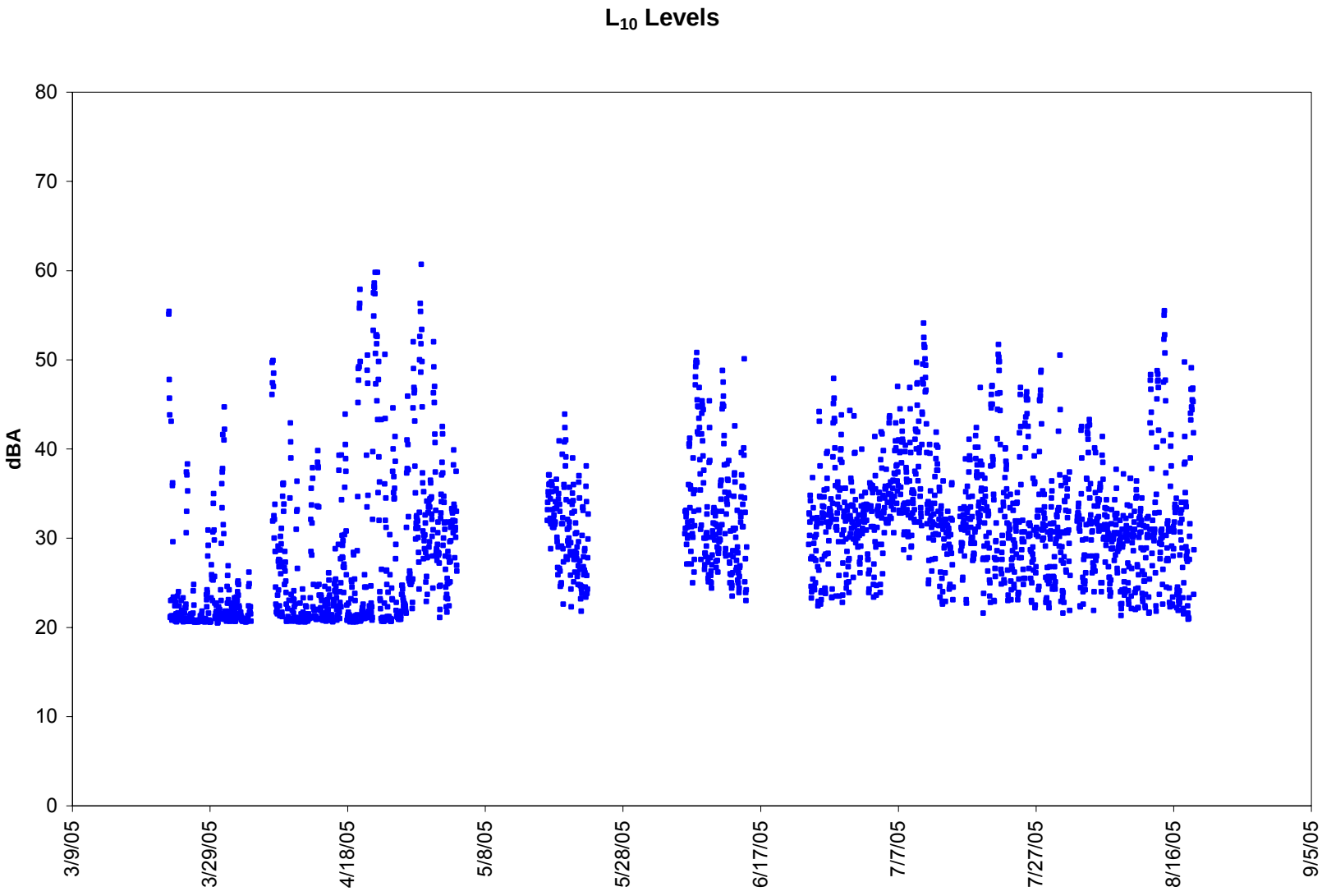
9/5/05
L0
L10
L50
L90
L100


L_{10} Levels
dBA
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
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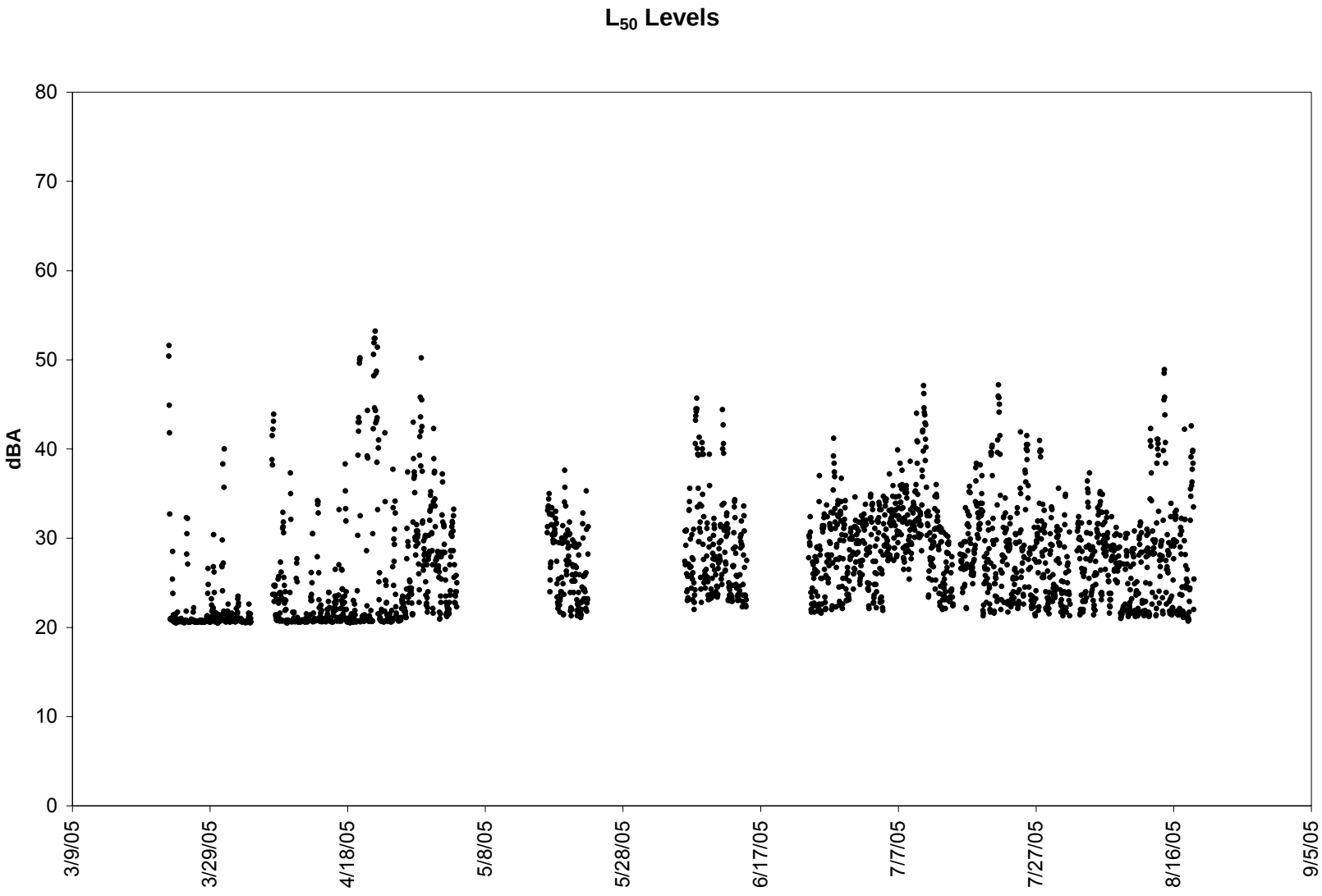
7/27/05
8/16/05
9/5/05


L50 Levels
dBA
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
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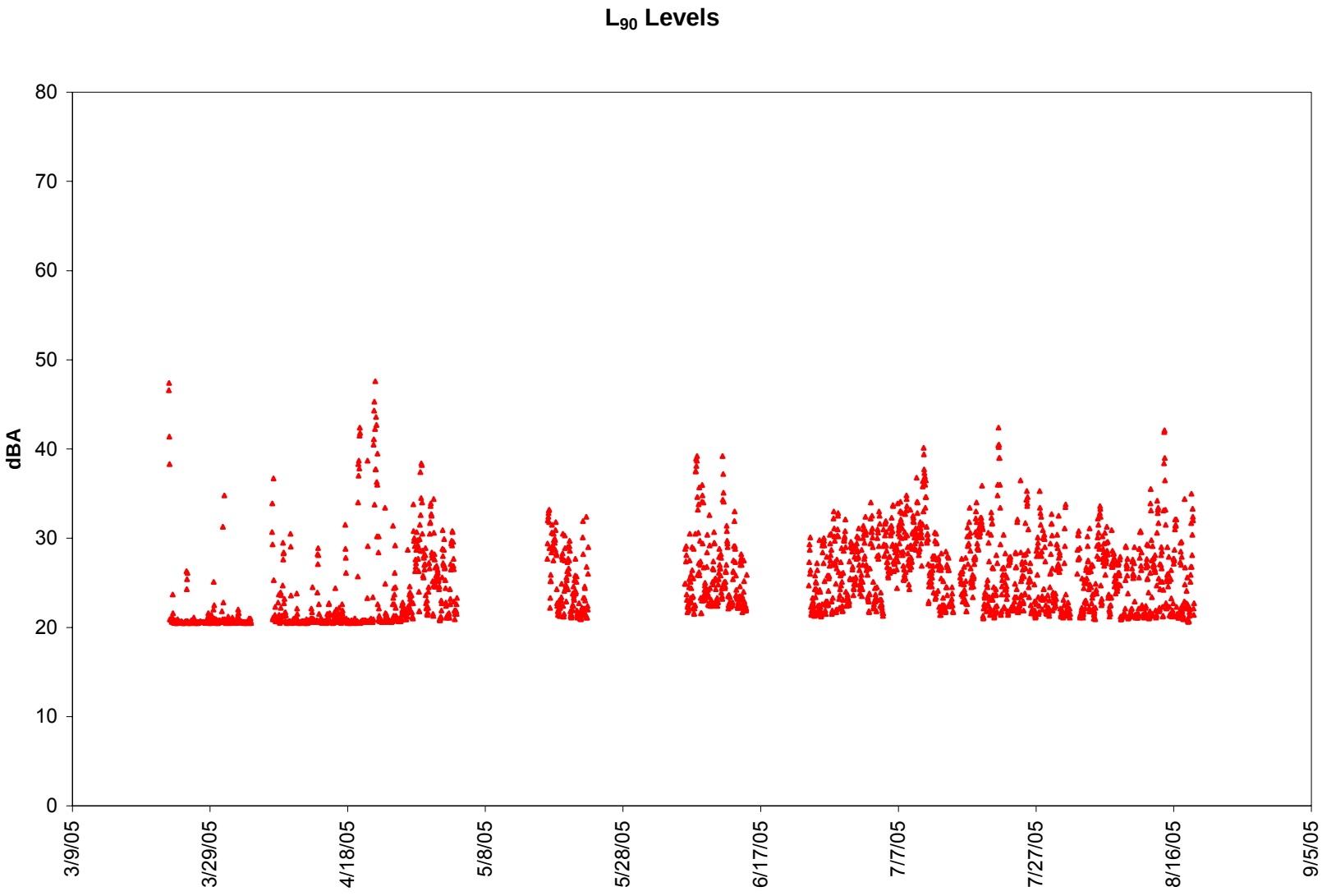
7/27/05
8/16/05
9/5/05


L90 Levels
dBA
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
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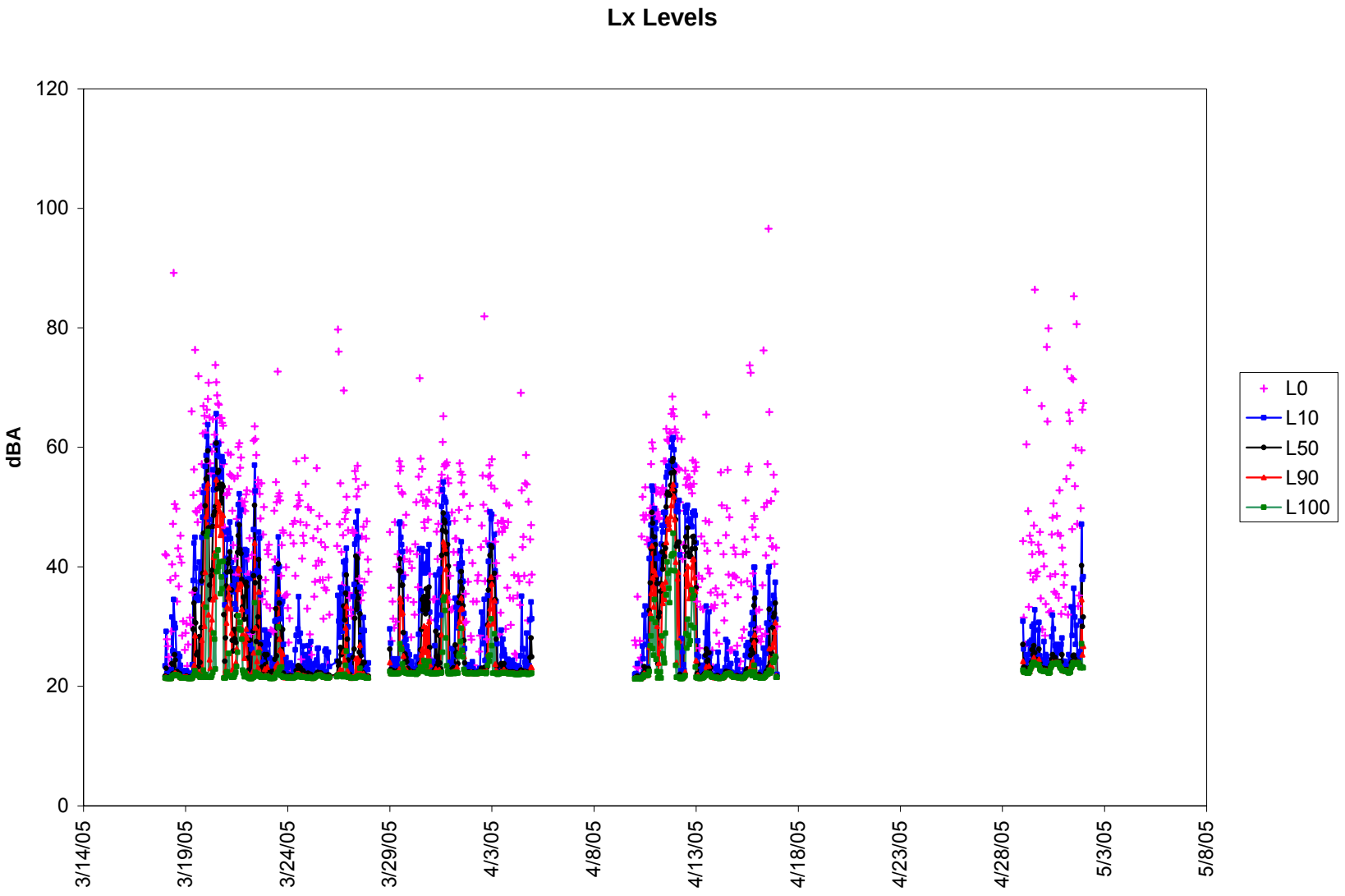
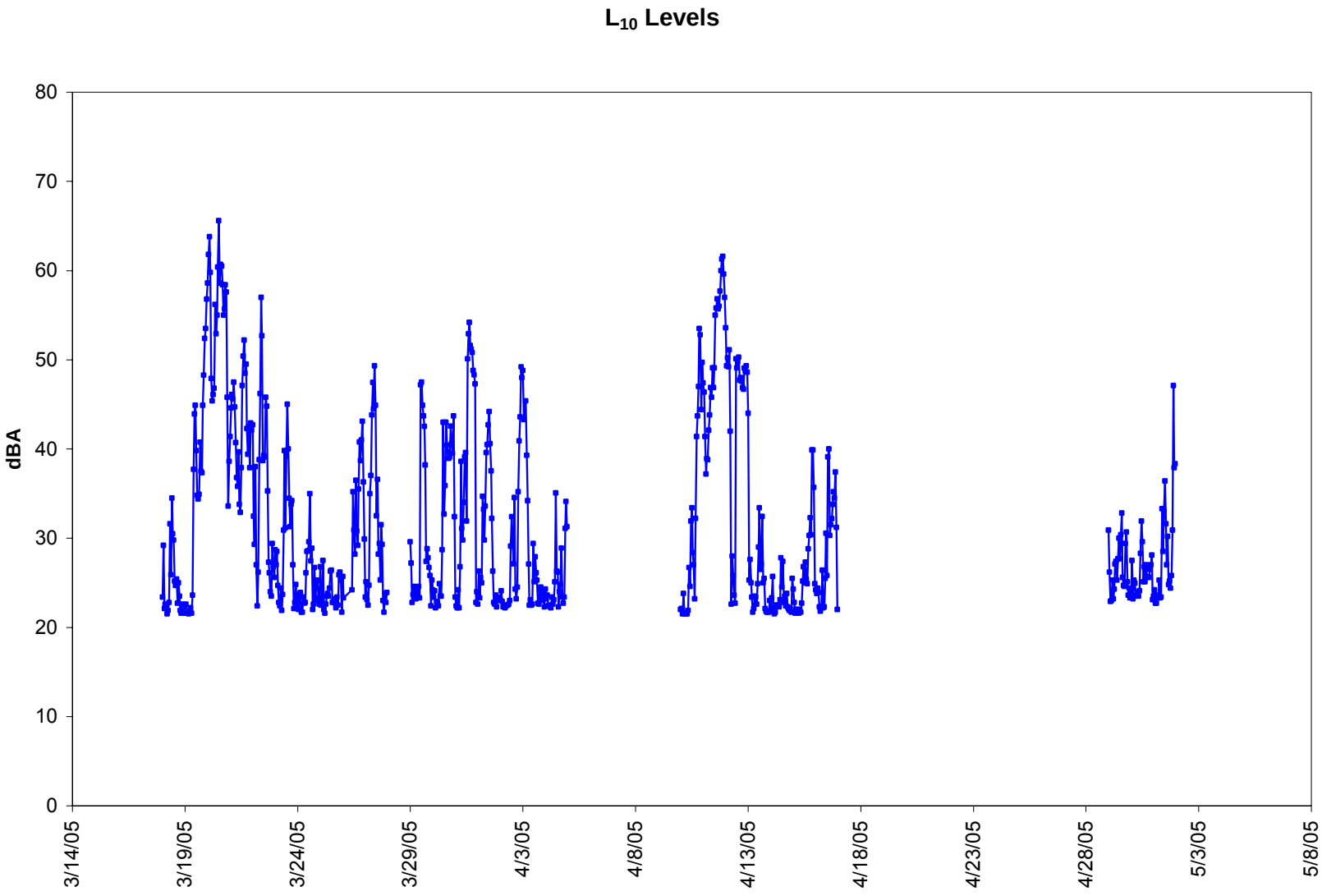
7/27/05
8/16/05
9/5/05


Lx Levels
dBA
120
100
80
60
40
20
0
3/14/05
3/19/05
3/24/05
3/29/05
4/3/05
4/8/05
4/13/05
4/18/05
4/23/05
4/28/05
5/3/05
5/8/05
L0
L10
L50
L90
L100


L10 Levels
dBA
80
70
60
50
40
30
20
10
0
3/14/05
3/19/05
3/24/05
3/29/05
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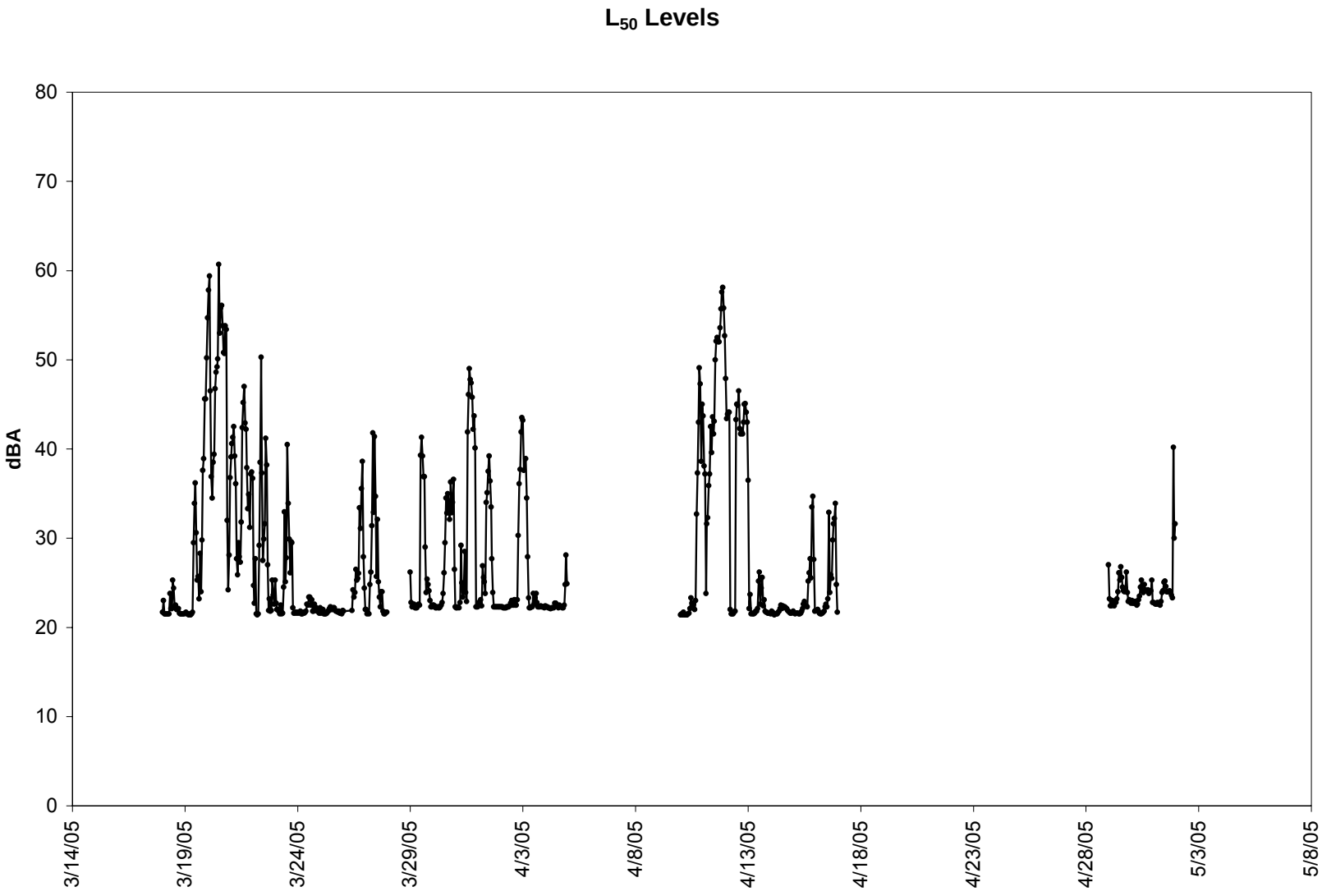
5/3/05
5/8/05


L50 Levels
dBA
80
70
60
50
40
30
20
10
0
3/14/05
3/19/05
3/24/05
3/29/05
4/3/05
4/8/05
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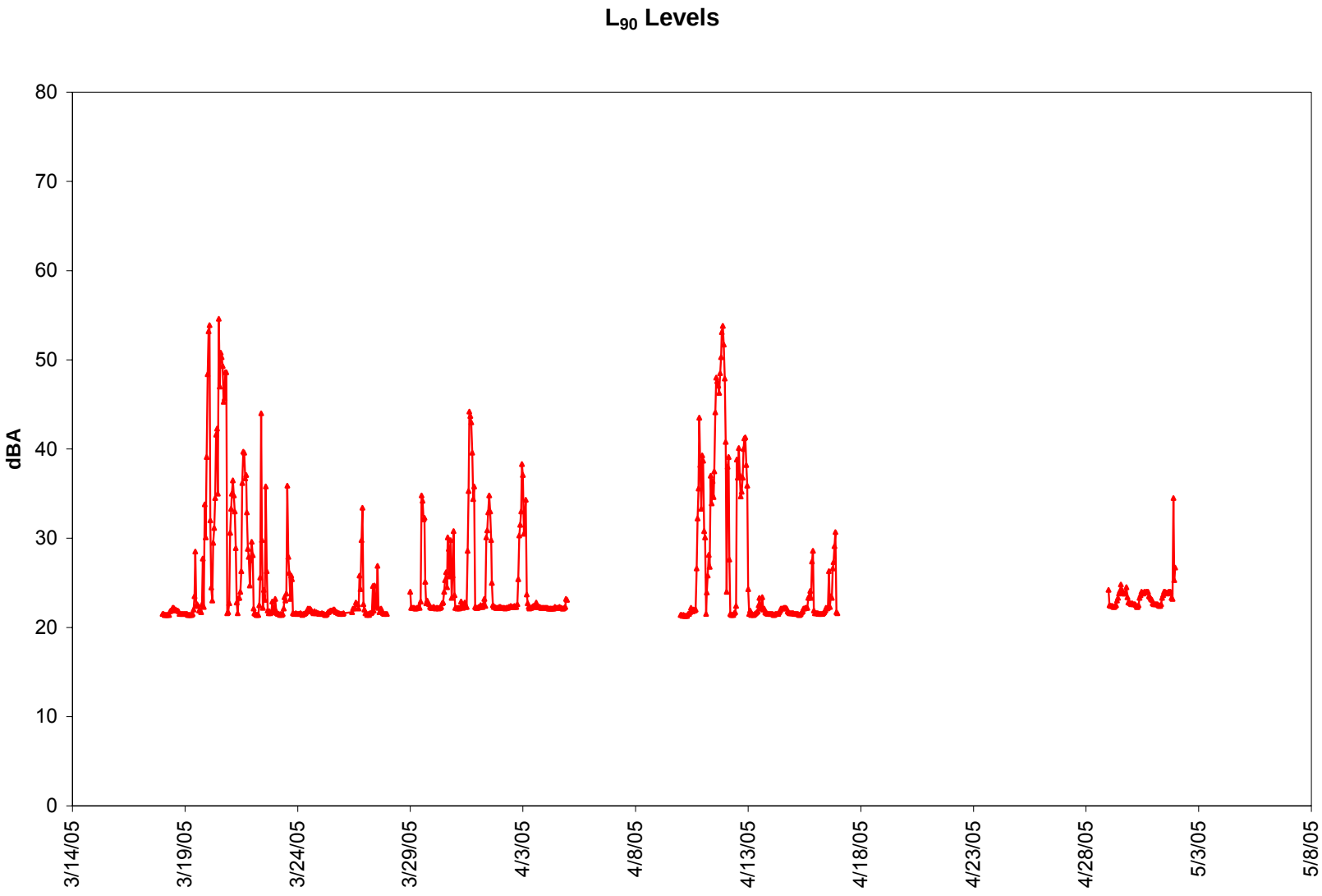
4/23/05
4/28/05
5/3/05
5/8/05


L90 Levels
dBA
80
70
60
50
40
30
20
10
0
3/14/05
3/19/05
3/24/05
3/29/05
4/3/05
4/8/05
4/13/05
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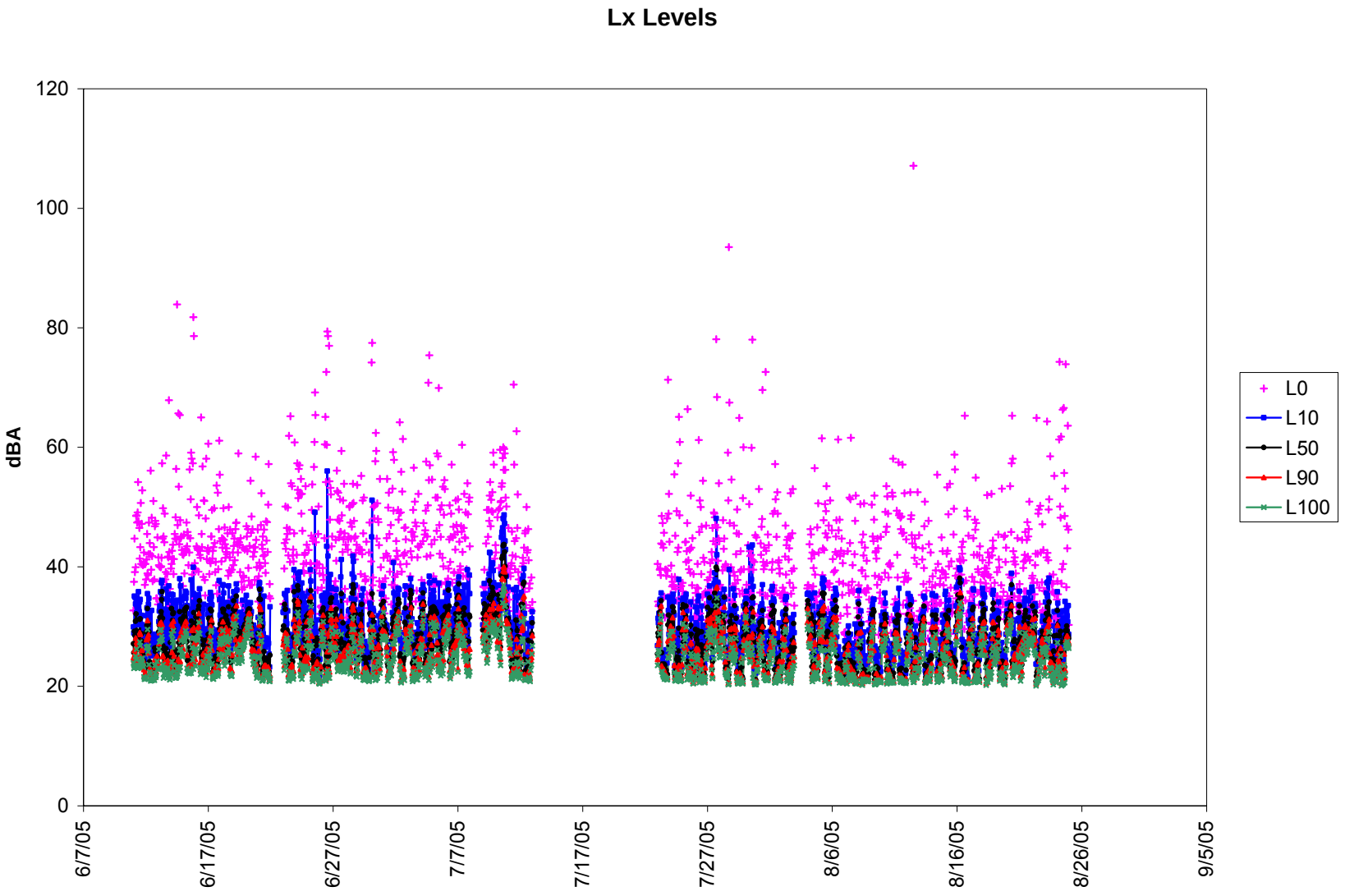
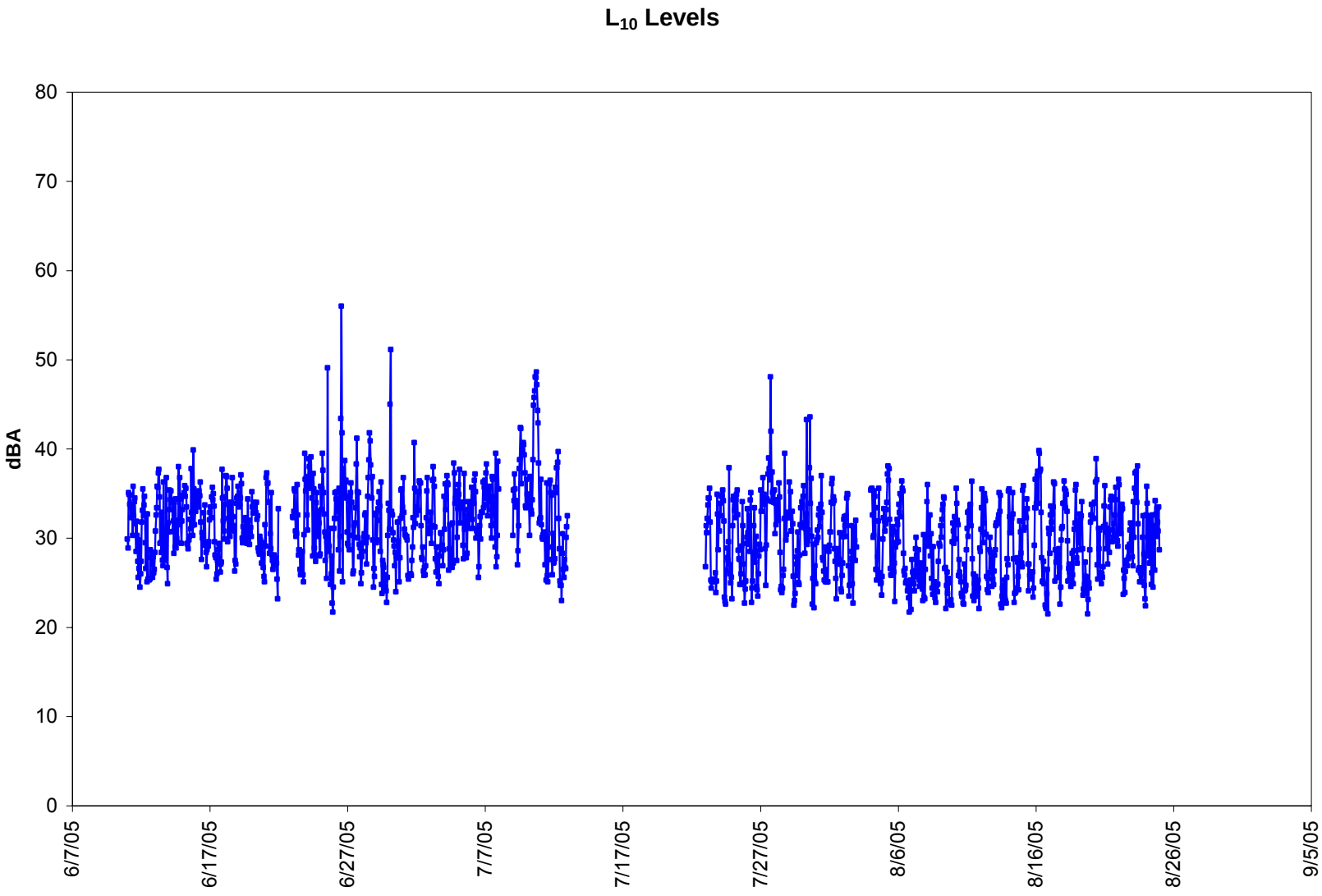
4/23/05
4/28/05
5/3/05
5/8/05


Lx Levels
dBA
120
100
80
60
40
20
0
6/7/05
6/17/05
6/27/05
7/7/05
7/17/05
7/27/05
8/6/05
8/16/05
8/26/05
9/5/05
L0
L10
L50
L90
L100


L10 Levels
dBA
80
70
60
50
40
30
20
10
0
6/7/05
6/17/05
6/27/05
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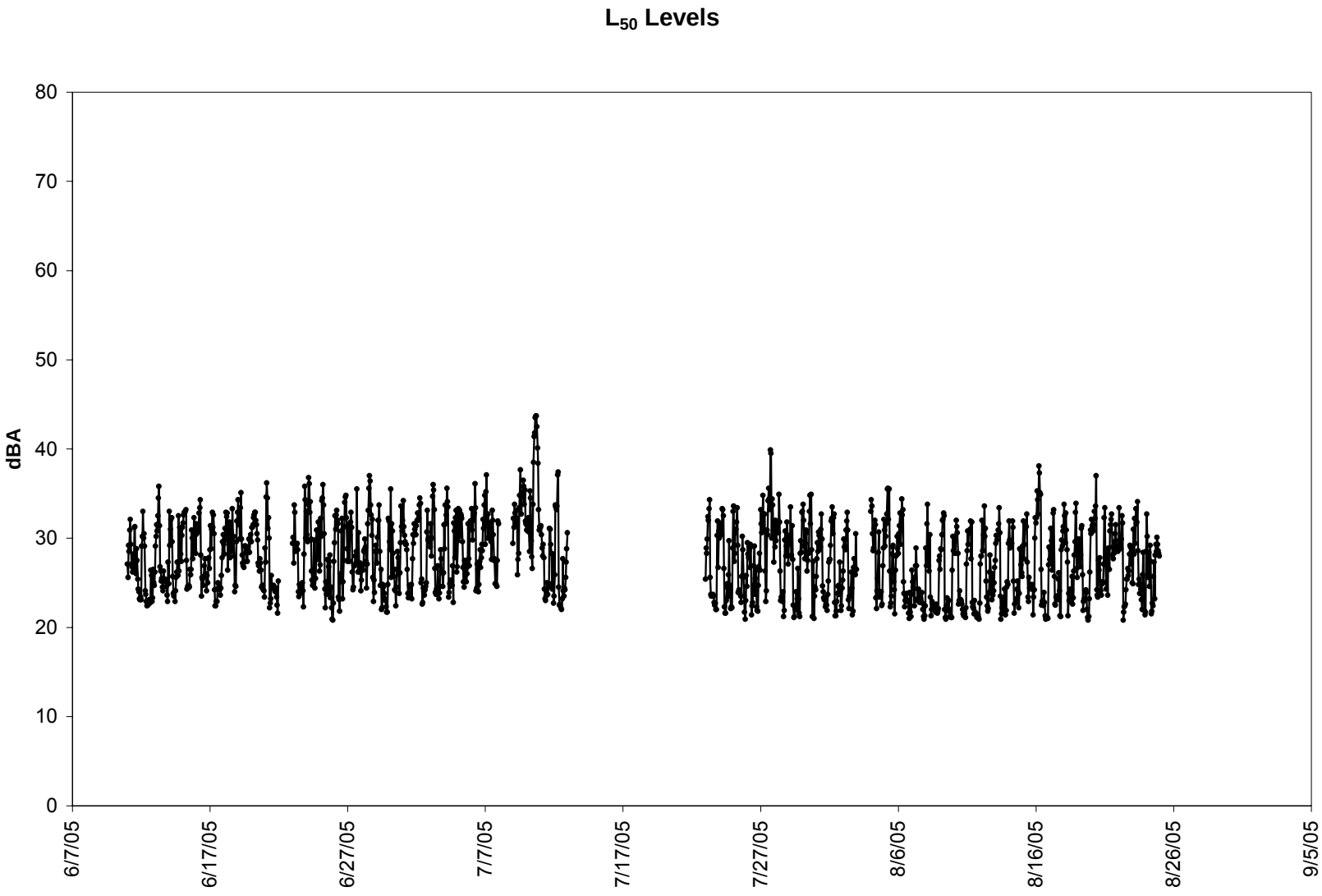
8/6/05
8/16/05
8/26/05
9/5/05


L50 Levels
dBA
80
70
60
50
40
30
20
10
0
6/7/05
6/17/05
6/27/05
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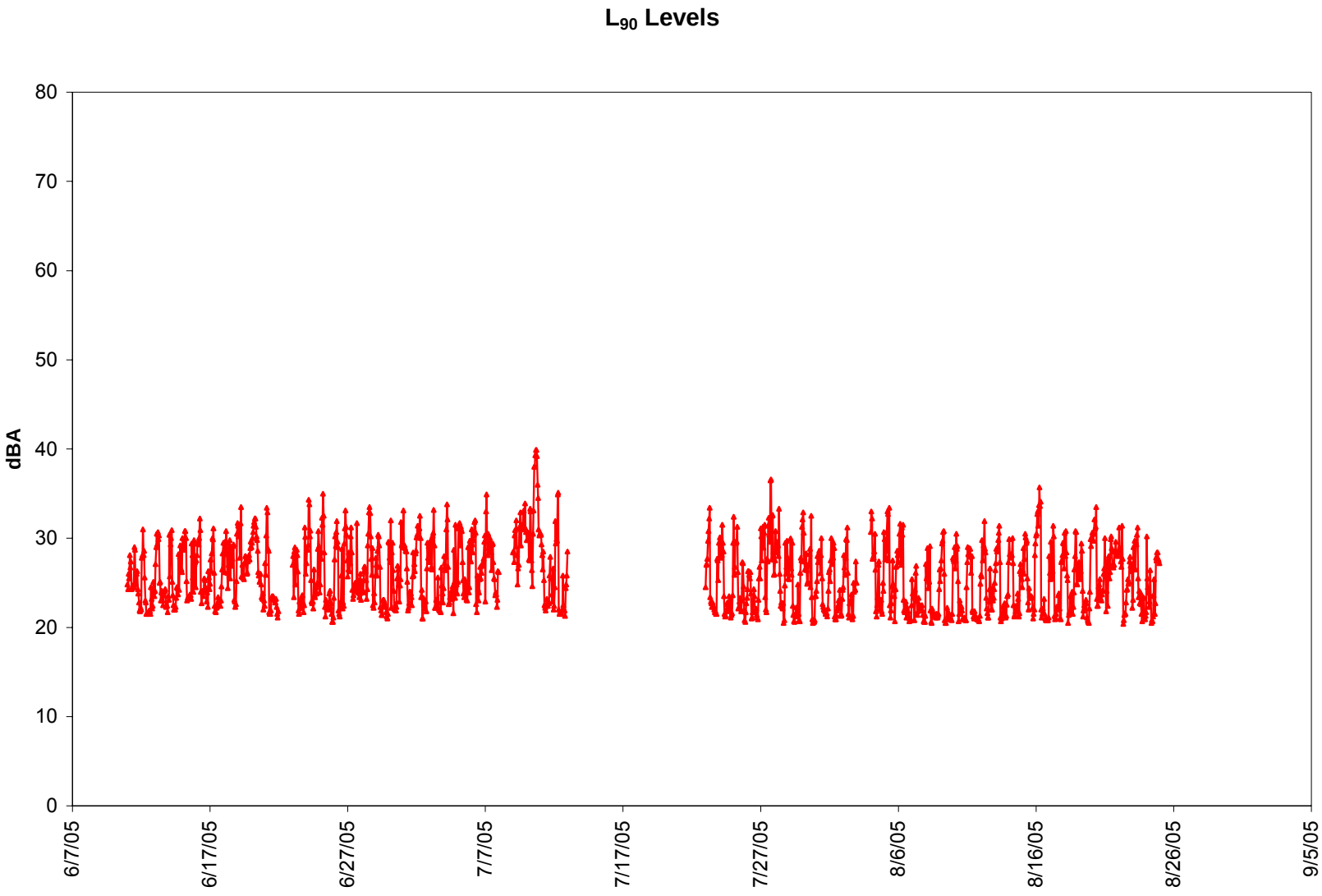
8/16/05
8/26/05
9/5/05


L90 Levels
dBA
80
70
60
50
40
30
20
10
0
6/7/05
6/17/05
6/27/05
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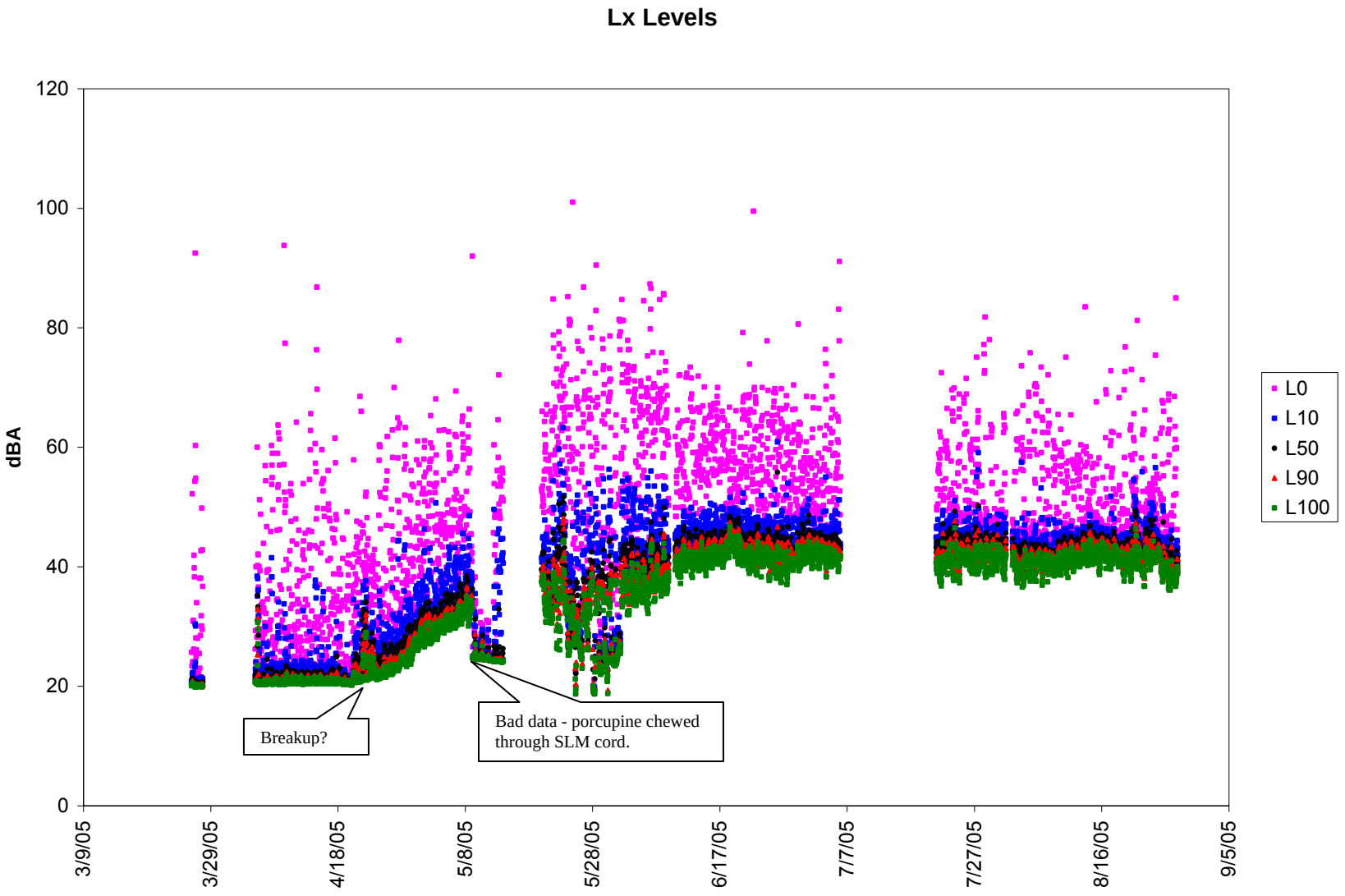
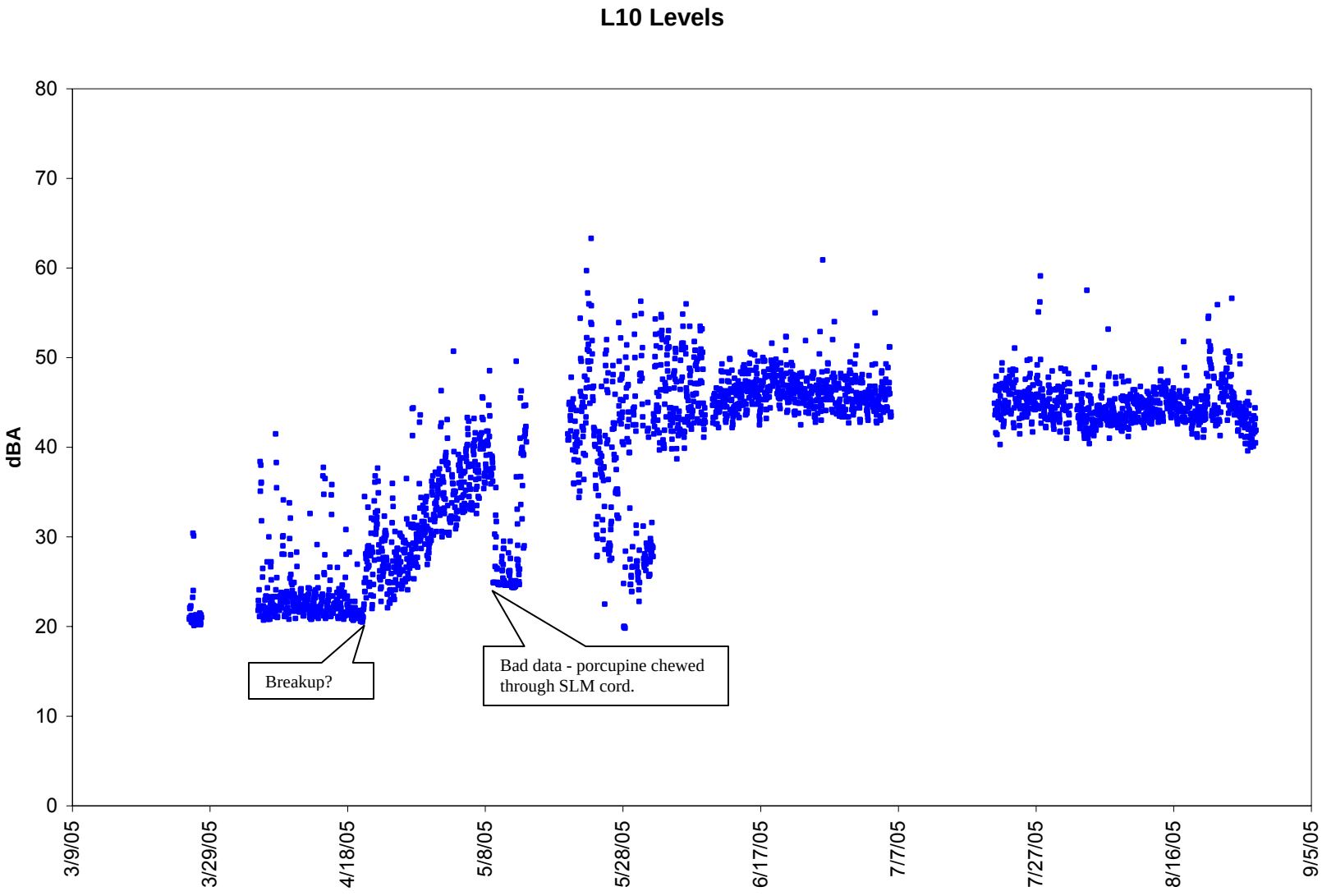
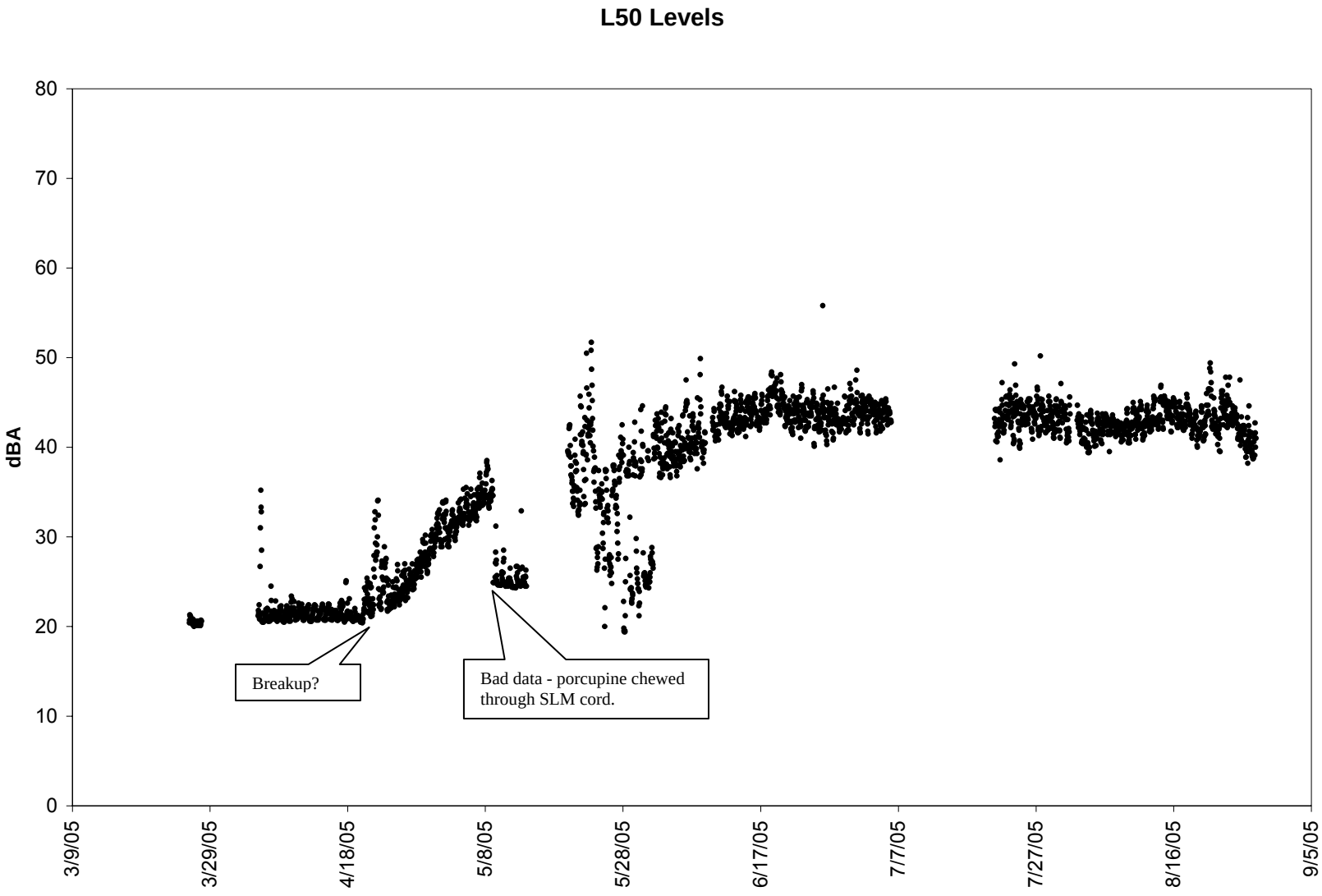
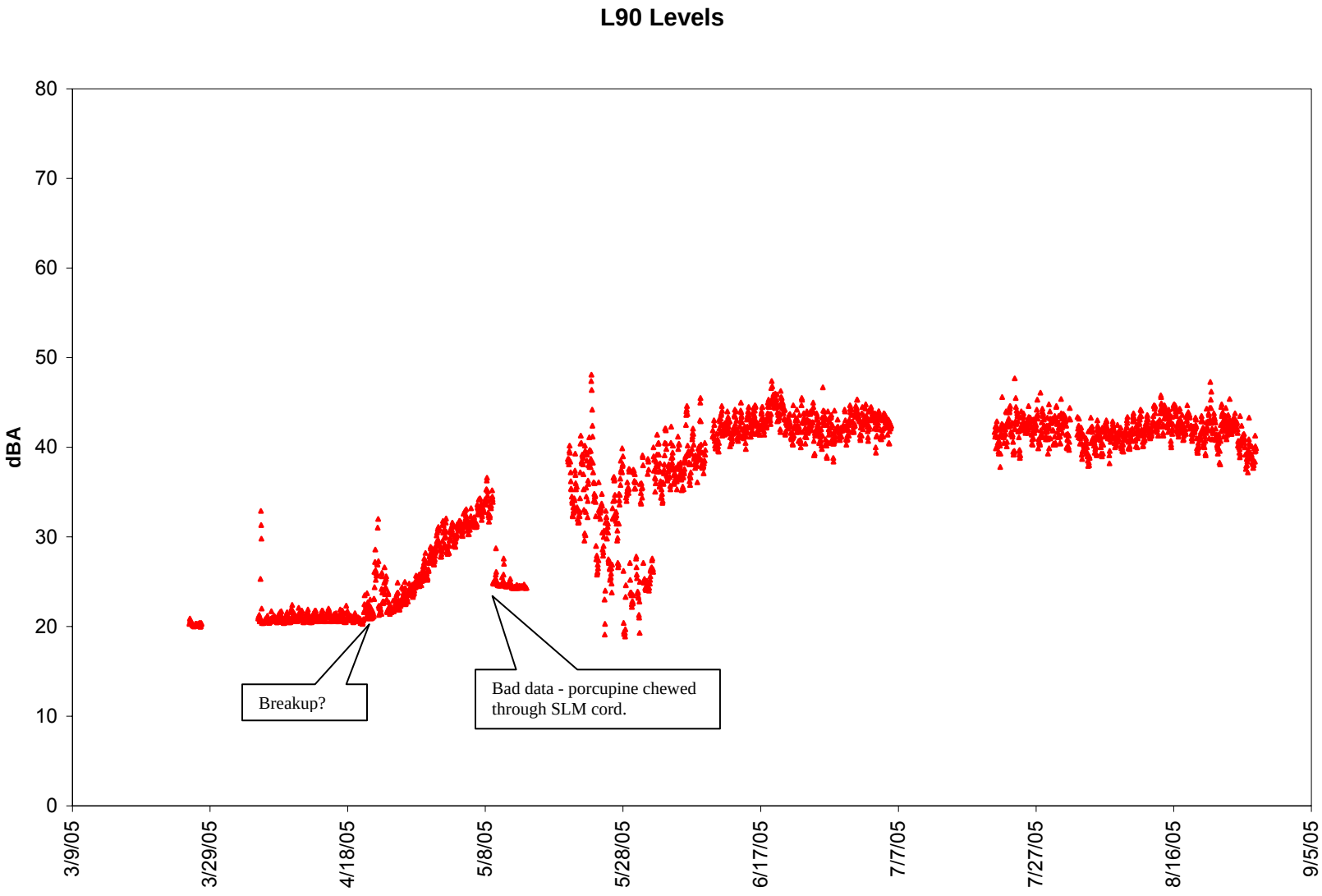
8/26/05
9/5/05


Lx Levels
dBA
120
100
80
60
40
20
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
6/17/05
7/7/05
7/27/05
8/16/05
9/5/05
L0
L10
L50
L90
L100
Breakup?
Bad data - porcupine chewed through SLM cord.


L10 Levels
dBA
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
6/17/05
7/7/05
7/27/05
8/16/05
9/5/05
Breakup?
Bad data - porcupine chewed through SLM cord.


L50 Levels
dBA
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
6/17/05
7/7/05
7/27/05
8/16/05
9/5/05
Breakup?
Bad data - porcupine chewed through SLM cord.


L90 Levels
dBA
80
70
60
50
40
30
20
10
0
3/9/05
3/29/05
4/18/05
5/8/05
5/28/05
6/17/05
7/7/05
7/27/05
8/16/05
9/5/05
Breakup?
Bad data - porcupine chewed through SLM cord.

APPENDIX E: Location Descriptions and Data Analysis

A summary of the data analyzed for the stations established during the 2005 field season (Fig. 8) are presented on the following pages. Each section begins with a location description cover sheet. Following the description cover sheet are selected charts that summarize the data analyzed thus far from each location. Each data compilation summary completed for each location contain ten charts; one chart showing the sum of all sounds identified, four charts characterizing the natural soundscape, based exclusively on audibility, and five charts relating to backcountry management planning, which show the levels of motorized sounds. The charts for each compilation are as follows:

General Soundscape Characterization (Using Audibility Only)

1. All sounds identified per day within the 288 5sec audio clips recorded every 5 min.

Natural Soundscape Characterization (Using Audibility Only):

2. Physical sounds identified per day within the 288 5sec audio clips recorded every 5min.
3. Biological sounds identified per day within the 288 5sec audio clips recorded every 5min.
4. Bird sounds identified per day within the 288 5sec audio clips recorded every 5min.
5. Insect Sounds identified per day within the 288 5sec audio clips recorded every 5min..

Levels of Motorized Impacts (Using Sound Levels and Audibility):

6. Motorized Sounds identified per day within the 288 5sec audio clips recorded every 5min.
7. Sum of Motorized Sound Levels Per Hour.
8. Percent Motorized Sounds Audible Per Hour.
9. Number of Motorized Sounds Greater than Natural Ambient Levels.
10. Motorized Sound Levels.

Explanation of the Calculations for Charts 9 and 10:

9. The number of motorized sounds greater than natural ambient levels is found by calculating the difference between two values; natural ambient and sound level of each motorized sound identified.
    a. Natural ambient: The natural ambient level is calculated for each hour of each day by first calculating the % time motorized sounds are audible for each hour (% motor/hr). The natural ambient for each hour is calculated by removing the top motorized percentage (% motor/hour) from all of the sound levels for the hour. The median is

then taken (L50), which is an approximation of the natural ambient level. In this calculation there is the assumption that the majority of motorized sounds are greater than natural ambient. Preliminary tests done by Skip Ambrose from the National Park Service Soundscape Program Center (personal communication) have shown that this calculation is consistently within 1dB of the actual natural ambient level calculated by removing all motorized sound levels for an hour identified by a continuous recording for the hour. The motorized sound level is calculated as explained in #10 below. A motorized sound is considered greater than the natural ambient level if the overall sound level during the time a motorized sound is audible, as calculated in #10 below, is greater than 3dBA than the natural ambient level for that hour.

10. The motorized sound levels are calculated by first identifying which of the 288 five second audio segments, recorded throughout the day, contain motorized sounds. The time for each segment is then identified. Then the median of the ten seconds of sound levels nearest each audio clip is calculated. The median of these ten seconds is assumed to be representative of the motorized sound level plus the natural ambient level.

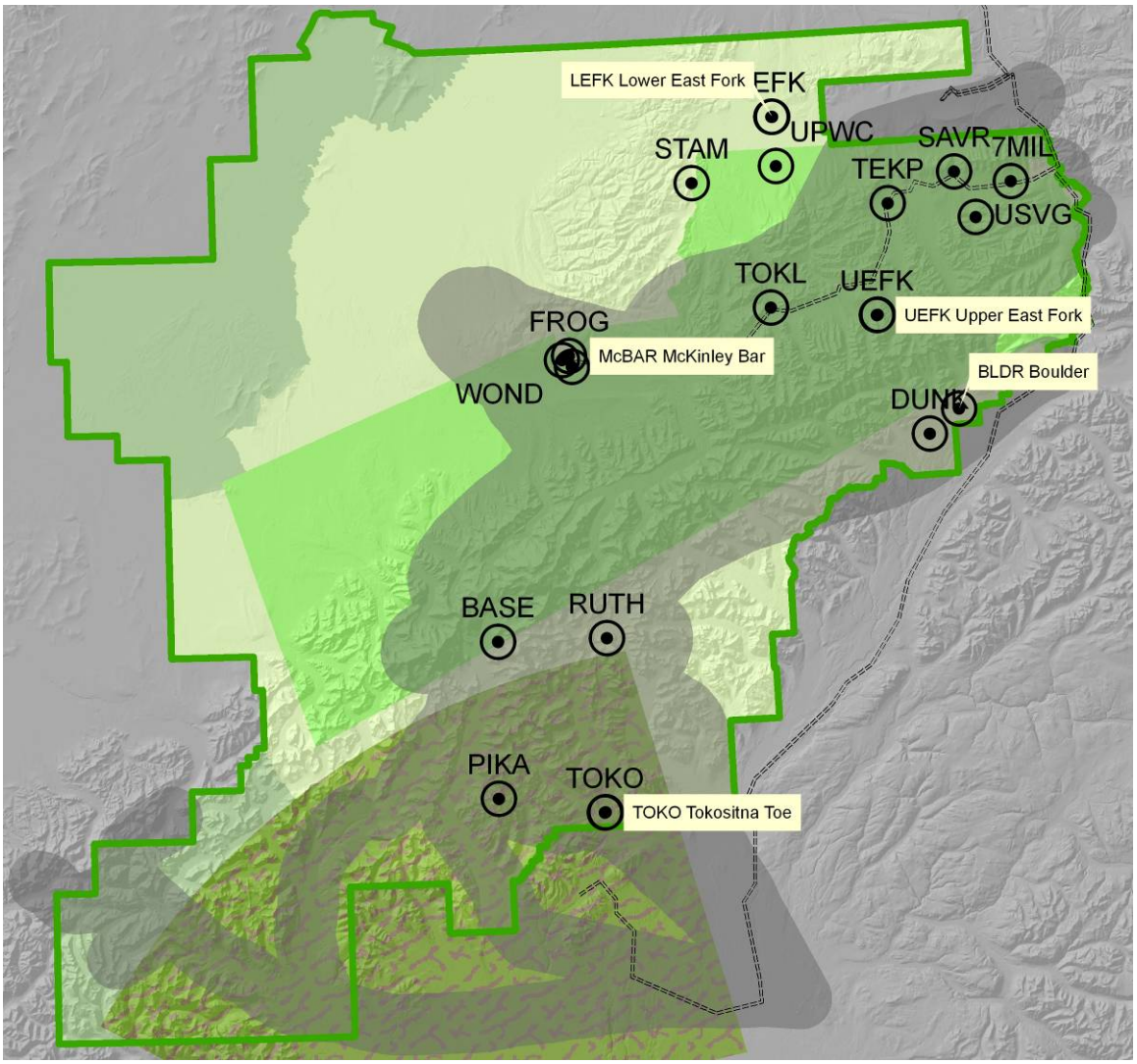


Figure 8. Map showing the sound station locations placed from 2001-2005. 2005 sound station locations are indicated by the yellow callouts. Common flightseeing path footprints are shaded in grey. The Military Operations Area is shown in camouflage. Data analysis charts for the 2005 charts are presented in this appendix.