The Development of Long-duration Acoustic Bat Detectors for Southeast Alaska

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http://alaskabats.org
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Bats in Alaska

- There are bats in Alaska!
- 1990s Parker (UAF) survey
- 2004-Present Hays/Boland (OSU) survey
- Six species identified in Alaska
  - *Myotis lucifugus* Little Brown Bat
  - *Myotis keenii* Keen’s Myotis
  - *Myotis californius* California Myotis
  - *Myotis volans* Long-legged Myotis
  - *Eptesicus fuscus* Big Brown Bat
  - *Lasionycteris noctivagans* Silver-haired bat
  - *Myotis septentrionalis* Northern Myotis
Bats in Alaska
Myotis lucifugus

Physical Size:
- Wing Span: 22 - 27 cm
- Mass: 7 - 13 g (.25 - .5 oz)
- Length: 8.5-10 cm

Lifespan: 33 yrs
- Diet: Insects, spiders
- Most common

Image Courtesy: Burke Museum, U Wash.

Image Courtesy: Phil Myers, Animal Diversity Web
Alaska Bats, Map

Parker et al, Arctic, 50(3), 256-265, 1997
SE Alaska Bats, Map

Parker *et al.*, Arctic, 50(3), 256-265, 1997
Bats in Alaska: Species Ranges
Ecology of Bats in Alaska

Alaska Specific Ecologic Questions:

- Population? Population Trend?
- Forest relationship?
- Cave occupation/usage?
- Response to Climate Change?
- Overwintering? Migration?
- Daylight activity?
- Bridges and Mine Usage?
- Management Implications...
How To Answer These Questions?

- Capture
- DNA Samples
- guano samples
- Infrared Photography
- Museum Vouchers
- Acoustics

Image Courtesy: BCI
Why a New Sensor?

What’s wrong with existing detectors?
Design Criteria

- Long (100+ days) Duration
- Robust
- Data Offloading/State of Health
- Low Power Consumption
- Additional Data Streams
- Relatively High Bandwidth
Design Criteria

- Long (100+ days) Duration
  - Robust
  - Data Offloading/State of Health
  - Low Power Consumption
  - Additional Data Streams
  - Relatively High Bandwidth
- Low Cost
Current Work: Digitize Bat Calls

Digitize over 30 hours of 2716 echolocation calls (from Parker)
Current Work: Analyze Bat Calls

Results: Mean Duration of Call

![Graph showing mean duration of bat calls in different environments]
Current Work: Initial Algorithm

Are There Bats? What are they doing? What kind?

Sound

- Only 1 Pulse
- More Than 1 Pulse

Rain (ignore)

Interesting Sound

- "Short" Duration
- "Long" Duration

Outdoor, Non-Feeding

Interesting Sound

- Max Freq

In-Cave

Feeding Buzzes

NASBR 2005: Detector – p.14/28
Current Work: A Better Bat Detector

What do we need to make a better bat detector? Or, How can we make long duration bat observations?

- Microphone/Transducer
Current Work: A Better Bat Detector

What do we need to make a better bat detector? Or, How can we make long duration bat observations?

- Microphone/Transducer
- Recorder/Digitizer
Current Work: A Better Bat Detector

What do we need to make a better bat detector? Or, How can we make long duration bat observations?

- Microphone/Transducer
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- ‘Smarts’ (or a computer)
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What do we need to make a better bat detector? Or, How can we make long duration bat observations?

- Microphone/Transducer
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- ‘Smarts’ (or a computer)
- Laptop
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  - Brick
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- Communication/Storage
- Power
# Hardware Comparison

<table>
<thead>
<tr>
<th></th>
<th>Laptop + Anabat</th>
<th>Brick</th>
<th>Gumstix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU</strong></td>
<td>975 MHz</td>
<td>133 MHz</td>
<td>400 MHz</td>
</tr>
<tr>
<td><strong>Digitizer</strong></td>
<td>sound card</td>
<td>250 kHz 4x</td>
<td>sound card</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>HD + MS</td>
<td>HD + MS</td>
<td>MS</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>12-20 W</td>
<td>10 W</td>
<td>0.8 W</td>
</tr>
<tr>
<td><strong>Networking</strong></td>
<td>802.11b</td>
<td>802.11 b/g</td>
<td>802.11 b/g</td>
</tr>
<tr>
<td><strong>$ (-power)</strong></td>
<td>$3,000</td>
<td>$1,200</td>
<td>$300</td>
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</table>
Developing Components

- Test Power
- Design (and simplify) Software
- Understand Deployment Realities
- Understand Tradeoffs (e.g. transducer choice)
- Software Design
- Using Threshold and/or Zero-Crossing and Record?
- What Question(s) are we answering? Would we like to answer?
  - Bat Presence/Absence
  - Species?
  - Activity
  - Population? Trend?
Deployment Tests

Jordan Creek
Mendenhall Valley, Juneau

Zina Cave, Scallop Cave

Legend
USDA Forest Service Data
- Forest Cover
- Trails
- Elev. Contours (100 ft)
- Streams
- Lakes

Legend
- roads_FS
- contour arc
- streams arc

0 1,250 2,500 5,000 Feet

NASBR 2005: Detector – p.18/28
Conclusions

- Goal: Low Power, Long Duration Sensor
- Durability (10 month test)
- Power (6 week test)
- Modular Design
- Analysis Requirements/Power Tradeoffs
- Identify Problems (‘quiet’ bats)
Questions?
Current Work: Species Differentiation

Examples of different species

Lasionycteris noctivagans  \hspace{1cm}  Myotis lucifugus

Images Courtesy: BCI
Current Work: Species Differentiation

Examples of different species

Siemers and Schnitzler, Nature 429, 657 - 661 (10 June 2004); doi:10.1038/nature02547
## ZC vs FFT

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<th>Zero-Crossing</th>
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<td>$S(f) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} s(t) e^{i\omega t} dt$</td>
<td>counter</td>
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<td>Full Spectrum</td>
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<td>Easy</td>
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<td>Notes</td>
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## ZC vs FFT

### Fourier Analysis

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### Zero-Crossing

- counter

**Notes**

- ‘Necessary’ Sufficient?
Myotis keenii

Common Name: Keen’s Myotis
Alaska: 3 specimen
Possible listing in Canada
Hot Springs
Trees year round?

Images Courtesy: Bat Conservation Int’l
Myotis californicus

Common Name: California Myotis
Lifespan: 15 yrs
Alaska: 1 live (4 dead)
El Cap Cave, POW
Feb ’92 Hibernating F
Roost switching

Images Courtesy: Bat Conservation Int’l
Common Name: Long-legged Myotis
Alaska: 5 specimen
Feed on moths
Few winter records
(AK or US)
**Eptesicus fuscus**

Common Name: Big Brown Bat  
Alaska: 1 found  
In British Columbia  
Uncommon in forests.  
→ Most likely not in AK

Images Courtesy: Bat Conservation Int’l
Lasionycteris noctivagans

Common Name: Silver Haired Bat
Lifespan: 11 yrs
Alaska: 4 specimens
All F in SE in winter
No summer calls
Migratory?

Images Courtesy: Bat Conservation Int’l