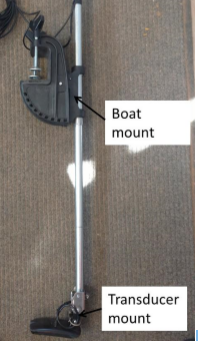
**Humminbird Bathymetric Mapping Protocol**

**Setup and Supplies**

From *NEON AOS Protocol and Procedure: Bathymetry and Morphology of Lakes and Non-Wadeable Streams*



boat mount, and transducer setup

1. Place the transducer at 0.3 m below the surface of the water. Should this not be possible due to the boat type, record the depth at which the transducer is installed for later data correction. In addition, if you have windier conditions you may want to lower the depth transducer to 0.5 m. Record the final depth of the transducer on the Bathymetry Settings datasheet.
2. Ensure the transducer is positioned horizontally to the lake or stream bottom, facing backwards and with a slight tilt. Ensure that the transducer cord is not too tight to prevent the cord from breaking free from the transducer.
3. Ensure that all connectors between the instruments are securely attached to the Humminbird Unit. Ensure that there is no stress on the cable where it enters the transponder (may be helpful to zip tie a short loop in the cable).

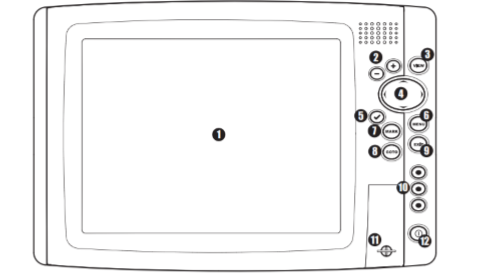


Rear view of the Humminbird control head with connector details. 1) Video-Out (RS-232), 2) Power, 3) GPS/Communications, 4) Video Out, 5) Ethernet, 6) Temperature/speed, and 7) Transducer

1. Ensure 2 blank SD cards have been inserted into the card slot:
   1. Remove the SD memory card slot cover.
   2. Position the SD memory card with the label facing the left side of the unit. Press down until the card clicks into place.
   3. Close the slot cover and turn the knob ¼ of a turn to close. DO NOT over-tighten as this will decrease the water resistance and may damage the cover.
2. Connect the main Humminbird unit to one of the 12V batteries, by first connecting the ground (black) then the hot (red). (Ensure that the cover to the battery pack is shut securely in order to avoid potential spraying by water). It is recommended by the manufacturer that the battery have at least 10V of power; signal transmission may be affected with low battery power. Be sure to check battery power before leaving the Domain Support Facility.
3. Turn on the Humminbird control panel and GPS unit with the POWER/LIGHT key.
4. Verify that you have a good GPS signal and that the transducer is functioning. Upon turning the Humminbird on, the unit will perform a:

**Self-Test:**

1. Displays results from the internal diagnostic self-test.
   1. From start-up screen select System Status.
   2. Accessory Test:
      1. Lists the accessories connected to the unit.
      2. Select view for Accessory Test.
   3. GPS Diagnostic View:
      1. Shows a sky chart and numerical data from the GPS receiver with locations of each visible GPS satellite, its number and its signal strength. Verify that the Fix Type is set on Enhanced, since this is the augmentation (more precise horizontal positioning) using information from WAAS and is required for navigation.
      2. To access the GPS diagnostic view, go to Views on the menu screen and turn on GPS diagnostics view from Hidden to Visible. Press MENU to access the Start-up Options menu.



Humminbird 1198cSI control head key functions: 1) Screen, 2) ZOOM (+/-), 3) View, 4) 4-WAY Cursor Control, 5) INFO, 6) MENU, 7) MARK, 8) GOTO, 9) EXIT, 10) View Preset, 11) SD Card Slots, and 12) POWER/LIGHT

**Humminbird Depth Calibration**

1. Navigate to the location of the staff gage. Take a reading of the water level and record on Bathymetry Settings datasheet
2. Verify calibration of transducer and record this information on the Bathymetry Settings datasheet.
3. Perform a bar check on the echosounder. Navigate to a shallow depth and use the handheld depth sounder or a weighted line with depth increments to get a depth reading and record this on the Bathymetry Settings datasheet under Depth Adjustments – Measured Depth.
4. Then, read the depth on the sonar display in the upper portion of the screen. Record the depth readings under Sonar Depth on the datasheet. Navigate to another location that is deeper than the first location. Repeat the measurements and record the results on the datasheet under Depth Adjustments.
5. Make adjustments to offset (draft of transducer below the water surface) the transducer in the computer software until sonar depth readings and the depth of the handheld depth meter (or weighted line) agree to within approximately 5 cm and note the final depth on your field datasheet.
6. Adjust the Depth offset in the Systems Set-up menu by pressing the menu key twice (can be accessed from any view). Include the transducer depth to the water line (0.3 m; 1 foot) in the total depth when making the adjustment to reflect the true water depth.
   1. To adjust the depth offset, go to the menu screen, select Setup and change the user mode to advanced, the depth offset will then appear in the setup menu
   2. Record changes made to the echosounder (i.e. sensitivity, Side Imaging range, chart speed, color etc.) on the Bathymetry Settings datasheet. This information is important for interpreting the data set and for future comparative work in the same aquatic body (A summary of the sonar settings can be found in the Sonar Menu Advanced).

**Humminbird Sensitivity Settings**

1. Use the View button to navigate between pages.
2. Only change settings of Sensitivity, Side Imaging (SI) and Down Imaging (DI) Sensitivity and SI Enhance – no other setting should be changed.
   1. SI and DI Sensitivity (all types): controls how much detail is shown on the display and will adjust the sensitivity of all sonar frequencies. Decrease the sensitivity to eliminate clutter particularly if in murky or muddy waters. Do not adjust too low since the unit may not display important sonar returns. Increase the sensitivity in clear waters in order to pick up weaker returns. If too high the screen may become too cluttered. Generally set this lower for hard bottoms and higher for soft bottoms. Sensitivity settings may need to be adjusted multiple times during sampling events if water column and substrate conditions change.
   2. SI Enhance: adjust your Side Imaging View into 3 categories: Sensitivity, Contrast and Sharpness. Unless needed leave Sensitivity and Contrast at default values and change Sharpness to Medium.
   3. SI Range: sets the depth of the Side Imaging views on the display. Auto shows depths between 6 – 360 feet (2-120 m); default is set at 150 feet (50 m). The SI range must be set manually. Adjust the SI range based on the known maximum depth of the lake or nonwadeable stream that is being surveyed. The SI range can be changed in the field and only adjusts the deepest extent visible extent on the control display; this does not affect data being recorded.
   4. Beam Select: Ensure the Beam Select under the Sonar tab is set to 200/83 kHz. Do not change the beam bandwidth setting.
   5. Imaging Frequency: Ensure the Imaging Frequency under the Sonar tab is set to 455 kHz.

**Collecting Bathymetric Data**

From *NEON AOS Protocol and Procedure: Bathymetry and Morphology of Lakes and Non-Wadeable Streams*

1. Start recording on the Humminbird unit.
   1. Press the MENU key once in the Snapshot and Recording View.
   2. Highlight Start Recording and press the RIGHT Cursor key. A waypoint will be created at the boat location and the recording shares the same file name (.SON).
2. Record the waypoint number from the Humminbird on Bathymetry Settings datasheet.
3. Remember your point of departure and note the exact time of departure on the Bathymetry Shoreline Boundary GPS datasheet so that it can be used as a cut-off point for data processing.
4. Combo views provide one or more views on the screen. To change the settings for either side of the view, the individual view must be selected as the ‘active side’. Ensure that the side-scan imaging sonar view is displayed as one of the views in order to use the information displayed to identify morphological characteristics of the water bottom.
   1. The GREEN ARROW points to the active side:
   2. Active Side: Press MENU key once and select ACTIVE SIDE from Menu. Choose RIGHT or LEFT to set the active side.
   3. Menu: after you set the Active Side, press MENU key once to access the Menu to provide settings for the active view and the updated display.
5. Travel at no more than 5 kilometers (3.1 miles or 2.7 knots) per hour. Faster speeds will add errors to the readings by changing the rate of return of the sounder signal versus the GPS coordinate. Monitor your speed on the Humminbird unit.
6. Travel at a constant speed in an approximate grid pattern. Once you start in a direction across the lake or stream as part of a cross section, drive the boat in the same heading (follow this on the screen under the “COURSE” window. Given the beam angle for the instrumentation, the grids should be spaced approximately 20 meters apart. Stay as close to the shoreline as possible without damaging the instrumentation.
   1. Create a scale bar using a small piece of paper and clear packing tape. Place the scale bar next to the boat icon in the center of the display with marks for 20 m on either side. This will aid in keeping the survey lines straight while underway.

**Ending Bathymetry Transect**

1. Once the bathymetric mapping is finished, stop recording.
2. To stop recording data, in any view press the MENU key once to open the Snapshot and Recording Menu.
3. Highlight Stop Recording and press the RIGHT Cursor key.

**Readout/ Converting Data**

* Download data from SD cards
* Open SonarTRX
* Import Humminbird file
* Select View and Edit
* Select the “Export” tab
* Export as elevation or depth
* Plot data and look for outliers (GIS)

**Making a map**

* Using DEM data
  + Create XYZ Points from DEM (GIS)
  + Create a Polygon outlining the transition from actual data to water surface (GIS)
  + Clip water surface from DEM points (GIS)
* Using Bathymetry
  + Plot data from transects (R)
  + Interpolate XYZ coordinates to missing area (R)

Example using R:

library(gstat)

library(sp)

setwd("C:/Users/Victoria Starnes/Documents/GitHub/Bluff-Lake-Project/\_analysis/Depth-Mapping")

## READ IN COORINDATES AND DEPTHS

vals <- read.csv("\_dat/Bathymetry/CombinedCorrected.csv")

## LOOK AT ELEVATION TRACK

plot(vals$ElevationBottom,ylim=c(-4,0));abline(h=0)

## ASSIGN LONGITUED AND LATITUDE AS X AND Y

## COORINDATES

coordinates(vals) = ~Longitude+Latitude

proj4string(vals) <- CRS("+proj=longlat +datum=WGS84")

## PROJECT TO UTM

vals\_utm<- spTransform(vals, CRS("+proj=utm +zone=16 ellps=WGS84"))

write.csv(vals\_utm, "depth\_vals\_utm.csv")

## PLOT THE COORDINATES

plot(vals\_utm,axes=TRUE)

## GET THE RANGE FOR X AND Y

xrange <- range(vals\_utm@coords[,1])

xrange <- c(xrange[1]-70, xrange[2]+60)

yrange <- range(vals\_utm@coords[,2])

yrange <- c(yrange[1]-60, yrange[2]+500)

## MAKE A GRID TO INTERPOLATE 15X15 METER GRID

grd <- expand.grid(x=seq(from=xrange[1],

to=xrange[2], by=15),

y=seq(from=yrange[1], to=yrange[2], by=15))

## CONVERT THE GRID TO A SPATIAL PIXEL CLASS

coordinates(grd) <- ~ x+y

gridded(grd) <- TRUE

proj4string(grd) <-CRS("+proj=utm +zone=16 ellps=WGS84")

## PLOT THE GRID AND THE DEPTH COORDINATES

plot(grd, cex=1.5)

points(vals\_utm, pch=1, col='red', cex=1)

## INTERPOLATE THE SURFACE BY INVERSE DISTANCE WEIGHTING

xx<-idw(formula=ElevationBottom ~ 1,

locations=vals\_utm, newdata=grd)

## SAVE THE OUTPUT OF THE INTERPOLATION AS A DATA.FRAME

xxoutput=as.data.frame(xx)[,-4]# DROP VARIANCE COLUMN

names(xxoutput)[1:3]<-c("long","lat","depth")

## ASSIGN COORDINATES TO THE INTERPOLOATIONS AND SPATIAL GRID

coordinates(xxoutput) = ~long+lat

gridded(xxoutput)<-TRUE

write.csv(xxoutput, "\_dat/Bathymetry/InterpolatedDepths.csv")

## PLOT THE INTERPOLATED GRID

plot(xxoutput["depth"],zlim=c(-3,0))

points(vals\_utm, col='white', type='l') # PUT DOWN TRACK

* + Merge points (GIS)
  + Create Raster (GIS)