

Digital Identification of Intrusive Noise

Pilot Study to Digitally Characterize Soundscapes and Intrusion

Tim Lavalley, Robert Kull, and Brigitte
Schulte-Fortkamp

Purpose and Need

- To examine ways and methodologies to effectively characterize differing and complex soundscapes.
- To continue developing tools for the evaluation of complex soundscapes
- To further the discussion on the characterization intrusion with respect to setting.
- To broaden the definition of 'background noise'
- To examine criteria defining intrusion for different soundscapes.

Overview

- Two soundscapes were chosen.
- Integrated 2 second sound time histories and third-octave spectra were measured.
- An individual manually logged acoustical events using a acoustic event logger.
- Independently, algorithms to identify both “normal” and “acoustically intrusive” events for the given soundscape were applied to the data.
- The digitally identified events were compared to the manually taken event log.

Soundscapes

- Newport News Park (Newport News, VA)
 - ◆ Suburban Park Setting
 - ★ Ball fields, walking trails and picnic tables
 - ★ Nearby roadways, military bases and public airport.
- Kiln Creek Elementary School (York, VA)
 - ◆ Public School in Residential Neighborhood
 - ★ Playground, community, school
 - ★ Nearby roadways, military bases and public airport.



Non-Acoustical Environment

Suburban Park

- Weather
 - ◆ Sunny and clear
 - ◆ Temperature 40°F
 - ◆ Wind 1.3 mph
 - ◆ RH 15%
- Setting
 - ◆ Wooded area near walking trail

Schoolyard

- Weather
 - ◆ Sunny and clear
 - ◆ Temperature 78°F
 - ◆ Wind 0.2 mph
 - ◆ RH 34%
- Setting
 - ◆ Semi-wooded area near elementary school

Overall Acoustical Environment

Suburban Park

■ Sound Sources

- ◆ Birds
- ◆ Vegetation
- ◆ Humans
- ◆ Traffic
- ◆ Overflights

■ Metrics

- ◆ $L_{eq} = 51.4$ dBA
- ◆ $L_{90} = 49.1$ dBA
- ◆ $L_1 = 56.1$ dBA

Schoolyard

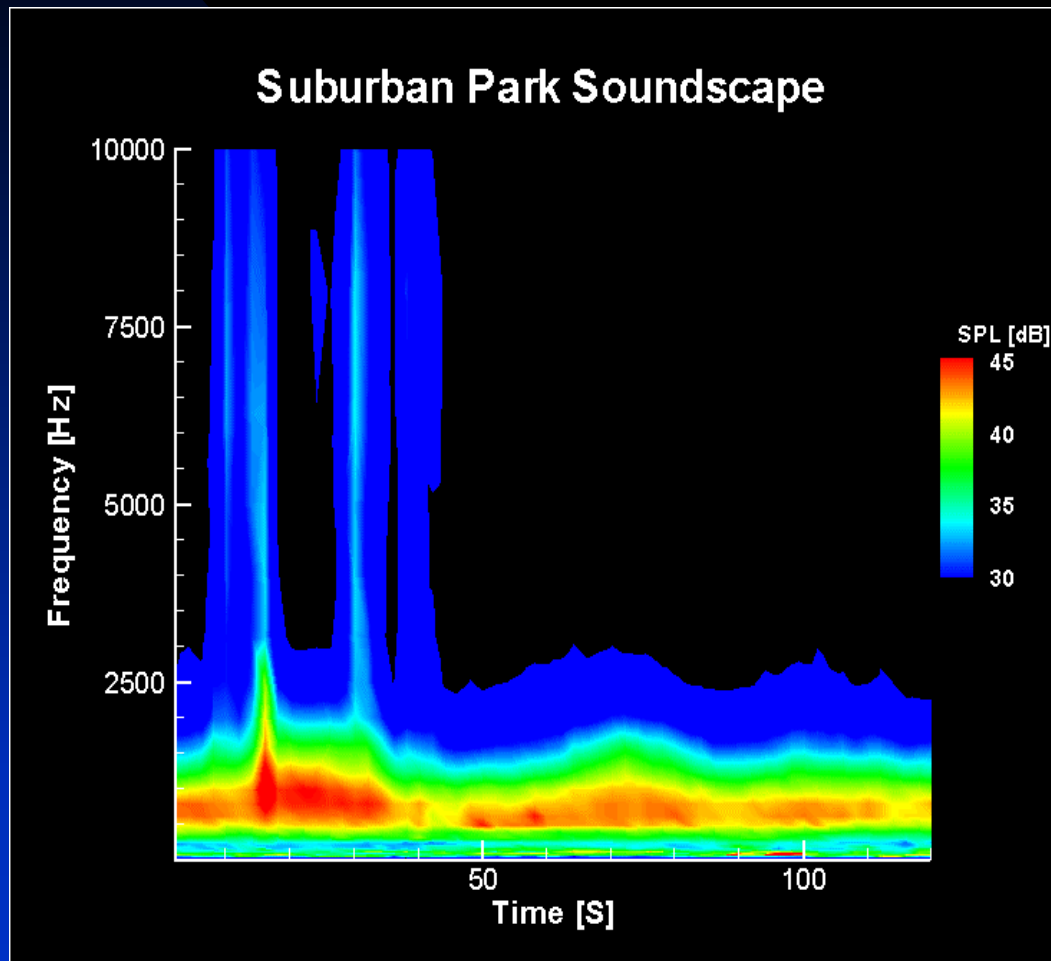
■ Sound Sources

- ◆ Birds
- ◆ Vegetation
- ◆ Humans
- ◆ Traffic
- ◆ Overflights

■ Metrics

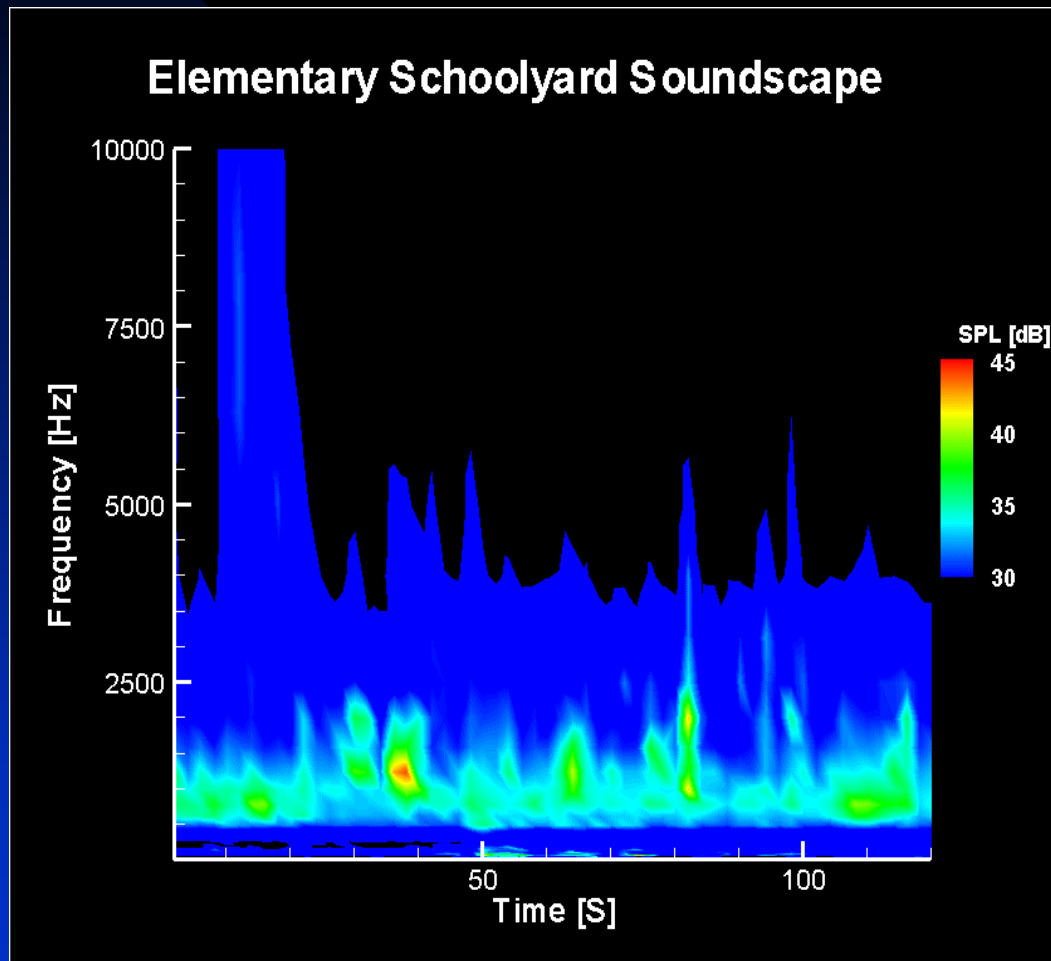
- ◆ $L_{eq} = 59.8$
- ◆ $L_{90} = 45.3$
- ◆ $L_1 = 73.0$

Suburban Park Soundscape



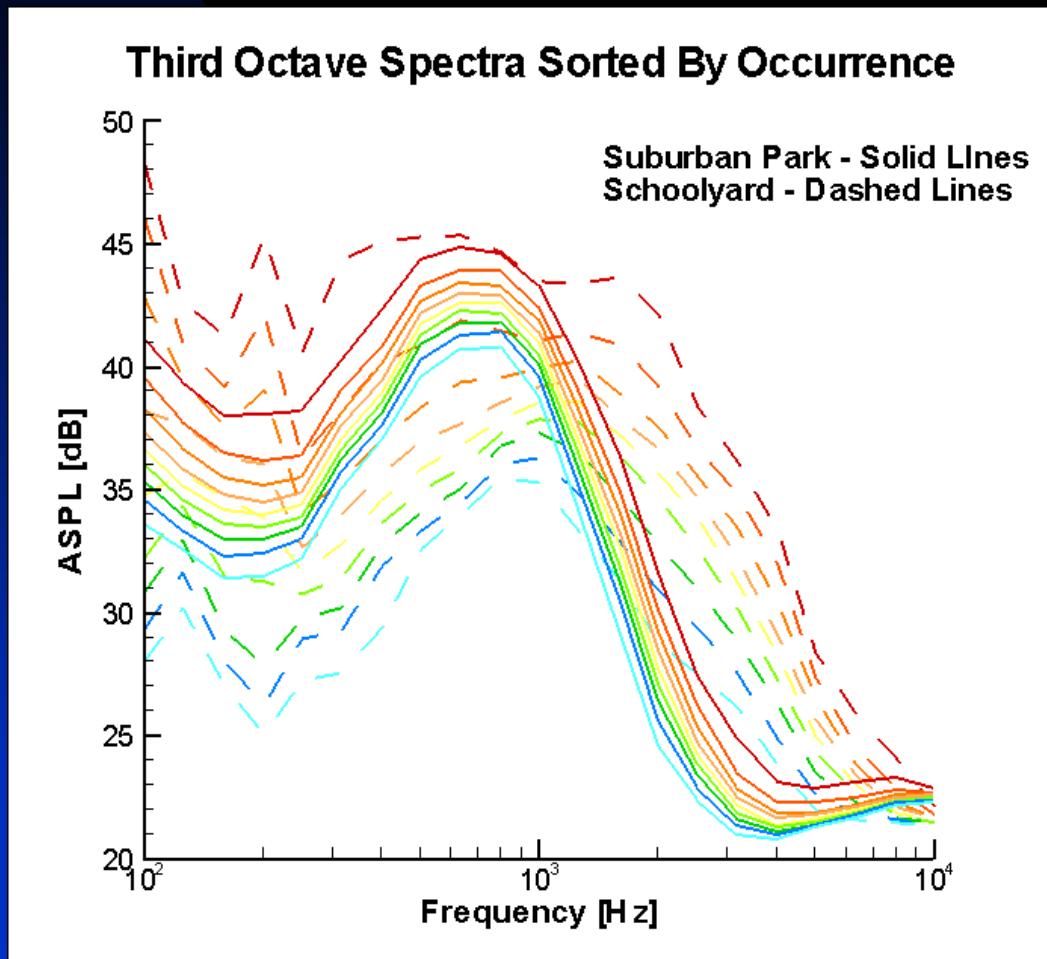
- Constant Sound Below 2000 Hz
- A Few Broad Band “Events”
- Several Tonal High Frequency “Events”

Schoolyard Soundscape



- Constant Sound Below 4000 Hz
- Several Broad Band “Events”
- Several Tonal High Frequency “Events”

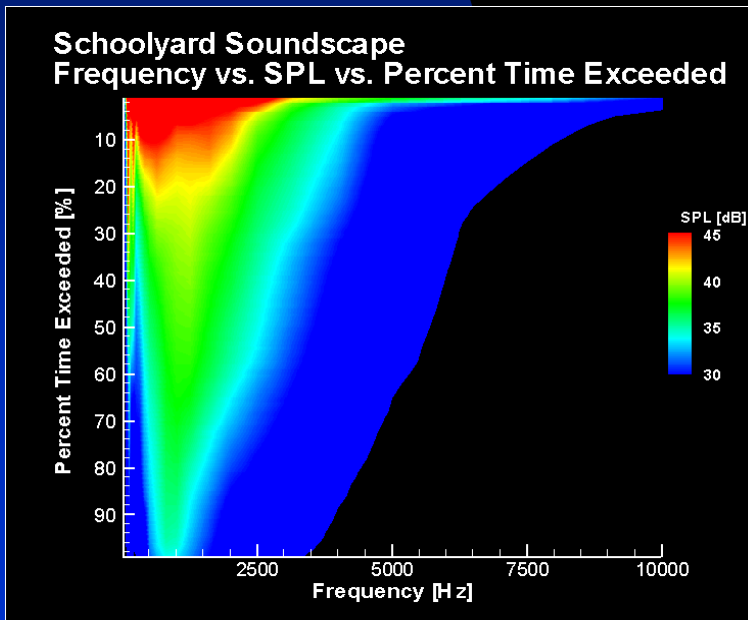
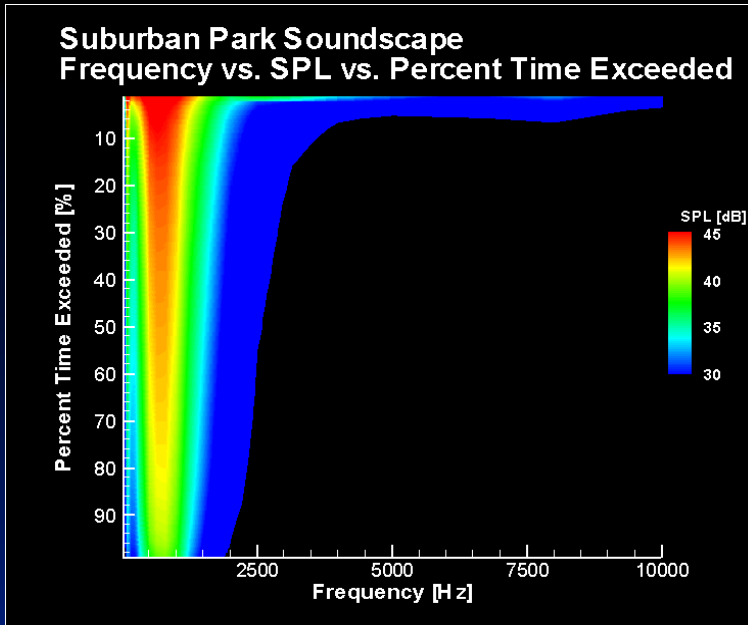
Spectral Environment



- Suburban Park
 - ◆ Narrower range for any given band
 - ◆ More stable
- Schoolyard
 - ◆ Broader range for any given band
 - ◆ More events
 - ◆ Less stable

Spectral Distribution

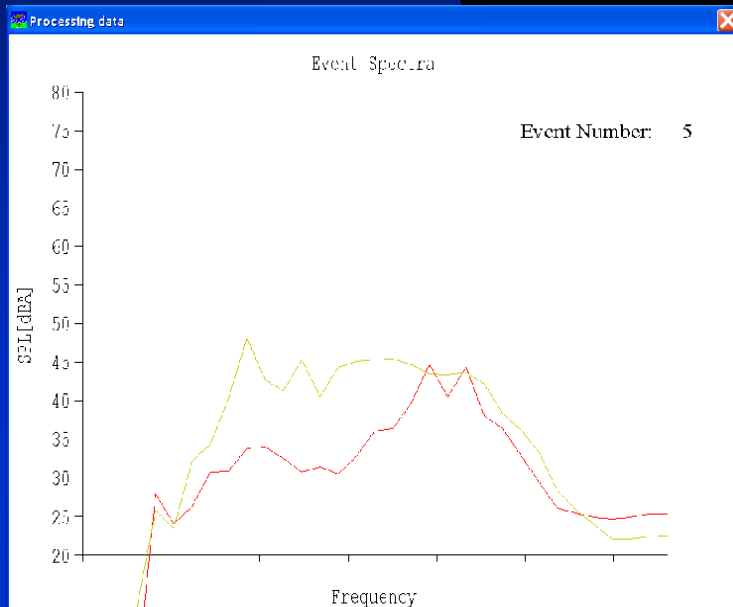
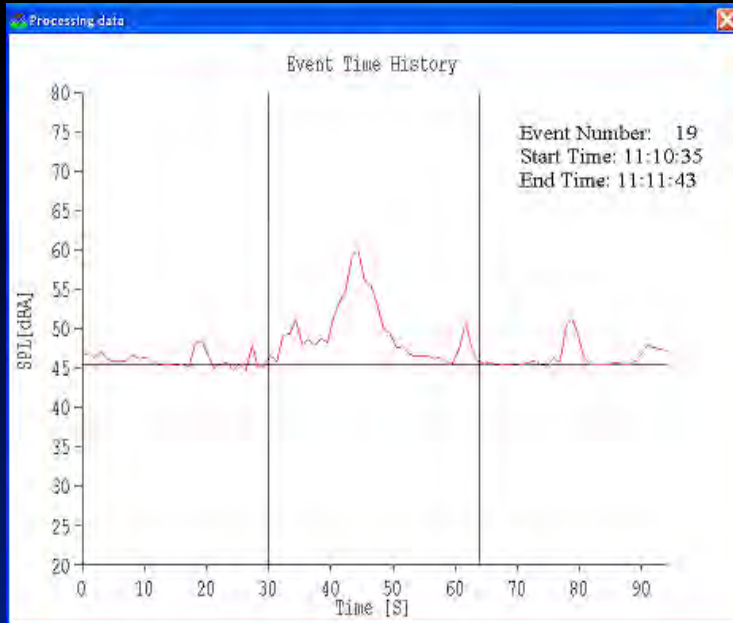
- The percent of time that levels are exceeded for a given frequency
- Soundscapes with a broader distribution have more 'Acoustical Events' and are often less desirable.



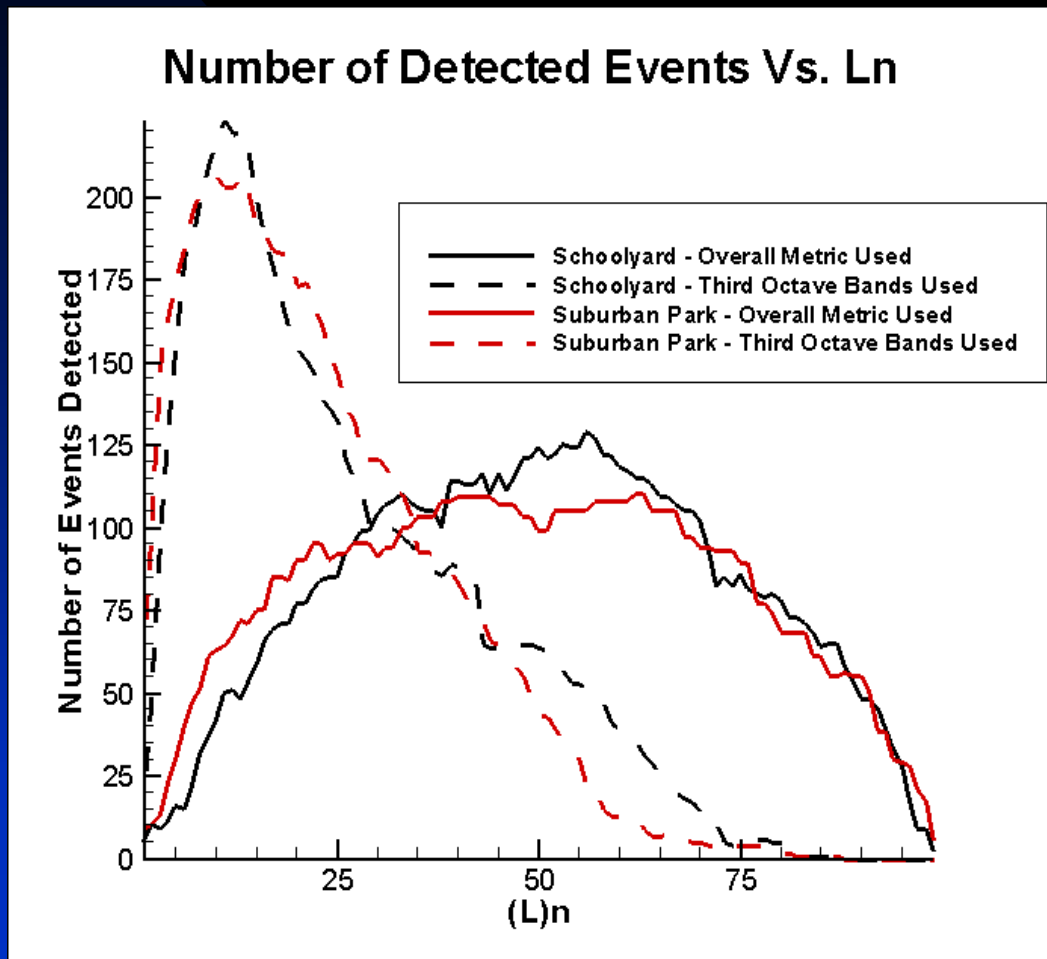
Identifying 'Acoustical Events'

- Traditionally overall metrics have been used to identify acoustical events.

- Comparing event spectra to background spectra better discriminate events.



The Search for Events



- The number of events detected is a function of the event threshold level.
- About twice as many are detected with spectral comparison



Acoustical Event Logger (AEL)

AEL - TEST INFORMATION

LOCATION
[]

OPERATOR
[]

WEATHER
[]

SOUNDSCAPE DESCRIPTION
[]

OK

Acoustical Event Logger V1.0 beta

MAN MADE SOUNDS

CAR JET PLANE

TRUCK PROP PLANE

TRAIN HELICOPTER

BOAT MOTORCYCLE

ATV LAWNMOWER

HORN LEAF BLOWER

SIREN WEED EATER

HUMAN CALL

OTHER MAN MADE

NATURAL SOUNDS

BIRD CALL

ANIMAL MOVEMENT

FROG

WATER

INSECTS

MAMMAL CALL

VEGETATION

WIND GUSTS

OTHER NATURAL

00000 11:33:20 11:33:22 16 BIRDCALL
00009 11:33:24 11:33:25 09 JETPLANE
00010 11:33:26 11:33:26 01 CAR
00011 11:33:28 11:33:28 01 CAR
00012 11:33:29 11:33:29 01 CAR
00013 11:33:30 11:33:31 02 TRUCK
00014 11:33:31 11:33:32 02 TRUCK
00015 11:33:33 11:33:33 02 TRUCK
00016 11:33:34 11:33:35 09 JETPLANE
00017 11:33:23 11:33:36 16 BIRDCALL
00018 11:33:41 11:33:41 11 HELICOPTER
00019 11:33:38 11:33:42 02 TRUCK
00020 11:33:37 11:33:42 09 JETPLANE
00021 11:33:36 11:33:43 16 BIRDCALL

SAVE AND CLOSE

- AEL is Simple Program to Log Acoustical Events.
- Logs Event Number, Type, Start Time, and End Time
- Allows For Simultaneous Events

Event Inventory

	Suburban Park	Schoolyard
CARS	1	8
HORNS	7	4
JET PLANES	15	11
LAWN MOWERS	0	4
MAN MADE OTHER	8	19
MOTORCYCLES	1	0
PROP PLANES	3	22
SIRENS	1	0
TRAINS	1	0
TRUCKS	33	2
BIRDCALLS	85	209
ANIMAL MOVEMENT	0	2
HUMAN CALLS	7	24
MAMMAL CALLS	0	3
VEGETATION MOVEMENT	33	5

Total Logged Events

195

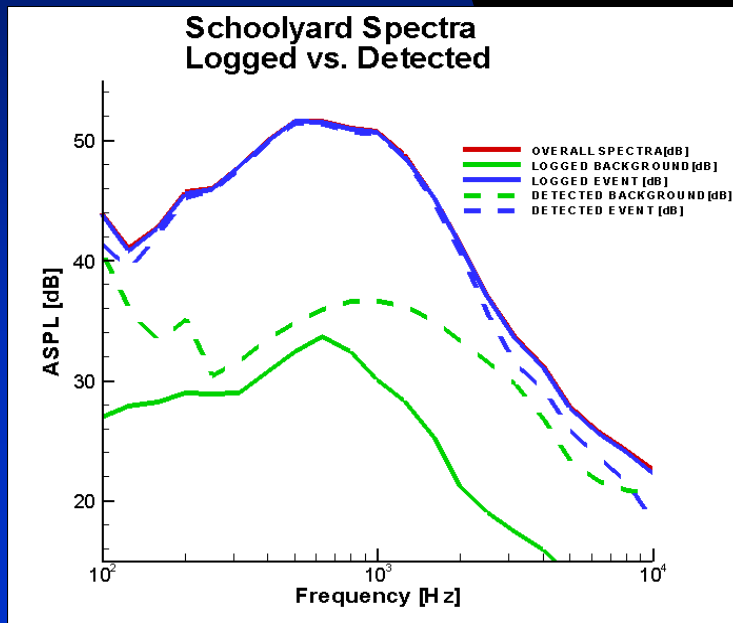
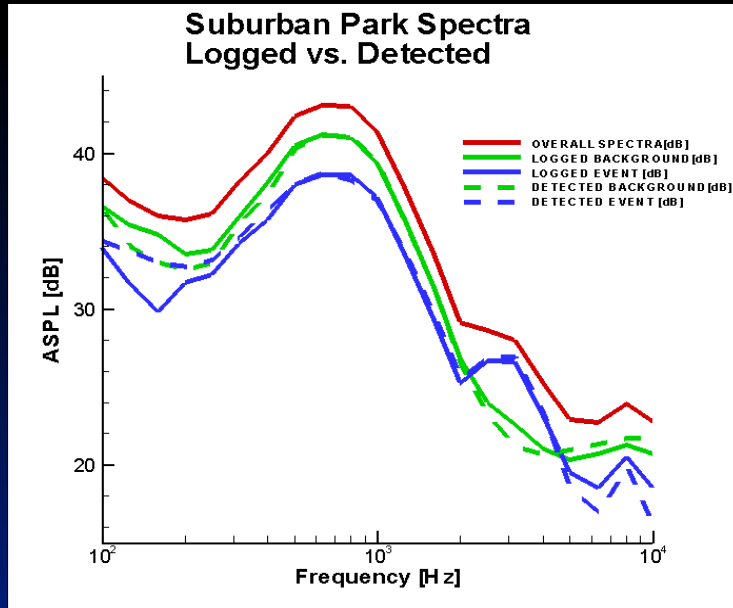
313

Detected Events vs. Logged Events

Events Detected by <i>Overall Metric Method</i>				
Soundscape	Manmade Matched	Natural Matched	Total Matched	Not Matched
Suburban Park	48 (66%)	87 (71%)	135(69%)	60 (31%)
Schoolyard	60 (85%)	152 (62%)	212 (67%)	101 (33%)

Events Matched by <i>Spectral Discrimination Method</i>				
Soundscape	Manmade Matched	Natural Matched	Total Matched	Not Matched
Suburban Park	57 (78%)	99 (81%)	156 (80%)	39 (20%)
Schoolyard	62 (88%)	199 (81%)	261 (83%)	52 (17%)

Logged vs. Detected Spectra



- Overall, Event-related, and Background Spectra from Detected Events Comparable to Logged Events
- Suburban Park Dominated by Background (Non-event) Noise
- Schoolyard Dominated by Non-background (Event) noise

Conclusions

- Manual event logging is tedious and labor intensive. However, logging software can be used to help document human perception of sound and give event specific information about sound sources in a given soundscape.
- Overall, event-related, and background spectra from digitally detected events are comparable to those calculated with logged events.
- Spectral interrogation is marginally better than the use of overall metrics at identifying acoustical events for both “event dominated” and “background dominated” soundscapes.

Future Work

- Attempt to differentiate types of events based on spectral profile for a given soundscape
- Attempt to digitally separate composite acoustical events
- Introduce critical ratios and determine masking parameters for a given soundscape
- Expand AEL to include non-acoustic information such as visual and tactual stimulus

Possible Future Uses

- Sampling of large numbers of short term soundscapes
- Identification of the distinguishing feature of each soundscape, to be separated from the mere existence of common sounds
- Evaluating the perceptual efficiency of different noise mitigation methods, in addition to the traditional approaches

Questions?