Questions to Ask Before Installing a Motus station

This document explores some questions that should be considered before installing a Motus station. For more information, see:

- Station hosting guide
- Receiver deployment guide

What is the purpose of this station?

There are a many reasons for installing a Motus station and placement will depend on what you intend to detect. For instance, projects seeking to learn more about movements through a corridor will benefit from having a stations deployed in a manner that creates a 'fence,' detecting any animals that pass through it. In this instance, only two antennas are needed per station to provide useful coverage. However, if the interest is more on the use of a specific habitat or geographic feature, it is better to circle that area with stations or place a single station in the centre. It is seldom necessary to have antennas pointing in all directions since three or four antennas is usually enough to cover the area of interest.

What kind of tags should I use?

There are two types of tags that can be purchased for use with the Motus network: Lotek and CTT. Motus was created around the use of Lotek tags so nearly the entire network is compatible with their frequency and codeset. CTT uses fairly new technology that involves a different frequency and codeset from Lotek therefore most Motus stations are not 'listening' for CTT tags. There is a lot of detail about these two tags that can't all be explored here, but the table below is an attempt to separate each:

	Lotek Nanotags	CTT LifeTags	CTT PowerTags
Manufacturer	Lotek	CTT	CTT
Frequency	150.1 – 166.380 MHz	433 MHz	433 MHz
Tag lifespan	Long (20 – 2000 d)	Infinite	Long (180 d to yrs)
Daily active period	24/7 or alternate 12-hour on/off	Only in direct sunlight (solar powered)	24/7
Tag sizes	0.15 g – 3.00 g	0.44 g and up	~1 g and up
Possible tag IDs	~525	~4 billion	~ 4 billion
Current number of compatible Motus Stations	712	9 (increasing)	9 (increasing)
Can produce false-positive detections?	Yes	No	No
Compatible with CTT Mammal, Eagle, and Vulture trackers	No	Yes	Yes
Price	~$200 USD	~$200 USD	~$200 USD

What type of antenna do I need?

A variety of antennas can be used, but the majority are 9-element Yagis (directional with ~15 km range) and omnis (non-directional with ~750 m range). Both have their pros and cons which depend largely on the research question of interest. In general, though, most questions are best served by the 9-element yagis since they provide the best range as well as directional information. Omni antennas are useful when you only want to detect presence/absence over a small area. For instance, we recommend researchers have at least an omnidirectional antenna near wherever they are tagging their study species. Omni antennas are also cheap ($50-100 USD) and can be used to create a high spatial-resolution network of stations over a small geographic area.
Antenna suppliers:

- Maple Leaf: http://www.mapleleafcom.com/
- Liard: https://www.arcantenna.com/plc1669-laird-yagi-heavy-duty-9-element-antenna-for-166-174-mhz-with-uhf-female-connector-track-migratory-birds.html

While the frequencies we use is good at penetrating vegetation, it's best to have a clear view in all directions you wish to detect. Make sure that wherever you mount the antennas they are high enough to be above any obstruction.

Where does my location sit among other stations in the network?

You will want to pick a site that compliments other stations in your area to maximize the utility of your station and help tackle your study question(s). One tactic employed by the Northeast Motus Collaboration is to build a receiver 'fence' over a geographic area such that any tagged animal passing through it will get detected. In Ontario, where many more stations are available, there is a

grid of stations (or series of fences) to allow for better spatial resolution of movements. In the end, you will need to decide what works best for your region based on migratory flyways, foraging locations, your goals, funding, and the location of nearby receivers.

Is there a building onto which I can mount a tower?

The actual tower structure doesn't matter as much as long as it's strong, elevated enough to provide a clear line-of-sight, and the antennas are not mounted close to sheet metal or other antennas (no closer than ~1 m). The easiest and perhaps cheapest method is to use a pre-existing building on which you can mount a DMX-style structure. Installation can be tricky, but once it's set up there won't be much maintenance. Note your tower will need at least 10 feet of clearance above any roof.

- DMX tower (36'): http://wadeantenna.com/product/36-foot-dmx-bracketed-tower/

For buildings with flat roofs, you can purchase non-penetrating roof mounts:

- NPRM-2: http://wadeantenna.com/product/heavy-duty-non-penetrating-roof-mount/
- Masting: http://wadeantenna.com/product/masting/

In remote locations where there aren't any buildings to attach towers, we use a tripod and mast made by Wade Antenna. These towers must be guyed (3 lines per 10-foot section) and anchored (1 anchor per guy or just 3 strong anchors). These structures are more sensitive to wind and ice than the DMX-style structures so regular maintenance will be necessary.

- Tripod: http://wadeantenna.com/product/10-foot-tripod/
- Mast (40'): http://wadeantenna.com/product/1499/

With all these mounting method in mind, we recommend you contact your local supplier for Wade Antenna to find the best solution for your location.

Can I find reliable AC power supply?

While there are options for setting up stations off-grid, this drastically increases the cost. Adding a solar panel, battery, and charge controller adds at least $500 USD in initial expense, not including the additional troubleshooting time and maintenance costs. If you're able to find a reliable source of AC, that's best. For an off-grid power supply, you will want at least 100-Watt panel for a year-round station with 3 antennas. The battery needs to be a deep-cycle marine battery (24-AGM preferred) with at least 70 Amp-hours (Ah) of storage. As for charge controllers, we use the SunSaver SS-10L-12V: https://www.morningstarcorp.com/products/productssunsaver-gen-3/

Is there internet available nearby?

You can connect Sensorgnome-based receivers (see below) to the internet via Wifi or Ethernet cable. It is valuable to have internet connectivity since this allows for automated data uploads to our servers as well as remote site diagnostics. Internet must be a WPA2-password protected network for Wifi connections.

Is there anyone in my region that can help?

It's worth contacting researchers in your region to for help with station procurement and setup. You can find contact information about individual researchers in your area by going to our receiver map (https://motus.org/data/receiversMap) and selecting the receiver of interest. A popup with information about the receiver will appear – click on the project name to get to the project page. The project page should give you the names and contact of the lead researchers involved. In addition, we recommend you get in touch with local radio experts, such as a ham radio club: https://en.wikipedia.org/wiki/List_of_amateur_radio_organizations

What kind of receiver do I need and where do I get it?

There are two types of receivers compatible with Motus that can be purchased: *Lotek SRX800-D* and *Sensorgnome*

- *Lotek SRX800-D*:
    - Made by the same manufacturer of the tags we use in this network
    - As close to "plug-and-play" as you can get
    - Reliable and robust system
    - Cannot be connected to the internet
    - Proprietary Lotek software with user support provided by Lotek
    - Far more expensive than *Sensorgnomes* (ask Lotek for a quote)
- *Sensorgnome*:
    - Developed at Acadia University in Nova Scotia, Canada
    - Very inexpensive (~$1500 with 4 antennas)
        - Can be built by hand for ~$800, but not recommended for first-time users
    - Can be connected to the internet for automated data downloads and remote diagnostics.
    - Open-source software
    - Compatible with both CTT and FUNcube dongles
        - Can detect either CTT or Lotek tags
    - Can have bugs, but *Sensorgnome* documentation and community are helpful for troubleshooting
- *CTT SensorStation*:
    - Developed by Cell Track Technologies based on the Sensorgnome design
    - Relatively inexpensive ($400 USD base price)
    - Can be connected to the internet for automated downloads and remote diagnostics
    - Open-source software
    - Can detect either CTT or Lotek tags
    - Comes with 5 built-in connectors for CTT antennas
        - An additional 6 USB ports for attaching FUNcubes (to detect Lotek tags) or other peripherals (+$200 per FUNcube)
    - **Newly developed - still in testing stages**

You may purchase these receivers from the following suppliers. Please note that these suppliers are only in North America and you must inform them of the Motus frequency you wish to use.

- *Lotek SRX800-D*:
    - Lotek: http://www.lotek.com/srx800.htm
- *Sensorgnome*:

    - You must inform suppliers of the number of antennas you wish to have attached. Base price is ~$700 and an additional ~$200 for each antenna.
    - Compudata: https://compudata.ca/sensorgnome/
    - RFS Scientific: https://www.rfsscientific.com/
        - If purchasing from RFS, make sure you select FUNcube dongle, not RTL-SDR since the latter model has not been as well tested.
- *CTT SensorStation*
    - CTT: https://store.celltracktech.com/products/sensorstation

I don't live in North America – is this equipment available in my region?

For the most part, all equipment listed here should be available in your region. The only exception are the antennas since these are uniquely tuned to the frequency of tags used in the Motus network. There are two suppliers in North America, not including Lotek. Regardless, it should be possible to ship these items to your location in most cases. If not, we recommend you get in touch with local radio experts to find out what options you have. Receivers will all have to be ordered from North America or built yourself using parts ordered online; however, we strongly recommend against building a receiver if you have no experience with this technology. As for mounting structure and power supply, these items are not unique to Motus and should be available in any region. The exact products may not be available, but it should be possible to find a suitable alternative.