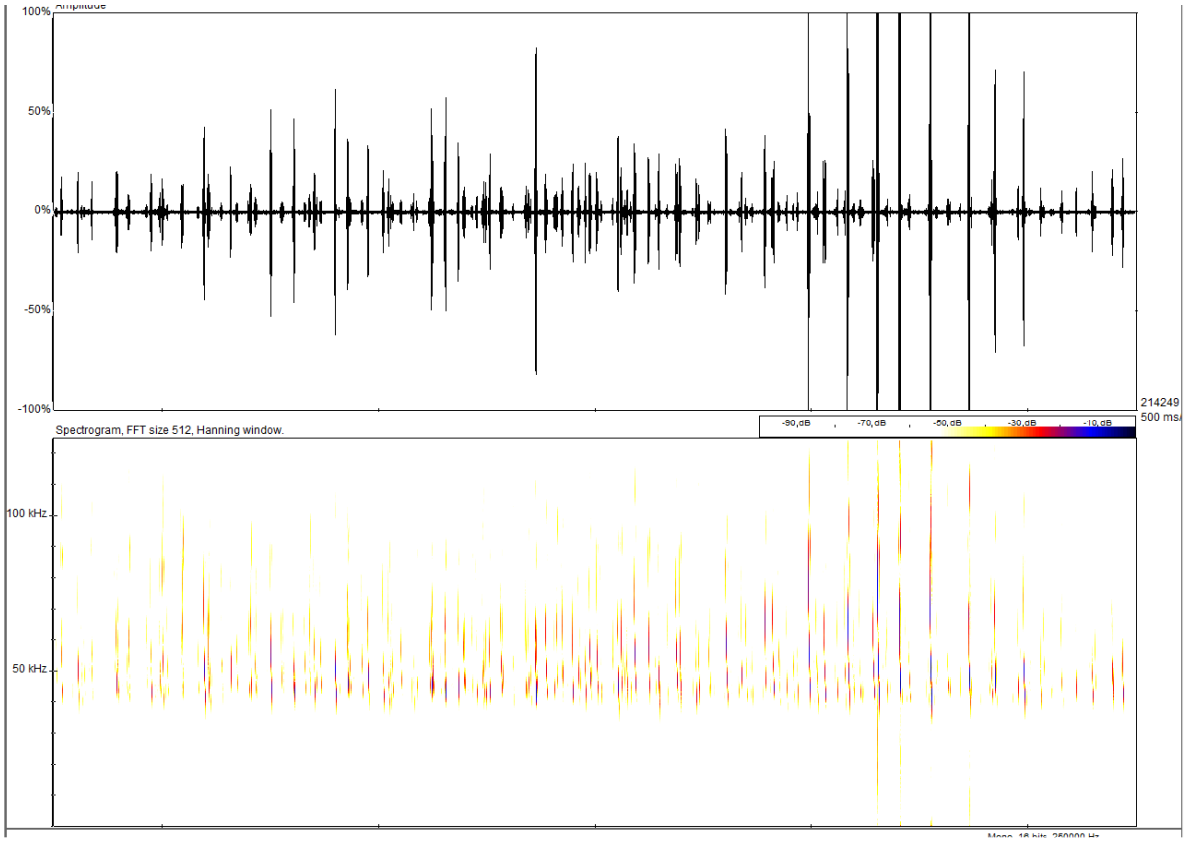
Acoustic Survey Design



Who conducts bat surveys?

Using an internet questionnaire to characterize bat survey efforts in the United States and Canada
Weller and Zielinski 2006; Wildlife Society Bulletin

- 415 responses
- 71% are government employees
- Most with < 5 years of experience ...
- and < 20% of responsibilities dedicated to bats
- Forests most highly surveyed
- Usually small area / single site sampled

What methods are used for bat surveys?

Comparison of Sampling Methods for Inventory of Bat Communities
Flaquer* et al. *2007; Journal of Mammalogy

- Acoustic monitoring
- Capture
  - Mist-netting
  - Harp trap
- Roost surveys
- Over or under representation of certain species
- *"Different techniques should be used to assess the richness of bat communities and we recommend combining all the methods described ... "*

Mist Net Surveys

Netting Surveys for Bats in the Northeast: Differences Associated with Habitat, Duration of Netting, and Use of Consecutive Nights
Winhold and Kurta 2008; Northeastern Naturalist

- Three years of surveys in Michigan
- First 4 hours after sunset = more bats caught
- Netting consecutive nights = 40% reduction in captures
- Netting in terrestrial location or near water = same total abundance, relative species abundance differs

Acoustic Surveys

- What factors to consider when determining optimal survey design?
  - What is the objective of the survey?
  - When to record (time of night)?
  - When to record (time of year)?
  - How long to record (night/season)?
  - Where to record?
  - How many detectors?

What is the objective of the survey?

- General bat activity/ Site characterization
- Hibernaculum use
- Migratory species
- Maternity colony
- Foraging area

When is the best time to record?

- It depends on the objective of the survey
- Survey design must account for basic bat ecology, both when choosing which time of year to survey and which time of the night.
- Researchers must be aware of the potential for temporal bias – if the survey cannot be adjusted to minimize this, then at the very least the data must be analyzed with this in mind.

Temporal Variation

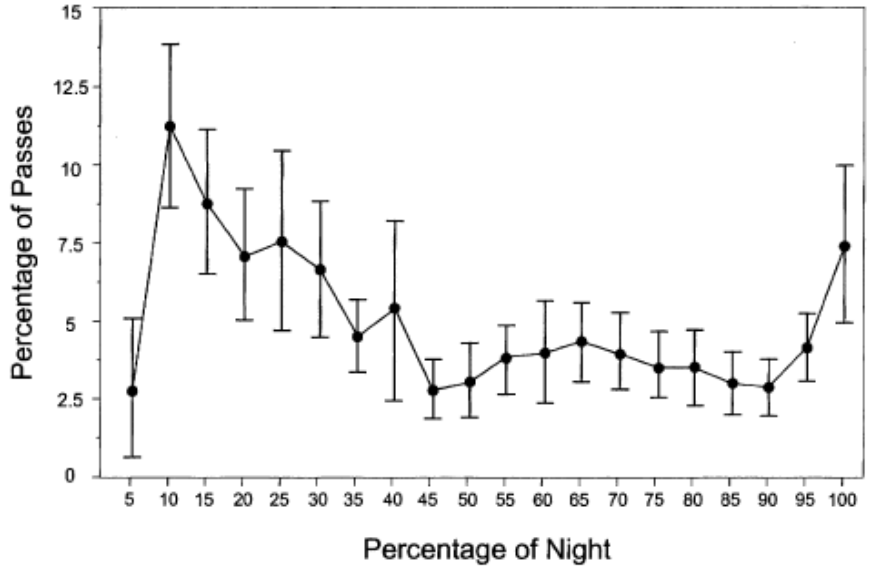
Temporal variation in activity of bats and the design of echolocation-monitoring surveys
Hayes 2007; Journal of Mammalogy

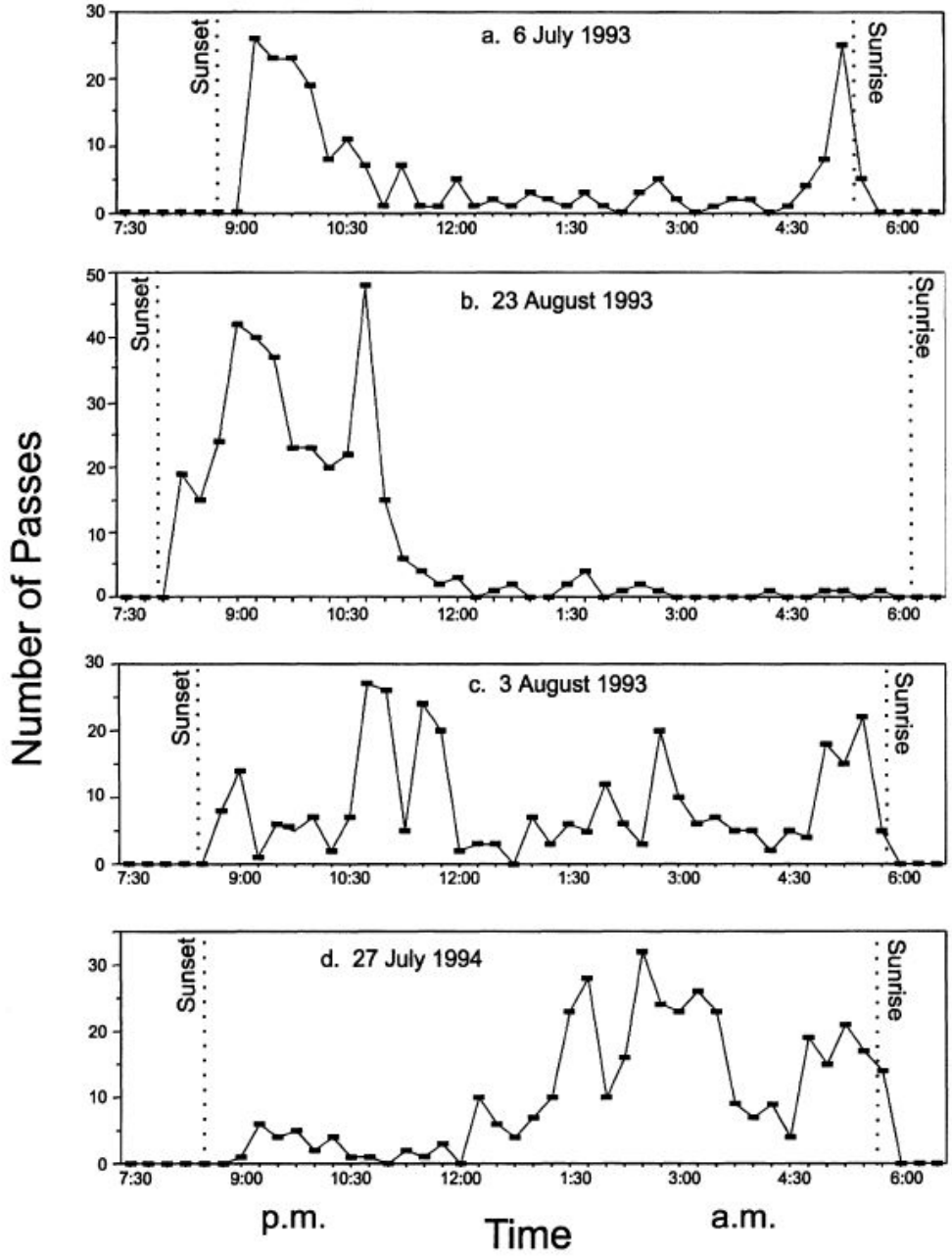
- "Failure to account for temporal variation in activity of bats when designing research projects and monitoring programs could result in biased estimates of activity of bats."
- Insect biomass, minimum temperature, length of night, moonlight?, time of night, night-to-night
- With subsamples ≥7 nights, 60% of subsets were within 20% of full dataset mean

Temporal Variation

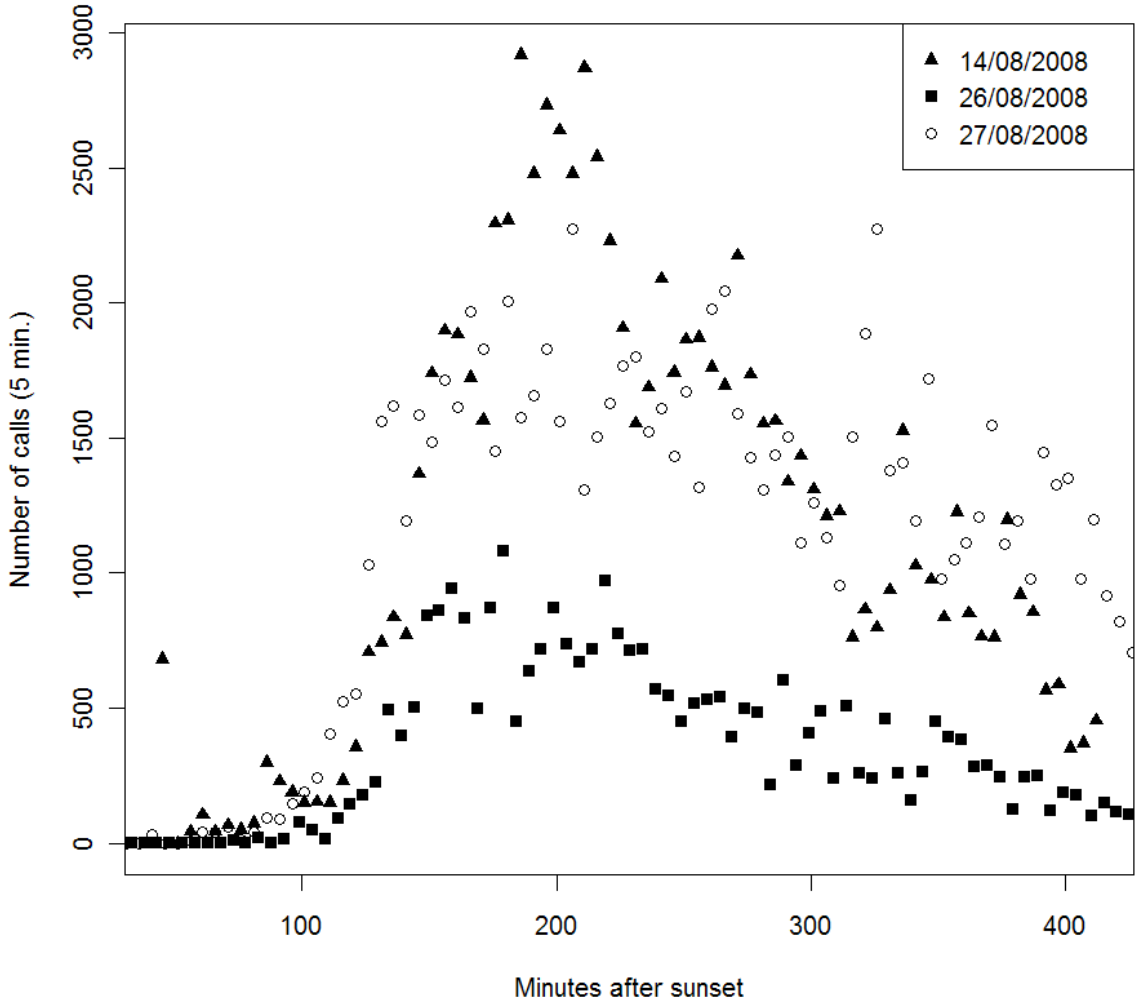
Temporal variation in activity of bats and the design of echolocation-monitoring surveys
Hayes 2007; Journal of Mammalogy

- "Level of activity within a night generally peaked shortly after sunset with a second, smaller peak in activity shortly before sunrise"

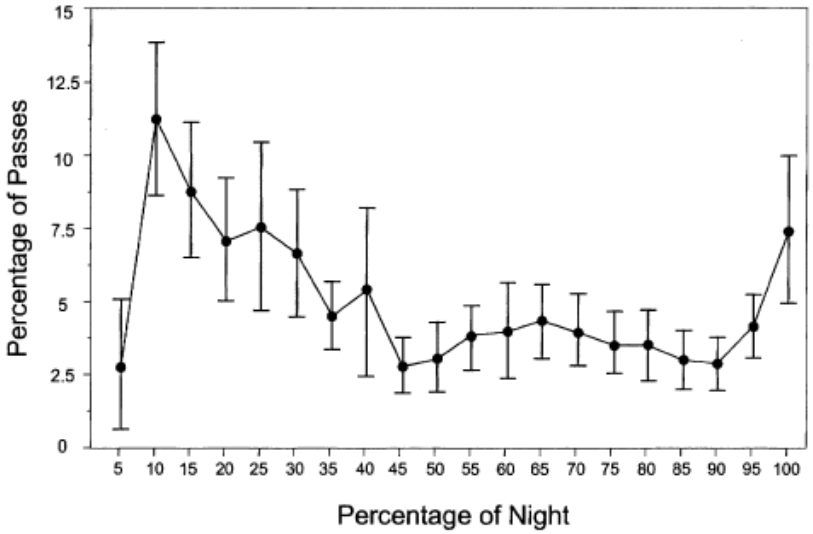


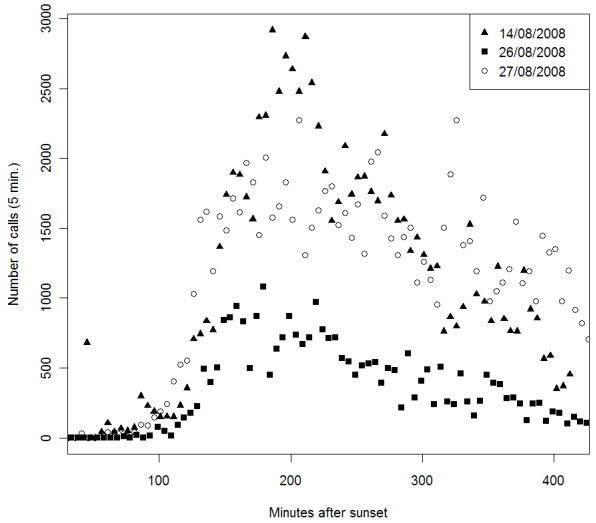

a. 6 July 1993
b. 23 August 1993
c. 3 August 1993
d. 27 July 1994
Sunset
Sunrise
Number of Passes
Time
p.m.
a.m.
7:30
9:00
10:30
12:00
1:30
3:00
4:30
6:00

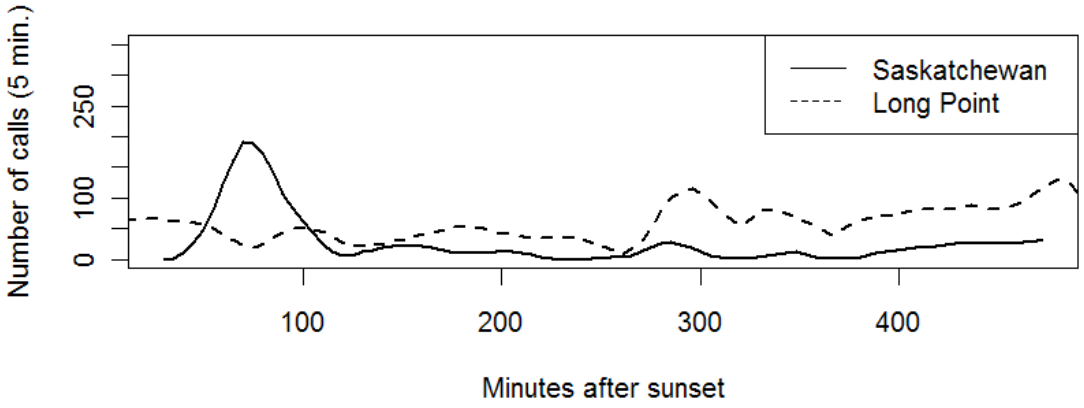
Variation within and among nights



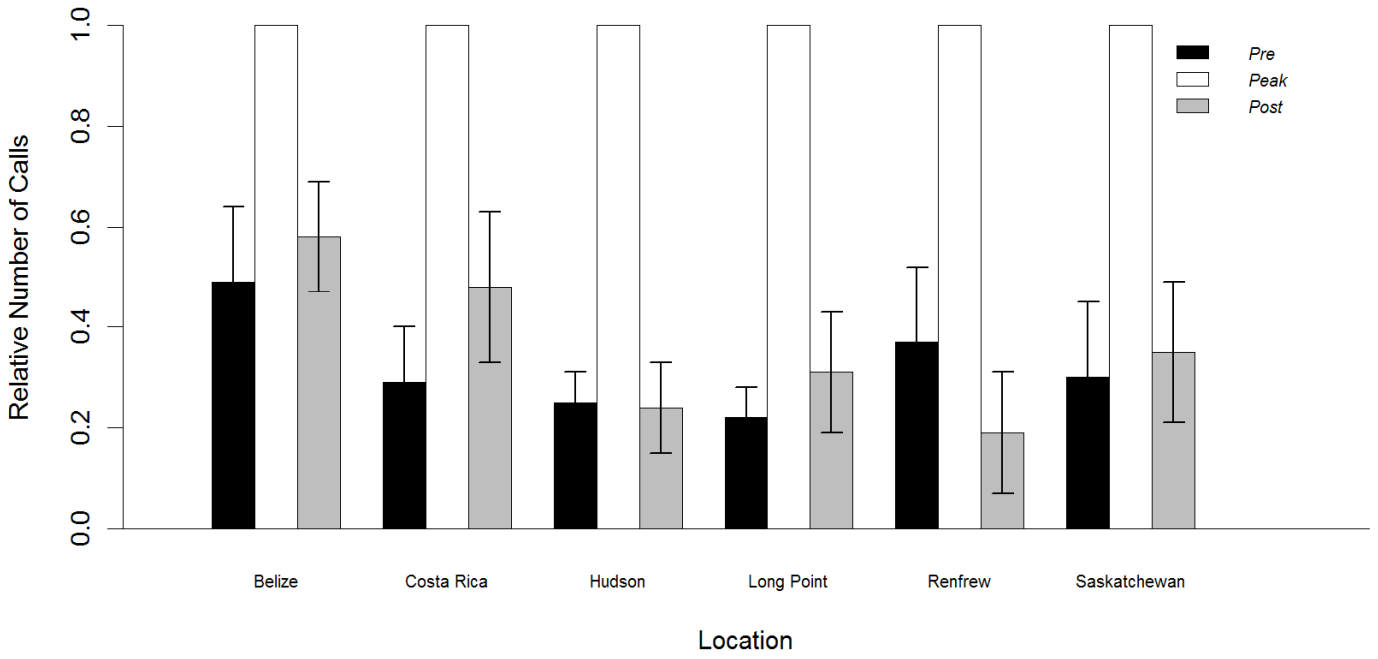
Nightly pattern variation







Short interval variation



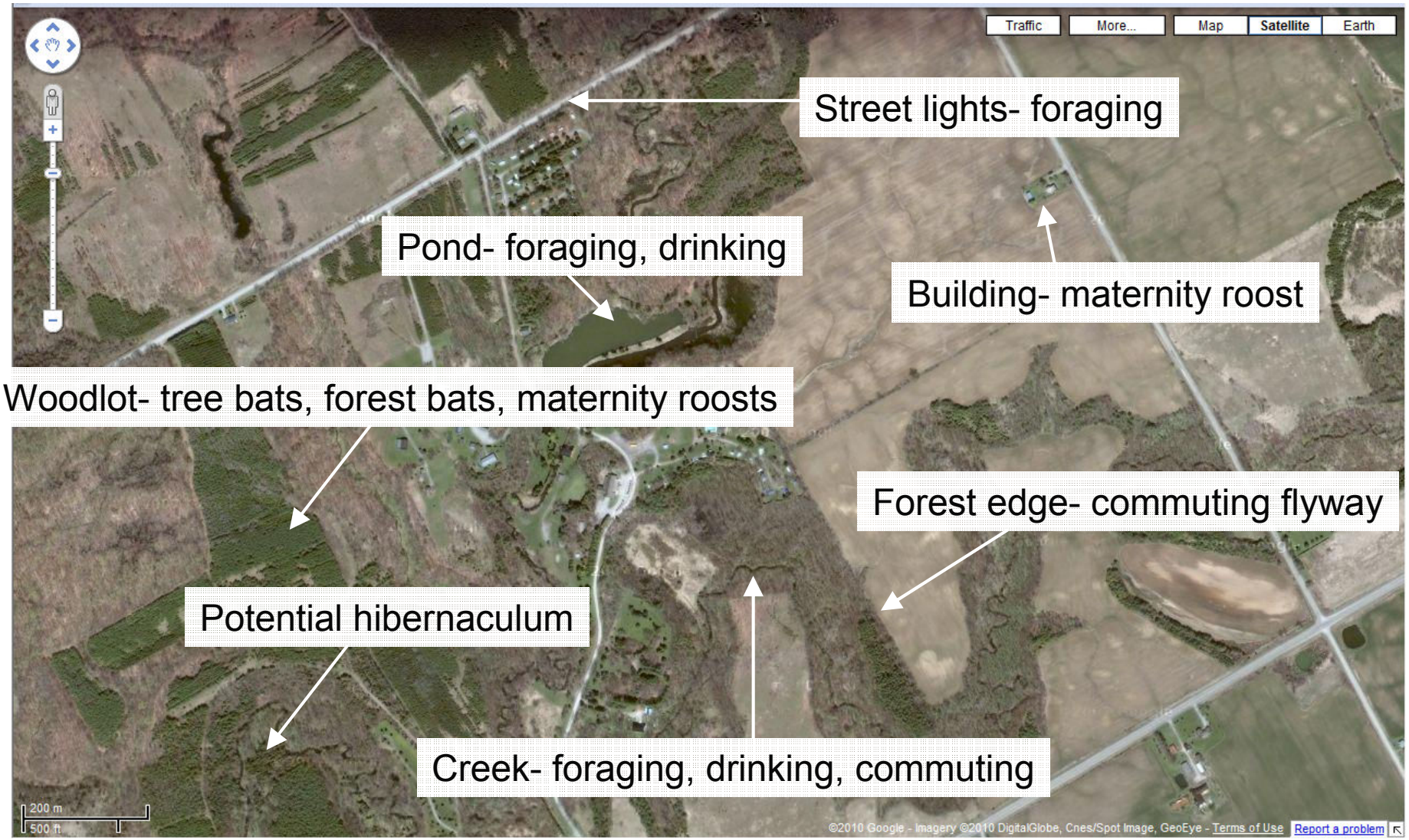
- Variation in activity 5 minutes before and after peak 5 minutes
- Activity may change 40 – 80% in 5 minutes

How many detectors and where to place them?

- Microphone range ~30 m
- Homogenous / heterogeneous habitat
- Bat Conservation Trust (UK):

Survey Area	# Detectors
< 5 ha	2
5 to 25 ha	4
25 to 75 ha	6
75 to 200 ha	8

Spatial Variation- Where to record?



So, where and how long do I have to record for?

- Hours each night, not minutes
  - If you are unfamiliar with the site, all night recording is best to determine the pattern of activity
- Several nights per session
  - Activity may vary dramatically among nights due to weather or even random fluctuation. Hayes (2007) would suggest 7 nights
- Multiple times of the season
  - Summer residency, migration, and swarming should all be considered and timing of each will vary with latitude
- Enough locations to thoroughly sample the area / range of features at your site

That's all very nice, but what about the cost…

- A good survey should be completed in a thorough manner such that all parties involved can be confident that the results present a true picture of bat activity at the site
- Obviously equipment, field personnel, and analysis costs will all factor in as limitations
- Optimal survey design must be determined on a case by case basis, considering all relevant factors
- A good rule of thumb: Would this survey pass peer review?

In the end…

- Riskier to undersample than oversample
- Clearly state assumptions and limitations in report