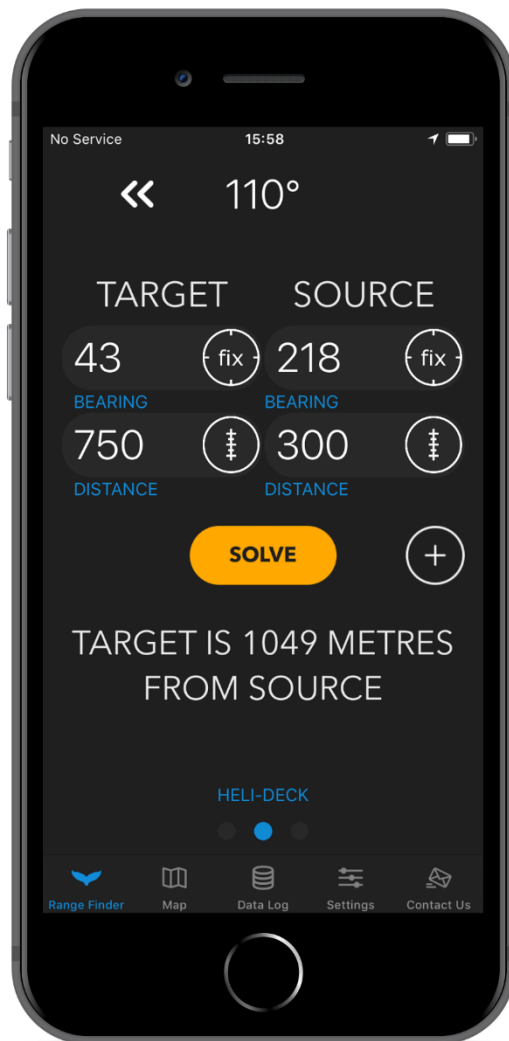


# **MMO** Range Finder

## User Guide



**SPATIAL**  
**EXPLORATION**



**Precision for your Mitigation**



## Introduction to the MMO Range Finder

Marine Mammal Observers (MMO) mitigate for the impact of anthropogenic noise exposure on marine fauna during geophysical surveys, naval sonar exercises, UXO clearance and civil engineering projects. The observer monitors a fixed area around the source of the noise for marine fauna and may initiate a delay prior to initiating any activity that introduces noise into the environment or shut down the activity until the animal has reached a safe distance.

Observers must quickly estimate distance to the animal and decide if the animal is inside a fixed mitigation zone. This can be problematic when the observer is located a considerable distance from the source of the noise and the animal is not approaching from dead ahead or behind. To solve this a trigonometric function is required to calculate the distance of the animal to the source. During shore-based watches the observer position may be fixed, and the source may be moving adding an extra complication in the calculation.

The MMO Range-Finder application was developed to assist the observer with mitigation decisions by calculating the distance from the animal to the source of the noise exposure using a trigonometric cosine function. The observer simply enters the distance and bearing to the animal and source from their observation position and the application calculates the rest.

### Disclaimer

The MMO Range-Finder application should be used as a reference tool and is only as precise as the user's ability to use range-finding tools at sea. Any mitigating actions taken are the responsibility of the user. If in use, the compass and GPS location should be verified often against calibrated instruments commonly available on the bridge of a ship.

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# 1. MMO Range-Finder Overview

## 1.1. Navigation

The MMO Range-Finder application is divided into 5 main navigation tab. The initial screen contains the main range-finder function.

*Table 1. Navigation tabs*

	Range-Finder Tab	This is the main range finding tool. Choose between 3 observation heights (e.g. bridge, heli-deck, etc.)
	Map Tab	Live vessel tracking with sightings. Radar button displays the distance and bearing to animal as you approach.
	Data Log Tab	Data can be viewed here. Select which sightings you want shown on the map and export all data as a .csv file.
	Settings Tab	User preferences can be fully customised as well as easy access to the online user guide.
	Contact Us Tab	Get in touch with any queries or suggestions.

## 1.2. Compatibility

MMO Range-Finder version 4.0.1 is compatible with iPhone, iPad and iPod touch running iOS 10.3 or later.

## 1.3. Referencing in reports

The MMO Range-Finder application should be referenced in reports and papers as follows;

Keating, J., 2018. Marine Mammal Observer Range-Finder Application for iOS Devices. Version 4.0.1., <https://spatial-exploration.com/informed-decisions/mmo-range-finder>

## 2. Range-Finder Tab

The range-finder tab contains all the functions necessary to calculate the distance from the animal (*TARGET*) to the source of the noise (*SOURCE*).

### 2.1. Functions

Table 2. Range-Finder buttons and functions

⏪	Direction to sighting	Guides the user back to the bearing that has been fixed to the <i>TARGET</i> for ease of resighting.
fix	Fix Compass Bearing	Point your device towards the <i>TARGET</i> or <i>SOURCE</i> and press this button to fix the position.
📏	Reticule Converter	Enter the number of reticules between the horizon and the <i>TARGET</i> and press to convert to distance in metres.
SOLVE	Solve Button	Once all data is entered, press solve to return the distance from the <i>TARGET</i> to the source.
+	Add to Data Logo	Saves all data associated with the sightings to the log. If GPS is disabled, location will return -1 values.
⋯	Observation Location	Each observation location can be assigned a name and a specific eye-height above sea level.

### 2.2. Deleting entered data



Figure 1. Swipe left on text-field to delete entered data

### 2.3. Basic use of the Range-Finder

Enter the distance in metres and bearing in degrees to the animal under the *TARGET* text-fields. Enter the distance and bearing to the source of noise under the *SOURCE* text-fields. User can choose to enter true bearings or bearings relative to the bow. True bearings will ensure the map correctly displays the animal. When all text-fields are filled the user can press *SOLVE* to return the distance of the *TARGET* from the *SOURCE* in metres.

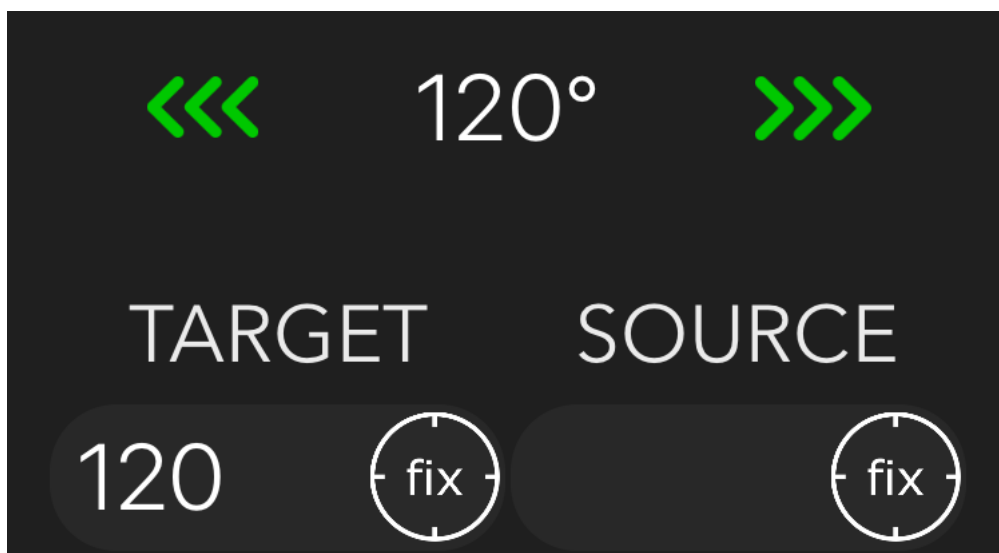




## 2.4. Using the compass

The compass bearing is displayed at the top of the screen showing the direction the device is pointed. With the device pointed towards either *TARGET* or *SOURCE*, press the relevant *Fix* button and the bearing will automatically be filled out in the text-field.

When the *TARGET* bearing is filled, arrows will be displayed at the top of the screen guiding the user back to the location of the sighting, Solid Green arrows mean the device is pointing towards the fixed bearing.



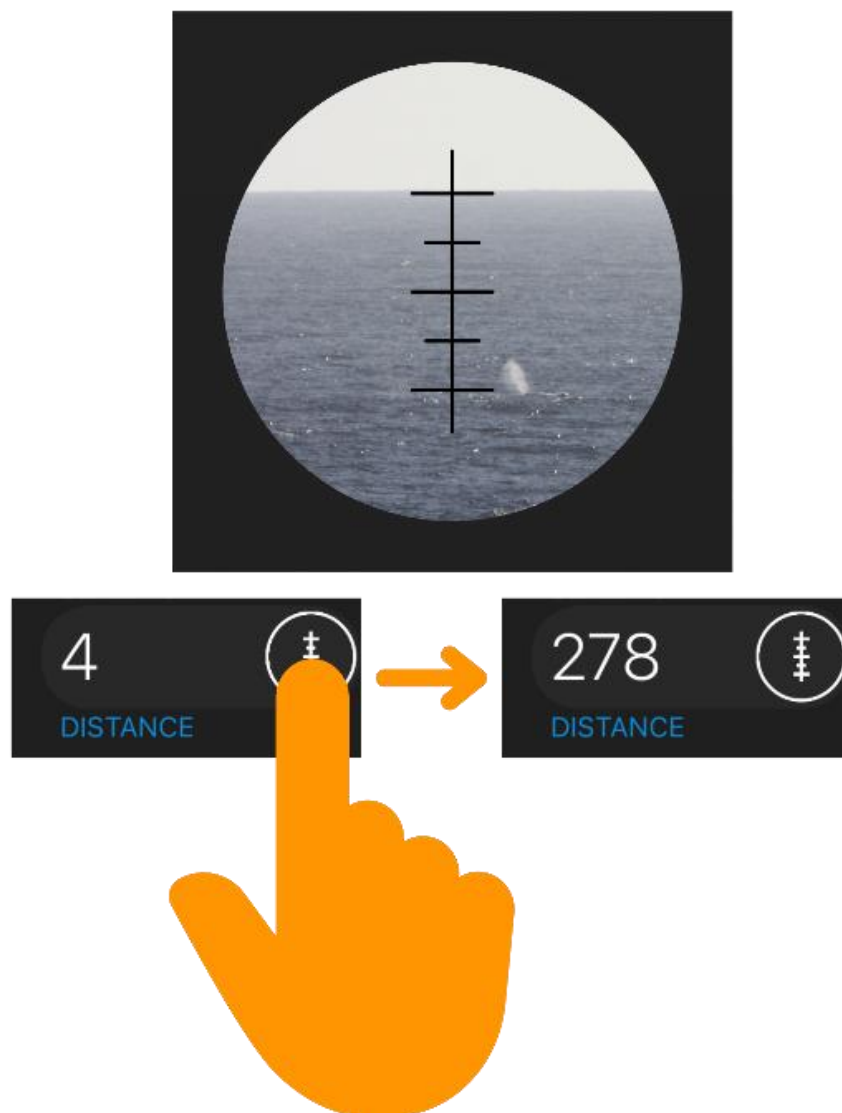
*Figure 2. Compass fix and directional arrows*

The application supports both True North and Magnetic North compass data which can be specified in the settings tab (see section 5).

True North is the GPS bearing directed towards the geographical location of the North Pole. Magnetic North detects changes in the magnetic field using your devices built in magnetometer sensor. It does not require location services (GPS) to be enabled however be advised this sensor is sensitive to electrical interference (common on survey ships) and by declination at different latitudes.

## 2.5. Using the reticule converter

Range-finding to an animal at sea can be achieved with reticule binoculars. By using the horizon as a reference point the observer can count the number of reticules between the horizon and the animal. When the observer knows the exact height of their eye above sea-level a trigonometric function can return the distance in metres. With your binocular specifications and eye-height correctly set up, the observer can simply enter the number of reticules and press the reticule button to make the conversion. Once pressed the reticule button is disabled until the text-field is cleared.



*Figure 3. Converting reticules (milliradians) to distance in metres. Image shows reticules superimposed over sperm whale blow 4 reticules below the horizon.*

Reticules are an angular measurement and the observer must check the manufacturers specifications for their model of binocular. It is common for 7 x 50 marine binoculars to come with 5 milliradian (MIL) spacing between reticules. If your binoculars didn't come with this information you can start by specifying 5 MIL in the settings section and testing against a known distance object (e.g. another ship on the radar, head-buoy etc.). The MMO Range-Finder reticule converter employs spherical trigonometry per the formulae presented by Lerczack and Hobbs, 1998<sup>1</sup>.

## 2.6. Saving data to the log

The MMO Range-Finder supports the logging of data to the user's device using the Realm<sup>2</sup> database. This allows the user to save and display sightings on the map as well as exporting the data in the Comma Separated Value (.csv) format. Once you have entered data in all 4 text-fields and pressed *SOLVE*; press the add button to save data to the device. If location services are enabled the position of the observer and projected position of the *SOURCE* and *TARGET* will be recorded in degrees decimal latitude, longitude format (WGS84).

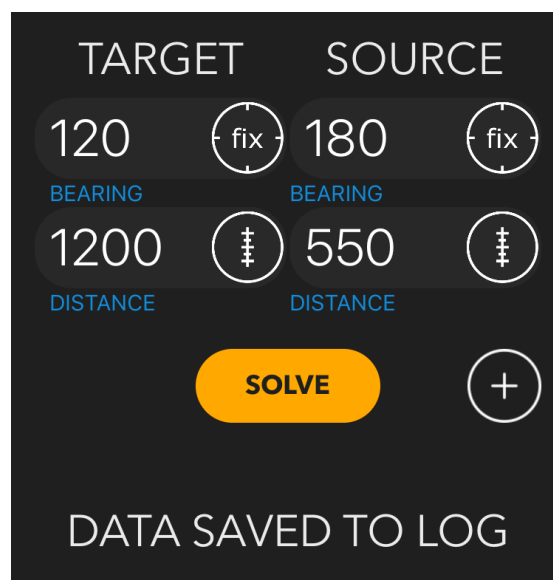


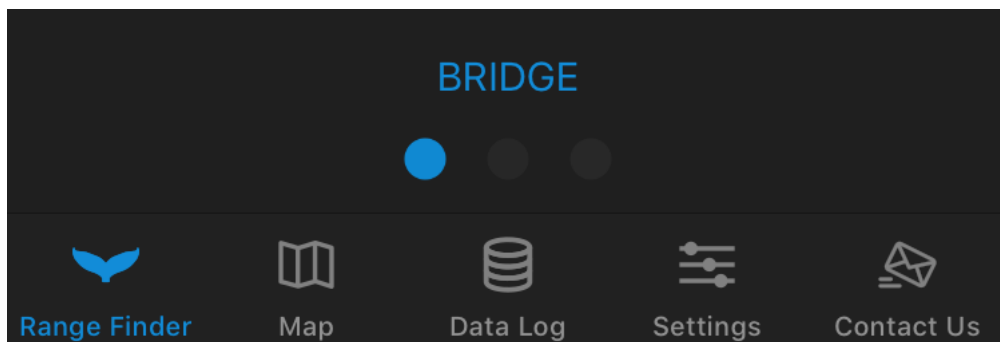
Figure 4. Alert showing data has been successfully saved to log

<sup>1</sup>Lerczak, J.A., Hobbs, R.C., 1998. Calculating sighting distances from angular readings during shipboard, aerial, and shore-based marine mammal surveys. *Mar. Mammal Sci.* 14, 590–598

<sup>2</sup> <https://realm.io/>

## 2.7. Selecting observation location

When using the reticule converter, it is critical that the correct eye-height is specified. This is done by swiping left or right on the location selector at the bottom of the screen. The user can specify up to 3 default locations with different display-name and eye-height above sea-level. If the distance to *SOURCE* from each location remains constant throughout a survey (e.g. a seismic source array being towed at a fixed distance behind the vessel), the user can enter this data in the settings tab. With this information the *SOURCE* distance text-field will automatically fill out appropriately as the user swipes through the different locations.

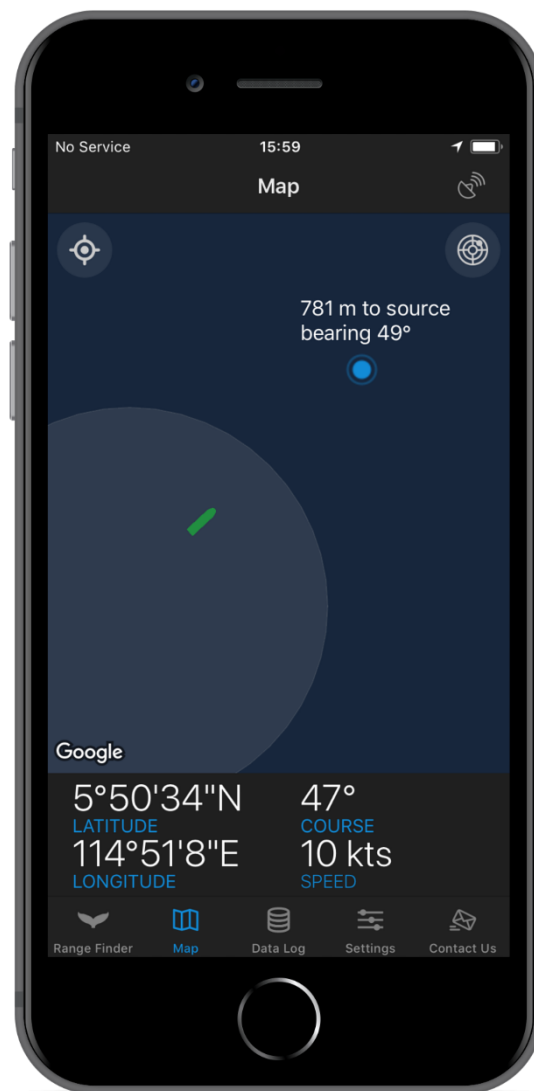


*Figure 5. Swipe left or right to select one of 3 default observation locations*

### 3. Map Tab

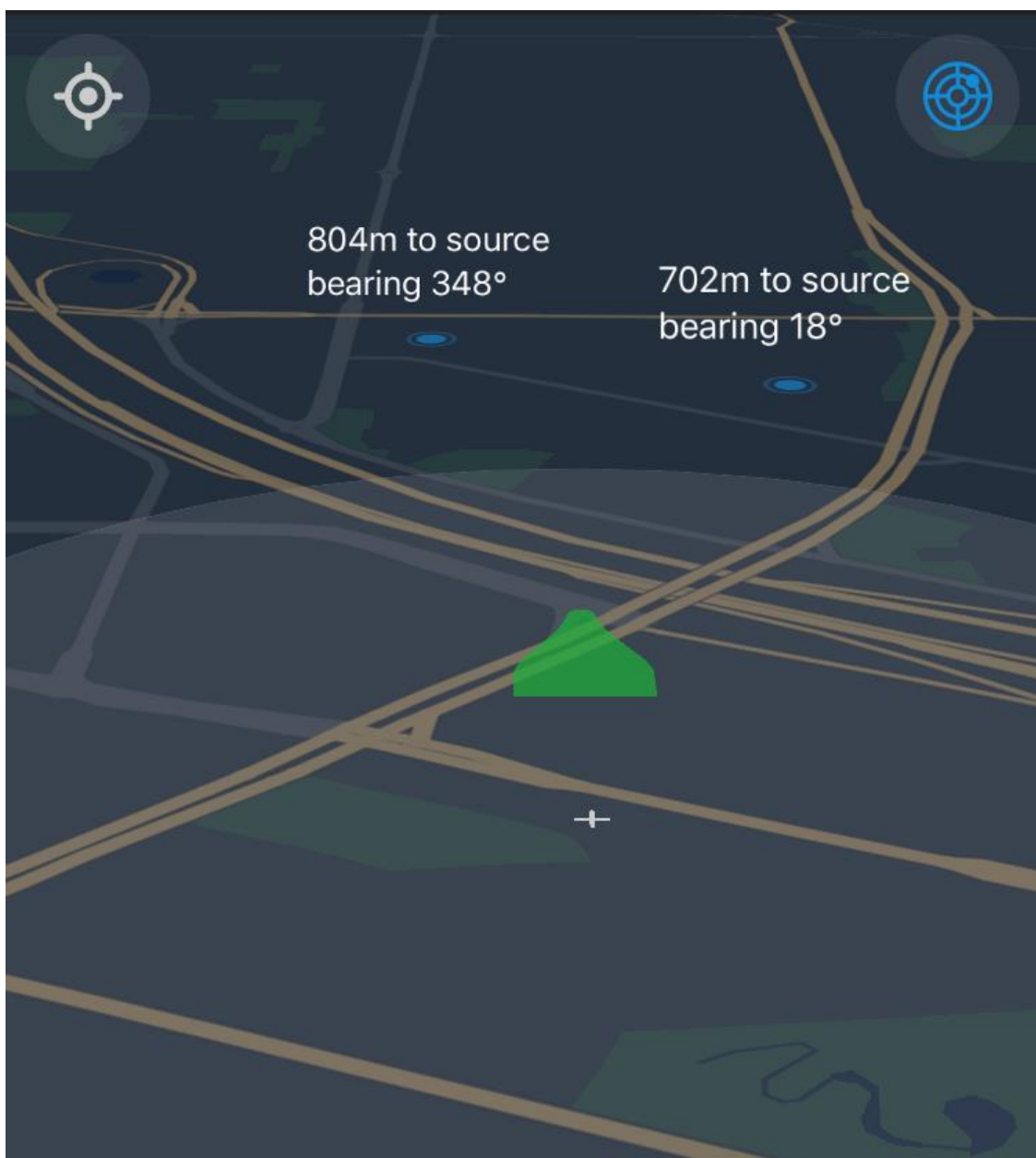
When location services are enabled, the MMO Range-Finder will display vessel position, mitigation zone and any sightings selected in the data log tab. The mitigation zone is specified in the settings tab and is calculated nominally as the reciprocal bearing of the vessel course with a fixed distance back from the stern.

The bottom of the screen shows the vessel position (latitude and longitude), course and speed. Different coordinate formats (DD.DDD°, DD° MM.MM', DD° M' SS") and speed (knots, km/h) can be specified in the settings tab.



### 3.1. Radar Button













When enabled, the radar button orients the map with the ship course upwards. The angle of view is also lowered to give a point of view perspective. Any sightings on the map will now show the distance of the sighting to the centre of *SOURCE* as well as the bearing from the ships position to the sightings thus assisting the observer with resighting the animal. Multiple sightings of the same animal over time can suggest the direction of travel of an animal.



*Figure 6. Radar button enabled shows vessel point of view*

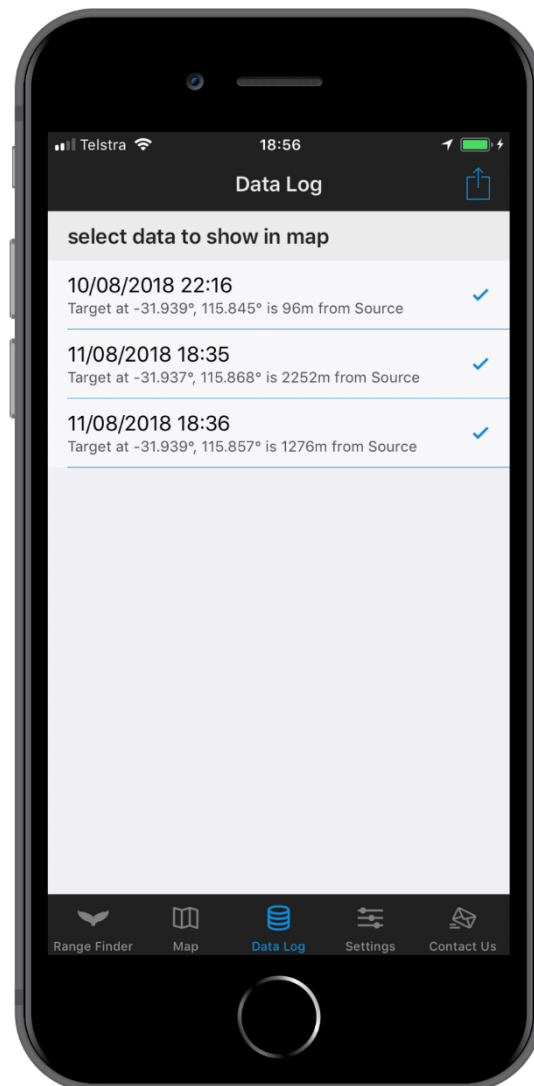
## 3.2. Map Functions

*Table 3. Symbols, buttons and functions of the map tab*

	No GPS connected	Location services not enabled or no GPS connectivity
	Poor GPS signal	Horizontal accuracy more than 30 metres
	Moderate GPS signal	Horizontal accuracy of 10 – 30 metres
	Good GPS Signal	Horizontal accuracy of 0 – 10 metres
	Radar Button	Orients map to vessel course up and displays distance of sighting to <i>SOURCE</i> and bearing from ship to sighting.
	Centre Map Button	Alternate map centre from the vessel position to the bounds of all sightings selected in the log.
	Centre of Source	Calculated from specifications in the settings tab
	Conventional Ship	
	Inverted X-Bow Ship	
	Ramform Ship	
	Sighting outside mitigation zone	
	Sighting inside mitigation zone	

## 4. Data Log Tab

Data for sightings is stored in a secure Realm database on the device. The data log tab acts as an overview of available data by showing the date, time, *TARGET* latitude, longitude and distance from the *SOURCE*.





#### 4.1. Selected data for mapping

The blue tick indicates that a sighting is selected to be displayed on the map. Scroll through the list and touch individual rows to select or deselect.

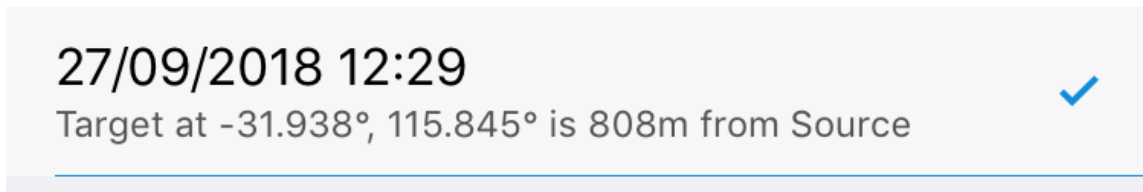


Figure 7. Blue tick indicates this sighting will be displayed on the map

#### 4.2. Deleting Data

Swipe left on any row to delete an individual data entry. To delete the entire database, go to the Settings Tab and select Delete Data.

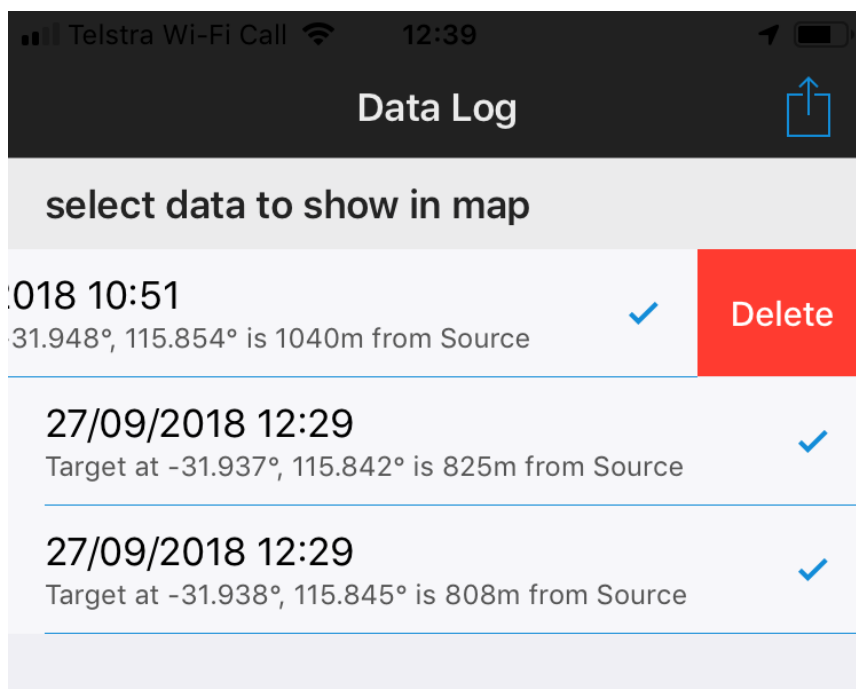


Figure 8. Swipe left on any sighting to delete individual rows from the database

### 4.3. Exporting data

The blue export button in the top right corner will open a prompt with several options for exporting the data to a .CSV file, depending on how the user's device is set up. This file can be opened with most common word processor and mapping software.

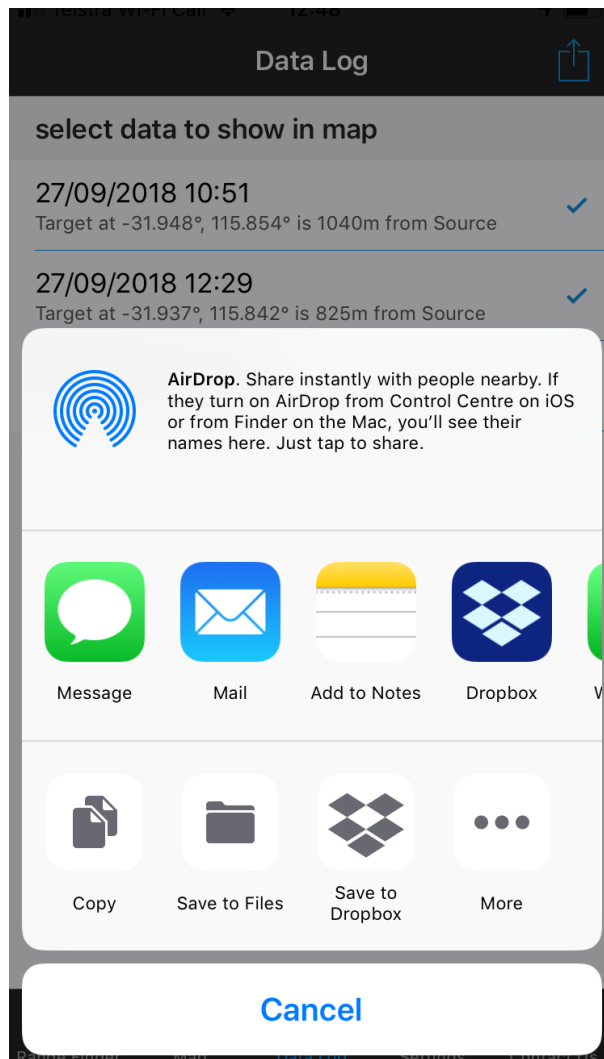


Figure 9. Options for exporting sightings data to .CSV file

## 4.4. Metadata

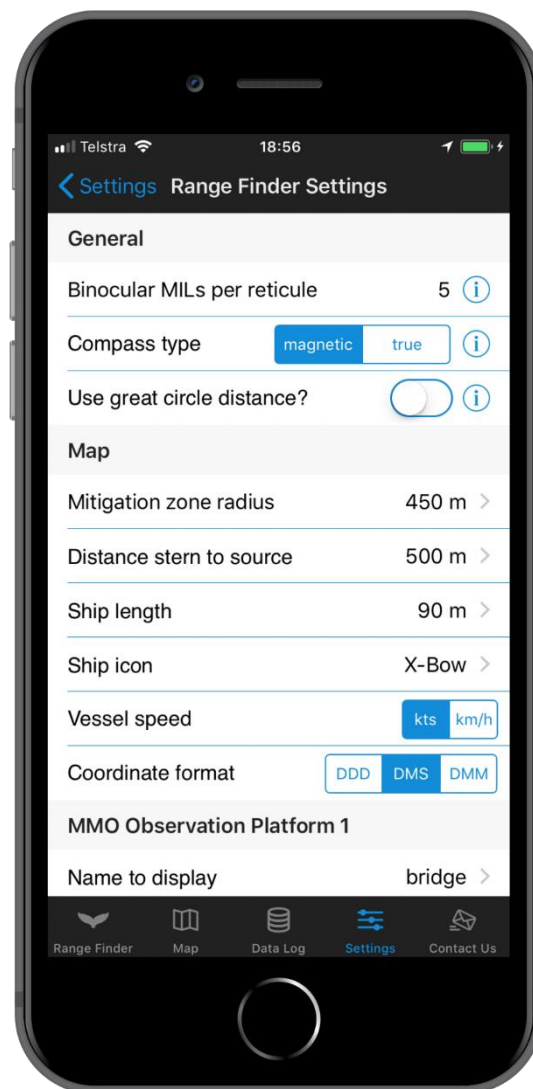
*Table 4. Metadata for exported sightings data*

Date	Device system date DD/MM/YYYY
Time	Device system time HH:MM
ObserverLat	Observer Latitude DD.DDD°
ObserverLon	Observer Longitude DD.DDD°
TargetLat	<i>TARGET</i> Latitude DD.DDD°
TargetLon	<i>TARGET</i> Longitude DD.DDD°
SourceLat	<i>SOURCE</i> Latitude DD.DDD°
SourceLon	<i>SOURCE</i> Longitude DD.DDD°
BearingToTarget	Bearing to <i>TARGET</i> in degrees
DistToTarget	Distance to <i>TARGET</i> in metres
BearingToSource	Bearing to <i>SOURCE</i> in degrees
DistanceToSource	Distance to <i>SOURCE</i> in metres
DistanceTargetToSource	Calculated straight line distance from <i>TARGET</i> to <i>SOURCE</i> in metres (law of cosines function)
GreatCircleDistanceTargetToSource	Great Circle distance from <i>TARGET</i> to source in metres (only if GPS enabled)
CourseOverGround	Ship course over ground in degrees
SpeedOverGround	Ship speed over ground in metres per second
gpsAccuracy	Accuracy of GPS in metres

## 5. Settings Tab

The MMO Range-Finder can be comprehensively configured to the user's exact specification for the highest possible precision in measurement. The settings tab contains *General*, *Data* and *Resource*.

*Data* and *Resources* are essentially self-explanatory. *General* is further divided into *Range-Finder settings* where the main configuration is achieved, *Privacy settings* where the user can enable location services, Siri and Mobile Data and the *User manual* which links to this document.



## 5.1. Range-Finder Settings

*Table 5. Description of range-finder settings*

<b>General</b>	
Binocular MILs per reticule	Refer to binocular manufacturer's guidelines
Compass Type	Magnetic North or True North
Use great-circle distance?	Shortest distance between two coordinates on a sphere. Requires location services to be enabled.
<b>Map</b>	
Mitigation zone radius	Size in metres to be displayed on map
Distance stern to source	Distance in metres for calculating location of mitigation zone in map
Ship length	Length in metres. Ship icon width will scale correctly for each icon type
Ship icon	Choose conventional, x-bow or Ramform hull
Vessel speed	Knots or kilometres per hour
Coordinate format	DDD, DMS or DMM
<b>MMO Observation Platform 1</b>	
Name to display	Name to be shown on Range-Finder tab
Observer eye-height	Metres of eye above sea level at this location
Distance to source	Distance in metres from this location to <i>SOURCE</i>
<b>MMO Observation Platform 2</b>	
Name to display	Name to be shown on Range-Finder tab
Observer eye-height	Metres of eye above sea level at this location
Distance to source	Distance in metres from this location to <i>SOURCE</i>
<b>MMO Observation Platform 3</b>	
Name to display	Name to be shown on Range-Finder tab
Observer eye-height	Metres of eye above sea level at this location
Distance to source	Distance in metres from this location to <i>SOURCE</i>

## 6. Contact Us Tab

Use the form found in the Contact Us tab to send an email to Spatial-Exploration with your comments, suggestions, criticisms and observations. We rely on input from Marine Mammal Observers in the wild to improve the product so please get in touch anytime.



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For updates about technology and tools for Marine Mammal Observer visit;

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