

# **North American Bat Monitoring Program (NABat) Mobile Acoustic Transect Surveys Standard Operating Procedure 1—Locating and Establishing Mobile Transect Routes**

Chapter 1 of  
Section C, Collection of Data Associated with the North American Bat Monitoring Program (NABat), of  
**Book 2, Collection of Environmental Data**

Techniques and Methods 2–C1



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Bethany Straw, and Brian Reichert

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## Conversion Factors

International System of Units to U.S. customary units

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
Length		
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
Velocity		
kilometer per hour (km/h)	0.6214	mile per hour (mph)

## **Abbreviations**

GIS	geographic information system
GPS	Global Positioning System
GRTS	Generalized Random Tessellation Stratified design
NABat	North American Bat Monitoring Program
SOP	standard operating procedure
USGS	U.S. Geological Survey

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## Abstract

This document is the first of three standard operating procedures (SOPs) providing instructions and considerations for conducting mobile acoustic surveys along road transects to collect bat acoustic data following the North American Bat Monitoring Program (NABat) protocol and sample design. This SOP focuses specifically on selecting NABat grid cells and establishing mobile transect survey routes using online tools available through the NABat Partner Portal. Intended audiences for this document include those in charge of facilitating surveys within their region (for example, State or provincial managers, and NABat regional hub coordinators), and project leaders or survey coordinators responsible for setting up and organizing NABat mobile transect monitoring for their organization or area.

## Introduction

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). This SOP includes

(1) guidance on how to evaluate and select cells for survey using the NABat Partner Portal (<https://sciencebase.usgs.gov/nabat/#/home>), (2) methods for establishing a mobile transect route within a selected grid cell, (3) step-by-step directions for how to submit route information through the NABat Partner Portal, and (4) steps for verifying the suitability and practicality of a proposed mobile transect route. [Figure 1](#) illustrates the workflow for locating and establishing mobile transects.

## Selecting NABat Grid Cells

Use the following steps to evaluate and select grid cells for survey within the NABat Partner Portal using the Cell Selection Tool:

1. Log in to the NABat Partner Portal (<https://sciencebase.usgs.gov/nabat/#/home>) and click the “Projects” tab in the top navigation pane to view all projects associated with your user account. If a project has not yet been created for your organization, see <https://www.nabatmonitoring.org/resources> for guidance or contact the NABat Coordinating Office for support (contact information is available at <https://www.nabatmonitoring.org/our-team>). Choose the project for which you wish to select and claim grid cells. When the project homepage loads, click the “Cell Selection Tool” button.
2. Identify the full spatial extent of the area of interest, defined either by political, natural, or artificial boundaries (for example, regional, county, territorial, or federally managed land boundaries). Note that the map will default to the sample frame selected when the project was created.
  - Users can apply spatial filters based on geographic or jurisdictional criteria (for example, State, county, territory, land management agency, and so forth) and locate cells by providing a specific GRTS ID (if known) or geographic coordinates using the search box above the map. To apply multiple filters, begin by searching for and selecting an initial filter. This

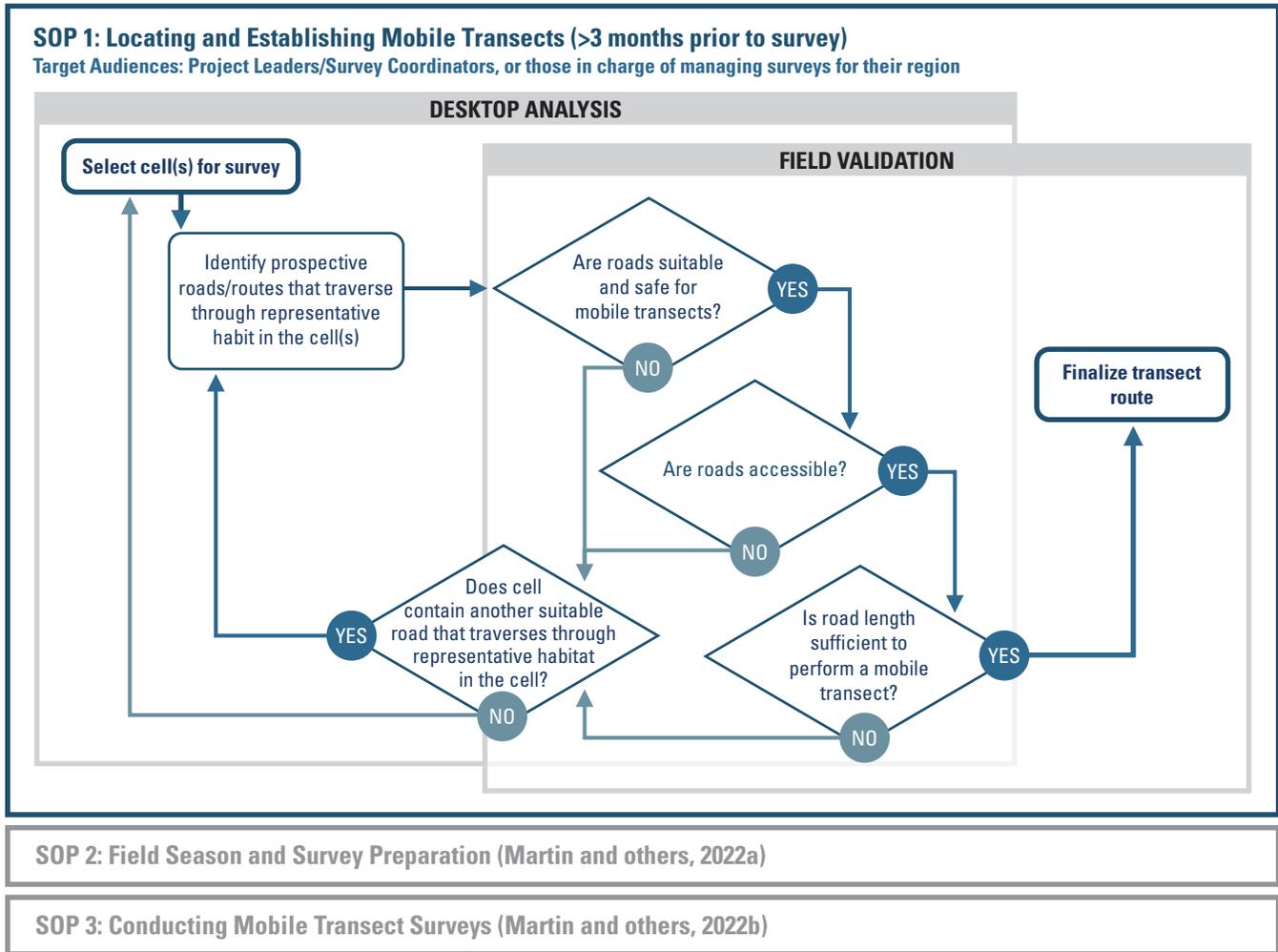
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**Figure 1.** The workflow for locating and establishing mobile transect routes, as detailed herein. SOP, standard operating procedure. Refer to SOP 2 (Martin and others, 2022a) for field season and survey preparation and SOP 3 (Martin and others, 2022b) for conducting mobile transect surveys.

- will reveal the “Advanced” search button (button icon resembles gears) which allows users to apply multiple filters using logical operators AND and OR. Apply additional filters by searching for the filter using the search box and dragging the filter to the appropriate logical operator. Alternatively, users can define a custom area of interest by using the drawing tool (button icon resembles a polygon).
  - The Cell Selection Tool map includes several layers to assist users in locating desired cells. Hover your mouse over the layers button to explore the available options (“Topographic,” “Imagery,” “NABat Priority Cells,” and so forth). Note that layers are not limited to your search criteria. Rather, they serve as map overlays to assist users in visualizing relevant spatial information.
  - Users may view which cells within their area of interest, and which monitoring type (for example, stationary acoustic surveys, mobile transect acoustic surveys, and so forth), have been selected for survey by another project. Users can also see if data have been uploaded for those cells in the last two years. These layers can be toggled on or off by checking the appropriate box in the filter card.
- Once the area(s) of interest are selected on the map, users can double-click individual cells to add them to the evaluation table, located to the right of the map, or click the “Apply!” button to add all highlighted cells to the table. If a custom area of interest was defined using the drawing tool, these cells will be automatically added to the evaluation table.

4. The final list of cells in the evaluation table should only include those which are relevant to your project (for example, all cells within your jurisdictional boundary, study or project area). After cells are added to the table, they must be evaluated by the user using the following steps:

- To begin, specify which type of surveys you intend to perform within your filtered cells by checking the appropriate box or boxes in the “Select Survey Types” card, located above the evaluation table (fig. 2). Users can make multiple selections.
- Next, sort cells within the evaluation table by their GRTS Cell ID to locate the highest priority grid cells (lower GRTS Cell ID = higher priority). To do this, use the arrows in the header of the GRTS Cell ID column to sort the GRTS cells in ascending order. Users should select cells for their survey(s) beginning with the highest priority cell (lowest GRTS Cell ID) and working down the list, selecting as many cells to survey as is feasible.

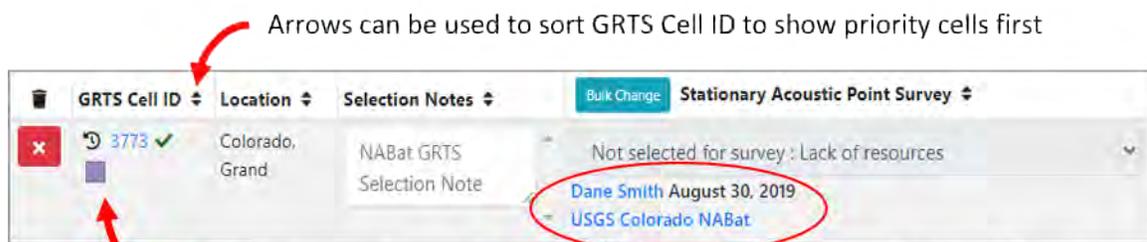
- If there are one or more colored boxes in the GRTS Cell ID column, this indicates that the cell is already selected for survey. The color of the box indicates the type of monitoring currently being conducted within that cell. The name of the project that has selected that cell for survey and the project leader will be listed in the column pertaining to the survey type (figs. 2 and 3). Contact information for project leaders can be viewed by clicking the name of the project leader or project name. To avoid duplicating efforts, users are encouraged to contact project leaders for other projects within the same area to establish who is responsible for surveying cells, including cells occurring on boundary lines, and identify if multiple organizations are monitoring bats within the same area.

5. Next, within the evaluation table, and beginning with the highest priority cell that is available to select for survey (lowest GRTS Cell ID), examine the properties of the cell to determine if it will be feasible to survey. This will depend on several factors such as the accessibility of the cell, availability of adequate resources to survey, suitability of the cell for survey as detailed in table 1 below, and so forth. Once you have thoroughly examined a cell, use the drop-down menu to indicate your intent to survey the cell, or if the cell cannot be selected for survey, provide this information along with the reason why it will not be surveyed. Repeat this step for all available cells in the evaluation table (fig. 4). The “Bulk Change” button can be used to simultaneously change the status of all grid cells, or just priority grid cells.

6. When all cells in the table have been evaluated, click the “Save” button. Return to the project homepage by clicking the “Back to Project” button. All cells selected for survey will now appear beneath the map on your project homepage.



**Figure 2.** The North American Bat Monitoring Program (NABat) Cell Selection Tool's legend of monitoring types. Users must select the type of monitoring they wish to conduct to evaluate grid cells and select them for monitoring.



Arrows can be used to sort GRTS Cell ID to show priority cells first  
 Box indicates that monitoring is currently being conducted within cell. In this example, monitoring includes a stationary acoustic point survey.

**Figure 3.** An example row from the North American Bat Monitoring Program (NABat) Cell Selection Tool's evaluation table. The red arrows show the sort column function and colored box indicating the cell has been claimed by another project. The red circle indicates the link to additional information about the owning project. GRTS, Generalized Random Tessellation Stratified design; NABat, North American Bat Monitoring Program; USGS, U.S. Geological Survey.



**Figure 4.** An example row from the North American Bat Monitoring Program (NABat) Cell Selection Tool's evaluation table. The red arrow indicates the drop-down menu which allows users to evaluate grid cells (select for survey or provide a reason for not surveying). GRTS, Generalized Random Tessellation Stratified design; NABat, North American Bat Monitoring Program.

## Establishing Transect Routes

There are two ways to establish a mobile transect route through the NABat Partner Portal: (1) drawing and saving the route directly to the project map or (2) uploading the route as a .kml or .geojson file. If you are uncertain of the final configuration of a mobile route, it can be useful to perform a preliminary mapping of the route within the NABat Partner Portal prior to going out into the field (see “Drawing Mobile Transect Routes” in this report). The Partner Portal contains a built-in map to facilitate the discovery of roads and allows you to draw a potential route. The route can be redrawn at any time or replaced by uploading the final route via a .kml or .geojson file (if uploading the final route, the preliminary route must be deleted by the user to avoid duplicate transect routes being saved to the project). Alternatively, you may skip the preliminary mapping effort and upload the route directly to the Partner Portal (see “Uploading Mobile Transect Routes” in this report).

Regardless of how the mobile transect route was established within the Partner Portal (for example, drawn or uploaded), a .csv file containing the metadata must be uploaded to the Partner Portal after the completion of surveys along the transect route, and collection of data and metadata (for example, call files and information about the route and survey). It is imperative that the “Location Name” field within the metadata .csv file being uploaded matches the transect name provided when drawing or uploading the route exactly. The Partner Portal will automatically match metadata from recorded bat echolocation, or calls, to the transect route based on the value provided in the “Location Name” field. More detailed guidance on uploading mobile transect metadata is available at <https://www.nabatmonitoring.org/resources> or by contacting the NABat Coordinating Office (contact information is available at <https://www.nabatmonitoring.org/our-team>).

## Drawing Mobile Transect Routes

1. Log in to the NABat Partner Portal (<https://sciencebase.usgs.gov/nabat/#/home>) and click the “MY PROJECTS” tab in the top navigation pane to view all projects associated with your user account.
2. Select the project for which you wish to establish a transect route(s).

3. Scroll down to the map (just below the project details) and use the search bar at the top of the map to locate the desired grid cell(s).
4. Select the desired map layer from the options provided in the map layers button. In most cases, the “Imagery” layer will provide the best representation of habitats and landscape features while the “Open Street Map” provides insight into road configurations for selecting transect routes. Overlays of surface management agency boundaries can be added by hovering the mouse over the map layers button and selecting the desired layer.
5. Evaluate the suitability of roads within the target grid cell(s), referencing the criteria mentioned in [table 1](#) below, to identify the desired location for the mobile transect route.
6. When a suitable location is identified, click the “Mark a transect route” button. Click to mark the starting point of the transect and continue to click along the length of the route. The mapping tool will drop points with each click and connect the points with a line. It will also display the total length of the route.
7. Click “Finish” beside the “Mark a transect route” button, or click the last point on the route, to complete the route.
8. A dialogue box will appear. Click the green “Edit” button to name the route (see “Establishing Transect Routes” in this report), provide a description, and use the drop-down menu under “Survey Type” to indicate that the object is a transect route.
9. Preliminary transect routes can be drawn, saved, and exported from a user's NABat project homepage in .kml or .geojson formats for use with handheld Global Positioning System (GPS) devices by clicking on the “Download KML | GeoJSON” button (located on the project homepage, in the map).

After the preliminary selection, a map and turn-by-turn guide should be generated for field staff conducting the mobile acoustic transect survey. In the turn-by-turn guide, each segment length and accumulative length can be estimated, and the road name and intersection type should be noted.

**Table 1.** Considerations for establishing a mobile acoustic transect route.

[Modified from Loeb and others (2015); Li and Kalcounis-Rueppell (2018). mph, miles per hour; km, kilometer; mi, mile; ~, approximately; %, percent; km<sup>2</sup>, square kilometer; m, meter]

Considerations for Route Selection
Safety Considerations
<ul style="list-style-type: none"> <li>• The route must be safe to drive at 20 mph with minimal stopping:               <ul style="list-style-type: none"> <li>o 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.</li> <li>o Avoid obvious u-shaped roads on the map, which are too curvy to drive safely while maintaining the recommended speed.</li> </ul> </li> <li>• 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.</li> </ul>
Road Types
<ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> </ul>
Route Configuration
<ul style="list-style-type: none"> <li>• Transects should be 15–31 mi in length, with most of the route (~85%) contained within a single grid cell (100 km<sup>2</sup>). 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.</li> <li>• The transect should never cover the same section of road twice.</li> <li>• 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.</li> <li>• The transect should spread out in the grid cell as much as possible.</li> </ul>
Habitat Types
<ul style="list-style-type: none"> <li>• 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).</li> <li>• 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.</li> </ul>
Timing and Access Considerations
<ul style="list-style-type: none"> <li>• 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:               <ul style="list-style-type: none"> <li>o Roads with heavy construction.</li> <li>o Roads segmented by gates, toll stations, and so forth.</li> <li>o Roads where intersections are regulated by traffic lights instead of a stop sign.</li> </ul> </li> <li>• 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.</li> </ul>

## Uploading Mobile Transect Routes

After conducting a preliminary mapping of the transect route, a test drive should be performed (see “Performing a Test Run of the Transect” in this report). During the test run, a GPS device should be used to record the exact route. This information can be uploaded directly to the user’s NABat project page as a .kml or .geojson file and saved as a spatial object as described in steps 1 and 2 below. If the file collected using GPS is not in .kml or .geojson file format, it can be easily converted using free online conversion tools. Once the file has been converted, follow the guidance below:

1. Log in to the NABat Partner Portal (<https://sciencebase.usgs.gov/nabat/#/home>) and click the “Projects” tab in the top navigation pane to view all projects associated with your user account. Select the desired project. Scroll down to the map, located just below the project details.
2. Click on the “KML | GeoJSON” button in the top right of the map. Navigate to the desired .geojson/.kml file and click “Open.”
3. The route will display on the map with a dialogue box. Click the green “Edit” button to name the route (see “Establishing Transect Routes” in this report), provide a description, and use the drop-down menu under “Survey Type” to indicate that the object is a transect route.
4. If a preliminary route was drawn directly within the Partner Portal, this route will need to be deleted to avoid duplicate routes being associated to the project.

For users who wish to conduct cell selection and spatial analysis using geographic information system (GIS) software, the NABat master sample can be downloaded as a shapefile or pulled directly into your GIS software as a web mapping service (<https://www.sciencebase.gov/catalog/item/get/5b7aec2ce4b0f5d578845c90>). This method can also be used to map mobile transect routes via GIS. Please note that each grid cell’s GRTS ID can be found under the GRTS\_ID column in the attributes table.

## Performing a Test Run of the Transect

To verify the suitability and practicality of a proposed mobile transect route, the hub or survey coordinator, along with the field staff performing the actual survey if possible, should run a test prior to the survey season. Staff may prefer to conduct an initial test run during the day as increased visibility of the route may make it easier to confirm route configuration and identify factors, such as clutter along the route, that are likely to impact route suitability. If possible, an additional test run should be performed by the field staff during the same time of day as the actual survey. This will allow field staff to better understand the safety and practicality of running the route with limited visibility and help prepare them to drive the route under similar conditions as the actual survey. During

the test drive, field staff should verify the accuracy of road names and transect segment lengths in the turn-by-turn guide. A GPS device should be used to record the final transect route for upload to the NABat Partner Portal following the guidance above. The considerations listed in [table 1](#) of this document can assist you in confirming the suitability of the route.

## Reevaluating Proposed Transect Routes

If, after performing a test run, you find that all or parts of the mobile transect route are unsuitable for conducting a mobile acoustic survey, proceed with the following steps:

1. Return to the Partner Portal’s Cell Selection Tool to reevaluate grid cells that were previously selected for survey.
2. If you determine a grid cell is no longer suitable for survey, use the drop-down menu to update your intent to “Not selected for survey” and provide the reason you will not survey the cell (for example lack of resources; [fig. 4](#)). This will release the cell, allowing another project to select it for survey.
3. If necessary, repeat the steps listed in the “Selecting NABat Grid Cells” section of this report to select new grid cells for survey.
4. Click the “Save” button to update your selections. Click the “Back to Project” button to return to your project’s homepage.
5. To delete an existing mobile transect route, click on the route within the map on your project’s homepage and click the “Delete” button. Remap the route by following the guidance above in the “Establishing Transect Routes” section of this report. Repeat the steps above to verify the suitability of the route.

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