Large Area Imaging / Photogrammetry Underwater Cheat Sheet | Version 2, June 2023
Will Greene, Perry Institute for Marine Science

Checklist of items:
- Camera, fully charged and with an empty memory card, installed inside underwater housing (o-rings checked, greased if necessary)
- Zip ties / weights to make camera neutrally/negatively buoyant. Test this before starting!
- Scale Bars (3 bars is fine)
- Keep on boat: hammer with extra nails and extra markers in case any need to be replaced (unlikely, don't necessarily need to bring these materials underwater – come back and get if needed)
- For revisits: credit card or other non-abrasive item to wipe off any growth on marker
- Optional: floating chains with weights to assist with navigation

If setting up for first time:
- Hammer (ideally 3lb sledge), 1.5-2.5" round fluted masonry nails (16x per plot – 4 per marker)
- Corner markers (1x of each number for each plot, plus extras in case you break any)
- Optional: cement/epoxy to help install markers
- Kickboard setup with fully charged Bad Elf / Garmin GLO2
- Phone and any waterproof case, even the simple zip-lock style ones is fine
- Dive watch with depth measurement set to meters
- Slate to record marker depths
- Optional: compass and/or tape measure to assist with setup

Camera Settings:
- **Manual Mode**, with **aperture set to f8** (should be reduced to f5.6 in deeper plots or with low ambient light), **shutter speed set to 1/320** (should be bumped up to 1/500 in shallow water / intense surge and waves), and **ISO set to Auto**
- Interval mode, 1 photo per second
- Raw + JPEG (large, fine quality) for recording mode
- Single autofocus (focuses on first shot, then remains constant)
- For Nikon DSLR cameras: Autofocus for first shot, then use external switch to lock into manual focus for duration of mosaic. Turn off distortion correction and auto-rotation of images.

Step 1: Set up plot *only if setting up brand new plot*
Start by choosing plot. Standard is 10m x 10m, but flexible to suit various needs. Orient yourself with compass directions before diving. Locate desired plot. Begin by placing marker 1 in the **northeast** corner of the plot. Find a suitable place on the reef to install (Criteria: easily visible from above, not too hard of substrate, i.e. most hard bottom or APAL skeletons, and not on coral head likely to erode / topple, not too close to living coral). The best locations are relatively flat carbonate pavement or on top of dead but very well-attached skeletons of brain / star coral species. Take care while installing nails to not damage round silicone central part of marker. When finished, remove protective cover. **Record depth for marker 1, in meters (usually dive computers record to the nearest 10th of a meter)**. Swim ~10m south, install marker 2, record depth, swim ~10m west, install marker 3, record depth, swim ~10m north, install marker 4 record depth. Optional: place floating chains next to each corner to aid in navigation.

Step 1a: Locate plot / check markers *only if revisiting old plot*
Get to dive site (have plot GPS marked on boat or handheld to help locate), find markers, inspect for damage, and "squeegee" off any growth on surface with credit card. **If marker is damaged or lost:** replace with new marker **OF SAME NUMBER** in as close to original location as possible (OK to put

marker in exact same spot but rotated so that you don't reuse nail holes. Goal: have center dot of marker in same place as before). Note each marker replacements on dive slate to tell data processor.

Step 2: Place scale bars
Set each scale bar in a visible location within plot, secure it with dive weights or piece of rubble to prevent it moving in surge. It is important that these markers do not move. Be sure that at least **one scale bar is near the median depth of the plot**, as it will be used for camera white balance.

Step 3: Prepare camera
Bring camera to scale bar at median depth, set white balance of camera to custom, and "set" it by placing scale bar's white part within the ( ) in the middle of camera screen, hit OK to enter it. Verify that the balance looks good on the screen. Place camera in interval mode and ensure settings are correct.

Step 4: Take photos
Starting at one of the corners, position yourself with the camera held 1.5-2m above the reef. Start the camera's interval, and begin photographing the plot by swimming toward an adjacent corner, taking note of recognizable features as you swim (large coral heads, gorgonians, sand patches, etc). Complete swimming passes over the entire plot, with the goal of 80% overlap between photos as you swim along, and at least 50% between passes, so that the entire area encompassed by the markers, as well as a ~1m buffer zone around the outside of the perimeter, is blanketed with overlapping photos. Thinking of yourself as "mowing the lawn" and not missing any spots is a useful metaphor. When finished with one complete set of passes, turn 90º and complete a second set of passes over the area. It's usually okay to use less passes with wider spacing on this second set, thinking of it as "stitching" back over the plot. In general, keep the camera pointed straight down, but it's helpful to slightly vary the angle as you swim to capture the sides of objects so that the 3D model is more accurate. **Note: areas not covered with detailed and overlapping photos will not be modeled, so ensuring complete coverage is important to avoiding data gaps / holes!**

Step 5: Clean up
When photo collection is complete, remember to pick up all scale bars and temporary materials.

Step 6: Record GPS points *Only if initially setting up a plot*
After returning to the boat, take kickboard GPS setup and waterproofed phone and snorkel back to the plot location. In the Metashape Reef Survey123 survey (can be accessed from QR), collect GPS points and respective depths for each corner marker. Swim to each, eyeball position the kickboard directly above, and use the crosshair button to record the location. Once 4 markers are complete, swim back to boat, add depths to each location, and submit / outbox the survey.