# Bat Mobile Acoustic Surveys: an overview of the mobile survey protocol and proposed adaptations for Western landscapes

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## Getting Started

- If you are currently conducting stationary monitoring continue with that methodology – we don't want to shift survey methods right before WNS really hits.
- If you have the capacity to add effort (you can maintain existing stationary monitoring) and are wondering if it would be better to add more stationary surveys or mobile routes, it would be good to start doing mobile surveys.
- It would be great if mobile surveys could be coupled with existing stationary surveys. This makes a lot of sense for locations with year–round acoustic monitoring for WNS and may help lower the bar logistically if you are already visiting a site to deploy or service equipment.
- When selecting cells for mobile surveys, choosing those that you think will be able to be surveyed for multiple years is a higher priority than selecting by GRTS cell number. Essentially, it is better to select routes that you think can actually be done regularly rather than follow GRTS order if that would make it more difficult to sample for multiple years. If the logistics are equivalent, then following the GRTS cell order (lower number is higher priority) is best.

## How do you conduct a mobile acoustic survey?

- The North American Bat Monitoring Program (NABat) published three protocols that thoroughly describe the process of conducting mobile acoustic surveys, including how to select a route, when to conduct surveys, and how to actively perform surveys.
- While this guidance works well overall for areas with dense road networks, in regions with few road options, like much of the western part of the continent, the protocol needs to be adapted to meet logistical constraints in the field.
- Below is a breakdown of the current guidance, its purpose, challenges encountered, and suggested updates or questions about how the protocol can be adapted to meet the challenge.

### Full Protocol Breakdown

current guidance, purpose, challenges, and suggested updates and discussion points

*Identifying a Route*

- Selecting GRTS cells

- *Current Guidance*

  The North American Bat Monitoring Program (NABat) uses a master-sample concept with multiple grid-based sample frames that cover the United States, Canada, and Mexico (Loeb and others, 2015; Reichert and others, 2021). Each of the sample frames are composed of 10×10 kilometer (km) grid cells as sample units. Every grid cell is assigned a priority ranking based on the Generalized Random Tessellation Stratified design (GRTS), termed GRTS ID. GRTS ID serves as a guide to selecting survey locations where lower GRTS IDs indicate higher priority cells. Following GRTS priority ranking order when selecting grid cells to survey ensures that sampling is spatially balanced (Larsen, Olsen, and Stevens, 2008).

  - In the NABat Partner Portal, apply a geographic filter to the GRTS map to narrow down your specific region of interest (e.g., jurisdictional boundaries
  - Sort the GRTS cells by priority order (lower numbers indicate higher priorities)
  - Evaluate the GRTS cells according to priority. If a cell cannot be surveyed due to access issues or other constraints, mark it as such and go on to assess the next cell.

- *Purpose*

  Evaluating and surveying cells according to their GRTS priority number ensures a random and spatially balanced sample that is more powerful for statistical analyses.

- *Challenges*

  With an emphasis on sampling "priority" GRTS cells, some have interpreted this to mean that sampling only those cells is valuable.

- *Clarification/Updates/Discussion Points*

  Clarify that the GRTS cell selection method is just a process for selecting cells to maintain unbiased spatial sampling. This method is often useful for users who have large areas under their jurisdiction (e.g., a forest with tens of thousands of acres) and limited capacity to conduct surveys. However, for users sampling a smaller area or with a specific research question in mind that prevents the implementation of the evaluation methodology outlined here, the data are still immensely valuable for our understanding of bat ecology at the landscape scale.

  If a project cannot follow the GRTS cell selection method, simply indicate this when setting up a project in the NABat Partner Portal.

The takeaway is that all data are valuable and can be uploaded to the Partner Portal—it is just important to specify whether the spatially balanced cell selection method was followed for downstream modeling.

It is fine for a survey transect to span multiple GRTS cells as long as a transect runs for greater than 500 m in any given cell.

*Safety Considerations*

- *Current Guidance*

  The route must be safe to drive at 20 mph with minimal stopping:
  - Avoid routes with heavy traffic volume during the survey time, such as interstate highways or roads within a large city center, as this will require pulling off the road to let other vehicles pass or endanger the surveyor and other drivers as they try to pass the survey vehicle.
  - Avoid obvious u-shaped roads on the map, which are too curvy to drive safely while maintaining the recommended speed.

  Start and end: verify that there will be a pull-off area or other safe location at the start and end of the transect to allow for assembling and disassembling the equipment on site.

- *Purpose*

  Driving at 20 mph enables the assumption that each detected bat sequence is independent

  Avoiding routes with heavy traffic and avoiding windy roads is both for the safety of the surveyor and to maintain a consistent speed throughout the survey.

  Having a space to pull off to set up and take down equipment is for the safety of the surveyors.

- *Challenges*

  In rural areas, some roads in a GRTS cell may not allow a vehicle to drive consistently at 20 mph due to lack of maintenance, substrate, grade, and other factors. Sometimes it is only possible to drive at 10-15 mph.

- *Clarification /Suggested Updates/Discussion Points*

  It is unlikely that a bat will follow a vehicle and as long as the relationship between the number of sequences recorded and abundance is constant, driving speed has little impact on statistical analysis.

It is fine to drive as slow as 10 mph and for speed to vary throughout a transect. First and foremost is the driver's safety.

*Road Types*

- *Current Guidance*

  Where possible, utilize secondary (for example, provincial highways and county roads) or tertiary roads (for example, county and forest roads). Suburban residential areas can usually be surveyed.

  Avoid very rough roads (for example, degraded paved roads with numerous potholes, unmaintained gravel/dirt roads) if possible. Some gravel and dirt roads that are well maintained and allow consistent travel at 20 mph can be used. Since gravel and dirt roads tend to generate more noise and have the possibility of reducing the quality of recordings, it is recommended to utilize well-maintained paved roads when possible.

  Avoid known flood zones as these roads may become unavailable or unsafe during the rainy season. Note that surveys should be completed on nights without rain.

- *Purpose*

  Traveling on secondary or tertiary roads and avoiding known flood zones are for the safety of the surveyor when consistently traveling at 20 mph.

  Rough roads often require a vehicle to travel slower than 20 mph and reduce the quality of recordings.

- *Challenges*

  In remote areas, unmaintained dirt or gravel roads are often the only roads available for survey.

- *Clarification /Suggested Updates/Discussion Points*

  It is unlikely that a bat will follow a vehicle and as long as the relationship between the number of sequences recorded and abundance is constant, driving speed has little impact on statistical analysis.
  A directional microphone is necessary for collecting quality call recordings when conducting a mobile acoustic survey. This will limit noise from the road and improve recording quality.

If a user only has an omnidirectional microphone, we recommend using a pole to raise it away from the road and/or adding a sound barrier to reduce the impact of the noise, which will improve recording quality.

*Route Configuration*

- *Current Guidance*

  Transects should be 15–31 mi in length, with most of the route (~85%) contained within a single grid cell (100 km2). However, if this is not possible due to the recommended route length or limited availability of suitable roadways, it is acceptable for a route to pass through multiple grid cells.

  The transect should never cover the same section of road twice.

  Any two sections of a transect should be at least 100 m apart. This is to avoid sampling the same area more than once when curving or turning along the route, assuming that a detector with a 100-m detection range is being used.

  The transect should spread out in the grid cell as much as possible.

- *Purpose*

  This guidance aims to confine a survey route to a single GRTS cell as much as possible, survey as much of the cell as possible, and avoid double sampling an area.

- *Challenges*

  In many remote areas and on a lot of public lands, there are very few roads that meet the survey requirements, making it very difficult or nearly impossible to identify routes that are 15–31 miles long and are mostly within one GRTS cell.

  In some instances, traveling through a series of switchbacks is necessary when sampling areas with large elevational gradients (e.g., mountains and canyons).

- *Clarification/Suggested Updates/Discussion Points*

  Emphasize that when confining a 15–31 mile route to a single GRTS cell is not possible, it is entirely acceptable for a route to go through multiple GRTS cells.

  The suggestion that a route sample as much of a GRTS cell as possible is a recommendation, not a requirement.

The analytical models are robust to slower speeds and switchbacks (even multiple switchbacks for a given route), assuming that, on average the same bat is not counted three times.

Transects should be longer than 6.5 miles (10 km). Shorter transects are not recommended because this limits the opportunity for call detections.

*Habitat Types*

- *Current Guidance*
  The transect should traverse all common habitat types within the cell when possible (Schimpp, Li, and Kalcounis-Rueppell 2018; Li, Parker, and Kalcounis-Rueppell 2019; Fisher-Phelps, Schwilk, and Kingston, 2017).

  Avoid areas dominated by densely forested corridors or where the vegetation canopy is low hanging. These conditions increase the chance of collecting lower quality calls due to the interference of clutter. Aim to maintain at least 3 m between the vehicle and the overhanging canopy.

- *Purpose*
  The guidance to survey all habitat types aims to sample as much of the bat biodiversity as possible.

  Avoiding densely forested areas is intended to maintain high recording quality.

- *Challenges*
  Sampling all habitat types in a GRTS cell is not possible for those GRTS cells with limited road access.

  Some GRTS cells are comprised entirely or primarily of dense forests.

- *Clarification /Suggested Updates/Discussion Points*
  The suggestion to sample all habitat types in a GRTS cell is a recommendation, not a requirement.

*Timing and Access Considerations*

- *Current Guidance*

Avoid roads that will require longer stopping times (for example, longer than 10 minutes) or where sections of the route will be inaccessible, such as:

- Roads with heavy construction.
- Roads segmented by gates, toll stations, and so forth.
- Roads where intersections are regulated by traffic lights instead of a stop sign.

Avoid roads that will require permission to access, such as those occurring on privately owned land or within a permit regulated area (for example, area managed by a State, county, Province, or National Park). If these roads are unavoidable, be sure to obtain the appropriate permission and permits well in advance of the survey season.

- *Purpose*
  Avoiding roads with known long stop times maintains survey consistency.

- *Challenges*
  Many public lands, such as NPS, USFS, and BLM, have gates on roads to control public access.

- *Clarification /Suggested Updates/Discussion Points*
  We suggest removing the stipulation to avoid roads that require permission to access and instead advise that surveyors secure permission for all non-public roads or for scientific sampling where required (e.g., National Parks).

*Selecting survey times*

- Time of year
  - *Current Guidance*
    Surveys should occur during the summer maternity season, after maternity colonies are fully formed and females have completed spring migration, and prior to juveniles becoming volant. As a general recommendation, the period between June 1 through early to mid-July allows for favorable weather conditions, while excluding most migrants and allowing surveys to be completed before juveniles are dispersed on the landscape. However, these dates should be used for reference only and may not be appropriate in every region. Exact dates of migration and volancy will vary by region, elevation, and species, therefore, it is important to account for location-specific variability in climate and species composition when determining the survey period.

During the survey season, each mobile transect should be completed twice, with both runs of a single transect occurring within the same week.

Surveys in subsequent years should occur within 1–2 weeks of the original survey date to maintain consistency in both the bat's life cycle stage and the overall weather conditions.

If conducting stationary acoustic surveys in the same year and within the same sampling grid, the timing of mobile transect surveys should overlap with that of stationary surveys whenever possible.

- *Purpose*
  By sampling during the period after migration and before pups start to fly, the survey is evaluating the adult population. Juveniles have a higher rate of mortality and estimates including their numbers will be more variable.

  Surveying a route twice in one week allows for the quantification of sampling variation and accounting of 'random' effects, which influence the spatiotemporal distribution of bat activity.

  By surveying at a consistent time of year, relative abundance metrics can be compared over time. If two surveys sample different populations (one pre-volancy and another post-volancy) this will have to be accounted for statistically (will use more degrees of freedom) and will consequently require more data (more surveys or more years of surveys) to parse out any changes in relative abundance.

- *Challenges* – None identified

- *Clarification /Suggested Updates/Discussion Points* – None needed

- Time of Night
  - *Current Guidance*
    Surveys should be conducted during peak activity times for bats within your study area to maximize detection of echolocating bats. For most locations, peak activity times occur early in the night within approximately two hours after sunset. The exact start time for a mobile transect survey is highly dependent on the location of the study area and behavior of the local species assemblage.

Once a start time has been determined, it is imperative that replicates of the same transect begin at the same time, both within and between years.

- *Purpose*
  Surveying during this time captures the greatest amount of bat activity.

  Consistent survey timing both at the scale of the time of year and the time of night ensures that surveys are sampling the same population (ideally post-migration and pre-volancy) at the same activity level.

- *Challenges*
  In some instances, a survey route might be a considerable drive for surveyors, and conducting multiple surveys is more logistically feasible. This would require flexibility in when surveys are conducted and might fall outside of the period with the greatest levels of activity.

- *Clarification/Suggested Updates/Discussion Points*
  We recommend starting a mobile acoustic survey at a time that is optimal for bat emergence in your area (considering latitude, elevation, etc.) and then consistently surveying at that time across surveys and years.

  While there will be some natural variation in bat activity and surveys might vary slightly in whether they capture peak activity, by consistently sampling at the same time of year and night, this variation will be limited.

*Survey Conditions*

- *Current Guidance*
- Ideally, surveys should be conducted on nights that are clear of clouds and lack wind.
  - Survey when the temperature is above 50 degrees Fahrenheit
  - Do not survey on nights with rain
  - Do not survey in dense fog
  - Do not survey when the wind exceeds 6 mph
  - Do not survey in heavy smoke. If there is light smoke and it is safe to do so, surveys may proceed.

- *Purpose*
  - Bat activity decreases below 50 degrees Fahrenheit.
  - Bats are less active in the rain and recording quality is negatively impacted by rain.
  - This is for the safety of the surveyor.

- Bat activity decreases as wind speed increases. Recording quality can also be negatively impacted by higher wind speeds.
- For the safety of the surveyor.

- *Challenges* – None identified

- *Clarification/Suggested Updates/Discussion Points* – None needed