Planning a mapping route

It is extremely difficult to map even small broods in their entirety, so you must carefully prioritize your mapping effort. It is not always easy to know where to start, but existing maps are reasonable predictors, and known collecting localities are good starting points.

Note that –decim species choruses are strongest in the mornings, while –cassini species choruses are stronger in the afternoons. Weak –decim choruses can be difficult to hear from a moving car or if there is a lot of ambient noise (highways, construction, mowing, etc.). Take these factors into account—under poor conditions, you will need to think carefully about planning your route—and you'll also need to be careful about estimating population densities or collecting negative records. If the weather cooperates, you can map from dawn until dusk

Here are some suggestions for planning a mapping route. These suggestions are based on the methodology described in (Cooley et al. 2013).

1. Use the maps on www.magicicada.org , records in the Cicada Central database (see **Appendix 9**), or a GPS navigator (see **Appendix 4**) to find areas of emergence and to keep track of how long cicadas have been out in any given area.
2. **If possible, begin and end each day with a positive record!** Each day, when you start mapping, you should go to an area where *Magicicada* are known to be present. Note the time, weather and temperature conditions, etc., and whether the cicadas are singing. You should return to known emergence locations (positive records) throughout each day (e.g., don't spend an entire day just obtaining negative records), and you should end each day by visiting an area of emergence.
3. If the cicadas are not singing (e.g., it is raining, cold, etc), you can still obtain records, though the process will be slow. Since negative records taken under poor conditions can be questionable, under poor conditions you should concentrate on visually locating areas of dense emergence (searching for adults, shed skins, etc.). You

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can also use periods of poor conditions to drive long distances to other mapping areas. Use the web to obtain current weather predictions.

4. If the cicadas are singing, then attempt to crisscross or "stitch" the brood boundary by driving slowly back and forth across the boundary, collecting both positive and negative records at 1/10 mile intervals (the trip odometer in some cars can be helpful here, as it may display 10ths even if the regular odometer does not). **Negative records are just as important as positives!** You can typically hear a *M. tredecassini* chorus from a closed vehicle at highway speeds, and extremely dense *M. tredecula* choruses can also be heard at speed. However, -decim choruses have a pitch that is closely imitated by the tread patterns on some car tires or by the alternators of some cars. For all but the strongest -decim choruses, or when mapping in the afternoon, you may need to stop your vehicle and turn off the engine. You don't need to fully stop the car or turn off the engine for every record, but you will need to do so on a regular basis.
5. You should also consider stopping occasionally to take voucher photographs, recordings, and specimens. If you are collecting for genetic studies, plan to make at least a few large (ca. 100+ decim, other spp. if possible) collections stored frozen (dry ice or nitrogen) or in 95% ethanol for later genetic analysis. Clearly label all vouchers!

What to look for

Most literature makes note of the extreme densities typical of *Magicicada* (e.g., Dybas and Davis 1962). In reality there are shades of gray—periodical cicadas emerge as single individuals, light density choruses, and full choruses. These kinds of emergences are qualitatively different; single individuals seem to be stragglers, or off-cycle cicadas; low-density emergences may occur because of extinction or straggling, and high density emergences seem to have shaped much of cicada biology and behavior. Mixing these types of records is one reason that older emergence maps often suggest that the geographic extent of certain broods was once much larger than at present—stragglers or off-cycle

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emergences adjacent to an emergence tend to give an inflated impression of a brood's geographic extent (Marshall 2001).

When periodical cicadas accidentally accelerate, or "straggle," they tend to do so in increments of ±1 or ±4 years. Straggling may be a source of confusion about brood boundaries since stragglers from one brood may be mistaken for low-density populations of another. **Thus, it is especially important to collect density information.** Beware that the timing of the emergence may affect your perceptions—choruses develop after adults emerge in large numbers, and choruses eventually die out, though individuals dwindle on.

The information below can help guide you in categorizing an emergence. As with any attempt to come up with simple categories, there will be situations that don't seem to fit well into this scheme. That's OK—take notes as you go, and if you find a situation that doesn't seem to fit, take especially detailed notes, photographs, recordings, etc..

1. **No cicadas present.** No physical evidence of cicadas, and no songs heard. Negative records based on lack of songs must be taken under appropriate conditions in quiet surroundings.
2. **Stragglers.** A single individual ("straggler cicada"), or a very small number of highly localized cicadas. You may find physical evidence of a straggler, such as a single adult, nymph, shed nymphal skin, fragment of an adult (often a wing). More likely, you will hear a single adult singing, or widely scattered adults singing. The individual songs will be clearly audible, and there will be no perceptible background chorus.
3. **Low-density populations.** This category is difficult to define—it's more than a handful of cicadas (category #2), and less than a full emergence (category #4). Low-density populations may consist of a few widely scattered individuals. You may find physical evidence of cicadas such as nymphs, skins, adults, or body parts. If you hear cicadas, you will be able to clearly distinguish individual calls, and there may be periods of silence between calls. As you back away from an area of calling, the calls will not blend together into a uniform chorus, though you may hear

more or less continuous, weak sound. Note that in the absence of other evidence, holes in the ground—even seemingly large numbers of holes—or even turrets—are not reliable evidence for *Magicicada* (though if you find suspicious holes, you should note that you found them).

4. **Full emergence.** Large numbers of nymphs, cast skins, or adults. If you are not at the very beginning or end of the emergence, you should also hear choruses. Large numbers of holes—of a size that you could insert you pinky into—and perhaps even turrets might be visible on patches of open ground. In extreme cases (or on open lawns), there may be piles of dead or rotting cicadas under trees, and the smell might be noticeable. Under appropriate weather conditions (warm, humid, sunny days) singing and flying cicadas will be clearly audible and visible. A full *M. tredecim* chorus will have a constant, tonal drone of about 1.1 kHz; a displaced *M neotredecim* chorus about 1.7 kHz, and an undisplaced *M. neotredecim* chorus about 1.3 or 1.4 kHz. You will be able to hear the individual songs of cicadas that are very close to you, but as you back away from the woods edge, the individual songs will blend together. A full *M. tredecassini* chorus may include synchronized calling and flying, which will be evident by intense waves of sound and periods of movement. A full *M. tredecula* chorus will have a metallic "beat" to it. Note that the relative densities of the species in a chorus will vary significantly, and over surprisingly short distances. An emergence is considered to be a full emergence if at least one species is dense.

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Using the laptop datalogger ("Map-O-Matic").

If you are using the laptop datalogger, as you drive along, use the keypad to enter data according to the following schemes:

For 17-year broods:

	Scattered Individuals	Light Chorus	Full Chorus
M. septendecim	7	8	9
M. cassini	4	5	6
M. septendecula	1	2	3
None Present	0		
Remove Previous	x		
Quit	q		

For 13-year broods:

	Scattered Individuals	Light Chorus	Full Chorus
M. -decim	7	8	9
M. neotredecim	7 /	8 /	9 /
M. tredecim	7 *	8 *	9 *
M. tredecassini	4	5	6
M. tredecula	1	2	3
None Present	0		
Remove Previous	x		
Quit	q		

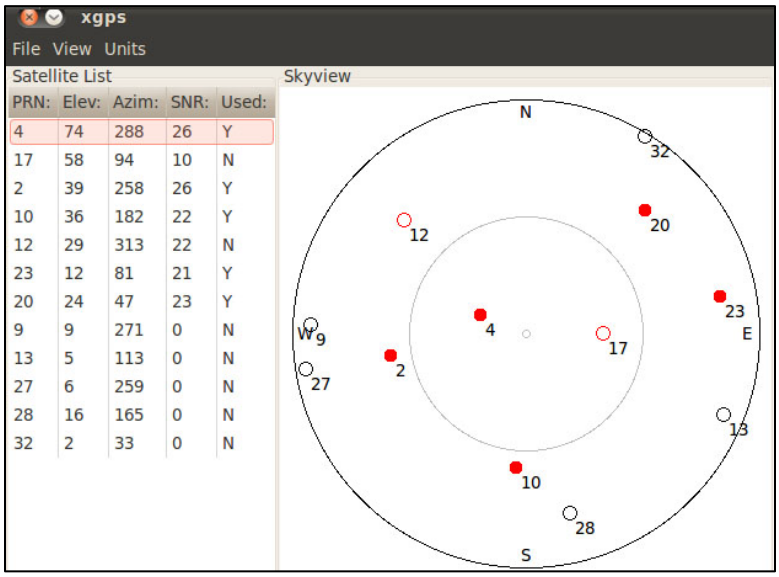
The datalogger will automatically record the time, latitude, and longitude of each keystroke. However, you should occasionally make notes about temperature and weather conditions. To quit the program, type "q". If you pass a chorus in which there are multiple species, make a separate record for each species in quick succession. They won't have the exact same coordinates, but they will be extremely close. When using this device, you should try to collect records on 1/10 mile intervals.

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How to test whether the GPS unit is finding satellites

1) Start the computer and wait for it to finish booting.
2) Place the GPS unit where it can "see" satellites (e.g., outdoors, away from trees)
3) Plug the GPS18 unit in and wait 30 seconds.
4) In a UNIX terminal window, type the command **xgps**

This command will bring up a window much like the screen on a standard GPS, as shown below:



Xgps Home Screen.

Available satellites are listed in the table on the left, while the graphic on the right shows their predicted locations in the sky. **If no satellites appear in the table or in the graphic**, then the computer is not communicating properly with the GPS unit. **If you can see satellites in xgps, then GPSRecorder should work correctly.** *Tip: Hold down the "alt" key to drag the XGPS window up so that you can see lat/lon*.