Monitoring for Protected Species During a Low-Energy Marine Geophysical Survey on the R/V Roger Revelle in the Southwest Pacific Ocean, East of New Zealand, May–June 2015

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FORWARD

This document serves to meet reporting requirements specified by the National Marine Fisheries Service, Office of Protected Resources (NMFS/OPR) in the Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography (SIO) on May 15, 2015. The IHA (Appendix A) authorized non-lethal takes of certain marine mammals and sea turtles incidental to a low-energy marine seismic survey in the southwest Pacific Ocean, east of New Zealand. Behavioral disturbance of marine mammals is considered to be “take by harassment” under the provisions of the U.S. Marine Mammal Protection Act (MMPA).

The temporary or permanent impact of seismic exploration sounds to marine mammals are unknown. Nonetheless, to minimize the possibility of any negative impact, and to document the extent and nature of any disturbance effects, NMFS requires that seismic research conducted under an IHA include provisions to monitor for marine mammals and sea turtles and to power down the sound sources when these marine protected species are detected within designated safety radii. Safety radii were defined based on the distance at which the received level of seismic sounds (RMS) were calculated at 160 db, 180 db and 190 db re 1uPa-m, as specified by NMFS. The IHA also required monitoring and mitigation procedures to minimize potential harassment of sea turtles using the same safety zone.

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I. INTRODUCTION

Scripps Institution of Oceanography (SIO) part of the University of California, with funding from the National Science Foundation (NSF) conducted low-energy seismic surveys and heat-flow measurements at three sites off the east coast of New Zealand in May-June of 2015. The seismic survey and heat-flow measurements took place in water depths from 200 to 3000 m within the Exclusive Economic Zone (EEZ) and outside the territorial waters of New Zealand. On behalf of SIO, the U.S. State Department was granted authorization for clearance to work within the EEZ. The research cruise was conducted on board R/V Roger Revelle, which is operated by SIO under a charter agreement with the U.S Office of Naval Research (ONR). The title of the vessel is held by the U.S Navy.

The primary objective of this project was to allow the development of a process-based understanding of the thermal structure of the Hikurangi subduction zone, and the expansion of this understanding by using regional observations of gas hydrate-related bottom-simulating reflections. To achieve the project's goals, the Principal Investigators (PIs), Drs. R.N. Harris and A. Tréhu (Oregon State University), proposed to collect low-energy, high-resolution MCS profiles and heat-flow measurements along transects seaward and landward of the Hikurangi deformation front. Heat-flow measurements were made in well-characterized sites, increasing the number of publicly available heat-flow and thermal conductivity measurements from this continental margin. Seismic survey data would be used to produce sediment structural maps and seismic velocities to achieve the project objectives.

The research plan included ~1250km of surveys (Fig. 1), in water depths from 200 to 3000 m. As GI airguns were towed along the survey lines, an 800-m, 48-channel hydrophone streamer was used to receive the returning acoustic signals and transfer the data to the on-board processing system. The northern and middle sites off the North Island were the primary study sites. Surveys consisted of a grid of straight lines whose lengths and orientations were chosen by the anticipated complexity of sub-seafloor geologic features at each site.

Heat-flow measurements were made using a "violin-bow" probe, 3.5 m long with 11 thermistors, that provides real time (analog) telemetry of the thermal gradient and in-situ thermal conductivity. Internal power allows 20–24 measurements during a single lowering of the tool, with profiles lasting as long as 48 h. Heat-flow measurements had a nominal spacing of 0.5–1 km, which was decreased in areas of significant basement relief or of large changes in gradient. Heat-flow transect locations are shown in Figure 1.

In addition to the GI airguns, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) were used throughout the cruise. Seismic data acquisition activities were conducted by engineers provided by SIO with on-board assistance by the scientists who proposed the study.

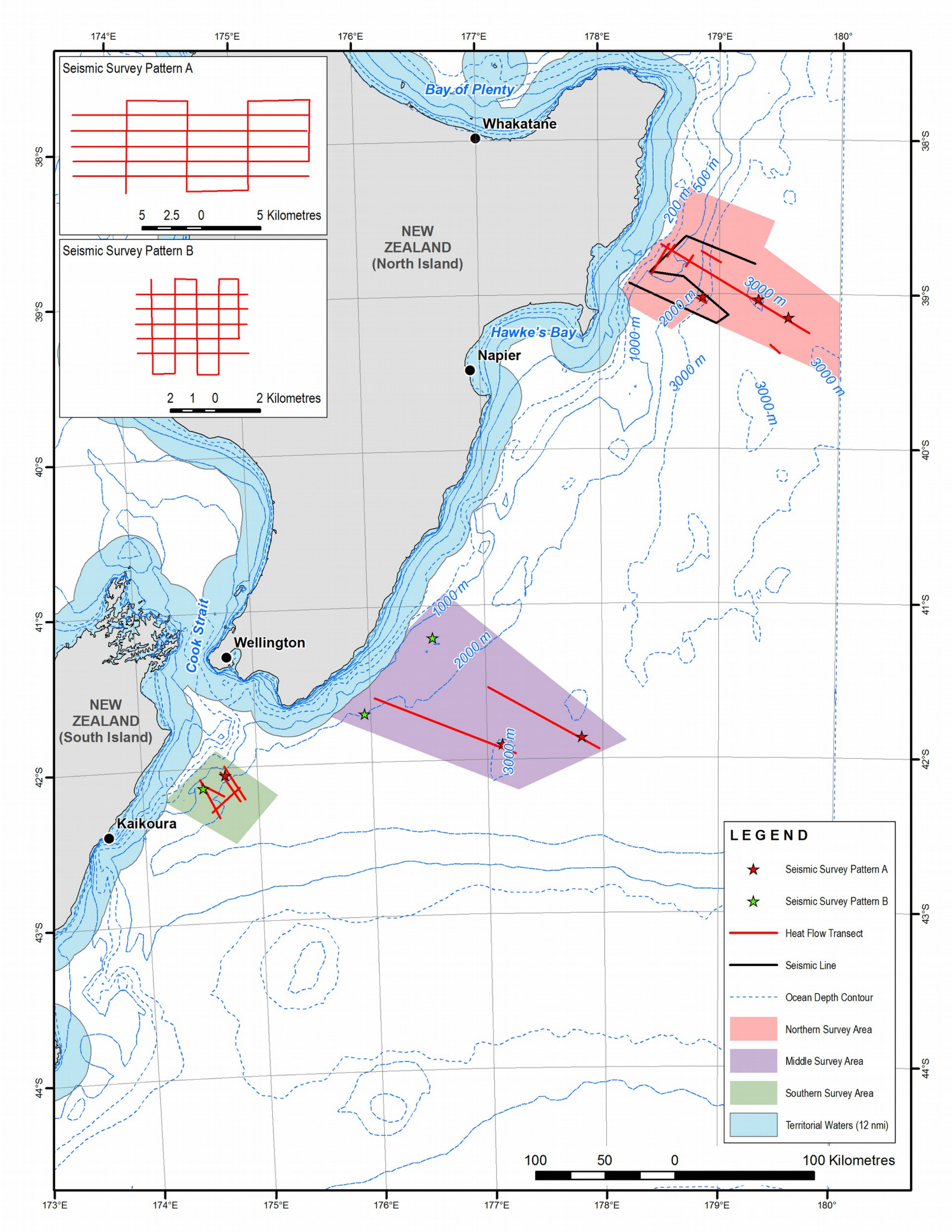


FIGURE 1. Locations of the low-energy seismic survey and heat-flow measurements sites east of New Zealand, May-June 2015

II. SCIENTIFIC PERSONNEL

Three observers were on board during the survey cruise to conduct the protected species mitigation and monitoring procedures. All three observers were accredited by NMFS, having previous training and experience with NMFS marine mammal surveys in the Pacific Ocean. In addition, all observers had experience in field identification of sea turtles and sea birds.

TABLE 1. Scientific party list.

LAST NAME	FIRST NAME	AFFILIATION	FUNCTION
Harris	Robert	Oregon State University	Chief Scientist
Trehu	Anne	Oregon State University	Co-Chief Scientist
Cole	Drew	UCSD/SIO	Technician
Ellett	Lee	UCSD/SIO	Geophysical Engineer
Galecki	Antoni	UCSD/SIO	Technician
Turnbull	Jay	UCSD/SIO	Geophysical Engineer
Antriasian	Anson	Oregon State University	Scientist
Baker	Dylan	University of Otago	Scientist
Colella	Harmony	Arizona State University	Scientist
Gorman	Andrew	University of Otago	Scientist
Haase	Patricia	UCSD/SIO	Protected Species Observer
Henrys	Stuart	GNS Science	Scientist
Lauer	Rachel	UCSC	Scientist
O'Hern	Julia	UCSD/SIO	Protected Species Observer
Phrampus	Benjamin	Southern Methodist University	Scientist
Rocco	Nicole	Oregon State University	Scientist
Watts	Bridget	UCSD/SIO	Protected Species Observer

III. SCIENTIFIC SOUND SOURCES

A. GI Airgun

The R/V *Roger Revelle* towed a pair of Sercel GI airguns along the survey lines. Ship speed was ~7.4 km/h and seismic pulse interval was ~25 m. Each GI airgun was configured with chambers of 45/105 cubic inches and this setup was used for the entire cruise. Thus, the generator chamber of each GI airgun, the one responsible for introducing the sound pulse into the ocean, was 45-in^3. The 105-in^3 injector chamber injects air into the previously-generated bubble to maintain its shape, and does not introduce more sound into the water. The two GI airguns were towed one behind the other beneath a single surface float, 24 m behind the ship, at a depth of 2 m.

GI Airgun Specifications

Energy Source	Two GI airguns of 45 in3
Source output (downward)	0-peak is 3.4 bar-m (230.6 dB re 1 μPa·m); peak-peak is 6.2 bar-m (235.8 dB re 1 μPa·m)
Towing depth of energy source	2 m
Air discharge volume	Approx. 90 in3
Dominant frequency components	0–188 Hz
Gun positions used	Two, fore-aft
Gun volumes at each position (in3)	45, 45

The nominal downward-directed source levels indicated above do not represent actual sound levels that can be measured at any location in the water. Rather, they represent the level that would be found 1 meter from a hypothetical point source emitting the same total amount of sound as is emitted by the combined GI airguns. The actual received level at any location in the water near the GI airguns will not exceed the source level of the strongest individual source. In this case, that will be about 230.7 dB re 1 μPa · m peak, or 235.9 dB re 1μPa · m peak-to-peak. Actual levels experienced by any organism more than 1 m from either GI airgun will be significantly lower.

A further consideration is that the rms[1] (root mean square) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak (p or 0–p) or peak to peak (p–p) values normally used to characterize source levels of airgun arrays. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the rms decibels referred to in biological literature. A measured received level of 160 dB re 1 μParms in the far field would typically correspond to ~170 dB re 1 μPap, and to ~176–178 dB re 1 μPap-p, as measured for the same pulse received at the same location (Greene 1997; McCauley et al. 1998, 2000). The precise difference between rms and peak or peak-to-peak values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Received sound levels have been modeled by Lamont-Doherty Earth Observatory of Columbia University (L-DEO) for a number of airgun configurations, including two 45-in3 Nucleus G. Guns, in relation to distance and direction from the airguns (Fig. 2). The model does not allow for bottom interactions, and is most directly applicable to deep water.

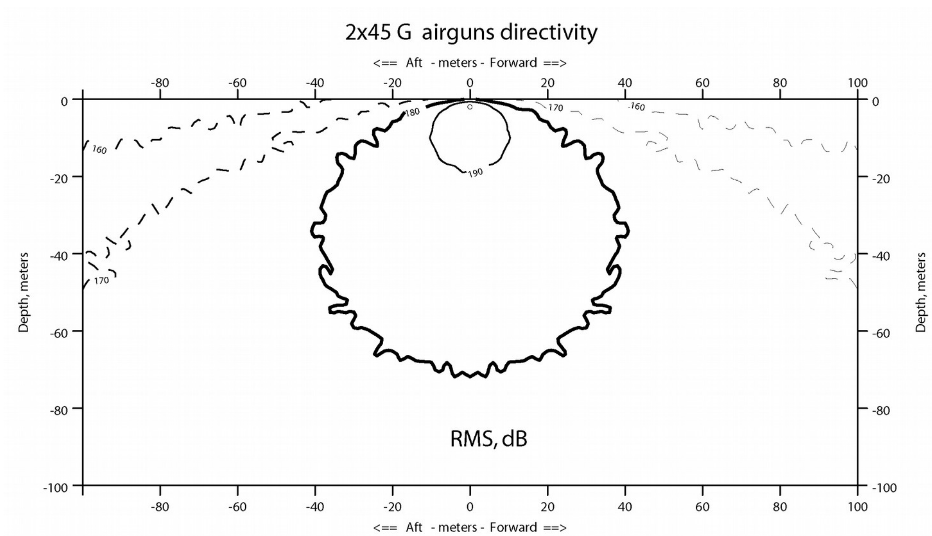
Empirical data on the 180- and 160-dB distances have been acquired for various airgun arrays based on measurements during acoustic verification studies conducted by L-DEO in the northern Gulf of Mexico in 2003 (6-, 10-, 12-, and 20-airgun arrays, and 2 GI airguns; Tolstoy et al. 2004) and 2007–2008 (18- and 36-airgun arrays; Tolstoy et al. 2009; Diebold et al. 2010). The empirical data for the 6-, 10-, 12-, and 20-airgun arrays indicate that, for deep water (>1000 m), the L-DEO model tends to overestimate the received sound levels at a given distance (Tolstoy et al. 2004). Measurements were not made for the 2 GI airguns in deep water, but we propose to use the "Safety Zone" radii predicted by L-DEO's model for the proposed GI airgun operations in deep water, although they are likely conservative given the empirical results for the other arrays.

The data also showed that radii around the airguns where the received level would be 180 dB re

[1] The rms (root mean square) pressure is an average over the pulse duration.

1 µPa (rms), the safety criterion applicable to cetaceans (NMFS 2000), varies with water depth. Correction factors were developed for water depths 100–1000 m and <100 m. The proposed surveys would occur in depths 200 m–3000 m, so only the correction factor for intermediate water depths is relevant here. The only empirical measurements made for intermediate depths (100–1000 m) were for the 36-aigun array in 2007–2008 (Diebold et al. 2010). The intermediate-water radii are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 *in* Diebold et al. [2010]).

The Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (June 2011) and Record of Decision (June 2012), referred to herein as the PEIS, defined a low-energy source as any towed acoustic source whose received level is ≤180 dB at 100 m, including any single or any two GI airguns and a single pair of clustered airguns with individual volumes of ≤250 in^3. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applied a 100-m exclusion zone (EZ) for all low-energy acoustic sources in water depths >100 m.



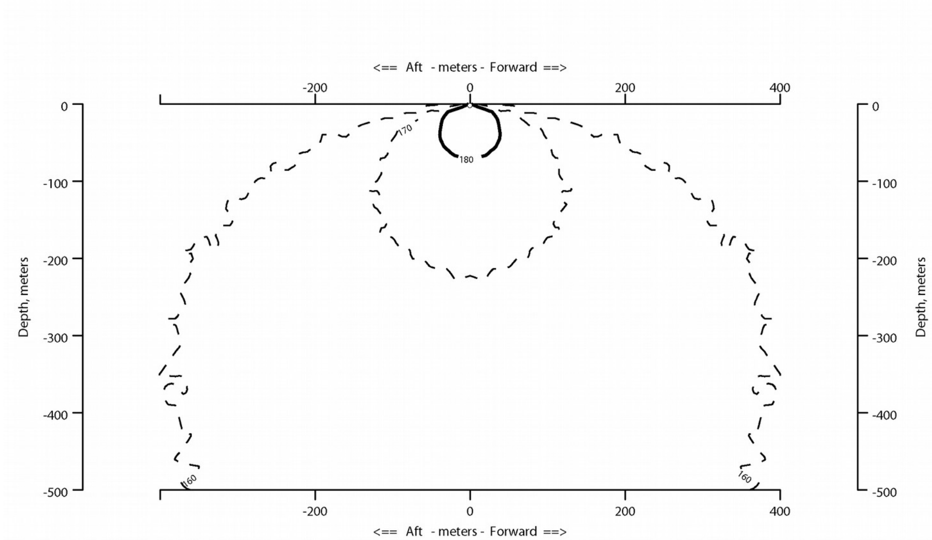


FIGURE 2. Modeled received sound levels from two 45-in^3 G. Guns, similar to the two 45-in^3 GI airguns that were used during the SIO surveys in the tropical western Pacific Ocean during May-June 2015. Model results were provided by L-DEO.

Consistent with the PEIS, that approach is used here for the pair of 45-in^3 GI airguns. A fixed full mitigation zone, or 160-dB "Safety Zone" was not defined in the PEIS for the same suite of low-energy sources; therefore, L-DEO model results for 45-in^3 G Guns were used here to determine the 160-dB radius for the pair of 45-in^3 GI airguns.

Table 2 shows the 180-dB EZ for the pair of 45-in^3 GI airguns based on the PEIS and the L-DEO modeled measurements for the 190-dB EZ and 160-dB safety zone, the distances at which the rms sound levels are expected to be received in >1000-m and 100–1000 m water. Because the model results are for G Guns, which have more energy than GI airguns of the same size, the distances are overestimated. The 180-dB re 1 μPa_{rms} distance is the safety criterion as specified by the National Marine Fisheries Service (NMFS 2000) for cetaceans. The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects. If marine mammals or sea turtles are detected in or about to enter the appropriate EZ, the airguns were shut down immediately.

TABLE 2. Predicted distances to which 190 and 160 dB re 1 μPa_{rms} sound levels could be received from two 45-in^3 G guns, similar to the two 45-in^3 GI guns that would be used during the seismic surveys off New Zealand during May–June 2015 (model results provided by L-DEO). Distances to which 180 dB re 1 μPa_{rms} sound levels could be received are based on the standard EZ established in the PEIS.

Water depth	Predicted or established distances at received levels		
	190 dB	180 dB	160 dB
>1000 m	10	100 m	400 m
100–1000 m	15	100 m	600 m

B. Multibeam Echosounder

The Kongsberg EM122 MBES operates at 10.5–13 (usually 12) kHz and is hull-mounted on *R/V Roger Revelle*. The transmitting beamwidth is 1° fore–aft and 150° athwartship. The maximum source level is 242 dB re 1 $\mu Pa \cdot m_{rms}$. Sounds from the MBES are very short pings, occurring for 5 ms once every 5–20 s, depending on water depth. At the water depths of this cruise the beam is narrow (1º) in the fore-aft extent and wide (36º) in the cross-track extent. Each ping consists of nine (in water >1000 m deep) or three (<1000 m deep) successive fan-shaped transmissions (segments) at different cross-track angles. Any given mammal at depth near the trackline would be in the main beam for only one or two of the nine segments. Also, marine mammals that encounter the Kongsberg EM122 are unlikely to be subjected to repeated pings because of the narrow fore–aft width of the beam and will receive only limited amounts of energy because of the short pings. Animals close to the ship (where the beam is narrowest) are especially unlikely to be ensonified for more than one 5-ms ping (or two pings if in the overlap area). Similarly, Kremser et al. (2005) noted that the probability of a cetacean swimming through the area of exposure when an MBES emits a ping is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pings that might result in sufficient exposure.

C. Single Beam Echosounder

The Knudsen Engineering Model 3260 sub-bottom profiler is a dual-frequency transceiver designed to operate at 3.5 and/or 12 kHz. It was used in conjunction with the MBES to provide data about the sedimentary features that occur below the sea floor. The energy from the sub-bottom profiler is directed downward via a 3.5-kHz transducer array mounted in the hull of *R/V Roger Revelle*. The maximum power output of the 3260 is 10 kilowatts for the 3.5-kHz section and 2 kilowatts for the 12-kHz section.

The pulse length for the 3.5 kHz section of the 3260 is 0.8–24 ms, controlled by the system operator in regards to water depth and reflectivity of the bottom sediments. The system produces one sound pulse and then waits for its return before transmitting again. Thus, the pulse interval is directly dependent upon water depth. Most of the energy in the sound pulses emitted by the sub-bottom profiler is at 3–6 kHz, and the beam is directed downward. The sub-bottom profiler on the *R/V Roger Revelle* has a maximum source level of 211 dB re 1 $\mu Pa \cdot m$. As presented for the MBES, the probability of a cetacean swimming through the area of exposure when a bottom profiler emits a pulse is small (Kremser et al. , 2005). If an animal was in the area, it would have to pass the transducer at very close range and swim in speed and direction similar to that of the ship in order to be subjected to sound levels that could cause harm.

IV. MITIGATION PROCEDURES

The primary responsibility of the protected species observers (PSOs) was to maintain a watch for marine mammals, sea turtles, and other protected marine animal species within the designated safety radii (Table 2) around the seismic GI gun source, and alert the seismic personnel on watch, who would then shut down the seismic source.

Mitigation watches by at least one observer were conducted 100% of the time during daylight hours. The observer platform was located one deck below and forward of the bridge (02 level, 12.5 meters above the waterline), affording relatively unobstructed 180-degree forward view. Aft views of the vessel could be obtained from a secondary station on the winch deck (Figure 3).

Before commencing seismic operations during daylight hours, two observers would maintain a 360-degree watch for all marine mammals and sea turtles for at least 30 minutes prior to start of the sound source. If no marine mammals or turtles were observed within the safety radius during this time, the observers would notify the seismic personnel of an "all clear" status.

Watch periods were typically scheduled as a 2-hour rotation. The observers continually scanned the water from the horizon to the ship's hull, and forward of 90 degrees from the port and starboard beams. In the event of any marine mammal or sea turtle approaching or within the safety zone, the seismic personnel were contacted via hand held radios and/or telephone and the seismic source was secured for the duration of the animal's presence within the safety zone. Seismic operations would resume only after the animals were seen to exit the safety radius, or after no further visual detection of the animal for 15 minutes (for small ondontocetes and pinnipeds) or 30 minutes (for mysticetes and large odontocetes).

Observers utilized reticulated 25x150 big eye binoculars and 7x50 hand held binoculars to determine bearing and distance of sightings. A clinometer was used to determine distances of animals in close proximity to the vessel. Also hand held fixed range finders and distance marks on the ship's side rails were used to measure the exact location of the 70-meter zone (Heinemann 1981). These simple devices proved more reliable for open water sighting than the laser range finders, which were also provided.

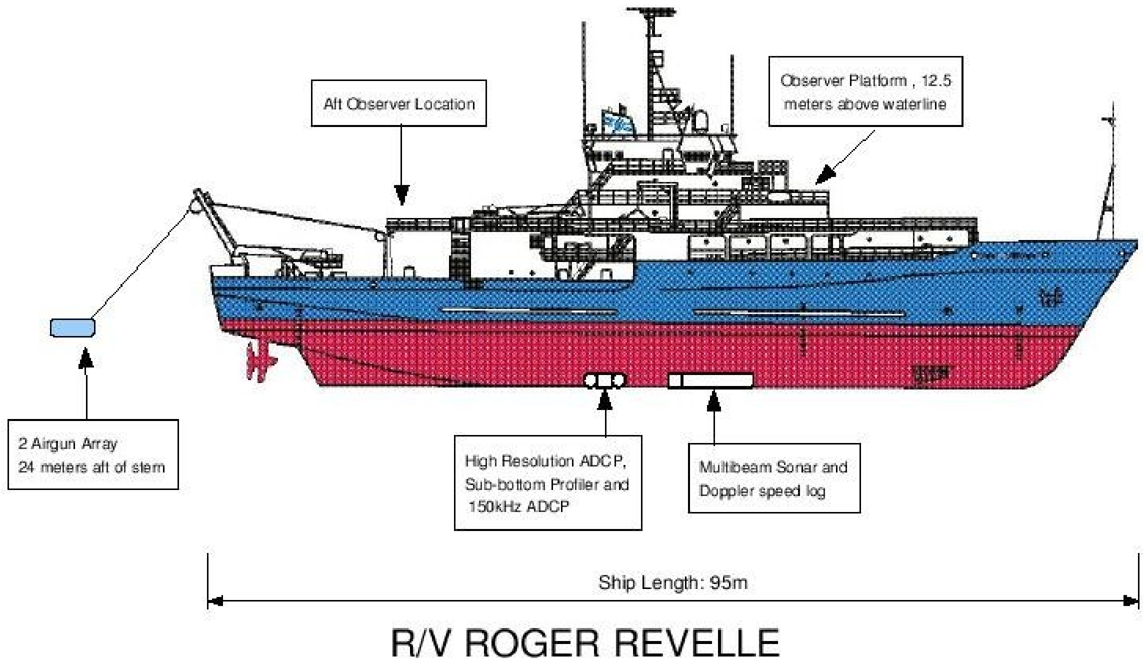


FIGURE 3. Outboard Profile of R/V Roger Revelle

The marine mammal observers provided training to the scientists and bridge crew at the beginning of the cruise. More importantly, the bridge officers and other crew were instructed to alert the observer on watch of any suspected marine mammal sighting. A hand held VHF radio was used by the observers for communication with the bridge crew. A phone and hand held radio were used to communicate with the seismic personnel in the lab spaces. If needed, the bridge was contacted in order to maneuver the ship to avoid interception with approaching marine mammals or sea turtles.

The Mysticetus Observation System (Appendix C) was used to record the visual data acquired during the cruise. Mysticetus is a software package for the real-time recording and integration of GPS data with visual observations provided by Dave Steckler of Entiat River Technologies. The System was developed with feedback from a number of marine biologists to perform Arial, Vessel and Land based surveys.. A laptop computer console was installed at the observer location with a GPS for ease of data entry. A customized data entry template was created in Mysticetus based on the IHA data requirements. The data entry management consisted of an Effort Log and Sighting Log. Formulas were included to estimate the position of sightings based on the optics used. A map with planned survey lines for the day was plotted on the display.

For each sighting the Observer on watch would enter the bearing, distance and optics type then use a series of preconfigured drop down menus to quickly record the species, behavior and environmental conditions. Each sighting was plotted on a real-time map with the vessel position and survey lines. A comments field was available to add additional context to sightings as necessary. At the end of each day sightings were checked for errors and edited as appropriate. A effort log was kept and populated with data whenever there was a change in sound source status, weather or observer on watch.

V. PROTECTED SPECIES EXPECTED IN SURVEY AREA

Marine Mammals

New Zealand is considered a hotspot for marine mammal species richness (Kaschner et al. 2011). Thirty-two marine mammal species, including 21 odontocetes, nine mysticetes, and two pinnipeds could occur in the proposed seismic survey areas (Table 3). Six of the 32 species are listed under the U.S. Endangered Species Act (ESA) as endangered: the sperm whale, humpback whale, blue whale, fin whale, sei whale, and southern right whale.

Based on the New Zealand Threat Classification System, three of the species are nationally critical, including Bryde's whale, killer whale, and southern elephant seal (Baker et al. 2010). Two other species are ranked as nationally critical (Baker et al. 2010) but are not included in Table 3: Maui's dolphin (Cephalorhynchu hectori maui) is only found along the west coast of the North Island, and the northern range of the New Zealand sea lion (Phocarctos hookeri) is not expected to extend to the proposed survey area based on New Zealand's National Aquatic Biodiversity Information System (NABIS 2014). Three species ranked as nationally endangered could occur in the proposed study area: the southern right whale, Hector's dolphin, and the bottlenose dolphin (Baker et al. 2010).

An additional 18 species are categorized as vagrant under the New Zealand Threat Classification System (Baker et al. 2010) and were not included in Table 3; these include Arnoux's beaked whale (Berardius arnouxi), Ginkgo-toothed whale (Mesoplodon ginkgodens), pygmy beaked whale (M. peruvianus), dwarf sperm whale (Kogia sima), spectacled porpoise (Phocoena dioptrica), Type B, C, D killer whale (Orcinus orca), melon-headed whale (Peponocephala electra), Risso's dolphin (Grampus griseus), Fraser's dolphin (Lagenodelphis hosei), pantropical spotted dolphin (Stenella attenuata), striped dolphin (S. coeruleoalba), rough-toothed dolphin (Steno bredanensis), Antarctic fur seal (Arctocephalus gazelle), Subantarctic fur seal (A. tropicalis), leopard seal (Hydrurga leptonyx), Weddell seal (Leptonychotes weddellii), crabeater seal (Lobodon carcinophagus), and Ross seal (Ommatophoca rossi).

According to Jefferson et al. (2008), the distributional range of two more species may include New Zealand: Hubb's beaked whale (Mesoplodon carlhubbsi) and True's beaked whale (M. mirus). However, these two species are not discussed further, as there are no records of Hubb's beaked whale in New Zealand, and only a single record of True's beaked whale, which stranded on the west coast of South Island in November 2011 (Constantine et al. 2014). Neither of these species is categorized under the New Zealand Threat Classification System (Baker et al. 2010).

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals are given in § 3.6.1, § 3.7.1, and § 3.8.1 of the PEIS. One of the qualitative analysis areas (QAAs) defined in the PEIS, the Sub-Antarctic, is located to the east of New Zealand and the proposed survey area, at 42ºS, 145ºW. The general distribution of mysticetes, odontocetes, and pinnipeds in the western South Pacific Ocean is discussed in § 3.6.3.8, § 3.7.3.8, and § 3.8.3.4 of the PEIS, respectively. The rest of this section deals specifically with species distribution in the proposed survey areas off the coast of New Zealand.

Few systematic surveys have been conducted in the waters of New Zealand, and these mainly consist of single-species surveys in shallow coastal waters (e.g., Dawson et al. 2004; Slooten et al. 2004, 2006); large-scale, multi-species surveys are lacking. Below we use various sources to describe the occurrence of marine mammals in the waters of New Zealand, such as opportunistic sighting records presented in previous reports, including the New Zealand Department of Conservation marine mammal sightings database.

TABLE 3. The habitat, occurrence, regional population sizes, and conservation status of marine mammals that could occur near the proposed seismic survey area off New Zealand, in the southwest Pacific Ocean.

Species	Habitat	Occurrence in study area during May-June	Regional population size[1]	U.S. ESA[2]	IUCN[3]	NZ[4]
Mysticetes						
Southern right whale	Coastal, shelf	Common	12,000[5]	EN	LC	NE
Pygmy right whale	Coastal, oceanic	Rare	N.A.	NL	DD	DD
Humpback whale	Coastal, oceanic	Common	42,000[5]	EN	LC	M
Bryde's whale	Coastal, oceanic	Very rare	48,109[6]	NL	DD	NC
Dwarf minke whale	Coastal, shelf	Uncommon	750,000[7,8]	NL	LC	NT
Antarctic minke whale	Coastal, oceanic	Uncommon	750,000[7,8]	NL	DD	NT
Sei whale	Mostly offshore, pelagic	Uncommon	10,000[7]	EN	EN	M
Fin whale	Oceanic	Uncommon	15,000[7]	EN	EN	M
Blue whale	Coastal, shelf, offshore	Uncommon	2300 true[5]; 1500 pygmy[7]	EN	EN	M
Odontocetes						
Sperm whale	Slope, oceanic; canyons	Common	30,000[7]	EN	VU	NT
Pygmy sperm whale	Outer shelf, oceanic	Uncommon	N.A.	NL	DD	DD
Cuvier's beaked whale	Mostly over slope	Uncommon	600,000[7,9]	NL	LC	DD
Shepherd's beaked whale	Oceanic	Rare	600,000[7,9]	NL	DD	DD
Southern bottlenose whale	Oceanic	Rare	600,000[7,9]	NL	LC	DD
Hector's beaked whale	Oceanic	Rare	600,000[7,9]	NL	DD	DD
Gray's beaked whale	Oceanic	~Common	600,000[7,9]	NL	DD	DD
Andrew's beaked whale	Oceanic	Rare	600,000[7,9]	NL	DD	DD
Strap-toothed whale	Oceanic	Uncommon	600,000[7,9]	NL	DD	DD
Blainville's beaked whale	Slope	Very rare	600,000[7,9]	NL	DD	DD
Spade-toothed whale	Presumed oceanic	Very rare	600,000[7,9]	NL	DD	DD
Common bottlenose dolphin	Coastal, shelf, offshore	Common	N.A.	NL[10]	LC	NE
Short-beaked common dolphin	Oceanic	Abundant	N.A.	NL	LC	NT
Dusky dolphin	Shelf, slope	Common	12,000-20,000 NZ[11]	NL	DD	NT
Hourglass dolphin	Oceanic	Uncommon	150,000[7]	NL	LC	DD
Southern right whale dolphin	Oceanic	Uncommon	N.A.	NL	DD	NT
Hector's dolphin	Nearshore	Rare	7,400[12]	NL[13]	EN	NE
False killer whale	Oceanic, occ. shelf	Uncommon	N.A.	NL	DD	NT
Killer whale	Coastal, occ. offshore	Common	80,000[7]	NL	DD	N[14]
Long-finned pilot whale	Mostly pelagic	Common	200,000[7]	NL	DD	NT
Short-finned pilot whale	Oceanic	Uncommon	N.A.	NL	DD	M
Pinnipeds						
New Zealand fur seal		Common	50,000-100,000 NZ[12]	NL	LC	NT
Southern elephant seal		Rare	607,000[11]	NL	LC	NC

NZ = New Zealand; N.A. = Not Available; ETP = Eastern Tropical Pacific; occ. = occasionally

[1] Abundance for the Southern Hemisphere or Antarctic unless otherwise noted

[2] U.S. Endangered Species Act (ESA) (NMFS 2014); EN = Endangered; NL = Not Listed

[3] Codes for classifications from IUCN Red List of Threatened Species (IUCN 2014): EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient

[4] New Zealand Threat Classification System (Baker et al. 2010); NC = Nationally Critical; NE = Nationally Endangered; DD = Data Deficient; NT = Not Threatened; M = Migrant

[5] IWC (2014)

[6] IWC (1981)

[7] Boyd (2002)

[8] Dwarf and Antarctic minke whales combined

[9] All Antarctic beaked whales combined

[10] The Fiordland population in New Zealand is a candidate species for ESA listing

[11] NZDOC (2014)

[12] Suisted and Neale (2004)

[13] Candidate species for ESA listing

[14] Only Type A is considered nationally critical.

Mysticetes

Southern Right Whale (Eubalaena australis)

The southern right whale occurs throughout the Southern Hemisphere between ~20°S and 60°S (Kenney 2009). Right whales used to be widely distributed throughout New Zealand waters (Stewart and Todd 2001), but they were decimated by commercial whaling operations (Carroll et al. 2014). Their populations have been slow to recover (Patenaude and Baker 2001). However, numbers of right whales using the waters near the sub-Antarctic Auckland Islands have been increasing, and these islands appear to be primary wintering/calving areas for this species in New Zealand (Patenaude and Baker 2001), particularly Port Ross (Carroll et al. 2011a). Southern right whales are also known to winter at sub-Antarctic Campbell Island (Stewart and Todd 2001), as well as mainland New Zealand (Patenaude 2003). Movement of whales between the islands, as well as between the islands and the mainland (e.g., Patenaude et al. 2001; Childerhouse et al. 2010; Carroll et al. 2011b), suggests that right whales in New Zealand comprise a single stock (Carroll et al. 2011b). The population size in New Zealand was estimated at 2,169 individuals (Carroll et al. 2013).

Southern right whales calve in nearshore coastal waters during the winter and typically migrate to offshore feeding grounds during summer (Patenaude 2003). The Chatham Rise area is thought to be an important feeding area for right whales (Torres et al. 2013a). Based on a re-analysis of historical and other documents, Richards (2002) suggested that right whales arrived at South Island from sub-Antarctic waters during May and occurred in nearshore waters along the coast of New Zealand to calve. By October, whales had moved northward into offshore waters east of the Kermadec Islands, between 173 and 165°W, and 30 and 37°S, or over the northern half of the Louisville Ridge. During November, there was a marked shift southward and eastward, reaching 50°S around January. Clement (2010) noted that southern right whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations.

Patenaude (2003) reported 110 sightings and 23 photo-identifications that were made between 1976 and 2002 around New Zealand. All of these records were for nearshore waters (generally within 200 m) along the three main islands of New Zealand. Patenaude (2003) noted that the majority of sightings were made during the winter (59%) and spring (23%), with fewer sightings during summer (7%) and fall (6%). Thirty percent of all sightings were made along the east coast of North Island, some of which occurred near the proposed northern survey area. The majority of sightings along the east coast of North Island were made within coastal waters of the East Coast/Hawke's Bay conservancy (Patenaude 2003). The area from Hawke's Bay to Bay of Plenty appears to be a primary calving area for right whales during August–November (Patenaude 2003). At least another 30 sightings have been reported for the region between Bay of Plenty and Hawke's Bay since 2008, mainly along the East Cape headland (Clement 2010). A right whale record for spring also exists for deep waters just to the south of the proposed southern survey area (Torres et al. 2013b). Patenaude (2003) reported a total of seven fall sightings off New Zealand; one sighting was made off North Island (Hauraki Gulf), there were two sighting records for eastern Cook Strait, one off Stewart Island, and three off South Island—one on the southwest and two on the southeast coast. Berkenbusch et al. (2013) reported 42 sightings during May–June 1970–2013.

During 2005, two right whales were reported on the west coast of New Zealand, two sightings were made at 35°15'S near Bay of Islands, and one sighting occurred north off Cape Reinga at 33°25'S (Richards 2009). In 2006, 64 sightings were reported off the North and South Islands, including one near Whangarei at 35°37'S (Richards 2009). During 2007, more than 60 sightings were made off the main islands of New Zealand, and in 2008, 43 sightings of at least 64 whales were made. In 2009, up to 1 August, more than 50 sightings had been made off North and South Islands (Richards 2009). In addition, there have been at least two strandings of southern right whales in New Zealand (Berkenbusch et al. 2013).

Habitat use modeling for New Zealand by Torres et al. (2013c) showed that the proposed survey areas have low habitat suitability for the southern right whale; sheltered coastal areas had the highest habitat suitability, at least during winter. Torres et al. (2013a,d) reported that southern right whale presence increases in water temperatures 7–13°C, with closer proximity to the subtropical front, and a mixed layer depth of <100 m.

The available information suggests that it is possible that southern right whales could be migrating through the proposed survey area at the time the survey is scheduled (May–June). However, the low population numbers indicate that few, if any, would be encountered. Thus, southern right whale sightings are likely to be uncommon in the project area during the austral fall.

Pygmy right whale (Caperea marginata)

The pygmy right whale's distribution is circumpolar in the Southern Hemisphere between 30°S and 55°S in oceanic and coastal environments (Jefferson et al. 2008; Kemper 2009). Pygmy right whales appear to be non-migratory, although there may be some movement inshore in spring and summer (Kemper 2002; Jefferson et al. 2008). Sightings of pygmy right whales in the southwestern Pacific Ocean are rare (Jefferson et al. 2008). Matsuoka et al. (2005) reported a sighting of 14 pygmy right whales at 46°26'S, 177°18'E in January 2001 that had been feeding in the area; this suggests that the Subtropical Convergence may be an important feeding area for this species during the austral summer (Matsuoka et al. 2005). In addition, Kemper et al. (2013) reported a sighting in very shallow water of Cook Strait during October 2002, and Berkenbusch et al. (2013) noted a sighting off the east coast of Northland. Other records include one whale that was captured at Stewart Island in 1874, and a skull that was trawled up by a fishing vessel at Chatham Rise (Kemper et al. 2013).

There have been at least 56 strandings in New Zealand, including at least eight live strandings (Kemper et al. 2013). Berkenbusch et al. (2013) reported 11 live strandings. Most strandings were concentrated at Stewart Island, Cook Strait, and the Auckland area; one stranding was also reported for Hawke's Bay (Kemper 2002). Strandings appear to be associated with favorable feeding areas in New Zealand, including upwelling regions, along the Subtropical Convergence, and the Southland Current (Kemper 2002; Kemper et al. 2013). Kemper et al. (2013) reported live strandings for the west coast of North Island (n = 4), Cook Strait (2), east coast of South Island (1), and Stewart Island (1). Records have been made throughout the year, but appear to be more frequent during austral spring and summer (Kemper et al. 2013).

Although Kemper (2009) noted that the number of strandings indicate that the pygmy right whale may be relatively common in Australia and New Zealand, it seems unlikely that this species would be encountered in the survey areas because of the scarcity of sightings.

Humpback Whale (Megaptera novaeangliae)

The humpback whale is found throughout all of the World's oceans (Jefferson et al. 2008). Although considered to be mainly a coastal species, humpback whales often traverse oceanic areas while migrating (Jefferson et al. 2008). Humpbacks migrate from winter breeding areas in the tropics to temperate or polar feeding areas in the summer (Jefferson et al. 2008). In the South Pacific Ocean, there are several distinct winter breeding grounds, including eastern Australia and Oceania (Anderson et al. 2010; Garrigue et al. 2011). Whales from Oceania migrate past New Zealand to Antarctic summer feeding areas (Constantine et al. 2007; Garrigue et al. 2000, 2010). The northern migration along the New Zealand coast occurs between May and August, with a peak in late June to mid July; the southern migration occurs from September to December, with a peak in late October to late November (Dawbin 1956). Dawbin (1956) suggested that northern migrating humpback whales travel along the east coast of South Island and then move along the east coast of North Island or through Cook Strait and up the west coast of North Island; smaller numbers migrate around southwestern South Island. Most southern migrating whales travel along the west coast of New Zealand, whereas some migrate along the east coast of North Island south to East Cape before moving to offshore waters (Dawbin 1956). Clement (2010) also noted that humpback whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations. Humpback whales that migrate past New Zealand are likely part of the International Whaling Commission (IWC) Area V Antarctic management zone (Dawbin 1956; Constantine et al. 2007), and also part of IWC breeding stock E (Constantine et al. 2007).

Large numbers of humpback whales were taken around New Zealand during the commercial whaling era, and the recovery of humpbacks in those waters has been slow (Gibbs and Childerhouse 2000; Constantine et al. 2007). Gibbs and Childerhouse (2000) reported 157 sightings consisting of 437 live individuals for the east coast of New Zealand during 1970 to 1999; approximately half were from Kaikoura, on the east coast of South Island, and Cook Strait. Over half of the total sightings were made during May–August; most sightings were made off the eastern coast of South Island (Gibbs and Childerhouse 2000), although none were reported in the proposed southern survey area. Torres et al.

(2013b) reported one summer humpback whale sighting in the proposed southern survey area near the 2000-m isobath, and several other humpback sightings just south of the southern survey area during spring, summer, and autumn. Gibbs and Childerhouse (2000) did not report any humpback records for the study areas off North Island, although numerous sightings were made in the Bay of Plenty to the northwest.

Since 1999, at least 30 additional sightings have been made between Hawke's Bay and Bay of Plenty (Clement 2010). Most sightings in the Bay of Plenty were made between August and January; sightings in the coastal waters of Gisborne District were made in June and July (Clement 2010). Several sightings of humpbacks have been reported for shelf waters adjacent to the northern survey area (Clement 2010). Clement (2010) noted that humpbacks regularly occur off eastern North Island during their migration, although they appear to be more prevalent in Hawke's Bay and coastal waters of the Gisborne District during fall migration. Clement (2010) also reported that humpbacks have been observed feeding in the Bay of Plenty before migrating south for the summer. In addition, there have been at least 20 humpback whale strandings in New Zealand (Berkenbusch et al. 2013).

A total of 34 whales were photo-identified off New Zealand during 1994–2004 (Constantine et al. 2007); most were sighted during a 2004 survey in Cook Strait (Gibbs and Childerhouse 2004 in Constantine et al. 2007). In addition, humpback whale vocalizations were detected off Great Barrier Island, northern New Zealand, from February through September 1997, with peak calling activity from May through September (McDonald 2006).

It is likely that some humpback whales will be encountered in the survey area during May–June as they migrate from summer feeding grounds in the Antarctic to winter breeding areas in the tropics.

Bryde's Whale (Balaenoptera edeni/brydei)

The distribution of Bryde's whale is circumglobal, but it generally occurs in tropical and sub-tropical areas (Jefferson et al. 2008). In New Zealand, Bryde's whale distribution is largely restricted to warmer waters north of East Cape off North Island (Baker 1999), within ~18 km from shore (NABIS 2014). The west and southeast coast of North Island, including the proposed survey areas, are not included in the species range description by NABIS (2014). Baker (1999) noted that Bryde's whales migrate along the northeast coast of North Island on a seasonal basis. Bryde's whales are found in the Bay of Plenty, Hauraki Gulf, and the eastern coast of Northland throughout the year (O'Callaghan and Baker 2002; Clement 2010; NZDOC 2009; Baker and Madon 2007; Wiseman 2008; Baker et al. 2010; Wiseman et al. 2011; Berkenbusch et al. 2013). Bryde's whale vocalizations were also detected year-round off Great Barrier Island, northern New Zealand, during 1997 (McDonald 2006). Berkenbusch et al. (2013) noted that there were 33 strandings for New Zealand during 1970–2013, and Baker et al. (2010) reported 38 mortalities from 1989 to 2008, including vessel strikes.

Although there have been strandings along the coast adjacent to the northern survey area (Clement 2010), a sighting in offshore waters southeast of New Zealand (Berkenbusch et al. 2013), and three sightings within the South Taranaki Bight region (Torres 2012), Bryde's whale is unlikely to occur in the proposed survey areas.

Dwarf minke (Balaenoptera acutorostrata) and Antarctic minke whale (B. bonaerensi)

The common minke whale has a cosmopolitan distribution ranging from the tropics and sub-tropics to the ice edge in both hemispheres (Jefferson et al. 2008). Its distribution in the South Pacific is not well known (Jefferson et al. 2008). A smaller form (unnamed subspecies) of the common minke whale, known as the dwarf minke whale, occurs in the Southern Hemisphere where its distribution overlaps with that of the Antarctic minke whale during summer (Perrin and Brownell 2009). The range of the dwarf minke whale is thought to extend as far south as 65°S (Jefferson et al. 2008) and as far north as 11°S off Australia, where it can be found year-round (Perrin and Brownell 2009). The Antarctic minke whale has a circumpolar distribution in coastal and offshore areas of the Southern Hemisphere from ~7?S to the ice edge (Jefferson et al. 2008). Antarctic minke whales are found between 60°S and the ice edge during the austral summer; in the austral winter, they are mainly found at breeding grounds at mid latitudes, including 10°S–30°S and 170°E–100°W in the Pacific, off eastern Australia, western South Africa, and northeastern Brazil (Perrin and Brownell 2009).

Populations of minke whales around New Zealand are migratory (Baker 1983). Clement (2010) noted that minke whales likely use East Cape to navigate along the east coast of New Zealand during the northern and southern migrations. Small groups of minke whales have been sighted off New Zealand (Baker 1999; Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b). Clement (2010) noted that at least one to two common minke whales are seen annually in the Bay of Plenty from mid winter through early summer; however, according to Berkenbusch et al. (2013), minke whales have also occurred there during austral fall (May–June). Minke whale sightings have also been made during fall in Hawke's Bay and in eastern Cook Strait during summer (Berkenbusch et al. 2013). Offshore sightings east of North Island and South Island, including at Chatham Rise southeast of the proposed survey areas, have primarily been made during spring and summer, although sightings have also been reported for fall and winter (Berkenbusch et al. 2013; Torres et al. 2013b).

Between 1970 and 2013, there were 85 strandings of dwarf minke whales in New Zealand, including 34 live strandings (Berkenbusch et al. 2013). Strandings occurred along North and South Island, including Hawke's Bay, Cook Strait, and Bay of Plenty (Brabyn 1991). In addition, 17 Antarctic minke whales stranded in New Zealand between 1970 and 2013, including 10 live strandings (Berkenbusch et al. 2013).

Although minke whales are considered to be one of the most frequently sighted rorquals in the area, both species are likely to be uncommon in the proposed survey areas during May–June.

Sei Whale (Balaenoptera borealis)

The sei whale occurs in all ocean basins (Horwood 2009). It undertakes seasonal migrations to feed in sub-polar latitudes during summer, returning to lower latitudes during winter to calve (Horwood 2009). In the South Pacific, sei whale typically concentrate between the sub-tropical and Antarctic convergences during the summer (Horwood 2009).

Numerous sightings of sei whales have been made in New Zealand waters (Baker 1999; Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b). Although most sightings have been made during October–April (Clement 2010), there are records of this species throughout the year, including May and June (Berkenbusch et al. 2013). The majority of sightings are for the east coast of North Island in shelf waters, including the Hauraki Gulf, Bay of Plenty, and East Cape (Clement 2010; Berkenbusch et al. 2013); nonetheless, sightings have also been recorded for the east coast of South Island, Cook Strait, Stewart Island, the west coast of New Zealand, and the Chatham Islands (Berkenbusch et al. 2013). Large groups (>100 whales) and single sei whales have been reported for Bay of Plenty and the Hawke's Bay area (Clement 2010). Some of the sightings have occurred in and near the proposed survey areas off North and South Island (see Clement 2010; Berkenbusch et al. 2013). Fall sightings have been reported for East Cape and eastern Cook Strait, as well as other areas around New Zealand (Berkenbusch et al. 2013). In addition, at least eight strandings have been reported for New Zealand, including strandings in the Bay of Plenty and Cook Strait (Brabyn 1991)

The sei whale is likely to be uncommon in the proposed survey area, especially during May–June.

Fin Whale (Balaenoptera physalus)

The fin whale occurs in all major oceans; however, its overall range and distribution is not well known (Jefferson et al. 2008). Northern and southern fin whale populations are distinct and are sometimes recognized as different subspecies (Aguilar 2009). In the Southern Hemisphere, fin whales are usually distributed south of 50ºS in the austral summer, and they migrate northward to breed in the winter (Gambell 1985).

Numerous sightings of fin whales have been made in New Zealand waters, mostly during spring and summer, although records exist throughout the year (Baker 1999; Clement 2010; Berkenbusch et al. 2013). The majority of sightings are for the east coast of North Island in shelf waters, including the Hauraki Gulf, Bay of Plenty, and East Cape (Clement 2010; Berkenbusch et al. 2013), although sightings have also been recorded for the east coast of South Island, Cook Strait, and the west coast of New Zealand (Berkenbusch et al. 2013). Some of the sightings have occurred in and near the proposed survey areas off North and South Island (see Clement 2010; Berkenbusch et al. 2013). Fall sightings have been reported for East Cape and Banks Peninsula, as well as other areas around New Zealand (Berkenbusch et al. 2013). Distant fin whale vocalizations were detected off Great Barrier Island, northern New Zealand, during June–September 1997 (McDonald 2006). At least 13 fin whale strandings have been reported for

New Zealand, including strandings in Hawke's Bay, Bay of Plenty, and Cook Strait (Brabyn 1991).

Fin whales could be encountered during the proposed survey, as they migrate to winter breeding areas at the time of the survey.

Blue Whale (Balaenoptera musculus)

The blue whale has a cosmopolitan distribution, but tends to be mostly pelagic, only occurring nearshore to feed and possibly breed (Jefferson et al. 2008). Three subspecies of blue whale are recognized: B. m. musculus in the Northern Hemisphere; B. m. intermedia (the true blue whale) in the Antarctic, and B. m. brevicauda (the pygmy blue whale) in the sub-Antarctic zone of the southern Indian Ocean and the southwestern Pacific Ocean (Sears and Perrin 2009). The pygmy and Antarctic blue whales occur in New Zealand (Branch et al. 2007). The blue whale is considered rare in the Southern Ocean (Sears and Perrin 2009). Most pygmy blue whales do not migrate south during summer; however, Antarctic blue whales are typically found south of 55°S during summer, although some are known not to migrate (Branch et al. 2007).

Blue whales have been sighted throughout New Zealand waters year-round, with most sightings reported for the South Taranaki Bight and the east coast of Northland (Berkenbusch et al. 2013; Torres 2013). Most sightings off the east coast, including at East Cape and Bay of Plenty, occurred during spring and summer (Clement 2010; Berkenbusch et al. 2013). Fall sightings were made in Cook Strait, South Taranaki Bight, and offshore from Banks Peninsula (Berkenbusch et al. 2013; Olson et al. 2013; Torres 2013). Sightings have been made near the proposed northern and middle survey areas off North Island, as well as near the southern area off South Island during summer (Berkenbusch et al. 2013; Torres 2013; Torres et al. 2013b). One blue whale was sighted on the Chatham Rise south of the survey area during fall (Torres et al. 2013b).

Blue whale vocalizations specific to New Zealand waters were detected within 2 km from Great Barrier Island, northern New Zealand, from June to December 1997; Southern Ocean blue whale songs were detected further offshore during May–July (McDonald 2006). Blue whale vocalizations were also detected within the southern survey area off the northeastern South Island during March 2013 (Miller et al. 2013).

The South Taranaki Bight, between North and South Island, appears to be a foraging area for blue whales, as the upwelling in this area likely concentrates their euphausiid prey (Torres 2013). There are likely other feeding areas in New Zealand for blue whales (Olson et al. 2013). There have been 20 strandings of blue whales on the New Zealand coast (Torres 2013), including at least three strandings of pygmy blue whales (Berkenbusch et al. 2013). One blue whale stranding was reported for Hawke's Bay, several were reported in the South Taranaki Bight/Cook Strait area, and the remainder were spread out along the rest of the coastline (Torres 2013).

Based on the available information, it is possible that pygmy or true blue whales could be encountered in the proposed survey areas during May–June.

Odontocetes

Sperm Whale (Physeter macrocephalus)

Sperm whales have an extensive world-wide distribution which is linked to social structure: mixed groups of adult females and juveniles of both sexes generally occur in tropical and subtropical waters, whereas adult males are commonly found alone or in same-sex aggregations, often occurring in higher latitudes outside the breeding season (Best 1979; Rice 1989). Females typically inhabit waters >1000 m deep and latitudes <40° (Rice 1989). Torres et al. (2013a) found that sperm whale distribution is associated with proximity to geomorphologic features, as well as surface temperature.

Sperm whales are widely distributed throughout New Zealand waters, occurring in offshore and nearshore regions, with decreasing abundance away from New Zealand toward the central South Pacific Ocean (Gaskin 1973). Year-round sightings of sperm whales have been made throughout New Zealand waters, both close to shore and offshore (Berkenbusch et al. 2013; Torres et al. 2013b). Clement (2010) noted that male and female sperm whales likely migrate through the Hawke's Bay area during summer and fall. An aggregation of sperm whales is known to occur off Kaikoura Peninsula, on the northeastern coast of South Island; this area is almost exclusively used by males on a year-round basis (Lettevall et al. 2002; Richter et al. 2003). Letteval et al. (2002) reported that 192 sperm whales used the area off Kaikoura Peninsula over the course of 1990–2001. Some individuals spend several weeks or months in the area at a time, revisiting the location over several seasons; some other individuals are only seen once, and are considered transients (Jaquet et al. 2000; Letteval et al. 2002). The mean residency times of sperm whales in the area was 42 days, and the mean number of whales in the area at any one time was 13.8 (Lettevall et al. 2002). More recently, Sagnol et al. (2014) reported a mean of four sperm whales were present in the area at any one time.

Childerhouse et al. (1995) noted that 60 to 108 whales may be present off Kaikoura in any season. Whales in that area are seen closer to shore in the winter than in summer, possible because of changes in the distribution of their prey (Jaquet et al. 2000; Richter et al. 2003). During summer, almost all sightings are made in waters deeper than 1000 m, whereas during winter, sperm whale distribution is more diffuse, with more whales seen south of Kaikoura, over the Conway Trench and in waters 500–1000 m deep (Jaquet et al. 2000; Richter et al. 2003).

Sperm whale sightings have been reported throughout the year in and near the proposed northern and middle survey areas, as well as the southern survey area (Clement 2010; Berkenbusch et al. 2013; Torres et al. 2013b). There have been at least 211 strandings reported for New Zealand (Berkenbusch et al. 2013), including along the coast of East Cape, and in Hawke's Bay and Cook Strait (Brabyn 1991).

Sperm whales, particularly adult males, are likely to be seen in the proposed survey areas during May–June.

Pygmy Sperm Whale (Kogia breviceps)

The pygmy sperm whale is distributed widely throughout tropical and temperate seas, but its precise distribution is unknown because much of what we know of the species comes from strandings (McAlpine 2009). Although there are few useful estimates of abundance for pygmy sperm whales anywhere in their range, they are thought to be common in some areas. They are known to occur in tropical and warm temperate areas of the western South Pacific Ocean.

There have been very few sightings of pygmy sperm whales in New Zealand. The lack of sightings is likely because of their subtle surface behavior and long dive times (Clement 2010). Berkenbusch et al. (2013) reported one sighting off Banks Peninsula and one in the Bay of Plenty, and Clement (2010) mapped a sighting off the north coast of East Cape. The pygmy sperm whale is one of the most regularly stranded cetacean species in New Zealand, suggesting that this species is not uncommon in those waters (Clement 2010). A total of 355 strandings were reported between 1970 and 2013; nearly half of those (154) were live strandings (Berkenbusch et al. 2013). The East Cape/Hawke's Bay area seems to be a key area for this species, as stranding events are common there (Suisted and Neale 2004; Clement 2010; Berkenbusch et al. 2013). Half of all female strandings at Hawke's Bay involved calves, suggesting that this area is an important breeding ground (Brabyn 1991; Clement 2010; Berkenbusch et al. 2013). Based on stranding data, the pygmy sperm whale calving season in New Zealand is during summer months (Baker 1999).

Pygmy sperm whales are likely to occur near the survey areas.

Cuvier's Beaked Whale (Ziphius cavirostris)

Cuvier's beaked whale is probably the most widespread of the beaked whales, although it is not found in polar waters (Heyning 1989). New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of Cuvier's beaked whales in the area (MacLeod et al. 2006). Beaked whale sightings in New Zealand primarily consist of Mesoplodon spp. and Cuvier's beaked whales (MacLeoad and Mitchell 2006), with sightings of Cuvier's beaked whale reported for the Bay of Plenty (Clement 2010). Cuvier's beaked whales also strand relatively frequently in New Zealand; at least 82 strandings have been reported (Berkenbusch et al. 2013). Strandings have been reported for East Cape, Mahia Peninsula, Hawke's Bay, Cook Strait, the southeast coast of North Island, and northeastern coast of South Island (Brabyn 1991; Clement 2010).

Cuvier's beaked whale could be encountered during the proposed surveys.

Shepherd's Beaked Whale (Tasmacetus shepherdi)

Based on known records, it is likely that Shepherd's beaked whale has a circumpolar distribution in the cold temperate waters of the Southern Hemisphere (Mead 1989a). This species is primarily known from strandings, most of which have been recorded in New Zealand (Mead 2009). Thus, MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for Shepherd's beaked whale. One possible sighting was made near Christchurch (Watkins 1976). At least 20 specimens have stranded on the coast of New Zealand (Baker 1999), including in southern Taranaki Bight and Banks Peninsula (Brabyn 1991).

Shepherd's beaked whale could be encountered during the proposed surveys.

Southern Bottlenose Whale (Hyperoodon planifrons)

The southern bottlenose whale can be found throughout the Southern Hemisphere from 30°S to the ice edge, with most sightings occurring from ~57°S to 70°S (Jefferson et al. 2008). It is apparently migratory and is found in Antarctic waters during the summer (Jefferson et al. 2008). New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of southern bottlenose whales in the area (MacLeod et al. 2006). At least four sightings have been reported for waters around New Zealand, including one in Hauraki Gulf, one on the southwest coast of South Island, and two sightings south of New Zealand within the EEZ (Berkenbusch et al. 2013). In addition, 24 strandings were reported for New Zealand between 1970 and 2013 (Berkenbusch et al. 2013). Strandings have been reported for East Cape, Hawke's Bay, southern North Island, northeastern South Island, and Cook Strait (Brabyn 1991; Clement 2010).

The southern bottlenose whale could be encountered during the proposed surveys.

Hector's beaked whale (Mesoplodon hectori)

Hector's beaked whale is thought to have a circumpolar distribution in deep oceanic temperate waters of the Southern Hemisphere (Pitman 2002). Based on the number of stranding records for the species, it appears to be relatively rare. One individual was observed swimming close to shore off southwestern Australia for periods of weeks before disappearing (Gales et al. 2002). This was the first live sighting in which species identity was confirmed.

MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for this species. There are sighting and stranding records of Hector's beaked whales for New Zealand (MacLeod et al. 2006; Clement 2010). One sighting has been reported for the Bay of Plenty on the North Island (Clement 2010). At least 12 strandings have been reported for New Zealand (Berkenbusch et al. 2013), including records for the Bay of Plenty, East Cape, Mahia Peninsula, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

Hector's beaked whale could be encountered during the proposed surveys.

Gray's beaked whale (Mesoplodon grayi)

Gray's beaked whale is thought to have a circumpolar distribution in temperate waters of the Southern Hemisphere (Pitman 2002). Gray's beaked whale primarily occurs in deep waters beyond the edge of the continental shelf (Jefferson et al. 2008). Some sightings have been made in very shallow water, usually of sick animals coming in to strand (Gales et al. 2002; Dalebout et al. 2004). One Gray's beaked whale was observed within 200 m of the shore off southwestern Australia off and on for periods of weeks before disappearing (Gales et al. 2002). There are many sighting records from Antarctic and sub-Antarctic waters, and in summer months they appear near the Antarctic Peninsula and along the shores of the continent (sometimes in the sea ice).

New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of Gray's beaked whales in the area (MacLeod et al. 2006). In particular, the area between the South Island of New Zealand and the Chatham Islands has been suggested to be a hotspot for sightings of this species (Dalebout et al. 2004). In addition, a mother and calf Grays' beaked whale was observed in Mahurangi Harbor on the North Island over five consecutive days in June 2001 (Dalebout et al. 2004). Gray's beaked whale is the most common beaked whale to strand in New Zealand with at least 252 records (Berkenbusch et al. 2013). Stranding records exist along the east coasts of North and South Islands, including Bay of Plenty, Mahia Peninsula, Hawke's Bay, and Cook Strait

(Brabyn 1991; Clement 2010).
Gray's beaked whale could be encountered during the proposed surveys.

Andrew's beaked whale (Mesoplodon bowdoini)

Andrew's beaked whale has a circumpolar distribution in temperate waters of the Southern Hemisphere (Baker 2001). This species is known only from stranding records between 32°S and 55°S, with more than half of the strandings occurring in New Zealand (Jefferson et al. 2008). Thus, New Zealand may be a globally important area for Andrew's beaked whale (MacLeod and Mitchell 2006). In particular, Clement (2010) suggested that the East Cape/Hawke's Bay waters may be an important habitat for Andrew's beaked whale.
There have been at least 19 strandings in New Zealand (Berkenbusch et al. 2013), at least 10 of which have been reported in the spring and summer (Baker 1999). Strandings have occurred from the North Island to the sub-Antarctic Islands (Baker 1999), including East Cape, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

Andrew's beaked whale could be encountered during the proposed surveys.

Strap-toothed beaked whale (Mesoplodon layardii)

The strap-toothed beaked whale is thought to have a circumpolar distribution in temperate and sub-Antarctic waters of the Southern Hemisphere, mostly between 35° and 60°S (Jefferson et al. 2008). Based on the number of stranding records, it appears to be fairly common. Strap-toothed whales are thought to migrate northward from Antarctic and sub-Antarctic latitudes during April–September (Sekiguchi et al. 1996).

New Zealand has been reported as a hotspot for beaked whales (MacLeod and Mitchell 2006), with both sightings and strandings of strap-toothed beaked whales in the area (MacLeod et al. 2006; Clement 2010). Strap-toothed whales commonly strand in New Zealand, with at least 78 strandings reported (Berkenbusch et al. 2013). Most strandings occur between January and April, suggesting some seasonal austral summer inshore migration (Baker 1999). Strap-toothed whale strandings have been reported for the east coast of North Island and South Island, including the Bay of Plenty, East Cape, Hawke's Bay, and Cook Strait (Brabyn 1991; Clement 2010).

The strap-toothed beaked whale could be encountered during the proposed surveys.

Blainville's Beaked Whale (Mesoplodon densirostris)

Blainville's beaked whale is found in tropical and temperate waters of all oceans (Jefferson et al. 2008). It has the widest distribution throughout the world of all Mesoplodon species (Mead 1989b). According to Berkenbusch et al. (2013), there have been at least three strandings of Blainville's beaked whale in New Zealand. One stranding has been reported for the west coast of Northland and another for Hawke's Bay (Baker and van Helden 1999).

Blainville's beaked whale could be encountered during the proposed surveys.

Spade-toothed beaked whale (Mesoplodon traversii)

The spade-toothed beaked whale is the name proposed for the species formerly known as Bahamonde's beaked whale (M. bahamondi). Recent genetic evidence has shown that they belong to the species first identified by Gray in 1874 (van Helden et al. 2002). The species is considered relatively rare and is known from only four records, three of which are from New Zealand (Thompson et al. 2012). One mandible was found at the Chatham Islands in 1872; two skulls were found at White Island, Bay of Plenty, in the 1950s; a skull was collected at Robinson Crusoe Island, Chile, in 1986; and most recently, two live whales, a female and a male, stranded at Opape, in the Bay of Plenty, and subsequently died (Thompson et al. 2012). MacLeod and Mitchell (2006) suggested that New Zealand may be a globally important area for the spade-toothed beaked whale.

The spade-toothed beaked whale could be encountered during the proposed surveys.

Common Bottlenose Dolphin (Tursiops truncatus)

The bottlenose dolphin is distributed worldwide in coastal and shelf waters of tropical and temperate oceans (Jefferson et al. 2008). There are two distinct bottlenose dolphin types: a shallow water type, mainly found in coastal waters, and a deep water type, mainly found in oceanic waters (Duffield et al. 1983; Hoelzel et al. 1998; Walker et al. 1999). In New Zealand, the inshore form appears to be more common than the offshore ecotype, and is restricted to waters north of 47°S in water <500 m deep (NABIS 2014). The offshore form occurs more widely (Baker et al. 2010), and is seen off eastern Northland during the summer and autumn (NABIS 2014). Baker et al. (2010) noted that there are 900–1000 bottlenose dolphins in inshore waters.

Although the bottlenose dolphin can occur along the entire coast of New Zealand, there are three hotspots (NABIS 2014) or main areas of distribution in New Zealand, including Northland, Marlborough Sounds, and Fiordland (Tezanos-Pinto et al. 2009). These three areas are treated as containing distinct populations that are mostly isolated from one another (Tezanos-Pinto et al. 2009). Even though the three populations occur in coastal waters, they are more similar to other offshore ecotypes than coastal ecotypes (Tezanos-Pinto et al. 2009).

Sightings of bottlenose dolphins have been made in shelf and deeper waters (>200 m) off the east coasts of North and South Islands throughout the year, including East Cape, Mahia Peninsula, Cape Palliser, and Cook Strait (Clement 2010; Berkenbusch et al. 2013). One sighting was made along the 2000-m isobath in the southern survey area, along with several other sightings on the Chatham Rise (see Torres et al. 2013b). Clement (2010) noted that in general, bottlenose dolphins in New Zealand occur closer to shore during summer and autumn, and farther offshore during winter. A total of 157 strandings were reported between 1970 and 2013 for New Zealand (Berkenbusch et al. 2013), including East Cape, Mahia Peninsula, and Cook Strait (Brabyn 1991; Clement 2010).

As sightings have been made near the proposed study areas during the austral autumn, it is likely that bottlenose dolphins would be encountered during the survey during May–June.

Short-beaked Common Dolphin (Delphinus delphis)

The common dolphin is found in tropical and warm temperate oceans around the world (Jefferson et al. 2008). It ranges as far south as 40°S in the Pacific Ocean, is common in coastal waters 200–300 m deep and is also associated with prominent underwater topography, such as seamounts (Evans 1994). Neumann (2001) noted that this species can be found in coastal and oceanic habitats.

Short-beaked common dolphins are found in shelf waters of New Zealand, generally north of Stewart Island; they are more commonly seen in waters along the northeastern coast of North Island (Stockin and Orams 2009; NABIS 2014) and may occur closer to shore during the summer (Neumann 2001; Stockin et al. 2008). They can be found all around New Zealand (Baker 1999) with abundance hotspots on the east coast occurring along Northland, Hauraki Gulf, Mahia Peninsula, Cape Palliser, Cook Strait, and Marlborough Sounds (NABIS 2014).

The short-beaked common dolphin is likely the most common cetacean species in New Zealand waters, occurring there year-round (Clement 2010; Hutching 2013). Numerous sightings have been made in shelf waters of the east coast of North and South Islands, as well as farther offshore, throughout the year, including near and within the proposed northern, middle, and southern survey areas (Clement 2010; Berkenbusch et al. 2013). Clement (2010) reported that dense areas of sightings occur in offshore waters off East Cape and just to the south of Mahia Peninsula, especially during fall and summer. Feeding has also been observed in the shelf waters off East Cape, and calves are sighted regularly there (Clement 2010). Short-beaked common dolphins are generally seen at a mean distance of <10 km from shore in the summer, and move farther offshore in winter (Neumann 2001). In addition, 749 strandings were reported between 1950 and 2008, including records for East Cape, Hawke's Bay, and Cook Strait (Stockin and Orams 2009).

As sightings have been made near and within the survey areas during austral fall, this species could be encountered during the proposed surveys in May–June.

Dusky dolphin (Lagenorhyncus obscurus)

The dusky dolphin is widespread in the Southern Hemisphere, occurring in disjunct subpopulations in the waters off southern Australia, New Zealand (including some sub-Antarctic islands), central and southern South America (including the Falkland Islands), and southwestern Africa (Jefferson et al. 2008). The species occurs in coastal and continental slope waters and is uncommon in waters >2000 m deep (Würsig et al 2007). The dusky dolphin is common in New Zealand (Hutching 2013) and occurs there year-round. Dusky dolphins migrate northward to warmer waters in winter and south during the summer (Gaskin 1968).

The dusky dolphin occurs along the entire coast of South Island and the southern part of North Island, up to Hawke's Bay (Würsig et al. 2007; NABIS 2014); they are rarely seen north of East Cape (Baker 1999). Concentration hotspots include Marlborough Sounds and the northeastern coast of South Island, particularly around Kaikoura (NABIS 2014). The shallow waters around Kaikoura serve as a nursery for mother-calf pairs (Weir et al. 2008), with calving occurring between November and January (Würsig et al. 2007). Gaskin (1968) noted that they are the most common dolphin species in the Cook Strait/Banks Peninsula region. They are more often sighted around northern South Island and southern North Island waters during winter (Würsig et al. 1997).

Sightings of dusky dolphins exist for shelf as well as deep, offshore waters (Berkenbusch et al. 2013). Würsig et al. (2007) noted that dusky dolphin typically moves into deeper waters during the winter. Sightings have been made in the northern survey area, and adjacent to the middle and southern survey areas (see Clement 2010; Berkenbusch et al. 2013). Sightings in the austral fall have been made off East Cape, southeastern North Island, and northeastern South Island and Cook Strait (Berkenbusch et al. 2013). Several sightings have been made along the 500-m isobath on the Chatham Rise, south of the survey areas (Torres et al. 2013b). In addition, at least 107 strandings have been reported for New Zealand (Berkenbusch et al. 2013), including records for East Cape, Hawke's Bay, Cape Palliser, and Cook Strait (Brabyn 1991; Clement 2010).

The dusky dolphin could be encountered during the proposed surveys.

Hourglass Dolphin (Lagenorhynchus cruciger)

The hourglass dolphin occurs in all parts of the Southern Ocean south of ~45°S, with most sightings between 45°S and 60°S (Goodall 2009). Although it is pelagic, it is also sighted near banks and islands (Goodall 2009). Baker (1999) reported that the hourglass dolphin is considered a rare coastal visitor to New Zealand. Berkenbusch et al. (2013) reported five sightings of hourglass dolphins in New Zealand waters, including one off Banks Peninsula, one off the southeast coast of South Island, and three south of New Zealand; all sightings were made during November–February. In addition, there have been at least five strandings in New Zealand (Berkenbusch et al. 2013), including records for the South Island (Baker 1999).

The hourglass dolphin likely would be rare in the proposed survey area.

Southern Right Whale Dolphin (Lissodelphis peronii)

The southern right whale dolphin is distributed between the Subtropical and Antarctic Convergences in the Southern Hemisphere, generally between ~30ºS and 65ºS (Jefferson et al. 2008). It is sighted most often in cool, offshore waters, although it is sometimes seen near shore where coastal waters are deep (Jefferson et al. 2008).

The species has rarely been seen at sea in New Zealand (Baker 1999). Berkenbusch et al. (2013) reported five sightings for the EEZ of New Zealand, including one each off the southeast coast and southwest coast of South Island, and three to the southeast of Stewart Island; sightings were made during February and September. During August 1999, a group 500+ southern right whale dolphins including a calf were sighted southeast of Kaikoura in water >1500 m deep (Visser et al. 2004). There were five additional sightings in the OBIS database, including one sighting in the South Taranaki Bight, two sightings southeast of Kaikoura during 1985–1986, and two sightings off the southwest coast of South Island (OBIS 2014).

At least 16 strandings have been reported for New Zealand (Berkenbusch et al. 2013). Most strandings have occurred along the north coast of South Island (Brabyn 1991), but one stranding was also reported for Hawke's Bay (Clement 2010).

The southern right whale dolphin could be encountered during the proposed surveys.

Hector's dolphin (Cephalorhynchus hectori)

Hector's dolphin is endemic to New Zealand and has one of the most restricted distributions of any cetacean (Dawson and Slooten 1988); it occurs in New Zealand waters year-round (Berkenbusch et al. 2013). Hector's dolphin (C. h. hectori) occurs around South Island, and Maui's dolphin (C. h. maui) is restricted to the northern west coast of North Island (Baker et al. 2002). Occasional sightings are made off the eastern coast of North Island (Berkenbusch et al. 2013), but it is unknown whether these individuals are from the South Island or the North island populations (Clement 2010).

There are at least three genetically separate populations off South Island: off the east coast (particularly around Banks Peninsula); off the west coast; and off the Southland coast (Baker et al. 2002). Hector's dolphins occur in coastal waters (Slooten et al. 2006). During summer on the east coast around Banks Peninsula, Hector's dolphins tend to aggregate in shallow waters close to shore. During winter, the distribution extends farther offshore, up to 33 km on shallow shelf areas (Rayment et al. 2006; Slooten et al. 2005). In general, Hector's dolphins prefer waters <90 m deep (Bräger et al. 2003; Rayment et al. 2006; Slooten et al. 2006) within 10 km from shore (Hutching 2013). However, several offshore sightings have also been made, including off Mahia and Banks Peninsula (Berkenbusch et al. 2013), with the farthest sighting at 60 km from shore (Hutching 2013). Sightings have been made in shallow (<100 m) water adjacent to the northern, middle, and southern survey areas (Berkenbusch et al. 2013). In addition, there have been at least 249 strandings of Hector's dolphin in New Zealand (Berkenbusch et al. 2013).

Habitat use modeling by Torres et al. (2013c) showed that nearshore waters adjacent to the southern survey area on the northeast coast of South Island have moderate to high habitat suitability for Hector's dolphin, at least during the winter. The highest habitat suitability occurred in shallow, coastal waters around South Island; suspended particulate matter, dissolved organic matter, wave height, and sea surface temperature were important predictors of suitable habitat (Torres et al. 2013c).

The occurrence of Hector's dolphins in the project area during May–June likely would be rare because of their nearshore distribution.

False Killer Whale (Pseudorca crassidens)

The false killer whale is found in all tropical and warmer temperate oceans, especially in deep, offshore waters (Odell and McClune 1999), but is also known to occur over the continental shelf and in nearshore shallow waters on occasion (Jefferson et al. 2008). In the western Pacific, the false killer whale is distributed from Japan south to Australia and New Zealand.

There have been at least 27 sightings of false killer whales in New Zealand during summer and fall, primarily along the coast of North Island, but also off South Island and in South Taranaki Bight (Berkenbusch et al. 2013). Several sightings have been reported for the Bay of Plenty, East Cape, and off northeastern South Island (Clement 2010; Berkenbusch et al. 2013). During 20 and 25 January 2011, two groups of false killer whales, consisting of 150 and 30 individuals, respectively, were seen cooperatively feeding with common bottlenose dolphins in Hauraki Gulf (Zaeschmar et al. 2013). On 25 March 2010, a group of eight killer whales was observed in the Bay of Islands attacking a group of 50–60 false killer whales that included ~15 calves (Visser et al. 2010). In addition, there have been at least 16 strandings in New Zealand (Berkenbusch et al. 2013), including East Cape, Hawke's Bay, and Cape Palliser (Brabyn 1991; Clement 2010). These strandings include a mass stranding on North Island (~37°S) of 231 whales in March 1978 (Baker 1999).

The false killer whale could be encountered during the proposed surveys.

Killer Whale (Orcinus orca)

The killer whale is cosmopolitan and globally fairly abundant; it has been observed in all oceans of the world (Ford 2009). It is very common in temperate waters and also frequents tropical waters (Heyning and Dahlheim 1988). The killer whale has been reported to be common in New Zealand waters (Baker 1999), with a population of ~200 individuals (Suisted and Neale 2004).

Killer whales have been sighted in all months around North and South Islands (Berkenbusch et al. 2013; NABIS 2014; Torres 2012). Calves and juveniles also occur there throughout the year (Visser 2000). Only the Type A killer whale is considered resident in New Zealand, while Types B, C, and D are vagrant and most common in the Southern Ocean (Visser 2000, 2007; Baker et al. 2010). Visser (2000, 2007) suggested that there might be three killer whale subpopulations in New Zealand, including off North Island, South Island, and one population that moves between the two regions. Visser (2000) noted that the east coast of North Island appears to be an important region for North Island and North-South populations. Killer whale sightings occur within 37 km of New Zealand throughout the year, but appear to occur more frequently off the southern part of North Island and the northernmost part of South Island from November through February (Visser 2007).

Killer whales sightings have been made in nearshore and offshore waters of New Zealand year-round, including sightings in and near the northern, middle, and southern study areas (Berkenbusch et al. 2013). Sightings have also been made in the northern study area, and off East Cape and Hawke's Bay (Clement 2010; Torres et al. 2013b). Pods of killer whales are known to frequent Wellington Harbour during the spring and summer (NZDOC 2014). In addition, there have been at least 45 strandings of Type A killer whales in New Zealand (Berkenbusch et al. 2013).

During winter, killer whales are usually found farther offshore, up to 150 km (Clement 2010). Habitat use modeling by Torres et al. (2013c) showed that the proposed survey areas likely have average to above average habitat suitability for killer whales. Sea surface temperature was the most important habitat predictor (Torres et al. 2013c).

As sighting of killer whales have been made near and within the survey areas during the austral fall, killer whale sightings may occur in small numbers near the project area during May–June.

Short-finned (Globicephala macrorhynchus) and Long-finned Pilot Whales (G. melas)

The short-finned pilot whale is found in tropical and warm temperate waters, and the long-finned pilot whale is distributed antitropically in cold temperate waters (Olson 2009). The ranges of the two species show little overlap, but both species are known to occur off North Island, New Zealand (Olson 2009). Short-finned pilot whale distribution does not generally range south of 40°S (Jefferson et al. 2008).

Pilot whales (Globicephala sp.) have been sighted in the coastal and offshore waters of New Zealand year-round, including in and near the northern, middle, and southern survey areas (Berkenbusch et al. 2013). Pilot whales also commonly strand en masse in New Zealand (Baker 1999; O'Callaghan et al. 2001). There have been at least 280 strandings of long-finned pilot whales and at least 12 short-finned pilot whale strandings in New Zealand (Berkenbusch et al. 2013). Short-finned and long-finned pilot whale stranding records exist for East Cape and Hawke's Bay (Clement 2010), and strandings for long-finned pilot whales have also been reported for Cook Strait (Brabyn 1991).

Most pilot whales sighted south of ~40°S likely would be the long-finned variety; however, short-finned pilot whales could also be encountered during the survey, particularly in the northern survey area.

Pinnipeds

New Zealand Fur Seal (Arctocephalus forsteri)

The New Zealand fur seal occurs throughout New Zealand waters and is the most common seal in the area (NZDOC 2014). It can be found on rocky shores of the mainland, the Chatham Islands, and sub-Antarctic islands (NABIS 2014; NZDOC 2014). The New Zealand fur seal population is expanding, with migrating seals colonizing new locations and haul-out sites becoming new breeding colonies (Bradshaw et al. 2000).

Large breeding colonies occur on the west and southern coast and islands around South Island; smaller colonies occur on North Island, including the east coast of Cape Palliser, and on the northeast coast of South Island (NABIS 2014). Marlborough Sounds, the Cook Strait area, and northeastern South Island are hotspots for New Zealand fur seal distribution (NABIS 2014). There are at least 15 haul-out sites and three breeding areas between Cape Palliser and Bay of Plenty, including haul out sites along Hawke's Bay (Clement 2010). There are also two haul-out sites adjacent to the southern survey area on (Taylor et al. 1995).

Pupping occurs from November to January; during this time, females stay close to breeding locations and foraging trips do not extend past the continental shelf (Harcourt et al. 1995). During autumn and winter, foraging occurs farther from the breeding sites, with trips extending more than 150 km from breeding sites, and into water depths >1000 m (Harcourt and Davis 1997; Harcourt et al. 2002).

It is likely that New Zealand fur seals would be encountered during the proposed survey, especially during May–June, when they tend to occur farther offshore.

Southern Elephant Seal (Mirounga leonina)

The southern elephant seal has a near circumpolar distribution in the Southern Hemisphere (Jefferson et al. 2008). However, the distribution of southern elephant seals does not typically extend to the proposed survey area (NABIS 2014). Breeding colonies occur on some New Zealand sub-Antarctic islands, including Antipodes and Campbell Islands (Suisted and Neale 2004); these are part of the Macquarie Island stock of southern elephant seals (Taylor and Taylor 1989). Pups are occasionally born during September–October on east coast beaches of the mainland, including the southern coast of South Island (between Oamaru and Nugget Point), Kaikoura Peninsula, and on the southeast coast of North Island (Taylor and Taylor 1989; Harcourt 2001).

Even though mainland New Zealand is not part of their regular distribution, juvenile southern elephant seals are sometimes seen over the shelf of South Island (van den Hoff et al. 2002; Field et al. 2004), including the area of the southern survey. Most sightings occur during the haul-out period in July and August and between November and January during the molt (van den Hoff 2001). Sightings have been made on the central coast of South Island and Kaikoura Peninsula (van den Hoff 2001). Individuals have also occurred in the Bay of Plenty, Christchurch, and Gisborne (Harcourt 2001); others have been seen in Wellington and other North Island beaches (Daniel 1971).

Although possible, it is unlikely that southern elephant seals would be encountered during the proposed survey, especially during May–June.

VI. OBSERVATIONS

On May 19, 2015 the *R/V Roger Revelle* departed Auckland, NZ and returned to port in Napier, NZ on June 16, 2015 (Figure 4). During that time the seismic sources were active for a total of 124 hours and 32 minutes and a distance of 896 kilometers (Table 5 and Figure 5). When the seismic sources were not active the ship was either in transit or taking heat flow measurements. The PSO's conducted observations during all daylight seismic operations. They also stood watch when the ship was underway and the seismic source was inactive.

There were an estimated 784 animals in 127 sightings on this cruise (Table 6). Of these 52 sightings were made while the sound source was active. Animals appeared to take evasive action in 26 of these sightings. During the majority of the sightings the animals appeared to not take evasive action from the vessel (Table 7). There were 42 mitigations actions that resulted in the shut down of the sound source. Of these shut downs 4 were for pilot whales, 38 were for New Zealand Fur Seals. Although not a mitigation action there was 1 shutdown for kelp mistaken as an animal sighting.

Little data was available on the population density of New Zealand Fur Seals in the work area. The authorized take limit was reached on June 7, 2015. Once this occurred the source was shut down at the 160dB range of 400m (>1000m) and 600m (100-1000m) to avoid additional takes while NMFS was consulted. On June 10, 2015 additional takes were authorized by NMFS. There were 32 shutdowns while operating with a 160dB exclusion zone for New Zealand Fur Seals. Seismic survey operations were completed on June 11, 2015.

TABLE 4. Level B Harassment Takes Authorized by NMFS and Observed Individuals within 160dB and 180 dB radii.

Species	IHA Authorized Takes	Number of Animals Observed Within the Predicted 180dB Radius	Number of Animals Observed Within the Predicted 160dB Radius
Unid Pilot Whale	40	0	27
New Zealand Fur Seal	615	0	23

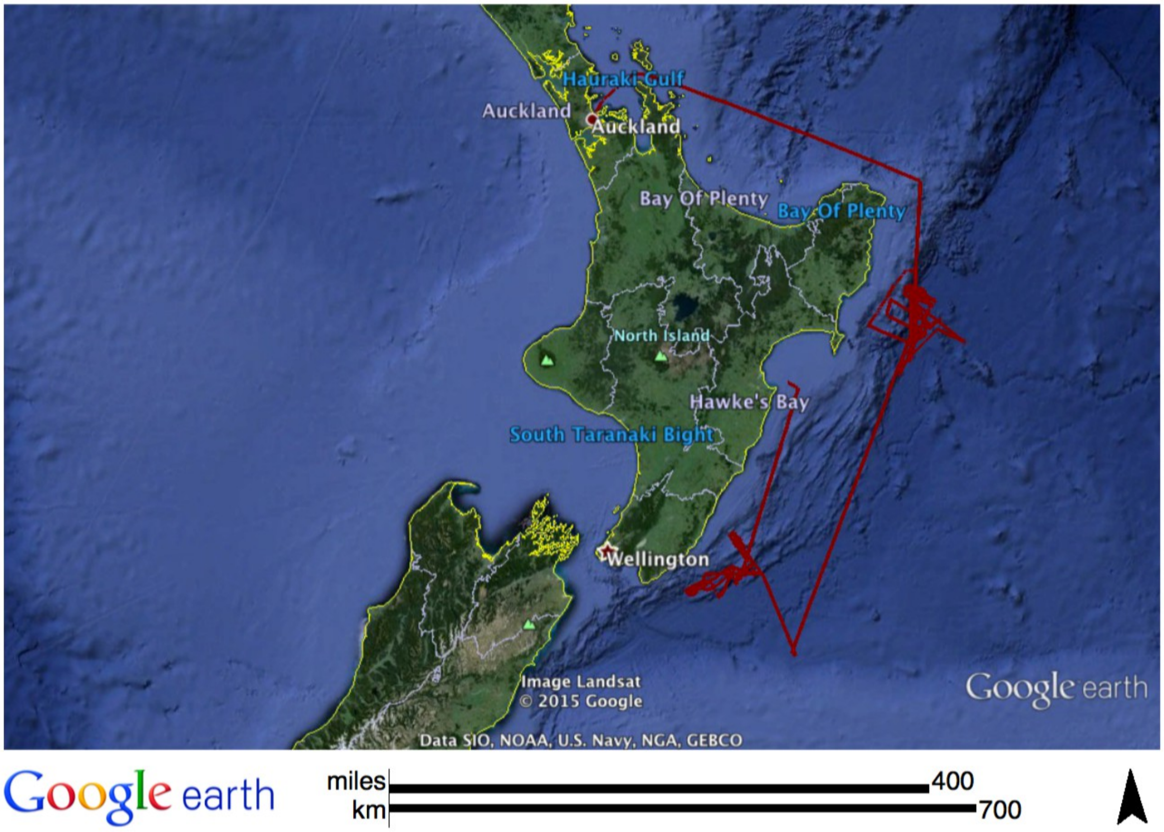


FIGURE 4. Trackline of the R/V Roger Revelle for the entire research cruise.

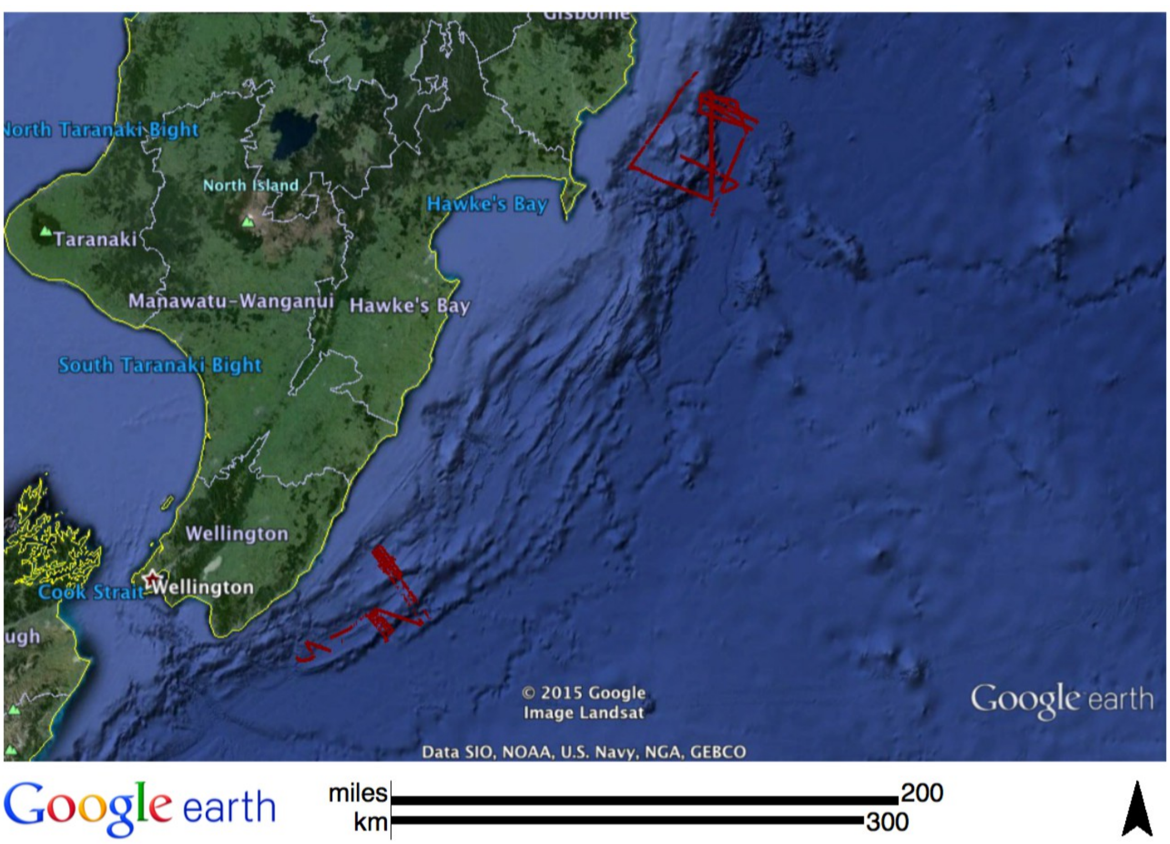


FIGURE 5. Trackline of the R/V Roger Revelle when the GI seismic sound source was active.

TABLE 5. Log of seismic sound source activity.

Time (UTC)	# Airguns	Mitigation Activity	Depth	Bft	Vis (km)	Glare Pct	Cloud Cover	GPS Pos	Speed (kts)	Course (°T)
2015-05-23T02:40:31	1	Ramp Up	Deep	6	3	0	100	39.27016 S 178.90839 E	2.88	23.39
2015-05-23T02:49:16	2	Monitoring	Deep	6	3	0	100	39.26456 S 178.91118 E	2.13	23.82
2015-05-23T02:59:59	0	Monitoring	Deep	6	3	0	100	39.25904 S 178.91387 E	2.35	34.27
2015-05-23T03:13:15	2	Monitoring	Deep	6	3	0	100	39.25193 S 178.91688 E	1.29	12.03
2015-05-23T03:20:12	0	Monitoring	Deep	6	3	0	100	39.24848 S 178.91859 E	2.26	20.77
2015-05-23T03:22:05	2	Monitoring	Deep	6	3	0	100	39.24737 S 178.91918 E	2.38	29.12
2015-05-23T03:22:27	0	Monitoring	Deep	6	3	0	100	39.24712 S 178.91931 E	2.5	22.24
2015-05-23T03:27:21	2	Monitoring	Deep	6	3	0	100	39.24417 S 178.92076 E	2.49	18.47
2015-05-23T04:59:43	0	Shut Down	Deep	7	2	0	100	39.16690 S 178.95765 E	4.25	13.72
2015-05-27T01:44:37	1	Ramp Up	Intermediate	7	12	12	90	38.46447 S 178.79002 E	2.81	208
2015-05-27T01:50:22	2	Monitoring	Intermediate	7	12	12	90	38.46645 S 178.78809 E	1.71	242.7
2015-05-28T01:41:05	0	Shut Down	Deep	4	12	0	100	38.97794 S 178.90100 E	3.67	357.39
2015-05-28T02:24:24	1	Ramp Up	Deep	4	12	0	100	38.96339 S 178.91992 E	3.33	190.93
2015-05-28T02:30:13	2	Monitoring	Deep	5	12	0	100	38.97030 S 178.92064 E	4.14	177.02
2015-05-28T03:35:48	1	Monitoring	Deep	5	12	0	100	38.97253 S 178.90147 E	3.63	355.55
2015-05-28T03:43:30	2	Monitoring	Deep	5	12	0	100	38.96455 S 178.90103 E	2.39	352.53
2015-05-28T21:04:47	0	Shut Down	Deep	3	12	0	80	38.62905 S 178.83874 E	4.36	113.28
2015-05-28T21:18:01	2	Monitoring	Deep	3	12	0	80	38.63656 S 178.85558 E	4.24	122.34
2015-05-29T01:45:31	0	Shut Down	Deep	1	12	6	50	38.78797 S 179.19119 E	5.12	50.24
2015-05-29T01:50:00	2	Monitoring	Deep	1	12	6	50	38.78190 S 179.19272 E	5.16	346.31
2015-05-29T02:37:56	0	Shut Down	Deep	2	12	3	40	38.76337 S 179.12575 E	4.18	289.21
2015-05-29T02:43:29	2	Monitoring	Deep	1	12	3	40	38.76138 S 179.11787 E	3.95	285.89
2015-05-29T22:45:28	0	Shut Down	Deep	4	12	9	10	39.04033 S 178.96974 E	3.97	292.41
2015-05-29T23:00:22	2	Monitoring	Deep	4	12	9	10	39.03293 S 178.94838 E	3.84	293.59
2015-05-30T02:25:04	0	Shut Down	Deep	5	12	12	10	38.93674 S 178.67577 E	4.24	290.3
2015-06-06T23:03:39	1	Ramp Up	Deep	3	12	10	70	41.52643 S 176.85750 E	2.46	314.9
2015-06-06T23:08:29	2	Monitoring	Deep	3	12	10	70	41.52390 S 176.85542 E	2.37	340.87
2015-06-07T00:12:24	0	Shut Down	Deep	3	12	10	95	41.47539 S 176.80901 E	3.84	313.73
2015-06-07T00:35:03	1	Ramp Up	Deep	3	12	10	95	41.45546 S 176.78997 E	5.57	335.57
2015-06-07T00:38:36	0	Shut Down	Deep	3	12	10	95	41.45241 S 176.78718 E	3.4	320
2015-06-07T00:59:41	1	Ramp Up	Deep	3	12	10	80	41.43395 S 176.76951 E	4.93	326.29
2015-06-07T01:05:23	2	Monitoring	Deep	3	12	10	80	41.42909 S 176.76433 E	3.13	321.79
2015-06-07T02:11:39	0	Shut Down	Deep	3	12	12	30	41.37028 S 176.70771 E	3.16	320.52
2015-06-07T03:57:43	1	Ramp Up	Deep	2	12	10	10	41.34930 S 176.66068 E	4.91	157.44
2015-06-07T04:00:02	0	Shut Down	Deep	2	12	10	10	41.35147 S 176.66267 E	3.99	149.45
2015-06-07T04:10:01	1	Ramp Up	Deep	2	12	10	10	41.36063 S 176.67152 E	6.7	147.75
2015-06-07T04:16:48	2	Monitoring	Deep	2	12	10	5	41.36689 S 176.67738 E	4.59	158.08
2015-06-07T04:36:00	0	Shut Down	Deep	2	12	10	10	41.38429 S 176.69400 E	3.68	133.59
2015-06-07T04:41:53	2	Monitoring	Deep	2	12	2	15	41.38944 S 176.69914 E	3.96	132.6
2015-06-07T04:55:22	0	Shut Down	Deep	2	6	0	20	41.40127 S 176.71008 E	4.28	145.82
2015-06-07T05:10:59	1	Ramp Up	Deep	3	0.5	0	20	41.41439 S 176.72359 E	3.96	137.99
2015-06-07T05:15:32	2	Monitoring	Deep	3	0.3	0	30	41.41811 S 176.72752 E	3.75	127.64
2015-06-07T19:37:43	0	Shut Down	Deep	4	12	2	10	41.24072 S 176.52269 E	4.14	139.77
2015-06-07T19:43:54	2	Monitoring	Deep	4	12	2	10	41.24668 S 176.52770 E	3.86	149.19
2015-06-07T20:11:03	0	Shut Down	Deep	5	12	4	5	0.00000 N 0.00000 E		
2015-06-07T20:16:59	2	Monitoring	Deep	5	12	4	5	41.23987 S 176.52025 E	4	58.68
2015-06-07T21:50:55	0	Shut Down	Deep	5	12	6	10	41.18690 S 176.56858 E	4.6	229.72
2015-06-07T22:10:36	1	Ramp Up	Deep	5	12	6	20	41.19992 S 176.54554 E	4.24	228.81
2015-06-07T22:12:58	0	Shut Down	Deep	5	12	6	20	41.20151 S 176.54277 E	4.19	229.32
2015-06-07T22:24:33	1	Ramp Up	Deep	5	12	6	20	41.20930 S 176.52872 E	4.39	234.49
2015-06-07T22:29:50	2	Monitoring	Deep	5	12	6	20	41.21304 S 176.52250 E	4	230.74
2015-06-07T23:09:06	0	Shut Down	Deep	6	12	10	50	41.22119 S 176.47938 E	3.46	356.82
2015-06-07T23:20:51	2	Monitoring	Deep	6	12	10	60	41.21184 S 176.48947 E	4.81	83.13
2015-06-08T01:33:27	0	Shut Down	Deep	6	12	12	70	41.33002 S 176.60265 E	4.14	148.09
2015-06-08T01:39:02	2	Monitoring	Deep	6	12	12	70	41.33493 S 176.60689 E	3.55	152.51
2015-06-08T01:42:20	0	Shut Down	Deep	6	12	12	70	41.33788 S 176.60946 E	3.86	151.96
2015-06-08T01:46:36	2	Monitoring	Deep	6	12	12	70	41.34168 S 176.61269 E	3.67	156.24
2015-06-08T01:51:56	0	Shut Down	Deep	6	12	12	70	41.34656 S 176.61676 E	4.08	144.93

Time (UTC)	# Airguns	Mitigation Activity	Depth	Bft	Vis (km)	Glare Pct	Cloud Cover	GPS Pos	Speed (kts)	Course (°T)
2015-06-08T01:53:45	2	Monitoring	Deep	6	12	12	70	41.34821 S 176.61815 E	3.97	153.3
2015-06-08T01:57:22	0	Shut Down	Deep	6	12	12	70	41.35156 S 176.62103 E	3.88	144.83
2015-06-08T02:38:00	1	Ramp Up	Deep	6	12	12	70	41.38742 S 176.65346 E	4.11	144.93
2015-06-08T02:43:24	2	Monitoring	Deep	6	12	12	70	41.39233 S 176.65814 E	3.9	134.65
2015-06-08T02:47:15	0	Shut Down	Deep	6	12	12	70	41.39582 S 176.66125 E	4.06	146.25
2015-06-08T02:57:05	2	Monitoring	Deep	6	12	12	70	41.40498 S 176.66914 E	4.08	143.67
2015-06-08T03:16:59	0	Shut Down	Deep	6	12	12	70	41.42406 S 176.68614 E	4.29	148.47
2015-06-08T03:32:26	1	Ramp Up	Deep	6	12	12	90	41.43921 S 176.69970 E	4.34	147.01
2015-06-08T03:37:48	2	Monitoring	Deep	6	12	12	90	41.44461 S 176.70444 E	4.23	140.74
2015-06-08T03:40:52	0	Shut Down	Deep	6	12	12	90	41.44771 S 176.70712 E	4.6	145.71
2015-06-08T04:08:31	1	Ramp Up	Deep	6	12	12	80	41.47556 S 176.73171 E	4.58	150.64
2015-06-08T04:13:57	2	Monitoring	Deep	6	12	12	80	41.48112 S 176.73626 E	4.26	144.92
2015-06-08T04:17:22	0	Shut Down	Deep	6	12	12	80	41.48441 S 176.73921 E	3.49	140.39
2015-06-08T04:26:08	2	Monitoring	Deep	6	12	12	80	41.49273 S 176.74708 E	4.5	141.31
2015-06-08T04:39:55	0	Shut Down	Deep	6	12	12	80	41.50597 S 176.75841 E	4	153.14
2015-06-08T04:51:35	2	Monitoring	Deep	6	12	0	80	41.51617 S 176.76788 E	4.09	149.06
2015-06-08T21:56:17	0	Shut Down	Deep	4	10	8	5	41.55600 S 176.44509 E	4.67	141.45
2015-06-08T22:07:36	1	Ramp Up	Deep	4	10	8	5	41.56636 S 176.45635 E	4.06	147.07
2015-06-08T22:11:18	0	Shut Down	Deep	4	10	8	5	41.56953 S 176.45983 E	4.17	146.78
2015-06-08T22:21:07	1	Ramp Up	Deep	5	10	8	5	41.57819 S 176.46929 E	4.64	136.38
2015-06-08T22:26:44	0	Shut Down	Deep	5	10	8	5	41.58321 S 176.47482 E	4.13	146.08
2015-06-08T22:49:02	1	Ramp Up	Deep	5	10	10	5	41.60378 S 176.49698 E	4.3	138.38
2015-06-08T22:51:24	0	Shut Down	Deep	5	10	10	5	41.60584 S 176.49934 E		
2015-06-08T23:20:41	1	Ramp Up	Deep	5	10	10	5	41.63145 S 176.52593 E	3.89	176.6
2015-06-08T23:27:15	2	Monitoring	Deep	5	10	10	5	41.63847 S 176.52304 E	3.88	204.31
2015-06-08T23:33:52	0	Shut Down	Deep	5	10	10	5	41.64485 S 176.51898 E	4.21	197.62
2015-06-08T23:41:29	2	Monitoring	Deep	5	10	10	10	41.65257 S 176.52047 E	3.37	136.68
2015-06-08T23:44:00	0	Shut Down	Deep	5	10	10	10	41.65399 S 176.52321 E	3.58	116.79
2015-06-08T23:59:55	1	Ramp Up	Deep	6	10	10	10	41.64782 S 176.53951 E	4.33	357.6
2015-06-09T00:05:56	2	Monitoring	Deep	6	10	10	10	41.64125 S 176.53652 E	4.06	339.19
2015-06-09T00:48:14	0	Shut Down	Deep	5	12	12	30	41.60277 S 176.49619 E	3.82	311.93
2015-06-09T00:56:34	2	Monitoring	Deep	5	12	12	30	41.59656 S 176.48888 E	3.44	314.11
2015-06-09T01:19:47	0	Shut Down	Deep	5	12	12	50	41.57924 S 176.47013 E	3.36	325.3
2015-06-09T01:25:28	2	Monitoring	Deep	5	12	12	50	41.57449 S 176.46506 E	3.98	322.53
2015-06-09T01:26:56	0	Shut Down	Deep	5	12	12	50	41.57326 S 176.46372 E	3.69	316.36
2015-06-09T01:33:07	2	Monitoring	Deep	6	12	12	50	41.56820 S 176.45889 E	3.31	323.54
2015-06-09T03:19:58	0	Shut Down	Deep	4	10	12	80	41.50905 S 176.36674 E	4.37	227.78
2015-06-09T03:23:46	2	Monitoring	Deep	3	10	12	80	41.51191 S 176.36235 E	3.99	224.93
2015-06-09T03:33:30	0	Shut Down	Deep	4	10	12	90	41.52585 S 176.34102 E	4.24	222.1
2015-06-09T03:42:24	2	Monitoring	Deep	5	10	12	90	41.52650 S 176.34025 E	3.67	224.51
2015-06-09T03:44:43	0	Shut Down	Deep	5	10	12	90	41.52752 S 176.33892 E	3.45	227.34
2015-06-09T03:55:34	2	Monitoring	Deep	5	10	12	90	41.53516 S 176.32763 E	3.88	234.19
2015-06-09T03:58:18	0	Shut Down	Deep	5	10	12	90	41.53673 S 176.32460 E	3.57	236.59
2015-06-09T04:11:03	2	Monitoring	Deep	5	10	12	90	41.54440 S 176.31087 E	4.04	225.25
2015-06-09T04:15:58	0	Shut Down	Deep	6	10	12	90	41.54765 S 176.30613 E	3.58	220.23
2015-06-09T04:25:31	2	Monitoring	Deep	6	10	12	90	41.55390 S 176.29735 E	3.34	229.51
2015-06-09T04:34:55	0	Shut Down	Deep	6	10	12	90	41.55896 S 176.28858 E	2.62	228.46
2015-06-09T04:41:39	2	Monitoring	Deep	6	10	12	90	41.56329 S 176.28045 E	4.43	229.63
2015-06-09T07:50:36	0	Shut Down	Deep	7	0.05	0	100	41.63211 S 176.10244 E	3.27	238.28
2015-06-10T02:38:38	1	Ramp Up	Deep	7	9	10	85	41.65089 S 176.19747 E	3.61	324
2015-06-10T02:44:02	2	Monitoring	Deep	7	9	10	95	41.64643 S 176.19286 E	3.86	320.86
2015-06-10T21:36:47	0	Shut Down	Deep	7	10	0	80	41.73042 S 175.86549 E	4.15	244.9
2015-06-10T21:38:54	2	Monitoring	Deep	7	10	0	80	41.73155 S 175.86268 E	4.19	237.82
2015-06-10T21:53:50	0	Shut Down	Deep	7	12	8	80	41.74609 S 175.85359 E	4.6832881	152.63309
2015-06-10T21:56:47	2	Monitoring	Deep	7	12	8	80	41.74885 S 175.85712 E	4.95	130.89
2015-06-11T02:32:56	0	Shut Down	Deep	6	12	6	95	41.70243 S 176.11019 E	4.2990446	116.4109

TABLE 6. Protected Species Sighting Log

Sgt Id	Time (UTC)	Species	Count	GPS Pos	Mitigation Activity	Bft	Visibility (km)	Glare	Cloud Cover
1	2015-05-19T21:12:18	Unid Beaked Whale	1	37.29484 S 178.36554 E	None	4	8	6	55
2	2015-05-20T00:52:20	New Zealand Fur Seal	1	37.65909 S 179.00631 E	None	4	9	10	5
3	2015-05-20T01:13:00	Unid Pilot Whale	25	37.72567 S 179.00252 E	None	3	9	15	5
3	2015-05-20T01:20:40	Unid Dolphin or Porpoise	10	37.75044 S 179.00049 E	None	3	9	15	5
4	2015-05-20T02:54:28	Unid Mysticete	4	38.03989 S 178.98182 E	None	2	9	15	10
5	2015-05-20T04:29:50	Unid Pilot Whale	15	38.33276 S 178.95992 E	None	2	9	15	5
6	2015-05-22T00:32:16	Unid Pilot Whale	75	39.14940 S 179.62202 E	None	7	6	12	10
7	2015-05-27T03:23:37	Unid Pilot Whale	40	38.51340 S 178.73913 E	Monitoring	6	12	12	80
8	2015-05-28T01:41:42	Unid Pilot Whale	20	38.97725 S 178.90099 E	Shut Down	4	12	0	100
9	2015-05-28T21:01:32	Unid Pilot Whale	30	38.62736 S 178.83447 E	Monitoring	3	12	0	80
10	2015-05-28T21:19:25	Bottlenose Dolphin	4	38.63738 S 178.85725 E	Monitoring	3	12	0	80
11	2015-05-28T22:16:57	Bottlenose Dolphin	20	38.66973 S 178.93110 E	Monitoring	3	12	0	90
11	2015-05-28T22:16:57	Unid Pilot Whale	60	38.66973 S 178.93110 E	Monitoring	3	12	0	90
12	2015-05-29T01:45:22	New Zealand Fur Seal	1	38.78812 S 179.19096 E	Monitoring	1	12	6	50
12	2015-05-29T02:04:14	New Zealand Fur Seal	1	38.77435 S 179.17292 E	Monitoring	1	12	6	50
13	2015-05-29T02:38:25	New Zealand Fur Seal	1	38.76318 S 179.12507 E	Monitoring	2	12	3	40
14	2015-05-29T03:10:02	Unid Mysticete	2	38.75195 S 179.07792 E	Monitoring	1	12	3	40
15	2015-05-29T21:17:13	Bottlenose Dolphin	2	39.08247 S 179.08295 E	Monitoring	4	12	4	10
16	2015-05-29T22:37:26	Bottlenose Dolphin	6	39.01187 S 178.88890 E	Monitoring	4	12	9	10
16	2015-05-29T22:37:26	Unid Pilot Whale	12	39.04431 S 178.98028 E	Monitoring	4	12	9	10
17	2015-05-30T03:59:26	Unid Dolphin or Porpoise	50	38.90530 S 178.58035 E	None	5	12	9	20
18	2015-06-04T01:53:21	Killer Whale	15	38.94986 S 179.09000 E	None	3	12	12	80
18	2015-06-04T02:05:20	Killer Whale	6	38.94932 S 179.08962 E	None	3	12	12	90
19	2015-06-05T02:54:42	Unid Pilot Whale	7	39.33247 S 178.78090 E	None	4	8	0	100

Sgt Id	Time (UTC)	Species	Count	GPS Pos	Mitigation Activity	Bft	Visibility (km)	Glare	Cloud Cover
20	2015-06-05T20:36:54	New Zealand Fur Seal	1	42.20436 S 177.38323 E	None	2	12	2	60
21	2015-06-05T22:17:10	Unid Mysticete	1	42.37562 S 177.29848 E	None	2	12	10	25
22	2015-06-06T21:12:48	New Zealand Fur Seal	1	41.68667 S 176.96227 E	None	3	12	3	50
23	2015-06-06T21:18:14	New Zealand Fur Seal	1	41.67068 S 176.95354 E	None	4	12	3	60
24	2015-06-06T22:18:37	New Zealand Fur Seal	2	41.54966 S 176.88037 E	Monitoring	4	12	6	35
25	2015-06-06T23:57:27	New Zealand Fur Seal	4	41.48838 S 176.82172 E	Monitoring	3	12	10	70
25	2015-06-07T00:11:52	New Zealand Fur Seal	1	41.47586 S 176.80945 E	Monitoring	3	12	10	95
26	2015-06-07T00:20:11	New Zealand Fur Seal	2	41.46854 S 176.80248 E	Shut Down	3	12	10	95
27	2015-06-07T00:27:19	New Zealand Fur Seal	3	41.46225 S 176.79637 E	Shut Down	3	12	10	95
28	2015-06-07T00:32:27	New Zealand Fur Seal	1	41.45782 S 176.79212 E	Shut Down	3	12	10	95
29	2015-06-07T00:36:18	New Zealand Fur Seal	1	41.45436 S 176.78901 E	Clearing Exclusion Zone	3	12	10	95
30	2015-06-07T00:42:38	New Zealand Fur Seal	1	41.44906 S 176.78380 E	Monitoring	3	12	10	95
31	2015-06-07T00:45:02	New Zealand Fur Seal	3	41.44703 S 176.78177 E	Monitoring	3	12	10	95
32	2015-06-07T00:48:55	New Zealand Fur Seal	2	41.44377 S 176.77848 E	Monitoring	3	12	10	95
33	2015-06-07T00:50:41	New Zealand Fur Seal	1	41.44221 S 176.77698 E	Monitoring	3	12	10	95
34	2015-06-07T00:51:11	New Zealand Fur Seal	2	41.44177 S 176.77657 E	Monitoring	3	12	10	95
35	2015-06-07T00:51:55	New Zealand Fur Seal	1	41.44110 S 176.77597 E	Monitoring	3	12	10	95
36	2015-06-07T01:04:13	New Zealand Fur Seal	1	41.43007 S 176.76533 E	Ramp Up	3	12	10	80
37	2015-06-07T01:15:07	New Zealand Fur Seal	1	41.42087 S 176.75657 E	Monitoring	3	12	10	80
38	2015-06-07T01:36:59	New Zealand Fur Seal	1	41.40165 S 176.73832 E	Monitoring	3	12	10	80
39	2015-06-07T01:47:24	New Zealand Fur Seal	1	41.39228 S 176.72895 E	Monitoring	3	12	10	60
40	2015-06-07T01:51:35	New Zealand Fur Seal	1	41.38849 S 176.72533 E	Monitoring	3	12	10	60
41	2015-06-07T01:54:54	New Zealand Fur Seal	1	41.38536 S 176.72252 E	Monitoring	3	12	10	60
42	2015-06-07T01:59:17	New Zealand Fur Seal	1	41.38140 S 176.71861 E	Monitoring	3	12	10	60

Sgt Id	Time (UTC)	Species	Count	GPS Pos	Mitigation Activity	Bft	Visibility (km)	Glare	Cloud Cover
43	2015-06-07T02:02:31	New Zealand Fur Seal	2	41.37851 S 176.71579 E	Monitoring	3	12	10	60
44	2015-06-07T02:02:44	New Zealand Fur Seal	2	41.37832 S 176.71558 E	Monitoring	3	12	10	60
45	2015-06-07T02:04:22	New Zealand Fur Seal	2	41.37684 S 176.71416 E	Monitoring	3	12	10	60
46	2015-06-07T02:09:54	New Zealand Fur Seal	6	41.37183 S 176.70926 E	Monitoring	3	12	10	60
47	2015-06-07T02:11:19	New Zealand Fur Seal	3	41.37057 S 176.70801 E	Monitoring	3	12	10	60
48	2015-06-07T02:14:02	New Zealand Fur Seal	2	41.36812 S 176.70561 E	Shut Down	3	12	10	30
49	2015-06-07T02:17:35	New Zealand Fur Seal	2	41.36485 S 176.70251 E	Shut Down	3	12	10	30
50	2015-06-07T02:20:53	New Zealand Fur Seal	5	41.36175 S 176.69958 E	Shut Down	3	12	10	30
51	2015-06-07T02:21:40	New Zealand Fur Seal	2	41.36104 S 176.69893 E	Shut Down	3	12	10	30
52	2015-06-07T02:23:31	New Zealand Fur Seal	2	41.35934 S 176.69732 E	Shut Down	3	12	10	30
53	2015-06-07T02:28:24	New Zealand Fur Seal	1	41.35486 S 176.69303 E	Shut Down	3	12	10	30
54	2015-06-07T02:37:02	New Zealand Fur Seal	10	41.34699 S 176.68539 E	Shut Down	3	12	10	30
55	2015-06-07T02:59:48	New Zealand Fur Seal	7	41.32611 S 176.66527 E	Monitoring	3	12	10	25
56	2015-06-07T03:01:34	New Zealand Fur Seal	1	41.32459 S 176.66369 E	Monitoring	3	12	10	25
57	2015-06-07T03:06:16	New Zealand Fur Seal	1	41.32040 S 176.65943 E	Monitoring	3	12	10	25
58	2015-06-07T03:07:39	New Zealand Fur Seal	1	41.31917 S 176.65825 E	Monitoring	3	12	10	25
59	2015-06-07T03:08:36	New Zealand Fur Seal	1	41.31829 S 176.65743 E	Monitoring	3	12	10	25
60	2015-06-07T03:09:12	New Zealand Fur Seal	1	41.31775 S 176.65694 E	Monitoring	3	12	10	25
61	2015-06-07T03:20:56	New Zealand Fur Seal	1	41.31318 S 176.64171 E	Clearing Exclusion Zone	2	12	10	5
62	2015-06-07T03:21:56	New Zealand Fur Seal	2	41.31370 S 176.64018 E	Clearing Exclusion Zone	2	12	10	5
63	2015-06-07T03:23:29	New Zealand Fur Seal	4	41.31476 S 176.63802 E	Clearing Exclusion Zone	2	12	10	5
64	2015-06-07T03:27:38	New Zealand Fur Seal	1	41.31918 S 176.63497 E	Clearing Exclusion Zone	2	12	10	5
65	2015-06-07T03:29:38	New Zealand Fur Seal	1	41.32175 S 176.63505 E	Clearing Exclusion Zone	2	12	10	5
66	2015-06-07T03:34:20	New Zealand Fur Seal	2	41.32689 S 176.63881 E	Clearing Exclusion Zone	2	12	10	5

Sgt Id	Time (UTC)	Species	Count	GPS Pos	Mitigation Activity	Bft	Visibility (km)	Glare	Cloud Cover
67	2015-06-07T03:42:24	New Zealand Fur Seal	1	41.33504 S 176.64613 E	Clearing Exclusion Zone	2	12	10	5
68	2015-06-07T03:55:28	Unid Dolphin or Porpoise	60	41.34722 S 176.65858 E	Clearing Exclusion Zone	2	12	10	5
69	2015-06-07T03:58:38	New Zealand Fur Seal	1	41.35017 S 176.66146 E	Ramp Up	2	12	10	10
70	2015-06-07T04:06:37	New Zealand Fur Seal	1	41.35749 S 176.66843 E	Shut Down	2	12	10	10
71	2015-06-07T04:10:37	New Zealand Fur Seal	4	41.36115 S 176.67205 E	Ramp Up	2	12	10	10
72	2015-06-07T04:11:49	New Zealand Fur Seal	1	41.36226 S 176.67305 E	Ramp Up	2	12	10	10
73	2015-06-07T04:36:12	New Zealand Fur Seal	1	41.38446 S 176.69418 E	Shut Down	2	12	10	10
74	2015-06-07T04:42:26	New Zealand Fur Seal	1	41.38994 S 176.69956 E	Monitoring	2	12	10	15
75	2015-06-07T04:42:42	New Zealand Fur Seal	1	41.39018 S 176.69978 E	Monitoring	2	12	10	15
76	2015-06-07T19:38:27	New Zealand Fur Seal	1	41.24149 S 176.52336 E	Shut Down	4	12	0	10
77	2015-06-07T20:11:09	New Zealand Fur Seal	2	41.24315 S 176.51238 E	Shut Down	5	12	4	5
78	2015-06-07T21:51:59	New Zealand Fur Seal	2	41.18771 S 176.56737 E	Shut Down	5	12	6	10
78	2015-06-07T21:55:19	New Zealand Fur Seal	1	41.19002 S 176.56349 E	Shut Down	5	12	6	10
79	2015-06-07T22:13:30	New Zealand Fur Seal	1	41.20186 S 176.54213 E	Shut Down	5	12	6	20
80	2015-06-07T22:15:39	New Zealand Fur Seal	2	41.20338 S 176.53955 E	Shut Down	5	12	6	20
79	2015-06-07T22:21:13	New Zealand Fur Seal	1	41.20710 S 176.53279 E	Monitoring	5	12	6	20
80	2015-06-07T22:23:27	New Zealand Fur Seal	2	41.20856 S 176.53007 E	Monitoring	5	12	6	20
81	2015-06-07T22:59:20	New Zealand Fur Seal	1	41.22862 S 176.48652 E	Monitoring	5	12	6	20
82	2015-06-07T23:06:34	New Zealand Fur Seal	1	41.22361 S 176.48013 E	Monitoring	5	12	6	20
83	2015-06-07T23:15:22	New Zealand Fur Seal	1	41.21507 S 176.48201 E	Monitoring	6	12	10	50
84	2015-06-08T01:33:31	New Zealand Fur Seal	3	41.33007 S 176.60268 E	Shut Down	6	12	12	70
85	2015-06-08T01:43:07	New Zealand Fur Seal	2	41.33857 S 176.61004 E	Shut Down	6	12	12	70
86	2015-06-08T01:58:02	New Zealand Fur Seal	1	41.35219 S 176.62154 E	Shut Down	6	12	12	70
87	2015-06-08T02:18:47	New Zealand Fur Seal	1	41.37032 S 176.63751 E	Shut Down	6	12	12	70

Sgt Id	Time (UTC)	Species	Count	GPS Pos	Mitigation Activity	Bft	Visibility (km)	Glare	Cloud Cover
88	2015-06-08T02:25:40	New Zealand Fur Seal	2	41.37637 S 176.64307 E	Shut Down	6	12	12	70
89	2015-06-08T02:29:34	New Zealand Fur Seal	1	41.37973 S 176.64632 E	Shut Down	6	12	12	70
90	2015-06-08T02:48:09	New Zealand Fur Seal	2	41.39811 S 176.66328 E	Shut Down	6	12	12	70
91	2015-06-08T03:17:11	New Zealand Fur Seal	2	41.42428 S 176.68634 E	Shut Down	6	12	12	70
92	2015-06-08T03:26:33	New Zealand Fur Seal	1	41.43337 S 176.69450 E	Shut Down	6	12	12	70
93	2015-06-08T03:40:56	New Zealand Fur Seal	3	41.44777 S 176.70717 E	Shut Down	6	12	12	90
94	2015-06-08T03:53:17	New Zealand Fur Seal	1	41.46049 S 176.71801 E	Clearing Exclusion Zone	6	12	12	80
93	2015-06-08T04:02:40	New Zealand Fur Seal	4	41.46970 S 176.72652 E	Clearing Exclusion Zone	6	12	12	80
95	2015-06-08T04:17:28	New Zealand Fur Seal	2	41.48449 S 176.73929 E	Shut Down	6	12	12	80
96	2015-06-08T04:39:42	New Zealand Fur Seal	3	41.50576 S 176.75824 E	Monitoring	6	12	12	80
97	2015-06-08T21:56:41	New Zealand Fur Seal	7	41.55640 S 176.44550 E	Shut Down	4	10	8	5
98	2015-06-08T22:01:37	New Zealand Fur Seal	4	41.56114 S 176.45045 E	Shut Down	4	10	8	5
99	2015-06-08T22:08:08	New Zealand Fur Seal	4	41.56681 S 176.45687 E	Ramp Up	4	10	8	5
100	2015-06-08T22:28:04	New Zealand Fur Seal	1	41.58441 S 176.47617 E	Shut Down	5	10	8	5
100	2015-06-08T22:38:52	New Zealand Fur Seal	1	41.59453 S 176.48703 E	Shut Down	5	10	8	5
101	2015-06-08T22:51:55	New Zealand Fur Seal	2	41.60630 S 176.49982 E	Shut Down	5	10	10	5
101	2015-06-08T22:55:50	New Zealand Fur Seal	2	41.60981 S 176.50347 E	Shut Down	5	10	10	5
102	2015-06-08T23:06:21	New Zealand Fur Seal	2	41.61878 S 176.51339 E	Shut Down	5	10	10	5
103	2015-06-08T23:11:11	New Zealand Fur Seal	3	41.62288 S 176.51803 E	Shut Down	5	10	10	5
104	2015-06-08T23:34:17	New Zealand Fur Seal	1	41.64527 S 176.51879 E	Shut Down	5	10	10	5
105	2015-06-08T23:39:17	New Zealand Fur Seal	5	41.65073 S 176.51890 E	Shut Down	5	10	10	5
106	2015-06-09T00:48:22	New Zealand Fur Seal	4	41.60268 S 176.49609 E	Shut Down	5	12	12	30
107	2015-06-09T01:18:57	New Zealand Fur Seal	2	41.57989 S 176.47080 E	Monitoring	5	12	12	30
108	2015-06-09T01:27:13	New Zealand Fur Seal	1	41.57301 S 176.46349 E	Shut Down	5	12	12	50

Sgt Id	Time (UTC)	Species	Count	GPS Pos	Mitigation Activity	Bft	Visibility (km)	Glare	Cloud Cover
109	2015-06-09T03:20:23	New Zealand Fur Seal	5	41.50935 S 176.36625 E	Shut Down	4	10	12	80
109	2015-06-09T03:22:38	New Zealand Fur Seal	5	41.51107 S 176.36363 E	Shut Down	4	10	12	80
110	2015-06-09T03:33:33	New Zealand Fur Seal	1	41.51906 S 176.35080 E	Shut Down	4	10	12	90
111	2015-06-09T03:45:07	New Zealand Fur Seal	2	41.52783 S 176.33851 E	Shut Down	5	10	12	90
112	2015-06-09T03:48:54	New Zealand Fur Seal	8	41.53063 S 176.33473 E	Shut Down	5	10	12	90
113	2015-06-09T03:58:37	New Zealand Fur Seal	1	41.53689 S 176.32427 E	Shut Down	5	10	12	90
113	2015-06-09T04:07:38	New Zealand Fur Seal	1	41.54229 S 176.31429 E	Shut Down	5	10	12	90
114	2015-06-09T04:16:08	New Zealand Fur Seal	1	41.54776 S 176.30599 E	Shut Down	6	10	12	90
115	2015-06-09T04:35:31	New Zealand Fur Seal	2	41.55927 S 176.28801 E	Shut Down	6	10	12	90
116	2015-06-10T02:12:24	New Zealand Fur Seal	1	41.66307 S 176.20560 E	Clearing Exclusion Zone	7	9	10	95
117	2015-06-10T02:22:59	New Zealand Fur Seal	1	41.65920 S 176.20364 E	Clearing Exclusion Zone	7	9	10	95
118	2015-06-10T21:36:51	New Zealand Fur Seal	4	41.73045 S 175.86540 E	Shut Down	7	10	5	80
119	2015-06-10T21:53:57	New Zealand Fur Seal	4	41.74640 S 175.85388 E	Shut Down	7	10	5	80
120	2015-06-11T02:59:28	New Zealand Fur Seal	1	41.70075 S 176.14625 E	Shut Down	6	12	6	95
121	2015-06-11T03:11:29	New Zealand Fur Seal	1	41.69705 S 176.15873 E	Shut Down	6	12	6	95
122	2015-06-14T01:26:37	Unid Odontocete	40	41.55813 S 176.52202 E	None	4	12	5	90
123	2015-06-14T01:56:09	New Zealand Fur Seal	1	41.51787 S 176.61043 E	None	4	12	5	40
124	2015-06-14T02:17:13	New Zealand Fur Seal	3	41.48555 S 176.69506 E	None	4	12	5	60
125	2015-06-14T02:21:54	New Zealand Fur Seal	1	41.47889 S 176.71384 E	None	4	12	5	60
126	2015-06-14T02:24:33	New Zealand Fur Seal	3	41.47506 S 176.72447 E	None	4	12	5	60
127	2015-06-16T01:07:53	Unid Pilot Whale	40	41.60800 S 176.57400 E	None	7	7	10	80

TABLE 7. Behavior of Protected Species during sightings

Sgt Id	Time (UTC)	Species	Bearing Obs	Cue	Heading	Sgt Dist (km)	Behavioral State	Pace	Addl. Behavior	Count	Reaction	Sighting Position	Mitigation Activity
1	2015-05-19T21:12:18	Unid Beaked Whale	45r	Body	30r	0.10	Moderate Travel	Medium	Unknown	1	None	37.29566 S 178.36601 E	None
2	2015-05-20T00:52:20	New Zealand Fur Seal	30l	Body	-90	0.10	Slow Travel	Slow	Unknown	1	None	37.65988 S 179.00684 E	None
3	2015-05-20T01:13:00	Unid Pilot Whale	36l	Splash	110r	0.50	Moderate Travel	Medium	Unknown	25	Paralleling	37.72943 S 179.00563 E	None
3	2015-05-20T01:20:40	Unid Dolphin or Porpoise	36l	Splash	110r	0.50	Moderate Travel	Medium	Bow Riding	10	Bow Ride	37.75424 S 179.00354 E	None
4	2015-05-20T02:54:28	Unid Mysticete	45r	Blow	130r	0.60	Slow Travel	Slow	Unknown	4	None	38.04350 S 178.97672 E	None
5	2015-05-20T04:29:50	Unid Pilot Whale	20 L	Blow	180r	3.00	Slow Travel	Slow	Unknown	15	None	38.35844 S 178.97048 E	None
6	2015-05-22T00:32:16	Unid Pilot Whale	90L	Body	unknown	0.05	Milling	Slow	Other	75	None	39.14940 S 179.62202 E	None
7	2015-05-27T03:23:37	Unid Pilot Whale	10L	Body	175R	0.35	Fast Travel	Fast	Milling	40	Other	38.51280 S 178.73518 E	Monitoring
8	2015-05-28T01:41:42	Unid Pilot Whale	170L	Splash	10R	0.40	Moderate Travel	Medium	Surface Active	20	Approach Boat	38.98083 S 178.90053 E	Shut Down
9	2015-05-28T21:01:32	Unid Pilot Whale	5L	Splash	170R	1.36	Fast Travel	Fast	Slow Traveling	30	Other	38.63380 S 178.84781 E	Monitoring
10	2015-05-28T21:19:25	Bottlenose Dolphin	55R	Body	10R	0.15	Surface Active	Medium	Associated Swimming	4	None	38.63870 S 178.85687 E	Monitoring
11	2015-05-28T22:16:57	Bottlenose Dolphin	5r	Body	90l	6.11	Unknown	Medium	Unknown	20	None	38.70481 S 178.98532 E	Monitoring
11	2015-05-28T22:16:57	Unid Pilot Whale	5r	Body	90l	6.11	Surface Active	Medium	Surface Active	60	None	38.70481 S 178.98532 E	Monitoring
12	2015-05-29T01:45:22	New Zealand Fur Seal	45r	Body	none	0.10	Milling	Slow	Other	1	Other	38.78842 S 179.19205 E	Monitoring
12	2015-05-29T02:04:14	New Zealand Fur Seal	42r	Body	none	1.24	Other		Unknown	1	None	38.76439 S 179.16637 E	Monitoring
13	2015-05-29T02:38:25	New Zealand Fur Seal	2R	Body	none	0.75	Other		Unknown	1	None	38.75955 S 179.11777 E	Monitoring
14	2015-05-29T03:10:02	Unid Mysticete	20r	Blow	110R	6.11	Moderate Travel	Medium	Unknown	2	None	38.71709 S 179.02344 E	Monitoring
15	2015-05-29T21:17:13	Bottlenose Dolphin	70r	Splash	none	0.89	Surface Active	Fast	Unknown	2	None	39.07450 S 179.08344 E	Monitoring
16	2015-05-29T22:37:26	Bottlenose Dolphin	30r	Splash	170	2.79	Moderate Travel	Medium	Unknown	6	None	38.99203 S 178.86915 E	Monitoring
16	2015-05-29T22:37:26	Unid Pilot Whale	30r	Splash	170	2.79	Moderate Travel	Medium	Unknown	12	Paralleling	39.02390 S 178.96150 E	Monitoring
17	2015-05-30T03:59:26	Unid Dolphin or Porpoise	20r	Splash	90	7.52	Fast Travel	Fast	Associated Swimming	50	Approach Boat	38.84518 S 178.54063 E	None
18	2015-06-04T01:53:21	Killer Whale	160L	Blow	190R	1.60	Slow Travel	Slow	Unknown	15	None	38.94253 S 179.10597 E	None
18	2015-06-04T02:05:20	Killer Whale	160L	Blow	90R	2.28	Slow Travel	Slow	Unknown	6	None	38.96954 S 179.09428 E	None
19	2015-06-05T02:54:42	Unid Pilot Whale	110L	Body	30R	0.35	Approaching	Fast	Fast Traveling	7	Approach Boat	39.33234 S 178.78497 E	None

Sgt Id	Time (UTC)	Species	Bearing Obs	Cue	Heading	Sgt Dist (km)	Behavioral State	Pace	Addl. Behavior	Count	Reaction	Sighting Position	Mitigation Activity
20	2015-06-05T20:36:54	New Zealand Fur Seal	30L	Body	none	0.18	Other	Slow	Other	1	Run from Boat	43.09153 S 177.58351 E	None
21	2015-06-05T22:17:10	Unid Mysticete	68l	Blow	180	7.52	Slow Travel	Slow	Unknown	1	None	42.39587 S 177.38580 E	None
22	2015-06-06T21:12:48	New Zealand Fur Seal	45R	Body	none	0.31	Resting	Slow	Unknown	1	None	41.68407 S 176.96344 E	None
23	2015-06-06T21:18:14	New Zealand Fur Seal	10R	Body	none	0.40	Resting	Slow	Slow Traveling	1	Run from Boat	41.66715 S 176.95258 E	None
24	2015-06-06T22:18:37	New Zealand Fur Seal	90L	Body	none	0.18	Resting	Slow	Unknown	2	None	41.55015 S 176.87833 E	Monitoring
25	2015-06-06T23:57:27	New Zealand Fur Seal	10L	Body	none	1.44	Resting	Unknown	Other	4	None	41.47822 S 176.81095 E	Monitoring
25	2015-06-07T00:11:52	New Zealand Fur Seal	10L	Body	none	0.08	Resting	Unknown	Moderate Traveling	1	Run from Boat	41.47533 S 176.80880 E	Monitoring
26	2015-06-07T00:20:11	New Zealand Fur Seal	45l	Body	none	0.21	Resting	Unknown	Other	2	None	41.46795 S 176.80013 E	Shut Down
27	2015-06-07T00:27:19	New Zealand Fur Seal	25l	Body	none	0.88	Other	Unknown	Other	3	None	41.45798 S 176.78743 E	Shut Down
28	2015-06-07T00:32:27	New Zealand Fur Seal	20l	Body	none	0.31	Resting	Unknown	Other	1	None	41.45618 S 176.78918 E	Shut Down
29	2015-06-07T00:36:18	New Zealand Fur Seal	3l	Body	none	0.74	Other	Unknown	Other	1	None	41.45010 S 176.78218 E	Clearing Exclusion Zone
30	2015-06-07T00:42:38	New Zealand Fur Seal	20l	Body	none	0.22	Other	Unknown	Other	1	None	41.44800 S 176.78150 E	Monitoring
31	2015-06-07T00:45:02	New Zealand Fur Seal	4r	Body	none	0.69	Resting	Unknown	Other	3	None	41.44158 S 176.77794 E	Monitoring
32	2015-06-07T00:48:55	New Zealand Fur Seal	42r	Body	none	1.24	Resting	Unknown	Other	2	None	41.43258 S 176.77788 E	Monitoring
33	2015-06-07T00:50:41	New Zealand Fur Seal	35l	Body	none	1.24	Resting	Unknown	Unknown	1	None	41.44027 S 176.76227 E	Monitoring
34	2015-06-07T00:51:11	New Zealand Fur Seal	20l	Body	none	1.24	Resting	Unknown	Unknown	2	None	41.43593 S 176.76382 E	Monitoring
35	2015-06-07T00:51:55	New Zealand Fur Seal	1r	Body	none	1.72	Resting	Unknown	Unknown	1	Run from Boat	41.42808 S 176.76494 E	Monitoring
36	2015-06-07T01:04:13	New Zealand Fur Seal	20l	Body	none	0.81	Resting	Unknown	Unknown	1	None	41.42503 S 176.75838 E	Ramp Up
37	2015-06-07T01:15:07	New Zealand Fur Seal	30l	Body	none	0.58	Resting	Unknown	Unknown	1	None	41.41868 S 176.75021 E	Monitoring
38	2015-06-07T01:36:59	New Zealand Fur Seal	51l	Body	none	0.88	Resting	Unknown	Unknown	1	None	41.40147 S 176.72773 E	Monitoring
39	2015-06-07T01:47:24	New Zealand Fur Seal	62L	Body	none	0.40	Resting	Slow	Slow Traveling	1	Run from Boat	41.39313 S 176.72428 E	Monitoring
40	2015-06-07T01:51:35	New Zealand Fur Seal	90L	Body	none	0.52	Resting	Unknown	Unknown	1	None	41.39123 S 176.72022 E	Monitoring
41	2015-06-07T01:54:54	New Zealand Fur Seal	30L	Body	none	0.40	Milling	Slow	Other	1	Unknown	41.38301 S 176.71887 E	Monitoring
42	2015-06-07T01:59:17	New Zealand Fur Seal	40R	Body	none	0.89	Resting	Slow	Unknown	1	None	41.37352 S 176.72031 E	Monitoring

Sgt Id	Time (UTC)	Species	Bearing Obs	Cue	Heading	Sgt Dist (km)	Behavioral State	Pace	Addl. Behavior	Count	Reaction	Sighting Position	Mitigation Activity
43	2015-06-07T02:02:31	New Zealand Fur Seal	25R	Body	none	0.27	Resting	Unknown	Unknown	2	None	41.37611 S 176.71514 E	Monitoring
44	2015-06-07T02:02:44	New Zealand Fur Seal	25R	Body	none	0.40	Resting	Unknown	Unknown	2	None	41.37485 S 176.71427 E	Monitoring
45	2015-06-07T02:04:22	New Zealand Fur Seal	90R	Body	none	0.31	Resting	Unknown	Unknown	2	Other	41.37515 S 176.71704 E	Monitoring
46	2015-06-07T02:09:54	New Zealand Fur Seal	90R	Splash	80R	0.27	Fast Travel	Fast	Other	6	Run from Boat	41.37046 S 176.71197 E	Monitoring
47	2015-06-07T02:11:19	New Zealand Fur Seal	45R	Body	none	0.06	Resting	Unknown	Other	3	None	41.37005 S 176.70822 E	Monitoring
48	2015-06-07T02:14:02	New Zealand Fur Seal	45L	Body	none	0.10	Resting	Unknown	Other	2	Run from Boat	41.36810 S 176.70442 E	Shut Down
49	2015-06-07T02:17:35	New Zealand Fur Seal	30L	Body	none	0.60	Other	Unknown	Unknown	2	None	41.36239 S 176.69611 E	Shut Down
50	2015-06-07T02:20:53	New Zealand Fur Seal	80R	Splash	90R	0.10	Fast Travel	Fast	Other	5	Run from Boat	41.36105 S 176.70032 E	Shut Down
51	2015-06-07T02:21:40	New Zealand Fur Seal	11L	Body	none	1.90	Resting	Slow	Unknown	2	None	41.34817 S 176.68401 E	Shut Down
52	2015-06-07T02:23:31	New Zealand Fur Seal	33R	Body	none	1.72	Resting	Unknown	Unknown	2	None	41.34391 S 176.69754 E	Shut Down
53	2015-06-07T02:28:24	New Zealand Fur Seal	20R	Body	none	0.76	Resting	Unknown	Unknown	1	None	41.34818 S 176.69137 E	Shut Down
54	2015-06-07T02:37:02	New Zealand Fur Seal	45L	Body	45L	0.31	Resting	Fast	Fast Traveling	10	Run from Boat	41.34651 S 176.68178 E	Shut Down
55	2015-06-07T02:59:48	New Zealand Fur Seal	25L	Splash	90R	4.91	Fast Travel	Fast	Milling	7	None	41.31173 S 176.60973 E	Monitoring
56	2015-06-07T03:01:34	New Zealand Fur Seal	30R	Body	45R	0.22	Milling	Medium	Fast Traveling	1	None	41.32260 S 176.66321 E	Monitoring
57	2015-06-07T03:06:16	New Zealand Fur Seal	10R	Body	none	1.36	Resting	Unknown	Unknown	1	None	41.30986 S 176.65113 E	Monitoring
58	2015-06-07T03:07:39	New Zealand Fur Seal	30l	Body	none	1.07	Resting	Unknown	Unknown	1	None	41.31577 S 176.64621 E	Monitoring
59	2015-06-07T03:08:36	New Zealand Fur Seal	35l	Body	none	1.07	Resting	Unknown	Unknown	1	None	41.31527 S 176.64521 E	Monitoring
60	2015-06-07T03:09:12	New Zealand Fur Seal	32l	Body	none	0.83	Resting	Unknown	Unknown	1	Run from Boat	41.31457 S 176.64796 E	Monitoring
61	2015-06-07T03:20:56	New Zealand Fur Seal	25l	Body	25l	0.08	Moderate Travel	Medium	Unknown	1	Run from Boat	41.31371 S 176.64106 E	Clearing Exclusion Zone
62	2015-06-07T03:21:56	New Zealand Fur Seal	15r	Body	none	4.15	Resting	Unknown	Unknown	2	None	41.32218 S 176.59185 E	Clearing Exclusion Zone
63	2015-06-07T03:23:29	New Zealand Fur Seal	100r	Splash	150r	2.66	Fast Travel	Fast	Unknown	4	None	41.29531 S 176.61940 E	Clearing Exclusion Zone
64	2015-06-07T03:27:38	New Zealand Fur Seal	60r	Body	none	2.41	Resting	Unknown	Unknown	1	None	41.32747 S 176.60833 E	Clearing Exclusion Zone
65	2015-06-07T03:29:38	New Zealand Fur Seal	75r	Body	none	1.10	Resting	Unknown	Unknown	1	None	41.32617 S 176.62333 E	Clearing Exclusion Zone
66	2015-06-07T03:34:20	New Zealand Fur Seal	4l	Body	none	2.79	Resting	Unknown	Unknown	2	None	41.34470 S 176.66234 E	Clearing Exclusion Zone

Sgt Id	Time (UTC)	Species	Bearing Obs	Cue	Heading	Sgt Dist (km)	Behavioral State	Pace	Addl. Behavior	Count	Reaction	Sighting Position	Mitigation Activity
67	2015-06-07T03:42:24	New Zealand Fur Seal	1R	Body	none	1.10	Resting	Unknown	Unknown	1	None	41.34231 S 176.65499 E	Clearing Exclusion Zone
68	2015-06-07T03:55:28	Unid Dolphin or Porpoise	234R	Splash	160L	4.37	Fast Travel	Fast	Surface Active	60	None	41.30987 S 176.67477 E	Clearing Exclusion Zone
69	2015-06-07T03:58:38	New Zealand Fur Seal	25R	Splash	80L	0.48	Resting	Slow	Fast Traveling	1	Run from Boat	41.35426 S 176.66312 E	Ramp Up
70	2015-06-07T04:06:37	New Zealand Fur Seal	25R	Body	none	2.41	Resting	Unknown	Unknown	1	None	41.37899 S 176.67185 E	Shut Down
71	2015-06-07T04:10:37	New Zealand Fur Seal	31R	Body	none	1.57	Resting	Unknown	Unknown	4	None	41.37385 S 176.68019 E	Ramp Up
72	2015-06-07T04:11:49	New Zealand Fur Seal	15R	Body	none	2.12	Resting	Unknown	Unknown	1	None	41.37965 S 176.68350 E	Ramp Up
73	2015-06-07T04:36:12	New Zealand Fur Seal	50L	Body	30L	0.05	Moderate Travel	Medium	Other	1	Run from Boat	41.38449 S 176.69478 E	Shut Down
74	2015-06-07T04:42:26	New Zealand Fur Seal	21R	Body	none	2.12	Resting	Unknown	Unknown	1	None	41.40826 S 176.70664 E	Monitoring
75	2015-06-07T04:42:42	New Zealand Fur Seal	10R	Body	none	1.90	Resting	Unknown	Other	1	None	41.40244 S 176.71558 E	Monitoring
76	2015-06-07T19:38:27	New Zealand Fur Seal	25l	Body	155R	0.05	Approaching	Slow	Moderate Traveling	1	Other	41.24176 S 176.52384 E	Shut Down
77	2015-06-07T20:11:09	New Zealand Fur Seal	45l	Body	none	0.31	Resting	None	None	2	None	41.24044 S 176.51297 E	Shut Down
78	2015-06-07T21:51:59	New Zealand Fur Seal	45L	Body	none	0.42	Milling	Slow	Diving	2	Unknown	41.19149 S 176.56763 E	Shut Down
78	2015-06-07T21:55:19	New Zealand Fur Seal	57L	Body	20R	0.35	Slow Travel	Slow	Diving	1	Unknown	41.19314 S 176.56367 E	Shut Down
79	2015-06-07T22:13:30	New Zealand Fur Seal	20L	Body	90R	0.01	Moderate Travel	Medium	None	1	None	41.20194 S 176.54207 E	Shut Down
80	2015-06-07T22:15:39	New Zealand Fur Seal	0	Body	none	0.03	Resting	None	Diving	2	Run from Boat	41.20311 S 176.53955 E	Shut Down
79	2015-06-07T22:21:13	New Zealand Fur Seal	165L	Body	10	0.43	Moderate Travel	Medium	None	1	None	41.20600 S 176.53770 E	Monitoring
80	2015-06-07T22:23:27	New Zealand Fur Seal	160L	Body	150R	0.74	Moderate Travel	Medium	None	2	None	41.20692 S 176.53865 E	Monitoring
81	2015-06-07T22:59:20	New Zealand Fur Seal	30R	Body	180R	1.44	Moderate Travel	Medium	None	1	None	41.21738 S 176.47792 E	Monitoring
82	2015-06-07T23:06:34	New Zealand Fur Seal	30R	Body	180R	0.05	Moderate Travel	Medium	Diving	1	Other	41.22316 S 176.48017 E	Monitoring
83	2015-06-07T23:15:22	New Zealand Fur Seal	135R	Body	none	0.74	Resting	None	None	1	None	41.22168 S 176.48313 E	Monitoring
84	2015-06-08T01:33:31	New Zealand Fur Seal	10R	Body	20L	0.02	Slow Travel	Slow	Moderate Traveling	3	Run from Boat	41.33024 S 176.60275 E	Shut Down
85	2015-06-08T01:43:07	New Zealand Fur Seal	60L	Body	30L	0.05	Fast Travel	Fast	None	2	Unknown	41.33861 S 176.61064 E	Shut Down
86	2015-06-08T01:58:02	New Zealand Fur Seal	0	Body	180	0.25	Moderate Travel	Medium	Surface Active	1	Approach Boat	41.34997 S 176.62154 E	Shut Down
87	2015-06-08T02:18:47	New Zealand Fur Seal	25R	Body	160L	0.20	Fast Travel	Fast	Unknown	1	Approach Boat	41.37209 S 176.63791 E	Shut Down

Sgt Id	Time (UTC)	Species	Bearing Obs	Cue	Heading	Sgt Dist (km)	Behavioral State	Pace	Addl. Behavior	Count	Reaction	Sighting Position	Mitigation Activity
88	2015-06-08T02:25:40	New Zealand Fur Seal	25L	Body	none	0.48	Resting	None	Unknown	2	Run from Boat	41.37760 S 176.64852 E	Shut Down
89	2015-06-08T02:29:34	New Zealand Fur Seal	30L	Body	145R	0.05	Moderate Travel	Medium	Approaching	1	Run from Boat	41.37997 S 176.64682 E	Shut Down
90	2015-06-08T02:48:09	New Zealand Fur Seal	95l	Body	90L	0.07	Moderate Travel	Medium	None	2	Run from Boat	41.39764 S 176.66383 E	Shut Down
91	2015-06-08T03:17:11	New Zealand Fur Seal	50R	Body	70L	0.48	Fast Travel	Fast	Unknown	2	Approach Boat	41.42839 S 176.68479 E	Shut Down
92	2015-06-08T03:26:33	New Zealand Fur Seal	45R	Body	none	0.58	Diving	Medium	Unknown	1	Unknown	41.43846 S 176.69280 E	Shut Down
93	2015-06-08T03:40:56	New Zealand Fur Seal	25R	Body	170L	0.27	Fast Travel	Fast	Unknown	3	Approach Boat	41.45021 S 176.70744 E	Shut Down
94	2015-06-08T03:53:17	New Zealand Fur Seal	0	Body	90L	0.40	Fast Travel	Fast	Unknown	1	Approach Boat	41.45688 S 176.71801 E	Clearing Exclusion Zone
93	2015-06-08T04:02:40	New Zealand Fur Seal	80R	Body	20L	0.06	Fast Travel	Fast	Surface Active	4	Approach Boat	41.47010 S 176.72605 E	Clearing Exclusion Zone
95	2015-06-08T04:17:28	New Zealand Fur Seal	40L	Body	160L	0.05	Fast Travel	Fast	Unknown	2	Unknown	41.48459 S 176.73987 E	Shut Down
96	2015-06-08T04:39:42	New Zealand Fur Seal	30L	Body	90R	0.03	Fast Travel	Fast	Approaching	3	Approach Boat	41.50589 S 176.75856 E	Monitoring
97	2015-06-08T21:56:41	New Zealand Fur Seal	30R	Body	none	0.48	Resting	None	None	7	None	41.56060 S 176.44658 E	Shut Down
98	2015-06-08T22:01:37	New Zealand Fur Seal	60L	Body	none	0.35	Resting	None	None	4	None	41.56072 S 176.45458 E	Shut Down
99	2015-06-08T22:08:08	New Zealand Fur Seal	10L	Body	none	0.81	Resting	None	Fast Traveling	4	Run from Boat	41.57192 S 176.46374 E	Ramp Up
100	2015-06-08T22:28:04	New Zealand Fur Seal	20L	Body	none	0.35	Resting	None	Diving	1	Unknown	41.58612 S 176.47966 E	Shut Down
100	2015-06-08T22:38:52	New Zealand Fur Seal	90L	Body	180	0.22	Slow Travel	Slow	None	1	Unknown	41.59340 S 176.48928 E	Shut Down
101	2015-06-08T22:51:55	New Zealand Fur Seal	45L	Body	145R	0.48	Surface Active	Fast	Approaching	2	Approach Boat	41.60704 S 176.50545 E	Shut Down
101	2015-06-08T22:55:50	New Zealand Fur Seal	90L	Body	varies	0.27	Milling	Medium	Unknown	2	None	41.60843 S 176.50619 E	Shut Down
102	2015-06-08T23:06:21	New Zealand Fur Seal	45L	Body	180	0.40	Slow Travel	Slow	Resting	2	Other	41.61976 S 176.51803 E	Shut Down
103	2015-06-08T23:11:11	New Zealand Fur Seal	24L	Body	45L	0.13	Slow Travel	Slow	Slow Traveling	3	Other	41.62342 S 176.51936 E	Shut Down
104	2015-06-08T23:34:17	New Zealand Fur Seal	10L	Body	90R	0.15	Slow Travel	Slow	None	1	None	41.64662 S 176.51883 E	Shut Down
105	2015-06-08T23:39:17	New Zealand Fur Seal	45L	Body	none	0.81	Resting	None	Fast Traveling	5	Run from Boat	41.65295 S 176.52813 E	Shut Down
106	2015-06-09T00:48:22	New Zealand Fur Seal	30R	Body	none	0.41	Resting	None	Moderate Traveling	4	Run from Boat	41.59903 S 176.49511 E	Shut Down
107	2015-06-09T01:18:57	New Zealand Fur Seal	15L	Body	none	0.40	Resting	None	None	2	None	41.57753 S 176.46715 E	Monitoring
108	2015-06-09T01:27:13	New Zealand Fur Seal	10L	Body	none	0.31	Resting	None	Milling	1	Other	41.57104 S 176.46093 E	Shut Down

Sgt Id	Time (UTC)	Species	Bearing Obs	Cue	Heading	Sgt Dist (km)	Behavioral State	Pace	Addl. Behavior	Count	Reaction	Sighting Position	Mitigation Activity
109	2015-06-09T03:20:23	New Zealand Fur Seal	30L	Body	none	0.41	Milling	Slow	Slow Traveling	5	Unknown	41.51278 S 176.36432 E	Shut Down
109	2015-06-09T03:22:38	New Zealand Fur Seal	90L	Body	none	0.52	Fast Travel	Fast	Other	5	Run from Boat	41.51449 S 176.36786 E	Shut Down
110	2015-06-09T03:33:33	New Zealand Fur Seal	45L	Body	170R	0.07	Fast Travel	Fast	Milling	1	Approach Boat	41.51969 S 176.35074 E	Shut Down
111	2015-06-09T03:45:07	New Zealand Fur Seal	45L	Body	90L	0.10	Moderate Travel	Medium	Approaching	2	Approach Boat	41.52873 S 176.33856 E	Shut Down
112	2015-06-09T03:48:54	New Zealand Fur Seal	0L	Body	45R	0.03	Fast Travel	Fast	Surface Active	8	Run from Boat	41.53080 S 176.33444 E	Shut Down
113	2015-06-09T03:58:37	New Zealand Fur Seal	10R	Body	20L	0.15	Resting	None	None	1	None	41.53768 S 176.32280 E	Shut Down
113	2015-06-09T04:07:38	New Zealand Fur Seal	80L	Body	90R	0.58	Moderate Travel	Medium	None	1	Unknown	41.54672 S 176.31806 E	Shut Down
114	2015-06-09T04:16:08	New Zealand Fur Seal	20R	Body	90R	0.25	Fast Travel	Fast	Surface Active	1	None	41.54870 S 176.30326 E	Shut Down
115	2015-06-09T04:35:31	New Zealand Fur Seal	0	Body	0	0.10	Fast Travel	Fast	None	2	Unknown	41.55837 S 176.28801 E	Shut Down
116	2015-06-10T02:12:24	New Zealand Fur Seal	135R	Body	none	0.30	Resting	None	Milling	1	Unknown	41.66423 S 176.20885 E	Clearing Exclusion Zone
117	2015-06-10T02:22:59	New Zealand Fur Seal	40L	Body	70L	0.40	Moderate Travel	Medium	None	1	Unknown	41.65760 S 176.19933 E	Clearing Exclusion Zone
118	2015-06-10T21:36:51	New Zealand Fur Seal	25R	Body	30R	0.05	Fast Travel	Fast	Other	4	Run from Boat	41.73046 S 175.86479 E	Shut Down
119	2015-06-10T21:53:57	New Zealand Fur Seal	10R	Body	none	0.04	Milling	Slow	Fast Traveling	4	Run from Boat	41.74672 S 175.85409 E	Shut Down
120	2015-06-11T02:59:28	New Zealand Fur Seal	178R	Body	0	0.04	Other	Medium	Approaching	1	Paralleling	41.70088 S 176.14579 E	Shut Down
121	2015-06-11T03:11:29	New Zealand Fur Seal	178L	Body	varies	0.04	Milling	Medium	Moderate Traveling	1	Paralleling	41.69720 S 176.15829 E	Shut Down
122	2015-06-14T01:26:37	Unid Odontocete	180 T	Blow	270 T	1.86	Slow Travel	Slow	Unknown	40	None	41.57490 S 176.52202 E	None
123	2015-06-14T01:56:09	New Zealand Fur Seal	50R	Body	none	0.00	Resting	None	Unknown	1	Other	41.51788 S 176.61046 E	None
124	2015-06-14T02:17:13	New Zealand Fur Seal	1 R	Body	none	0.35	Resting	None	Other	3	Run from Boat	41.48454 S 176.69900 E	None
125	2015-06-14T02:21:54	New Zealand Fur Seal	30L	Body	none	0.40	Diving	Medium	Unknown	1	Unknown	41.47605 S 176.71680 E	None
126	2015-06-14T02:24:33	New Zealand Fur Seal	25L	Body	20R	0.06	Resting	Slow	Diving	3	Paralleling	41.47465 S 176.72494 E	None
127	2015-06-16T01:07:53	Unid Pilot Whale	90R	Body	180R	0.02	Moderate Travel	Medium	Milling	40	Approach Boat	41.60800 S 176.57400 E	None

VII. ANALYSIS

In order to minimize the potential impacts to and Level-B incidental taking of protected species during the May-June 2015 seismic survey on R/V Roger Revelle, mitigation measures were implemented whenever these protected species were seen approaching, entering, or within the safety radii designated in the IHA. All mitigation and monitoring measures specified in the IHA were implemented during the cruise, as described in this report.

Visual observations alone cannot account for the true number of marine mammals and sea turtles present in a given area due to normal surfacing and dive behaviors, which limit visual detection capabilities. Marine mammals spend a significant portion of time subsurface, and visual detection of deep-diving cetaceans is limited, in the best of sighting conditions, by the short duration of their surface time compared to their dive time. The probability of detecting certain species of marine mammals also varies relative to an animal's size, distance from the vessel, and regional population density.

All potential marine mammal takes (50) represents 3.88 percent of the total takes authorized for marine mammals for the survey. Observation conditions were highly variable during the survey, with some monitoring conducted during poor conditions, therefore it is unlikely that Protected Species Observers detected all animals during survey operations, especially given there were night time operations. However, in spite of this, the monitoring and mitigation measures required by the IHA appear to have been an effective means to protect the marine species encountered during this survey.

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Appendices

A. Incidental Harassment Authorization

B. Modification Incidental Harassment Authorization

C. Mysticetus Observation System Users Guide

D. Observer Guide to Dolphin Behavior

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

MAY 15 2015

Woody C. Sutherland
Shipboard Technical Support
Scripps Institution of Oceanography
8602 La Jolla Shores Drive
La Jolla, California 92037

Dear Mr. Sutherland:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the Scripps Institution of Oceanography, under the authority of section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), to harass small numbers of marine mammals, by Level B harassment, incidental to the R/V *Roger Revelle*'s low-energy marine geophysical (seismic) survey in the Southwest Pacific Ocean, East of New Zealand during May to June 2015.

You are required to comply with the conditions contained in the IHA, which have also been included as Terms and Conditions for incidental take of endangered species in the Biological Opinion. In addition, you must submit a report to the National Marine Fisheries Service's (NMFS) Office of Protected Resources within 90 days of the completion of the cruise. The IHA also requires monitoring of marine mammals by qualified individuals before, during, and after seismic operations and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from this activity.

If you have any questions concerning the IHA or its requirements, please contact Howard Goldstein, Jeannine Cody, or Jolie Harrison, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Donna S. Wieting
Director
Office of Protected Resources

Enclosures

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

Incidental Harassment Authorization

The National Marine Fisheries Service (NMFS) hereby authorizes the Scripps Institution of Oceanography (SIO), 8602 La Jolla Shores Drive, La Jolla, California 92037 and the U.S. National Science Foundation (NSF), Division of Ocean Sciences, 4201 Wilson Boulevard, Suite 725, Arlington, Virginia 22230, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a low-energy marine geophysical (seismic) survey conducted aboard the R/V *Roger Revelle* (*Revelle*) in the Southwest Pacific Ocean, East of New Zealand, May through June 2015:

1. *Effective Dates*

This Authorization is valid from May 18, 2015 through July 30, 2015.

2. *Specified Geographic Region*

This Authorization is valid only for SIO's activities associated with low-energy seismic survey, bathymetric profile, and heat-flow probe measurements conducted aboard the *Revelle* that shall occur in the following specified geographic area:

(a) In selected regions of the Southwest Pacific Ocean off the east coast of New Zealand. The survey sites are located in the Exclusive Economic Zone, outside of territorial waters (located between approximately 38.5 and 42.5° South, and between 174 and 180° East). Water depths in the survey area are expected to be 200 to 3,000 meters (m) (656.2 to 9,842.5 feet [ft]). No airgun operations would occur in shallow (less than 100 m) water depths. Airgun operations will take approximately 135 hours in total and 1,250 kilometers (km) (674.9 nautical miles [nmi]), and the remainder of the time would be spent in transit and collecting heat-flow measurements. The low-energy seismic survey will be conducted as described in SIO's Incidental Harassment Authorization application and the associated NSF and SIO's *Environmental Analysis of a Low-Energy Marine Geophysical Survey by the R/V Roger Revelle in the Southwest Pacific Ocean, East of New Zealand, May to June 2015.*

3. This Authorization does not permit incidental takes of marine mammals in the territorial sea of foreign nations, as the MMPA does not apply in those waters. The territorial sea extends at most 22.2 km (12 nmi) from the baseline of a coastal State.

4. *Species Authorized and Level of Takes*

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the Southwest Pacific Ocean, East of New Zealand:

(i) *Mysticetes* – see Table 1 (attached) for authorized species and take numbers.

(ii) *Odontocetes* – see Table 1 (attached) for authorized species and take numbers.

(iii) *Pinnipeds* – see Table 1 (attached) for authorized species and take numbers.

(iv) If any marine mammal species are encountered during seismic activities that are not listed in Table 1 (attached) and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 µPa (rms) for seismic airgun operations, then SIO must alter speed or course or shut-down the airguns to prevent take.

(b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 4(a) above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

5. The sources authorized for taking by Level B harassment are limited to the following acoustic sources, absent an amendment to this Authorization:

(a) A two Generator Injector (GI) airgun array (each with a discharge volume of 45 cubic inches [in^3]) with a total volume of 90 in^3 (or smaller).

6. *Prohibited Take*

The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, NMFS, at 301-427-8401.

7. *Mitigation and Monitoring Requirements*

SIO is required to implement the following mitigation and related monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

Protected Species Observers and Visual Monitoring

(a) Utilize at least one, NMFS-qualified, vessel-based Protected Species Observer (PSO) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night. Three PSOs shall be based onboard the vessel.

(i) The *Revelle*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSO(s) shall have access to reticle binoculars (7 x 50 Fujinon) equipped with a built-in daylight compass and range reticles, big-eye binoculars (25 x 150), optical range finders, and night-vision devices.

(iii) PSO(s) shifts shall last no longer than 4 hours at a time.

(iv) PSO(s) shall also make observations during daytime periods when the seismic airguns are not operating, when feasible, for comparison of animal abundance and behavior.

(v) PSO(s) shall conduct monitoring while the airgun array and streamer are being deployed or recovered from the water.

(b) PSO(s) shall record the following information when a marine mammal is sighted:

(i) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (*e.g.*, none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace; and

(ii) Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), Beaufort sea state and wind force, visibility, cloud cover, and sun glare; and

(iii) The data listed under Condition 7(b)(ii) shall also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

Buffer and Exclusion Zones

(c) Establish a 160 dB re 1 μPa (rms) buffer zone as well as 180 dB re 1 μPa (rms) exclusion zone for cetaceans and 190 dB re 1 μPa (rms) exclusion zone for pinnipeds before the two GI airgun array (90 in^3 total volume) is in operation. See Table 2 (attached) for distances and buffer and exclusion zones.

Visual Monitoring at the Start of the Airgun Operations

(d) Visually observe the entire extent of the exclusion zones (180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds; see Table 2 [attached] for distances) using two NMFS-qualified PSOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) If the PSO(s) sees a marine mammal within the exclusion zone, SIO must delay the seismic survey until the marine mammal(s) has left the area. If the PSO(s) sees a marine mammal that surfaces, then dives below the surface, the PSO(s) shall wait 30 minutes, and if the PSO(s) sees no marine mammals during that time, the PSO should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (*i.e.*, rough seas, fog, darkness), or if marine mammals are near, approaching, or in the exclusion zone, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), SIO may start the second airgun without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the exclusion zone (in accordance with Condition 7[e] below).

Ramp-up Procedures

(e) Implement a "ramp-up" procedure, which means starting with a single GI airgun and adding a second GI airgun after five minutes, when starting up at the beginning of seismic operations or anytime after the entire array has been shut-down for more than 15 minutes. During ramp-up, the two PSOs shall monitor the exclusion zone, and if marine mammals are sighted, a shut-down shall be implemented as though the full array (both GI airguns) were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the two PSOs be able to view the full exclusion zone as described in Condition 7(d) (above).

Shut-down Procedures

(f) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A shut-down means all operating airguns are shut-down *(i.e.*, turned off).

(g) Following a shut-down, the airgun activity shall not resume until the PSO(s) has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes, for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, dwarf and pygmy sperm, killer, and beaked whales).

(h) Following a shut-down and subsequent animal departure, airgun operations may resume, following ramp-up procedures described in Condition 7(e).

Speed or Course Alteration

(i) Alter speed or course during airgun operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, further mitigation measures, such as a shut-down, shall be taken.

Survey Operations

(j) To the maximum extent practicable, SIO will conduct the low-energy seismic survey (especially when near land) from the coast (inshore) and proceed towards the sea (offshore) in order to avoid herding or trapping marine mammals in shallow water.

Survey Operations during Low-Light Hours

(k) Marine low-energy seismic surveys may continue into low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(l) No initiation of airgun array operations is permitted from a shut-down position during low-light hours (such as in dense fog or heavy rain) when the entire relevant exclusion zone cannot be effectively monitored by the PSO(s) on duty.

(m) To the maximum extent practicable, schedule seismic operations (*i.e.*, shooting airguns) during daylight hours, and heat-flow measurements at nighttime hours.

8. <u>*Reporting Requirements*</u>

SIO is required to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Revelle*'s Southwest Pacific Ocean off the East coast of New Zealand cruise. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity *(e.g.*, number of shut-downs), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeled values for the two GI airgun array) to the seismic activity at received levels greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds, with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(iv) A description of the implementation and effectiveness of the: (A) Terms and Conditions of the Biological Opinion's Incidental Take Statement (ITS) (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report shall confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act-listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report shall be considered to be the final report.

9. *Reporting Prohibited Take*

(a) In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (*e.g.*, through ship-strike, gear interaction, and/or entanglement), SIO shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by e-mail to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov*. The report must include the following information:

(i) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with SIO to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SIO may not resume their activities until notified by NMFS via letter, e-mail, or telephone.

Reporting an Injured or Dead Marine Mammal with an Unknown Cause of Death

(b) In the event that SIO discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition as described in the next paragraph), SIO will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by e-mail to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov*. The report must include the same information identified in Condition 9(a)(i) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with SIO to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

(c) In the event that SIO discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), SIO shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by e-mail to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov*, within 24 hours of the discovery. SIO shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while NMFS reviews the circumstances of the incident.

10. *Endangered Species Act Biological Opinion and Incidental Take Statement*

(a) SIO is required to comply with the Terms and Conditions of the ITS corresponding to NMFS's Biological Opinion issued to SIO, NSF, and NMFS's Office of Protected Resources (attached).

(b) A copy of this Authorization and the ITS must be in the possession of all contractors and PSO(s) operating under the authority of this Incidental Harassment Authorization.

Donna S. Wieting
Director
Office of Protected Resources
National Marine Fisheries Service

MAY 15 2015
Date

Attachments

Attachment

Table 1. Authorized take numbers, by Level B harassment, for each marine mammal species during SIO's low-energy marine seismic survey in the Southwest Pacific Ocean, East of New Zealand, May to June 2015.

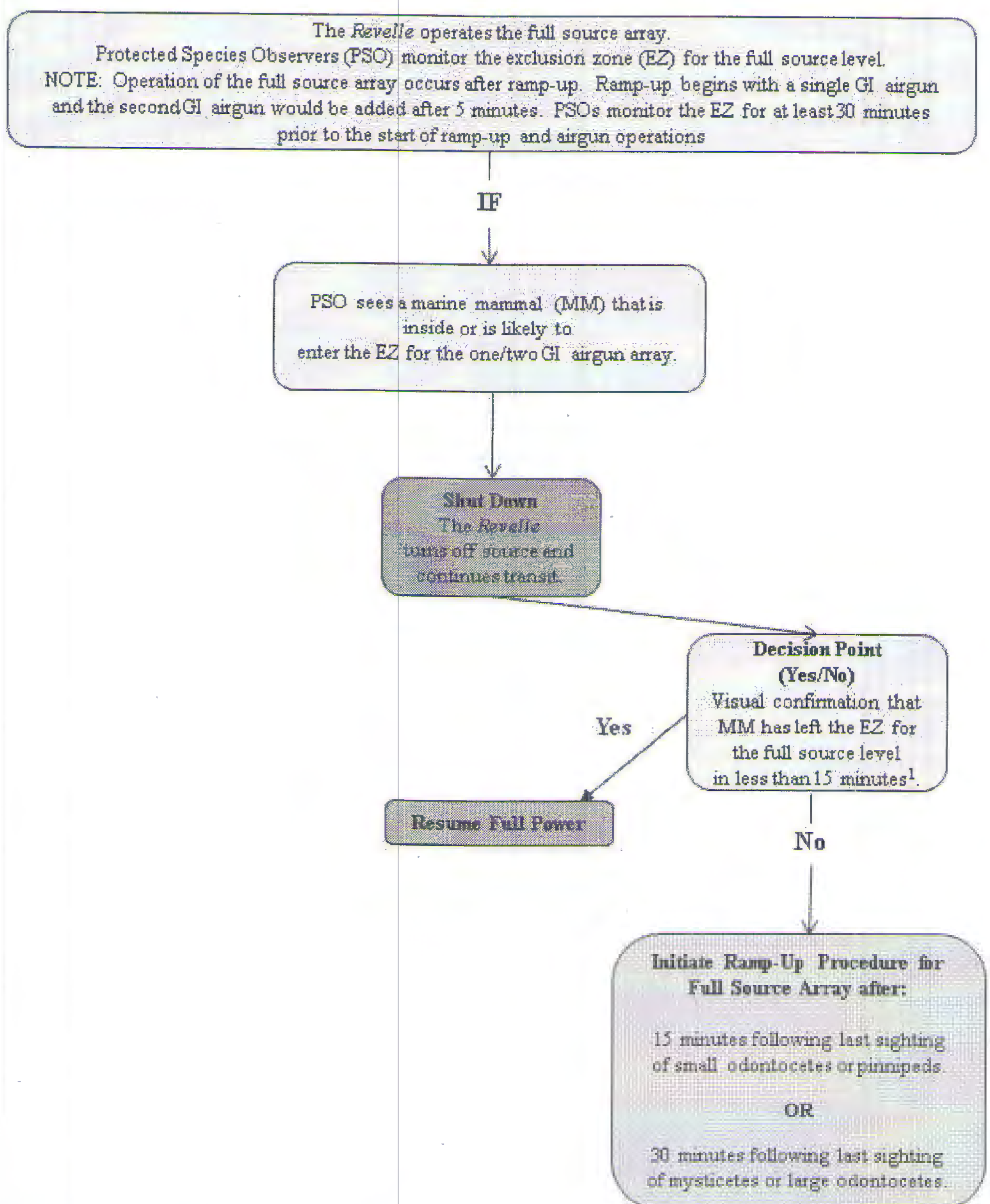
Species	Authorized Take in the Southwest Pacific Ocean, East of New Zealand, Study Area
Mysticetes	
Southern right whale (*Eubalaena australis*)	2
Pygmy right whale (*Caperea marginata*)	2
Humpback whale (*Megaptera novaeangliae*)	2
Antarctic minke whale (*Balaenoptera bonaerensis*)	2
Minke whale (*Balaenoptera acutorostrata*)	2
Bryde's whale (*Balaenoptera edeni*)	2
Sei whale (*Balaenoptera borealis*)	2
Fin whale (*Balaenoptera physalus*)	2
Blue whale (*Balaenoptera musculus*)	2
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	10
Pygmy sperm whale (*Kogia breviceps*)	5
Arnoux's beaked whale (*Berardius arnuxii*)	8
Cuvier's beaked whale (*Ziphius cavirostris*)	2
Shepherd's beaked whale (*Tasmacetus shepherdi*)	3
Southern bottlenose whale (*Hyperoodon planifrons*)	2

Andrew's beaked whale (*Mesoplodon bowdoini*)	2
Blainville's beaked whale (*Mesoplodon densirostris*)	2
Gray's beaked whale (*Mesoplodon grayi*)	2
Hector's beaked whale (*Mesoplodon hectori*)	2
Pygmy beaked whale (*Mesoplodon peruvianis*)	3
Spade-toothed beaked whale (*Mesoplodon traversii*)	2
Strap-toothed beaked whale (*Mesoplodon layardii*)	3
Killer whale (*Orcinus orca*)	12
False killer whale (*Pseudorca crassidens*)	10
Long-finned pilot whale (*Globicephala melas*)	20
Short-finned pilot whale (*Globicephala macrorhynchus*)	20
Bottlenose dolphin (*Tursiops truncatus*)	95
Dusky dolphin (*Lagenorhynchus obscurus*)	95
Hector's dolphin (*Cephalorhynchus hectori*)	38
Hourglass dolphin (*Lagenorhynchus cruciger*)	57
Risso's dolphin (*Grampus griseus*)	10
Short-beaked common dolphin (*Delphinus delphis*)	189
Southern right whale dolphin (*Lissodelphis peronii*)	57
Pinnipeds	
Southern elephant seal (*Mirounga leonina*)	6
New Zealand fur seal (*Phocarctos hookeri*)	15

Table 2. Modeled distances to which sound levels greater than or equal to 160, 180, and 190 dB could be received during the low-energy marine seismic survey in the Southwest Pacific Ocean, East of New Zealand, during May to June 2015. The buffer and exclusion zone radii are used for triggering mitigation. No airgun operations will occur in shallow water depths (<100 m).

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Radii Distances (m)		
			Shut-down Exclusion Zone for Pinnipeds 190 dB	Shut-down Exclusion Zone for Cetaceans 180 dB	Level B Harassment Zone 160 dB
Two 45 in^3 GI airguns (90 in^3 total)	2	Intermediate (100 to 1,000)	100 (328.1 ft)	100 (364.2 ft)	600 (1,968.5 ft)
Two 45 in^3 GI airguns (90 in^3 total)	2	Deep (>1,000)	100 (328.1 ft)	100 (364.2 ft)	400 (1,312.3 ft)

Figure 1. Current mitigation procedures for low-energy seismic surveys.



[1] **Ramp-Up Procedures**
SIO has used similar periods (15 minutes) for previous low-energy seismic surveys. Ramp-up would not occur if a marine mammal has not cleared the exclusion zone for the full airgun array.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUN 10 2015

Woody C. Sutherland
Shipboard Technical Support
Scripps Institution of Oceanography
8602 La Jolla Shores Drive
La Jolla, California 92037

Dear Mr. Sutherland:

On June 8, 2015, the National Science Foundation (NSF) requested a modification to the Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography (SIO) on May 15, 2015, under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq*.), to harass marine mammals, by Level B harassment, incidental to the R/V *Roger Revelle*'s low-energy marine geophysical (seismic) survey in the southwest Pacific Ocean, east of New Zealand during May to June, 2015. NSF and SIO requested 600 additional authorized takes of New Zealand fur seals for the remainder of the cruise.

The National Marine Fisheries Service (NMFS) has reviewed NSF and SIO's request and has granted additional authorized takes of New Zealand fur seals for the seismic survey east of New Zealand. Accordingly, NMFS has amended Table 2 of the IHA to include the 600 additional (615 total) authorized takes of New Zealand fur seals as requested by NSF and SIO.

A copy of this modification letter must be attached to the IHA and must be in the possession of the operator of the vessel and marine mammal monitors operating under the authority of this Authorization.

If you have any questions concerning the IHA or its requirements, please contact Howard Goldstein, Jeannine Cody, or Jolie Harrison, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Wandall

Donna S. Wieting
Director
Office of Protected Resources

Enclosures

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

Incidental Harassment Authorization

The National Marine Fisheries Service (NMFS) hereby authorizes the Scripps Institution of Oceanography (SIO), 8602 La Jolla Shores Drive, La Jolla, California 92037 and the U.S. National Science Foundation (NSF), Division of Ocean Sciences, 4201 Wilson Boulevard, Suite 725, Arlington, Virginia 22230, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a low-energy marine geophysical (seismic) survey conducted aboard the R/V *Roger Revelle* (*Revelle*) in the Southwest Pacific Ocean, East of New Zealand, May through June 2015:

1. *Effective Dates*

This Authorization is valid from May 18, 2015 through July 30, 2015.

2. *Specified Geographic Region*

This Authorization is valid only for SIO's activities associated with low-energy seismic survey, bathymetric profile, and heat-flow probe measurements conducted aboard the *Revelle* that shall occur in the following specified geographic area:

(a) In selected regions of the Southwest Pacific Ocean off the east coast of New Zealand. The survey sites are located in the Exclusive Economic Zone, outside of territorial waters (located between approximately 38.5 and 42.5° South, and between 174 and 180° East). Water depths in the survey area are expected to be 200 to 3,000 meters (m) (656.2 to 9,842.5 feet [ft]). No airgun operations would occur in shallow (less than 100 m) water depths. Airgun operations will take approximately 135 hours in total and 1,250 kilometers (km) (674.9 nautical miles [nmi]), and the remainder of the time would be spent in transit and collecting heat-flow measurements. The low-energy seismic survey will be conducted as described in SIO's Incidental Harassment Authorization application and the associated NSF and SIO's *Environmental Analysis of a Low-Energy Marine Geophysical Survey by the R/V Roger Revelle in the Southwest Pacific Ocean, East of New Zealand, May to June 2015.*

3. This Authorization does not permit incidental takes of marine mammals in the territorial sea of foreign nations, as the MMPA does not apply in those waters. The territorial sea extends at most 22.2 km (12 nmi) from the baseline of a coastal State.

4. *Species Authorized and Level of Takes*

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the Southwest Pacific Ocean, East of New Zealand:

(i) *Mysticetes* – see Table 1 (attached) for authorized species and take numbers.

(ii) *Odontocetes* – see Table 1 (attached) for authorized species and take numbers.

(iii) *Pinnipeds* – see Table 1 (attached) for authorized species and take numbers.

(iv) If any marine mammal species are encountered during seismic activities that are not listed in Table 1 (attached) and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 μPa (rms) for seismic airgun operations, then SIO must alter speed or course or shut-down the airguns to prevent take.

(b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 4(a) above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

5. The sources authorized for taking by Level B harassment are limited to the following acoustic sources, absent an amendment to this Authorization:

(a) A two Generator Injector (GI) airgun array (each with a discharge volume of 45 cubic inches [in^3]) with a total volume of 90 in^3 (or smaller).

6. *Prohibited Take*

The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, NMFS, at 301-427-8401.

7. *Mitigation and Monitoring Requirements*

SIO is required to implement the following mitigation and related monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

Protected Species Observers and Visual Monitoring

(a) Utilize at least one, NMFS-qualified, vessel-based Protected Species Observer (PSO) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night. Three PSOs shall be based onboard the vessel.

(i) The *Revelle*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSO(s) shall have access to reticle binoculars (7 x 50 Fujinon) equipped with a built-in daylight compass and range reticles, big-eye binoculars (25 x 150), optical range finders, and night-vision devices.

(iii) PSO(s) shifts shall last no longer than 4 hours at a time.

(iv) PSO(s) shall also make observations during daytime periods when the seismic airguns are not operating, when feasible, for comparison of animal abundance and behavior.

(v) PSO(s) shall conduct monitoring while the airgun array and streamer are being deployed or recovered from the water.

(b) PSO(s) shall record the following information when a marine mammal is sighted:

(i) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (*e.g.*, none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace; and

(ii) Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), Beaufort sea state and wind force, visibility, cloud cover, and sun glare; and

(iii) The data listed under Condition 7(b)(ii) shall also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

Buffer and Exclusion Zones

(c) Establish a 160 dB re 1 μPa (rms) buffer zone as well as 180 dB re 1 μPa (rms) exclusion zone for cetaceans and 190 dB re 1 μPa (rms) exclusion zone for pinnipeds before the two GI airgun array (90 in^3 total volume) is in operation. See Table 2 (attached) for distances and buffer and exclusion zones.

Visual Monitoring at the Start of the Airgun Operations

(d) Visually observe the entire extent of the exclusion zones (180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds; see Table 2 [attached] for distances) using two NMFS-qualified PSOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) If the PSO(s) sees a marine mammal within the exclusion zone, SIO must delay the seismic survey until the marine mammal(s) has left the area. If the PSO(s) sees a marine mammal that surfaces, then dives below the surface, the PSO(s) shall wait 30 minutes, and if the PSO(s) sees no marine mammals during that time, the PSO should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (*i.e.*, rough seas, fog, darkness), or if marine mammals are near, approaching, or in the exclusion zone, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), SIO may start the second airgun without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the exclusion zone (in accordance with Condition 7[e] below).

Ramp-up Procedures

(e) Implement a "ramp-up" procedure, which means starting with a single GI airgun and adding a second GI airgun after five minutes, when starting up at the beginning of seismic operations or anytime after the entire array has been shut-down for more than 15 minutes. During ramp-up, the two PSOs shall monitor the exclusion zone, and if marine mammals are sighted, a shut-down shall be implemented as though the full array (both GI airguns) were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the two PSOs be able to view the full exclusion zone as described in Condition 7(d) (above).

Shut-down Procedures

(f) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 2, attached). A shut-down means all operating airguns are shut-down *(i.e.*, turned off).

(g) Following a shut-down, the airgun activity shall not resume until the PSO(s) has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes, for species with shorter dive durations (small odontocetes and pinnipeds) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, dwarf and pygmy sperm, killer, and beaked whales).

(h) Following a shut-down and subsequent animal departure, airgun operations may resume, following ramp-up procedures described in Condition 7(e).

Speed or Course Alteration

(i) Alter speed or course during airgun operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant exclusion zone. If speed or course alteration is not safe or practicable, or if after alteration the marine mammal still appears likely to enter the exclusion zone, further mitigation measures, such as a shut-down, shall be taken.

Survey Operations

(j) To the maximum extent practicable, SIO will conduct the low-energy seismic survey (especially when near land) from the coast (inshore) and proceed towards the sea (offshore) in order to avoid herding or trapping marine mammals in shallow water.

Survey Operations during Low-Light Hours

(k) Marine low-energy seismic surveys may continue into low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(l) No initiation of airgun array operations is permitted from a shut-down position during low-light hours (such as in dense fog or heavy rain) when the entire relevant exclusion zone cannot be effectively monitored by the PSO(s) on duty.

(m) To the maximum extent practicable, schedule seismic operations (*i.e.*, shooting airguns) during daylight hours, and heat-flow measurements at nighttime hours.

8. <u>Reporting Requirements</u>

SIO is required to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Revelle*'s Southwest Pacific Ocean off the East coast of New Zealand cruise. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (*e.g.*, number of shut-downs), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeled values for the two GI airgun array) to the seismic activity at received levels greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds, with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(iv) A description of the implementation and effectiveness of the: (A) Terms and Conditions of the Biological Opinion's Incidental Take Statement (ITS) (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report shall confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act-listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report shall be considered to be the final report.

9. <u>*Reporting Prohibited Take*</u>

(a) In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (*e.g.*, through ship-strike, gear interaction, and/or entanglement), SIO shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by e-mail to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov*. The report must include the following information:

(i) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with SIO to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SIO may not resume their activities until notified by NMFS via letter, e-mail, or telephone.

Reporting an Injured or Dead Marine Mammal with an Unknown Cause of Death

(b) In the event that SIO discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent *(i.e.*, in less than a moderate state of decomposition as described in the next paragraph), SIO will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by e-mail to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov*. The report must include the same information identified in Condition 9(a)(i) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with SIO to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

(c) In the event that SIO discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), SIO shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by e-mail to *Jolie.Harrison@noaa.gov* and *Howard.Goldstein@noaa.gov*, within 24 hours of the discovery. SIO shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while NMFS reviews the circumstances of the incident.

10. <u>*Endangered Species Act Biological Opinion and Incidental Take Statement*</u>

(a) SIO is required to comply with the Terms and Conditions of the ITS corresponding to NMFS's Biological Opinion issued to SIO, NSF, and NMFS's Office of Protected Resources (attached).

(b) A copy of this Authorization and the ITS must be in the possession of all contractors and PSO(s) operating under the authority of this Incidental Harassment Authorization.

Donna S. Wieting
Director
Office of Protected Resources
National Marine Fisheries Service

10 June 2015
Date

Attachments

Attachment

Table 1. Authorized take numbers, by Level B harassment, for each marine mammal species during SIO's low-energy marine seismic survey in the Southwest Pacific Ocean, East of New Zealand, May to June 2015.

Species	Authorized Take in the Southwest Pacific Ocean, East of New Zealand, Study Area
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Minke whale (*Balaenoptera acutorostrata*)	2
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Southern bottlenose whale (*Hyperoodon planifrons*)	2

Andrew's beaked whale (*Mesoplodon bowdoini*)	2
Blainville's beaked whale (*Mesoplodon densirostris*)	2
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False killer whale (*Pseudorca crassidens*)	10
Long-finned pilot whale (*Globicephala melas*)	20
Short-finned pilot whale (*Globicephala macrorhynchus*)	20
Bottlenose dolphin (*Tursiops truncatus*)	95
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Hector's dolphin (*Cephalorhynchus hectori*)	38
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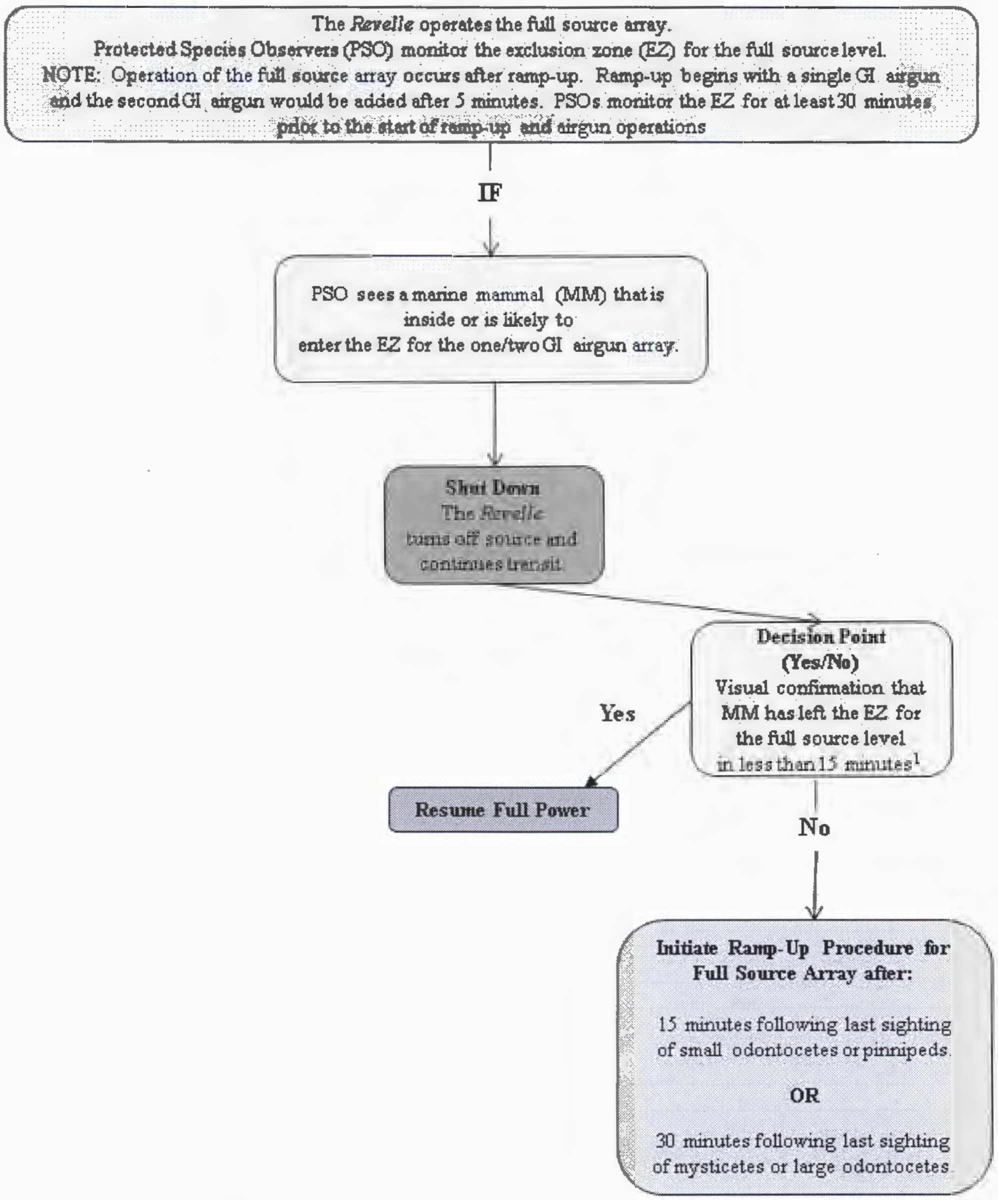
Short-beaked common dolphin (*Delphinus delphis*)	189
Southern right whale dolphin (*Lissodelphis peronii*)	57
Pinnipeds	
Southern elephant seal (*Mirounga leonina*)	6
New Zealand fur seal (*Arctocephalus forsteri*)	615

Table 2. Modeled distances to which sound levels greater than or equal to 160, 180, and 190 dB could be received during the low-energy marine seismic survey in the Southwest Pacific Ocean, East of New Zealand, during May to June 2015. The buffer and exclusion zone radii are used for triggering mitigation. No airgun operations will occur in shallow water depths (<100 m).

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Radii Distances (m)		
			Shut-down Exclusion Zone for Pinnipeds 190 dB	Shut-down Exclusion Zone for Cetaceans 180 dB	Level B Harassment Zone 160 dB
Two 45 in^3 GI airguns (90 in^3 total)	2	Intermediate (100 to 1,000)	100 (328.1 ft)	100 (364.2 ft)	600 (1,968.5 ft)
Two 45 in^3 GI airguns (90 in^3 total)	2	Deep (>1,000)	100 (328.1 ft)	100 (364.2 ft)	400 (1,312.3 ft)

Figure 1. Current mitigation procedures for low-energy seismic surveys.



[1] **Ramp-Up Procedures**
SIO has used similar periods (15 minutes) for previous low-energy seismic surveys. Ramp-up would not occur if a marine mammal has not cleared the exclusion zone for the full airgun array.

ENTIAT RIVER TECHNOLOGIES

http://www.mysticetus.com

Mysticetus Observation System Users Guide

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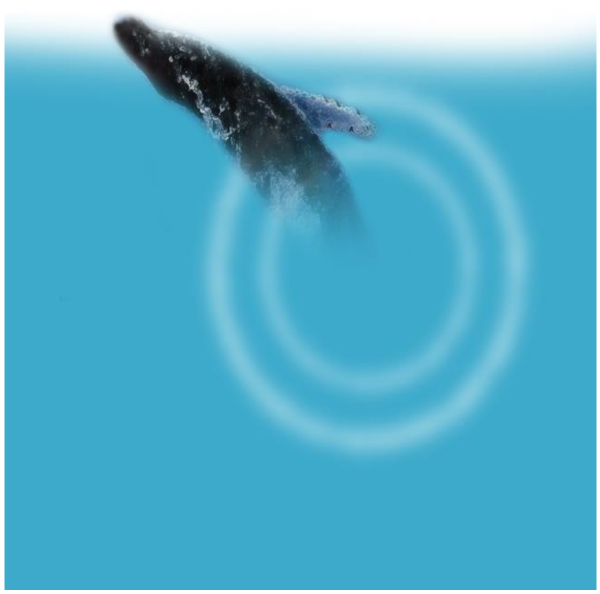

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info@mysticetus.com

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1 Introduction

Mysticetus is a powerful – yet easy to use and configure - system for recording observations, integrating real-time GPS data and maps, and creating detailed GIS-oriented reports

Welcome to Mysticetus. With Mysticetus you can easily define your own data entry requirements and formats, hook your system to a GPS and have Mysticetus automatically incorporate geo-position and bathymetric (and derived) data into your observations, easily and quickly record data entries, and create professional reports. Along the way, Mysticetus is also a full-featured real-time navigation system, including maps, route planning, GPS tracking, heads-up nav center, and complete display of detailed bathymetric/topographic information.

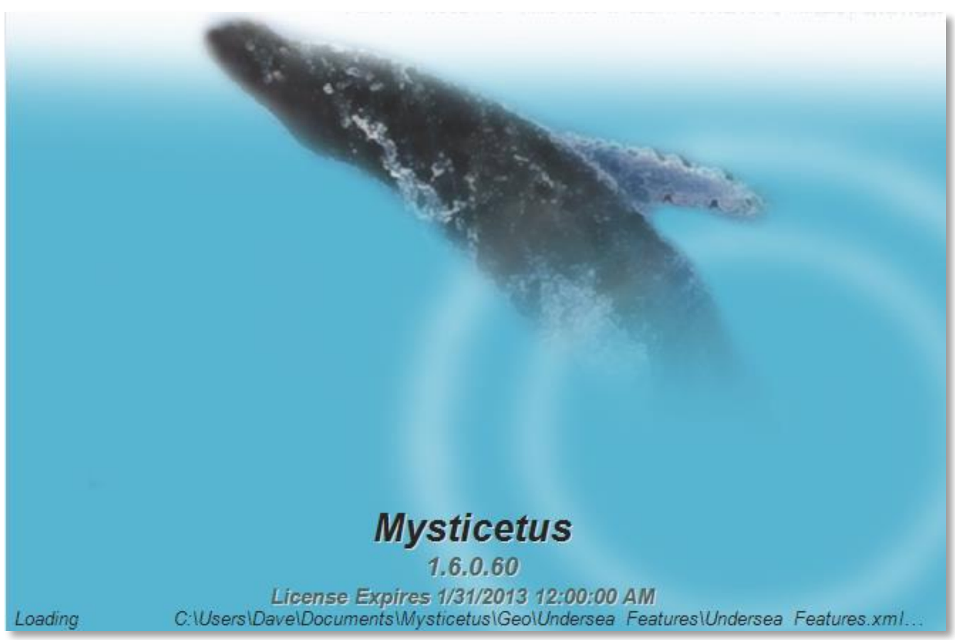
This introduction section will (lightly) walk you through a few of the fundamentals of using Mysticetus. Each of these topics is discussed in detail in later chapters.

1.1 Sample.Mysticetus

A great way to start using Mysticetus is to download the Sample.Mysticetus file from http://www.mysticetus.com/downloads. Save it somewhere you can find (your desktop, or a folder in your Documents library), and double-click on it to launch Mysticetus.

1.2 Splash Screen

The first thing that shows is a splash screen that looks something like this:



Pro Tip: Version and License information is also available at any time from the About menu

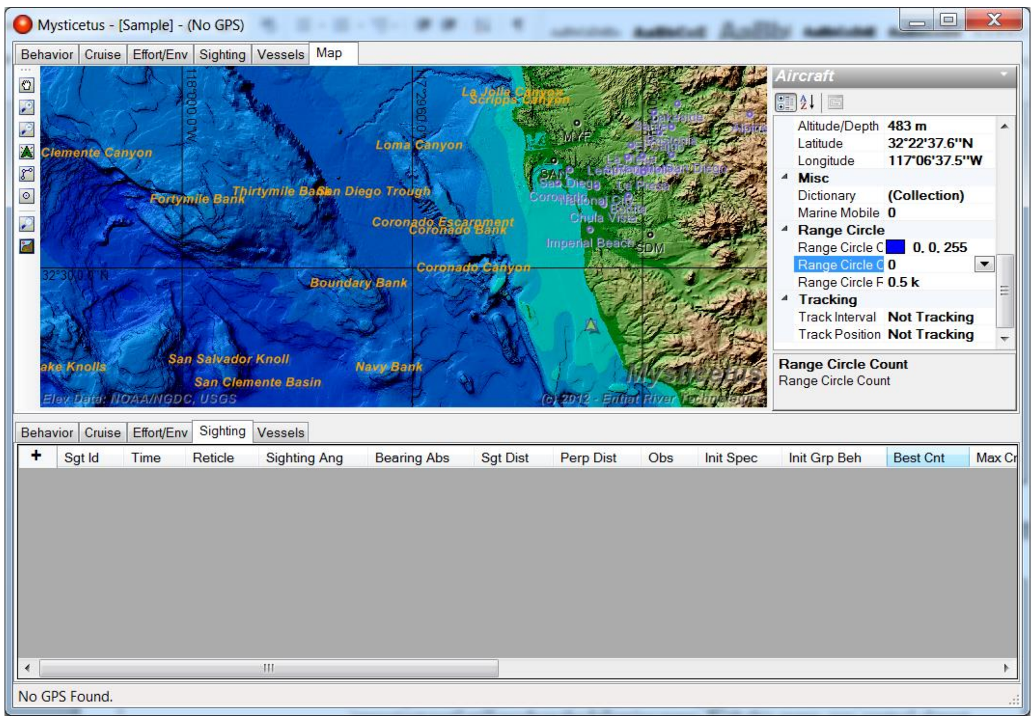
This screen shows you – for a couple seconds – some useful information.

- Version of Mysticetus you currently have installed. This could be important if you need tech support or have questions.

- License expiration date. Mysticetus is licensed for your use by time – you are allowed to use Mysticetus for a certain period of time and when that time runs out you need to insert more quarters into your CD drive…just kidding – instead, email info@mysticetus to obtain a new license key for more time.

1.3 Overview

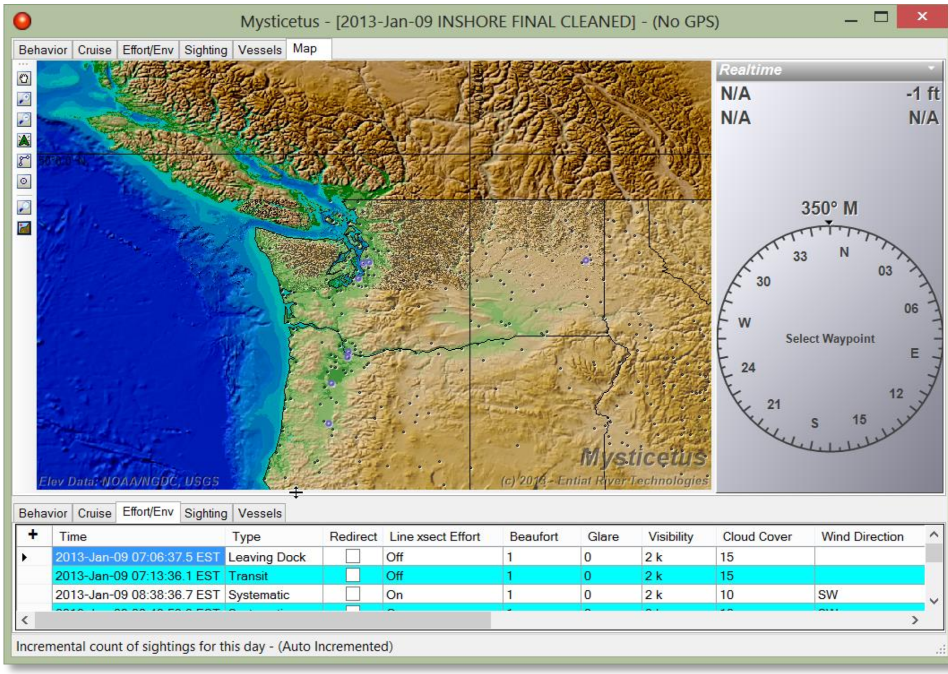
After Sample.Mysticetus loads, you will see something like the following



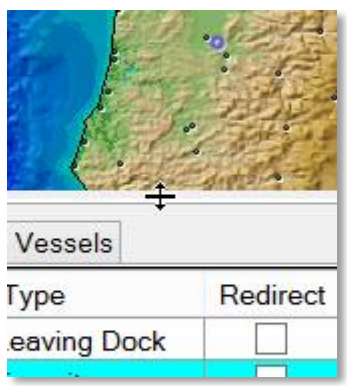
Whoa. That's a lot of information. Let's walk through some of the basics of the screen just to get rolling.

1.4 Splitters

First of all, note that every section of Mysticetus is configurable, first and foremost its size. Hold your mouse over the area in between any two sections (this small in-between area is called a "splitter") and your cursor will change to indicate the splitter can be dragged to change the size of the areas. There are horizontal and vertical splitters appropriately placed between main components. For example, here we are dragging the primary horizontal splitter down so there is more map window displayed:

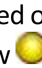


It is a little hard to see in that screenshot, but note the mouse cursor in the middle – it is dragging the splitter:



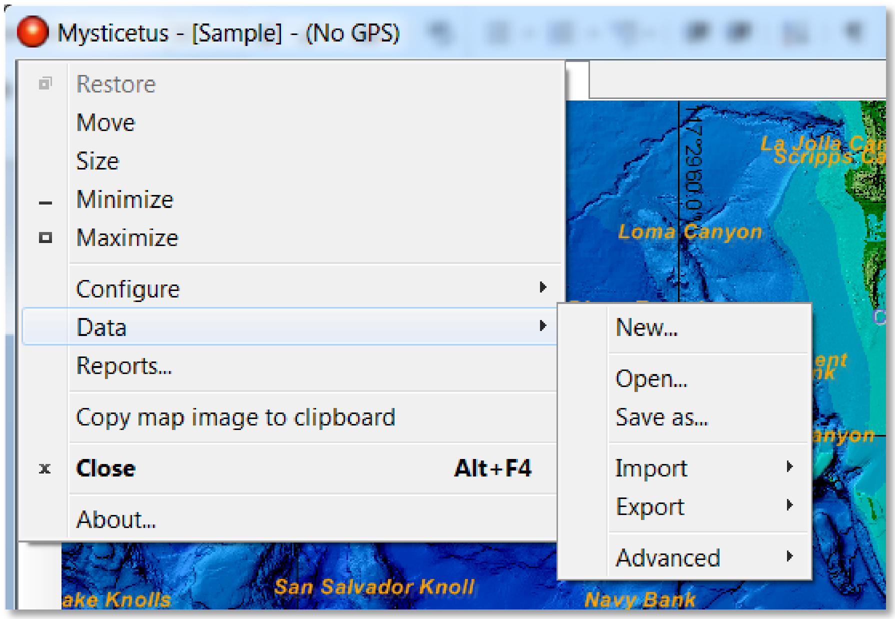
Move your mouse over the various regions – if the cursor changes to a Splitter cursor, you can drag it and change the overall layout.

1.5 Globe and Main Menu

In the upper left corner, we have a little globe. Remember that – it is important. It is currently red because we have no GPS hooked up. If a GPS is connected the globe will be green . If something goes wrong with a GPS hookup (say, you tripped over the wire or spilled coffee on your brand-new, expensive GPS unit), it will go yellow  for a while – indicating no signal has been seen recently - before turning red  again after another minute.

Pro Tip: you can also access this menu at any time by pressing Alt+Shift – it is the Windows system menu for the Mysticetus application.

Clicking on the globe (of whatever color) will produce the following menu. With this menu, you control almost everything in Mysticetus.

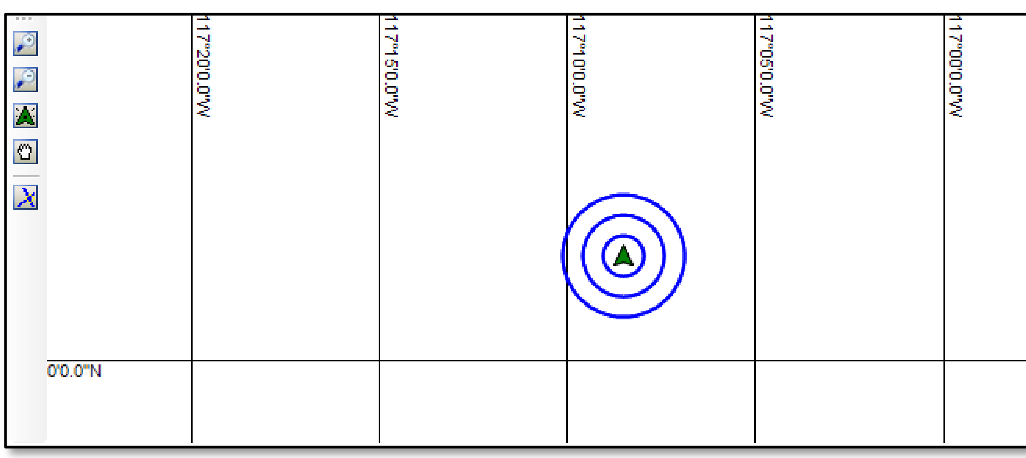


We will go into each of these menu items in later chapters, but for now just remember this is how you can configure everything, load or save data, import or export information, print reports, send GIS data to Google Earth, etc.

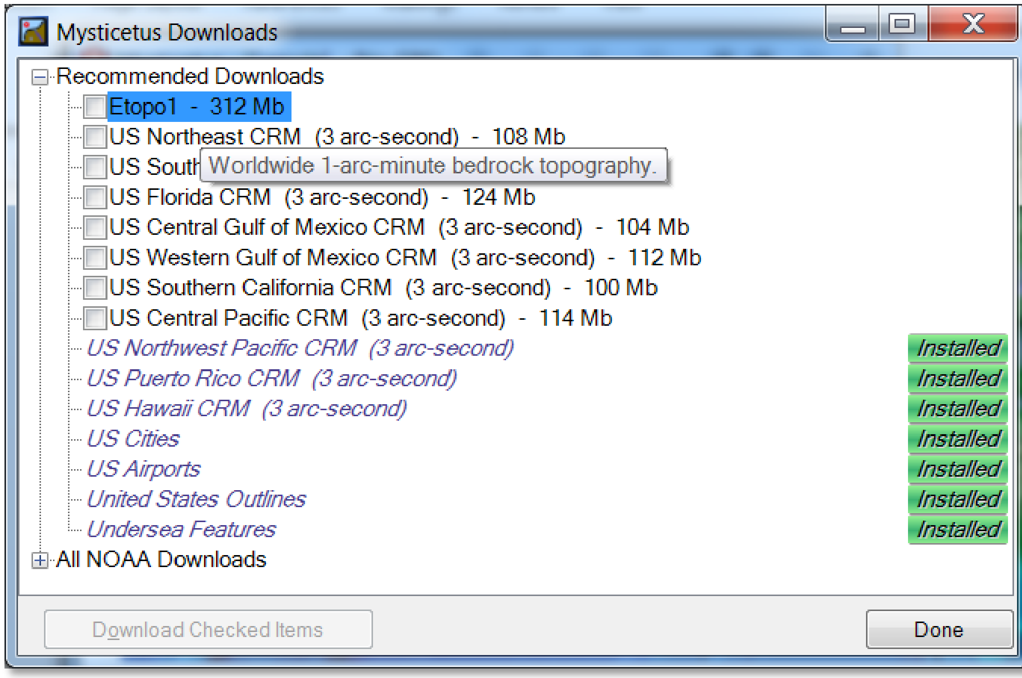
Mysticetus puts all the controls in this menu so as to remove as many toolbars and menus from the default screen as possible. As you know, in the field we are frequently running on small computers and, even on larger computers, every bit of screen real estate is precious.

1.6 Download Bathymetry

If you haven't downloaded any cartographic or bathymetric data yet, your map will actually look like a simple grid with latitude and longitude lines.

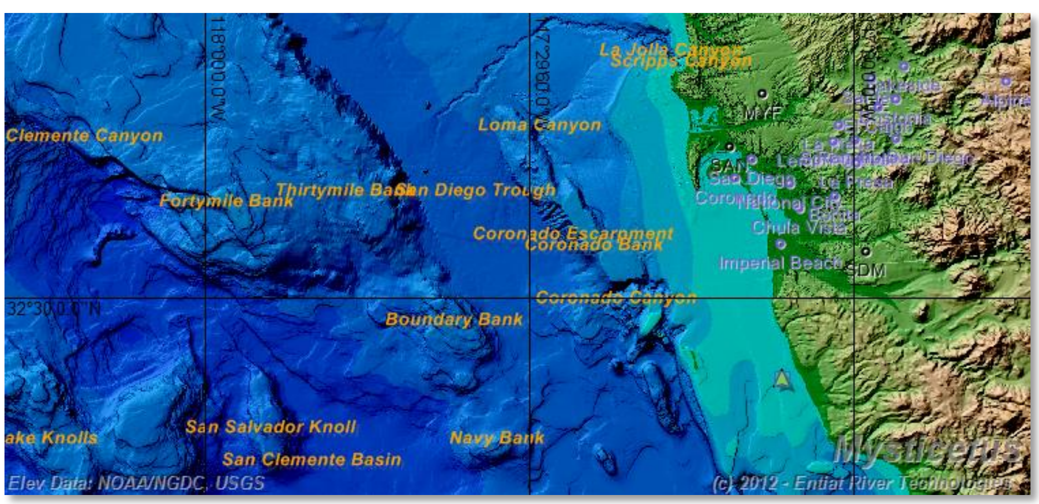


To get a detailed map, choose ***Configure->Download Geographic Data***.



At a minimum, download Etopo1 – this contains a base set of bathymetry for the entire world. Hover your mouse over an entry to get more information about the download, including how detailed the data are. Etopo1 is rather coarse (1 arc minute), but NOAA provides datasets of certain coastal regions down to 1/9th of an arc-second (a few meters of accuracy).

Once data is downloaded and installed, your map will look more like this:



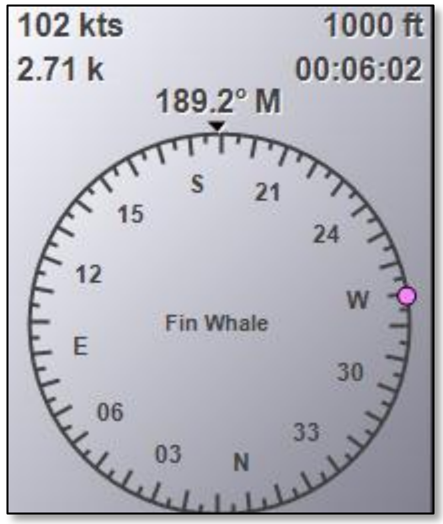
Note that this includes downloading and installing Undersea Features – go ahead and download and install various things that might be of interest to you (such as Cities and Airports, etc.)

1.7 Data Panel

Over on the right side of the map is your real-time flight/vessel display. In flight or on a moving vessel it will look something like this:

Pro Tip: Mysticetus can be configured to display distances, speeds, altitudes, etc. using a variety of different units – metric, nautical, statute, etc.

See the *Configure->System Options->Display* page.

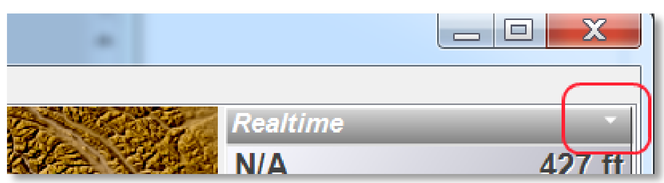


Pro Tip: Mysticetus can be configured to override GPS Altitude with a fixed value (say, the height of the observation platform on a vessel).

See Configure->System Options>System

This display includes your speed, heading, altitude, range and time to go to your active sighting (explained later). It also provides a nifty little dot showing the exact direction to your active sighting – useful for re-acquiring a hard-to-spot critter in higher Beauforts.

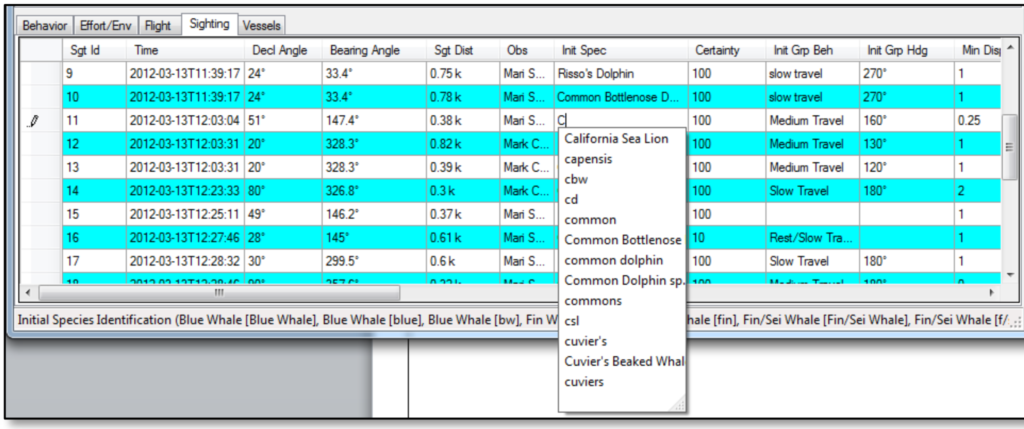
This panel can also be used to display a few other items by pulling down the little triangle in the upper right corner – we'll explain more later, but if you want to try it out now, feel free.



From here, you can display detailed information about mapping objects, synchronize your PC clock with the GPS clock, and so on.

1.8 Data Entry

Moving on, here is the real-time data entry system. As you are working, it might look something like this:

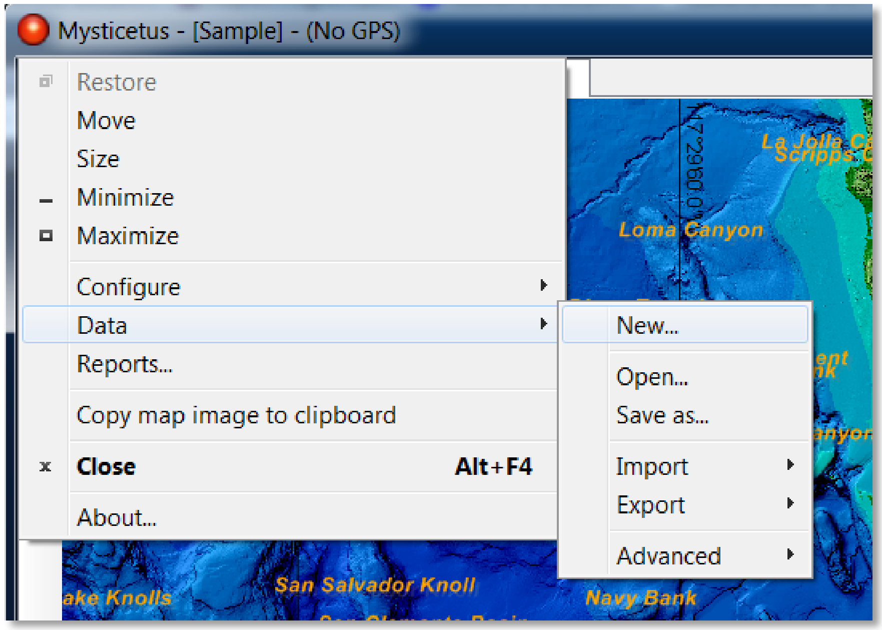


This is where you enter your observations. There is a lot of functionality here, only some of which we will touch on in this introduction. One very, important thing to note: you control what goes here. You can add or remove fields. You can change things such as species and observer lists. You control the order of data in the entry tables. If you want an automatic timestamp in the 17th column, sweet – put one there. If you want the position of the sighting automatically calculated (based on, say, reticle and your current GPS position) and stamped in the 18th column, no sweat – tell Mysticetus to do that and it will. You can also control things like how many digits of precision, how to display sightings on the map (or not), how to calculate whether you are on-effort or not, and so on.

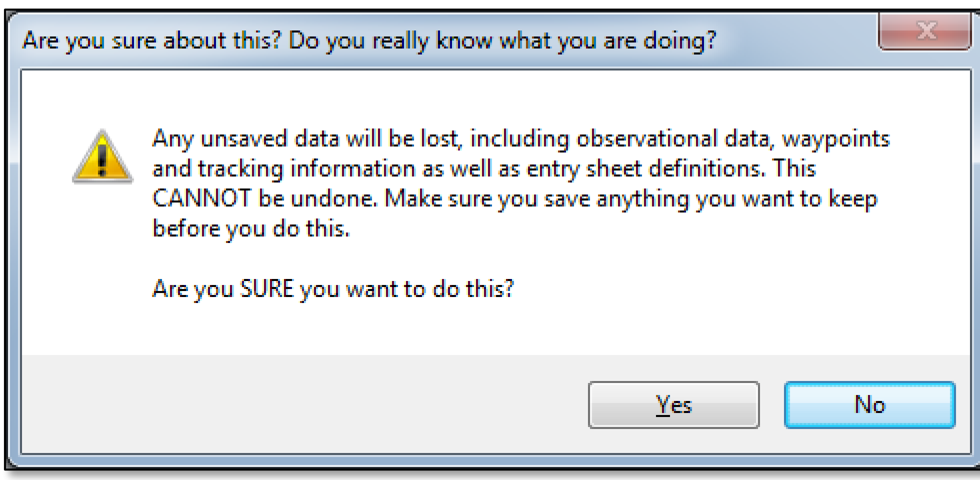
The sample sheet contains a few sheets used by some of the first people to use Mysticetus. You can start from there and modify it, or you can create your own protocol from scratch. We will discuss this is more detail later, but here's a preview of creating your own entry sheets from scratch.

1.9 Entry Configuration

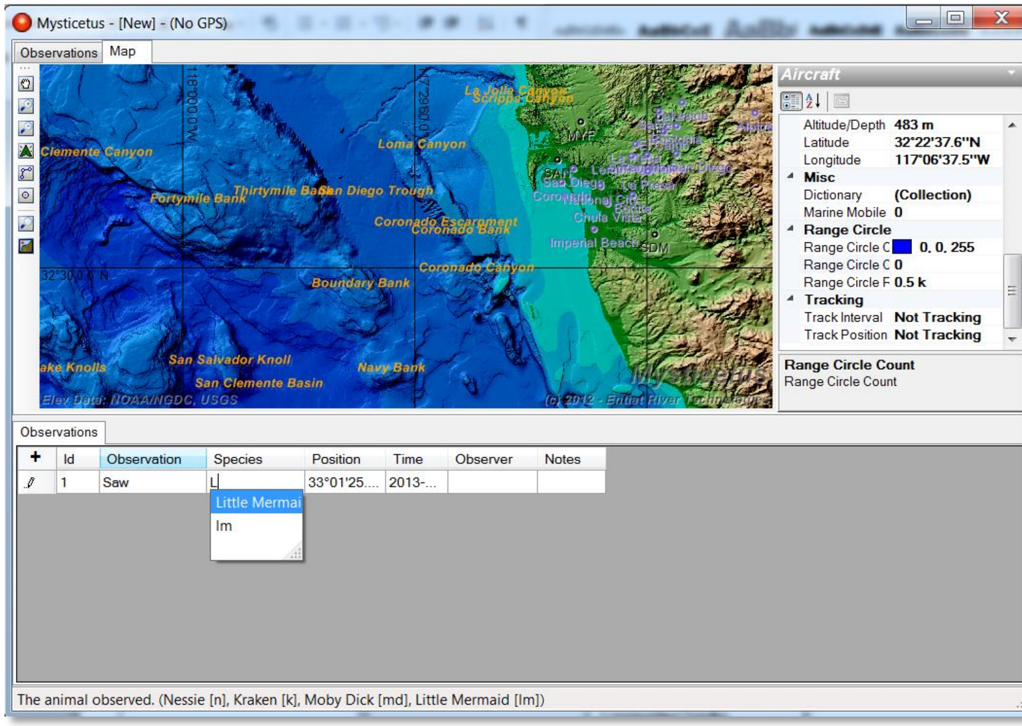
Click the ball, and choose ***Data->New***.



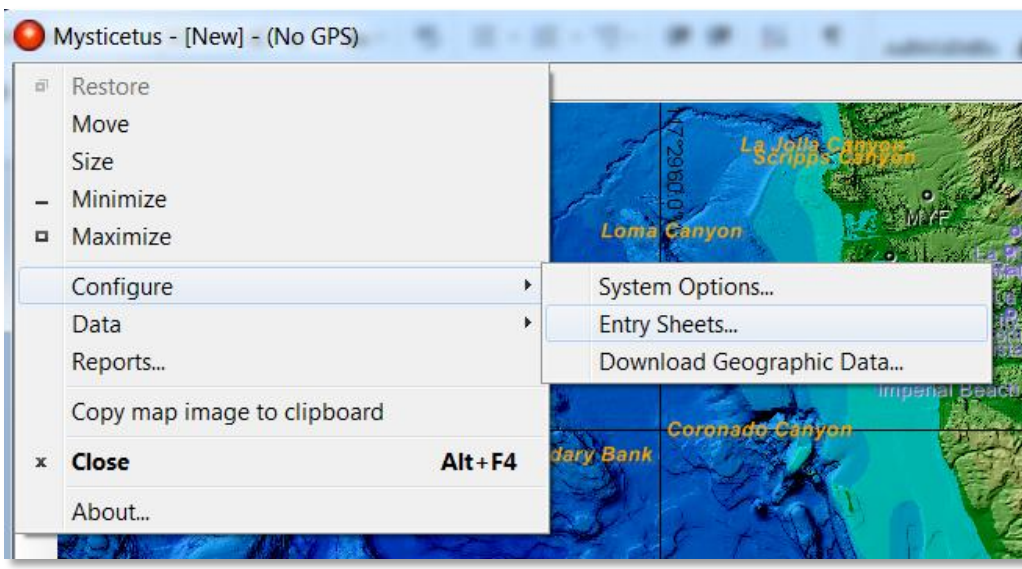
A scary warning will appear, reminding you that choosing "New" will overwrite any unsaved data.



Since you don't have any unsaved data at this point in time, choose "Yes". This will create a new "set" of a single very simple entry sheet. This simple sheet contains an auto-incrementing Id, a basic text field for entering an observation, automatically stamped position and time fields, and basic text field for entering observer name and notes. None of these fields have complex behavior defined...yet.

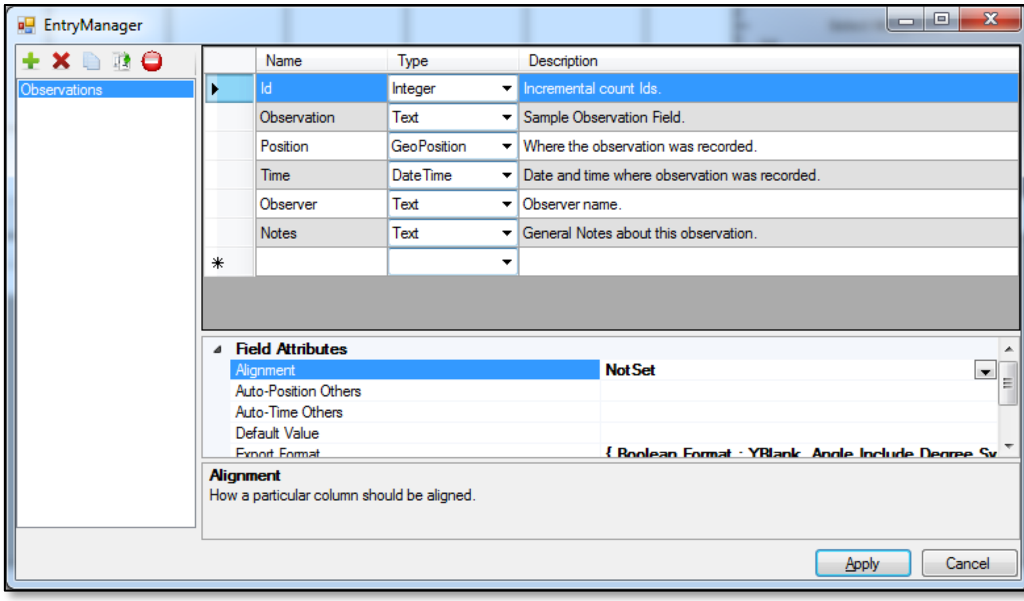


Click the ball, choose ***Configure->Entry Sheets***



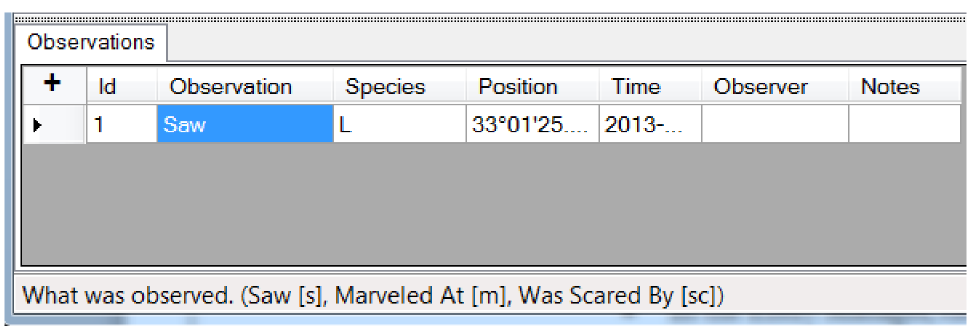
The Entry Sheet Editor will appear. This is where you can create new sheets and add them to your pages, you can edit existing sheets, delete or rename sheets and fields. Adding auto-complete data to cells is also accomplished in this editor.

Go ahead, play around in here. Later chapters will explain things in detail, but for now just poke at it and have fun.



A final couple "Intro" things to note in here:

- The Description for a field will be displayed in the status bar when the user starts typing in a field in the entry sheets. For example, here's what the status bar looks like when the Observation field is selected. This can be incredibly useful to give your observers hints about things they might not otherwise remember, such as definitions of Beaufort levels, glare levels, etc. Any shortcuts will be displayed, too. In this case, the default – somewhat whimsical - shortcuts include 's' for "Saw", 'm' for "Marveled At", and so on. You can (and should) change shortcuts to something more applicable for your protocol



- Back in the Entry Manager, clicking on a field will show the field's properties below. Clicking in the properties will provide a nice description of what that property controls. In the above picture, we've clicked in the Alignment field, and it tells us what that means. Don't forget to look down there for helpful hints about things you can do with a field.

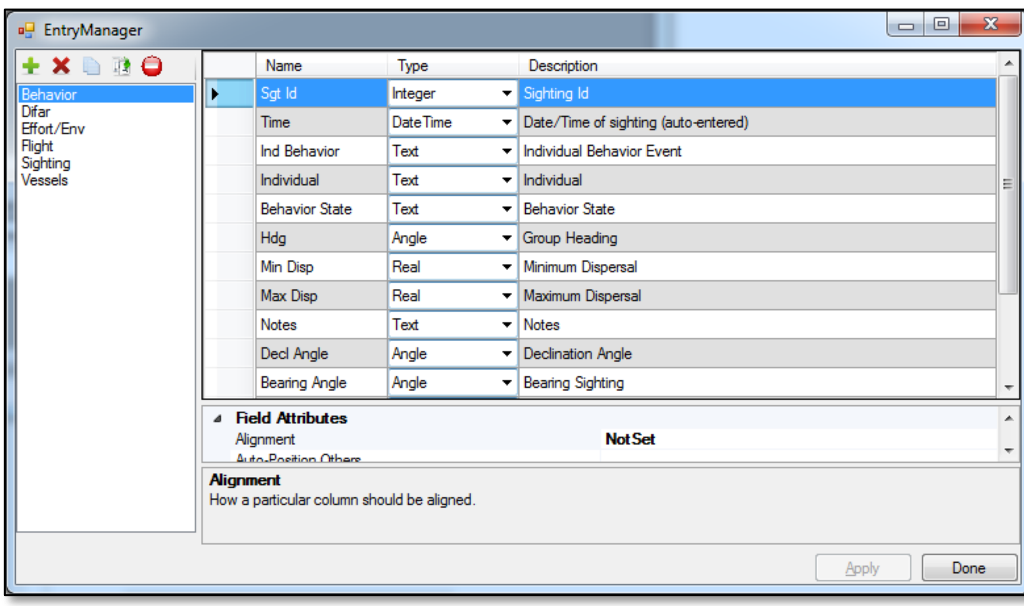
That's it for the introduction – the following chapters go into a lot more detail about all of these concepts, and more.

2 Entry Manager

The Entry Manager is where you define what data is collected, how data is collected and what data is automatically updated. There are no restrictions on data types or names or amounts – everything is at YOUR discretion and determination

Entry Manager is the place to control exactly what data Mysticetus collects. Text fields, date/time fields, count fields, angle fields, geo-position fields and so on are all defined here.

Here is a example of Entry Manager with a sample Mysticetus file loaded. Let's dive into more detail about each of the options available.

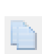


2.1 Sheet Management

In the top left are a number of icons that control the creation of pages. Pages in Mysticetus are always displayed in alphabetical order, so if you want to move pages around, you need to name them appropriately.

 - Add a new page.

 - Deletes a page.

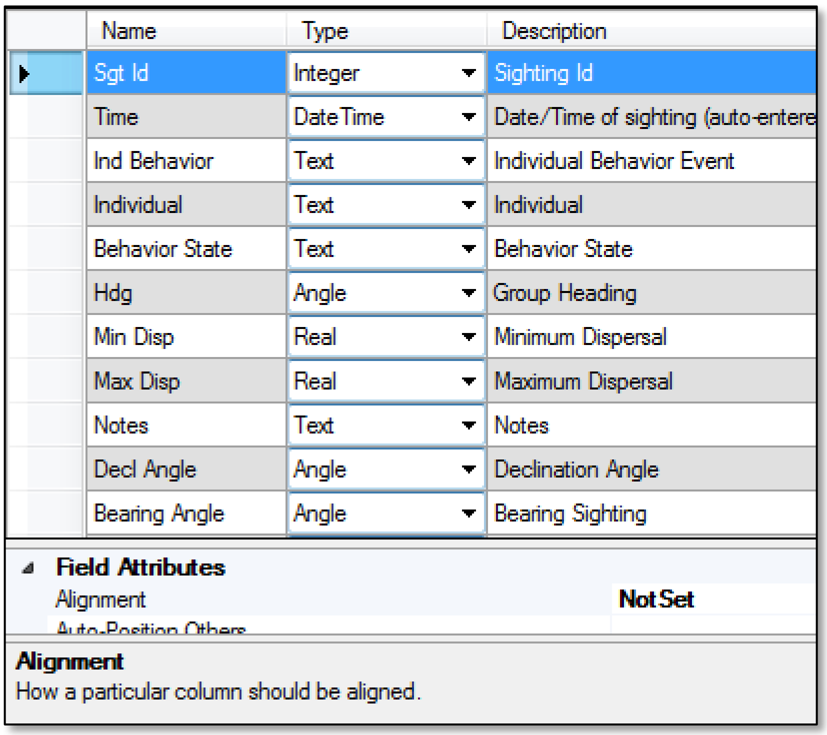
 - Copies a page. A copy of the currently selected page will be created.

 - Renames the currently selected page.

 - Clears data out of the currently selected page. A page layout can only be changed when there is no data associated with (recorded in) the page. Note that clearing the data cannot be undone so make sure you have saved the data before you clear it from the page.

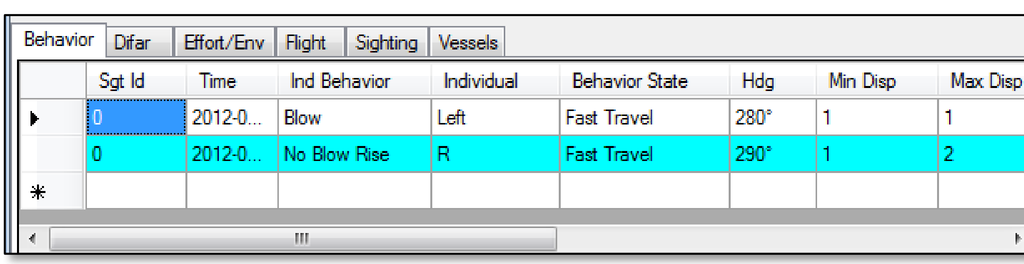
2.2 Fields

Over on the right side of the Entry Manager are the field definitions:



Name	Type	Description
Sgt Id	Integer	Sighting Id
Time	DateTime	Date/Time of sighting (auto-entere
Ind Behavior	Text	Individual Behavior Event
Individual	Text	Individual
Behavior State	Text	Behavior State
Hdg	Angle	Group Heading
Min Disp	Real	Minimum Dispersal
Max Disp	Real	Maximum Dispersal
Notes	Text	Notes
Decl Angle	Angle	Declination Angle
Bearing Angle	Angle	Bearing Sighting

These field definitions map 1:1 to what is displayed on the data entry form (see *Chapter 3 - Data Entry*).



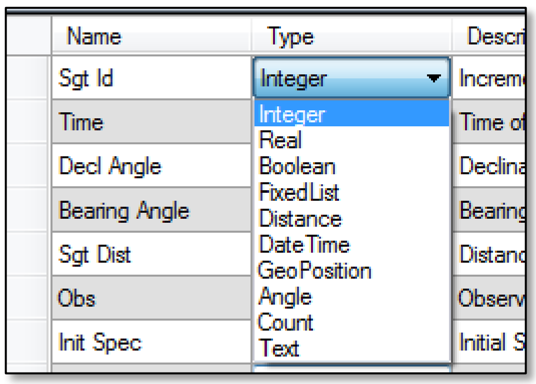
Sgt Id	Time	Ind Behavior	Individual	Behavior State	Hdg	Min Disp	Max Disp
0	2012-0...	Blow	Left	Fast Travel	280°	1	1
0	2012-0...	No Blow Rise	R	Fast Travel	290°	1	2

Each Name field must be unique within the context of a sheet; the same name can appear on different sheets, but only once on a given sheet. This name will be used as a column heading on the Data Entry form.

These data items can be dragged and dropped into new orderings, they can be deleted by clicking on the row header (on the left) and pressing the Delete key. New entries are created by entering them at the bottom of the list and then (optionally) dragging and dropping them where you want them.

2.3 Field Types

Each column can contain a single type of data, one of the following: This is controlled by pulling down the Type dropdown.



There are ten different data types that can be represented in Mysticetus:

2.3.1 Integer

Contains whole numbers. 0, 13, 42, -256, 8834773 are examples.

2.3.2 Real

Contains real numbers. 0.0, 159.123, 5.725, 14.2 are examples.

2.3.3 Boolean

Represents True or False values. On the data entry sheet it will be presented as a checkbox. Checked is True.

2.3.4 FixedList

The user must select from a fixed list of items. The contents of the list are found in the Fixed List attribute of this entry.

2.3.5 Distance

Contains a distance. The distance will be formatted as specified in the System Options (***Configure->System Options->Display***). See *section 7.4 - Display* for more information on Display Options.

2.3.6 DateTime

Contains a date/time stamp. In the data sheet, this field can be automatically entered by Mysticetus (see *Chapter 4 - Formulas*), or the user can enter an explicit date/time. The user can also type ‘x’ or ‘now” and Mysticetus will enter the current local date/time.

2.3.7 Elevation

Contains an elevation (positive) or depth (negative) value. The value will be formatted as specified in the System Options (***Configure->System Options->Display***). See *section 7.4 - Display* for more information on Display Options.

2.3.8 GeoPosition

Contains a Latitude/Longitude/Altitude triplet - although in the data sheet, only the Latitude and Longitude will be displayed. Like a DateTime entry, this can be automatically entered by Mysticetus via a number of Formulas (see *Chapter 4 - Formulas*).

2.3.9 Angle

Contains an angle ranging from 0-360 degrees. In the data sheet a large number of options are available for the user to enter angles, including Left or Right, which maps to 90 degrees left and right of the current GPS heading, as well as explicit offsets from the current heading. Absolute angles can, of course, be entered directly as well (e.g. 278).

2.3.10 Count

Contains a positive integer.

2.3.11 Text

Contains any text. This field can be further modified to use an auto-complete list (see *section 2.5.4 - Auto-Complete List*) which makes data entry significantly easier and requires fewer keystrokes by data recorders in real-time.

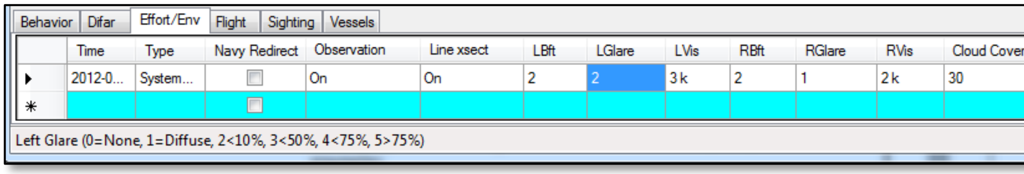
2.4 Field Descriptions

The Description field contains a description or hint to the person who actually records the data.

Description
Date/Time of this record
Leg type being flown
Whether or not the Navy redirected this leg.
On, Off or Compromised
On when at 1000', observers on effort.
Left Beaufort (0 to 8)
Left Glare (0=None, 1=Diffuse, 2<10%, 3<50%, 4<75%, 5>75%)
Left Distance to see 25 Dolphins
Right Beaufort (0 to 8)
Right Glare (0=None, 1=Diffuse, 2<10%, 3<50%, 4<75%, 5>75%)
Right Distance to see 25 Dolphins

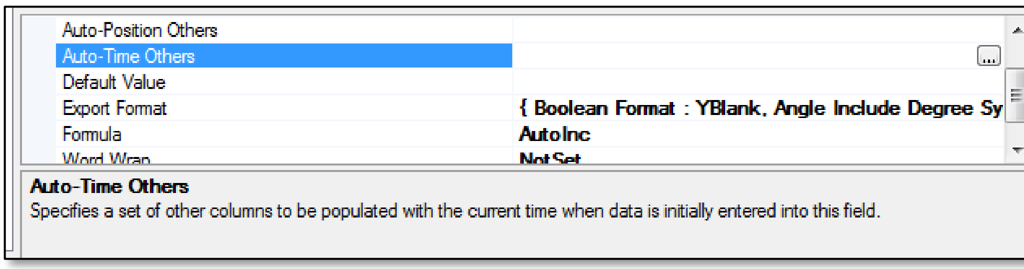
Pro Tip: Be careful how much text you put in the description – small screens may not be able to show it all in the Status Bar

When entering data in a data sheet, Mysticetus will display the Description as a hint in the Status Bar:



2.5 Field Attributes

Additional Field Attributes are controlled down below the field list, and will contain the properties for the selected field.



Some properties only apply to certain field types. Note that selecting a field property will also display a helpful hint about the property. In the above example, basic information about the “Auto-Time Others” property is displayed.

Available properties:

2.5.1 Alias List

Contains a list of alias values that can be used to simplify data entry. This is a list of 1:1 mappings of shortcut to full value. For example, one might map “bw” to “Blue Whale” and “fw” to “Fin Whale”. Mysticetus will map the shortcut (alias) directly to the full value when the shortcut is entered in the data entry sheet cell. Mysticetus will also display the list of aliases in the status bar as an additional hint to the person entering data.

2.5.2 Alignment

Describes how the field values are aligned in their cells. Leaving this as the default (Not Set) will use the default formatting for this data type.

2.5.3 Angle Type

Only available on Angle fields. Can be set to Degrees or Reticles. If set to Reticles, the System Reticle conversion factor will be applied to anything entered in this field (***Configure->System Options->System->Reticle***)

2.5.4 Auto-Complete List

Contains a pre-populated list of auto-complete terms. For example, this may contain a list of common terms for animal behavior. When the data entry person enters the first few letters of the behavior, a list will drop down with appropriate matches for those letters.

2.5.5 Auto-Complete Source
Specifies that anything typed into this cell will be added to the Auto-Complete List for this cell.

2.5.6 Auto-Position Self
Only available in a GeoPosition cell – enters the current GPS position (or fixed position – see *section 7.1.7 - (Fixed) Observation Position*) in this cell when a new row is added. (*note: generally this behavior is not what you want, as it stamps the position as soon as a new row is created – use Auto-Position Others instead*)

2.5.7 Auto-Position Others
When data is entered into the current cell, Mysticetus will populate the list of other columns with the current GPS position (or fixed position – see *section 7.1.7 - (Fixed) Observation Position*).

2.5.8 Auto-Time Self
Only available in Date/Time fields. When True, any time a new row is created this field will be stamped with the current Date and Time. (*note: generally this behavior is not what you want, as it stamps the time as soon as a new row is created – use Auto-Time Others instead*)

2.5.9 Auto-Time Others
When data is entered into the current cell, Mysticetus will populate the list of other columns with the current time.

2.5.10 Default Value
If specified, any time a new row of data is created the default value will be applied.

2.5.11 Export Format
Includes some additional hints about how to export this data (see *chapter 9 - Data Export*).

2.5.12 Formula
A more complex way of controlling behavior in this cell. This is actually where a significant amount of Mysticetus' functionality is defined. Definitely read *chapter 4 - Formulas*.

2.5.13 Waypoint
Only available on a GeoPosition cell – will create a mapping waypoint at the position on the earth specified by the cell contents (see *chapter 5 - Mapping*). The value of the formula's single parameter also specifies the name of the waypoint as displayed on the screen. The name is constructed from the contents of named columns. For example, "[ID] – [Species] – [Time]" will create a waypoint with a name something like "17 – Blue Whale – 12:13:14 PST" (assuming those were the values of the ID, Species and Time fields for that record).

2.5.14 Word Wrap
Whether or not to wrap contents of this cell if the data exceeds the cells horizontal bounds.

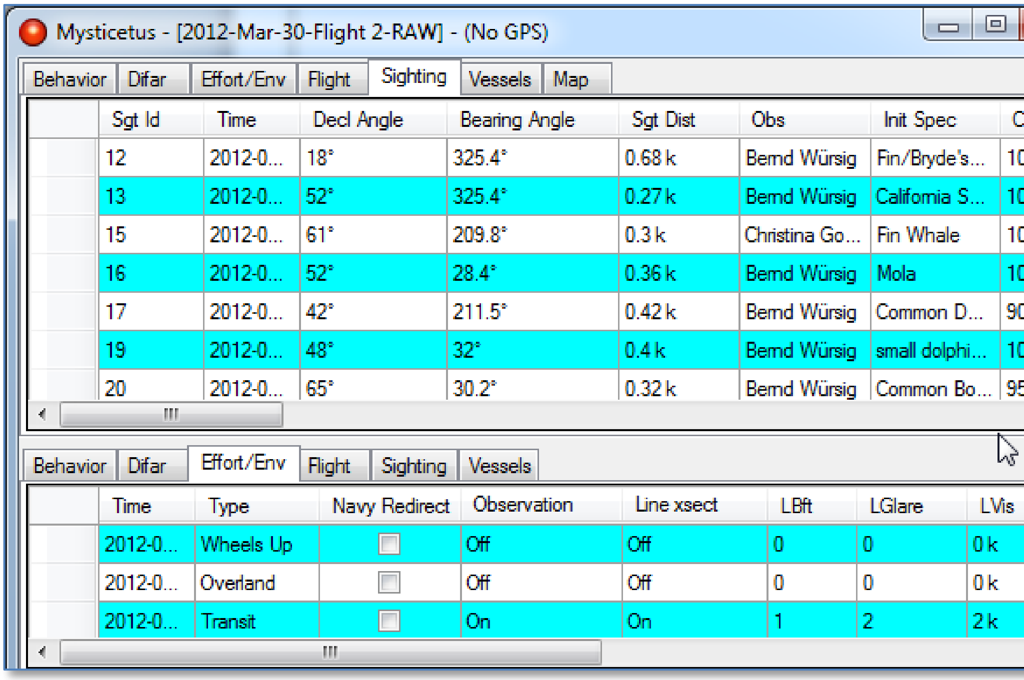
Pro Tip: Auto-Time Self and Auto-Position Self are rarely used. It can become inconvenient to have time and position stamp values entered the instant the cursor moves into a new record. Rather, the selected use of "auto-time others" and "auto-position others" is a more powerful way to time/position stamp a field when actual data entry begins.

3 Data Entry

Without data, Mysticetus is just a cute little application that shows you pretty pictures of the earth.

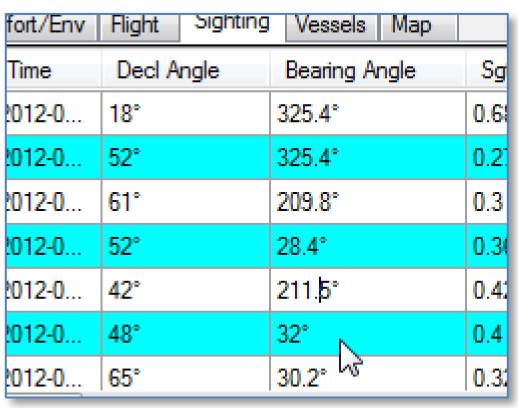
Entry of data happens in a few different fashions, either by importing data from another source (see *Chapter 8 - Data Import*) or by manually entering data while in the field. This chapter addresses the latter case.

Data entry starts by defining the Entry Sheets in the Entry Manager (see *chapter 2, Entry Manager*). Once defined, entering data is a simple matter of selecting a cell and typing in the data. All fields can be typed into, although many fields will be automatically calculated by other fields. In the picture below, the Sighting tab is set up such that the declination angle and bearing angle are entered by a human, but the Sighting Distance (and, off screen, the Sighting Position) are automatically calculated by Mysticetus (see *Chapter 4, Formulas*).



3.1 Sheet Navigation

Navigating around the sheets is very straightforward and follows all standard Windows conventions. You can click on any cell with the mouse and start typing. When in editing mode for a particular cell, all standard text editing rules apply.



(note the cursor in the 211.5 entry). This includes Copy and Paste, arrow keys, etc.

When not editing a cell, you can use one of the following keys to navigate around the cells:

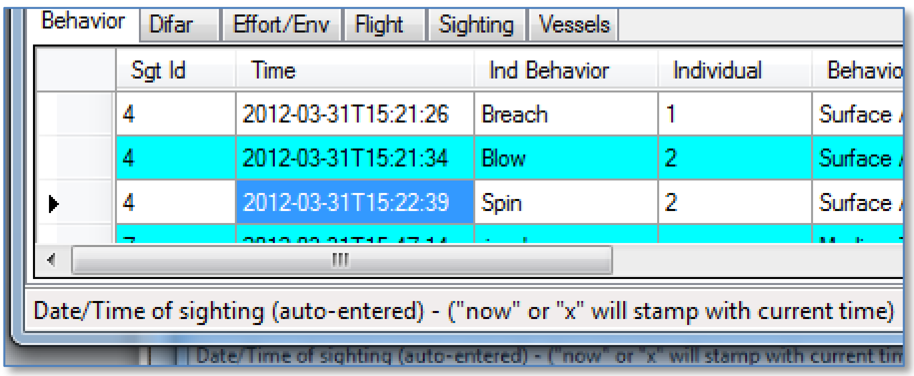
- Enter/Right Arrow – Moves the selection to the cell to the right.
- Down Arrow – Moves down. If you are at the last item in the list, a new item is automatically created and the cursor moves down there.
- Up Arrow – Moves up.

- Left Arrow – Moves left.

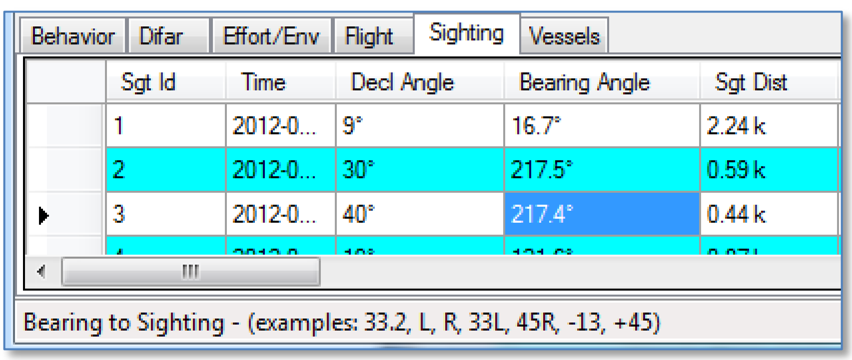
There are a few subtleties to be aware of, though. If you are editing a cell, pressing the right arrow past the end of the text will move the cursor to the next cell to the right. Similarly, pressing the left arrow when the cursor is at the start of text will move to the cell to the left.

3.2 Special Entries

Certain value types allow for built-in shortcut keys – that is, you don't need to configure these keys as aliases in the Entry Manager. Hints about these built-in shortcut keys will show up in the status bar when a cell is selected, in addition to whatever Description was entered in the Entry Sheet Editor for this cell. For example, the following shows the additional built-in shortcut for DateTime values – you can enter the word "now" or a simple "x" and Mysticetus will stamp the entry with the current date/time:



In addition to DateTime values, there are built-in shortcuts for Angle cells:



The available angle formats are:

- Raw angle value such as 332 – this will be entered as typed.
- R or L – this will be entered as the current heading plus 90 and 270 degrees (normalized from 0 to 360), respectively.

- A number starting or ending with R or L, such as 45R, L20 or 33L. If R, the number will be added to the current heading, if L it will be subtracted from the heading.
- A number starting with a plus (+) or minus (-) sign. The value will be added (or subtracted) with the heading. In this sense, plus means Right or heading and minus means Left.
- A clock face value, such as 4:00 or 12:30. The clock face value will be applied to the heading of the vessel or aircraft.

3.3 Units

Units will be converted to the Display settings (***Configure->System Options->Display***) for the appropriate unit type. For example, if distances are currently configured to display kilometers, entering a value of "500 m" in a Distance cell will display a value of "0.5 k". Available distances types are:

- Meters – e.g. 123 m
- Millimeters – e.g. 1234 mm
- Feet – e.g. 3.45 ft
- Inches – e.g. 12.34 in
- Statute Miles – e.g. 123.4 mi
- Kilometers – e.g. 12.34 k
- Yards – e.g. 1234.5 yds
- Nautical Miles – e.g. 12.34 nm

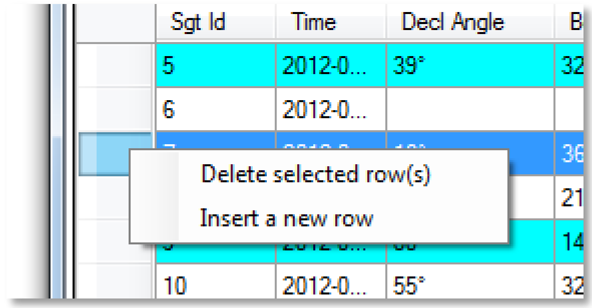
Similarly, GeoPosition cells will display their position according to the Lat/Lon setting. As with distances and other values, entering a GeoPosition can be done in any of the following formats:

- Raw Degrees (west and south are negative) – e.g. 43.2123 -117.340
- Degrees with direction indicator – e.g. 43.2123 N 117.340 W
- Degrees, minutes and fractional minutes – e.g. 43 21.23 N 117 34.12 W
- Degrees, minutes, seconds and fractional seconds – e.g.

43 21 23.23 N 117 34 12.32 W

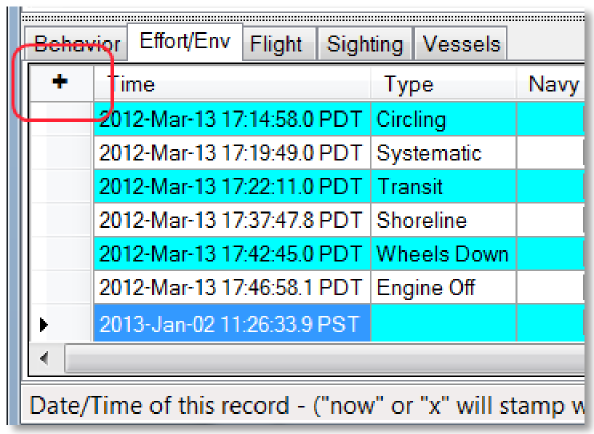
3.4 Inserting and Deleting Rows

Right clicking on the row header (the gray area off to the left of the row) will pop up the following menu:



From these items you can insert a single new row or delete the selected row(s).

New rows at the bottom of the list can be created by either simply moving to that row via the arrow keys, or by clicking the little plus in the upper left corner:

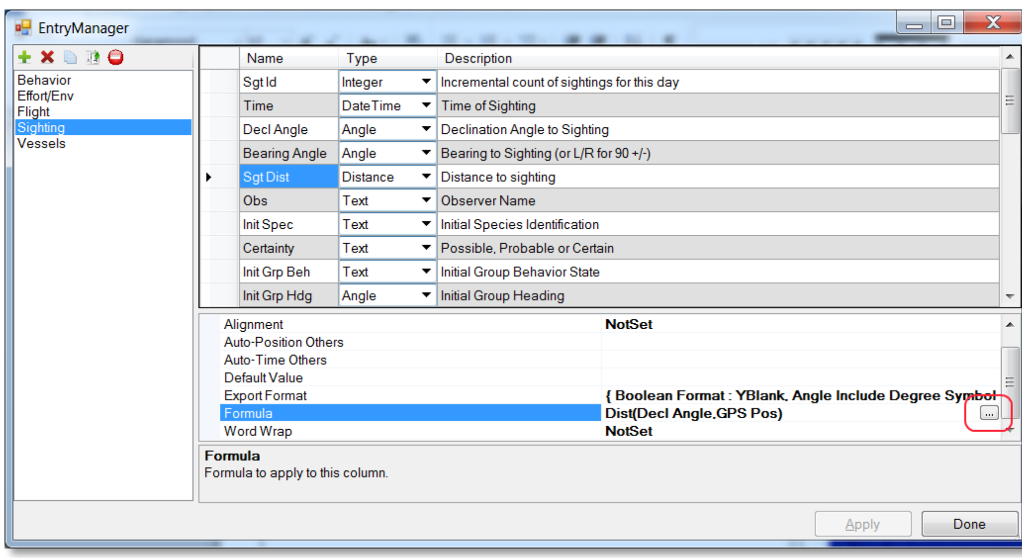


4 Formulas

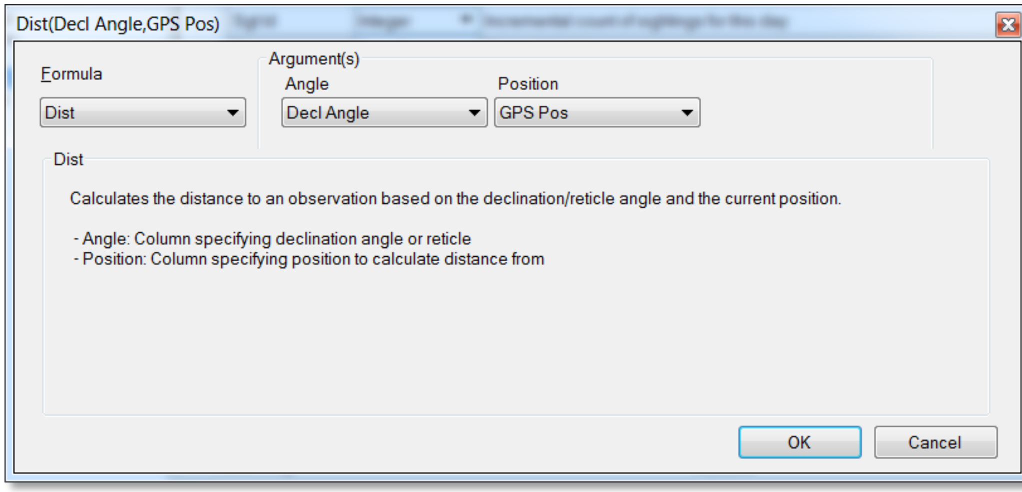
Formulas are the true power behind some of the more complex Mysticetus operations. They compute distance and geo-position of sightings, they turn aircraft and vessel tracking on and off, and they control various automations Mysticetus performs on the data.

Formulas are entered via the Entry Manager (***Configure->Entry Sheets***). Formulas are found as a property on each cell.

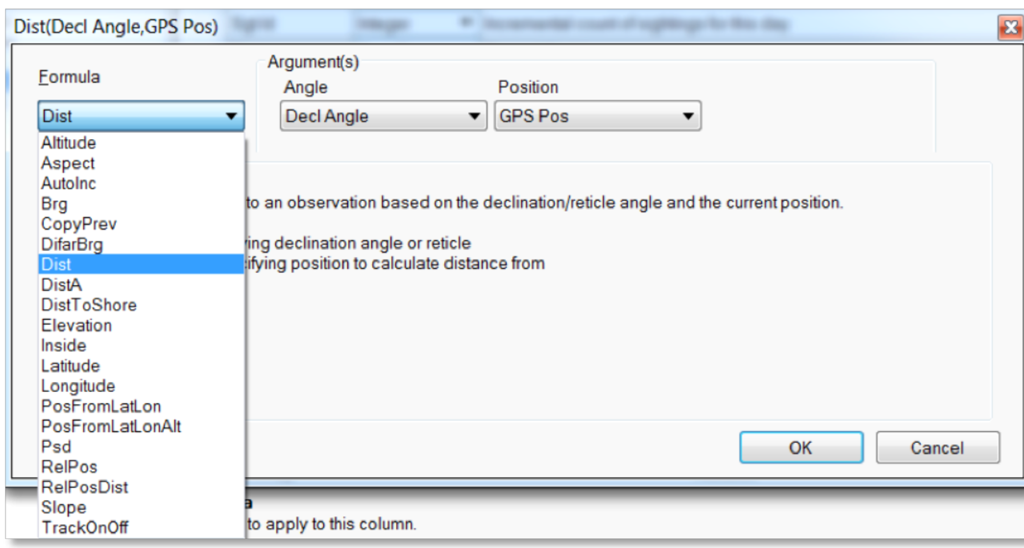
Formulas are edited by either simply typing the formula name (plus arguments) directly into the Formula line, or by opening the Formula Editor by clicking on the ellipses (…) after the formula:



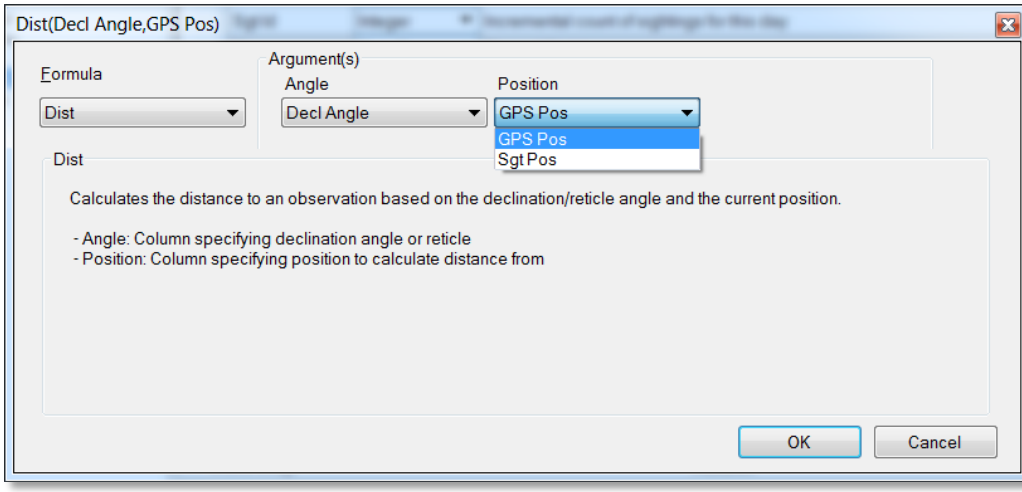
The Formula Editor makes it simple to build formulas.



The formula editor shows the list of possible formulas, and supplies drop-down boxes containing fields that might be appropriate for the arguments.



The formula editor will only display fields that match the appropriate argument type. For example, if a particular argument (Dist, in this case) requires a GeoPosition argument type, it will only display fields that match that type for you to choose from:



4.1 Formula Details

This section contains details about all available formulas.

4.1.1 Altitude

Altitude(Position)

Extracts the altitude component from a Position cell. Position has typically been set from the GPS via the Auto-Position Self or Auto-Position Others attribute (see *section 2.5 - Field Attributes*).

4.1.2 Aspect

Aspect(Position)

Calculates the terrain aspect at the specified Position. Position is typically a sighting location cell.

Aspect is defined as the compass direction a pole perpendicular to the earth surface will point. For example, a "north-facing slope" would have an aspect near 0, a "south facing slope" near 180.

Note that this calculation is only as precise as the highest resolution bathymetry/topographic data installed at Position. Mysticetus uses a 3x3 grid of data surrounding Position to perform the calculation. The more precise the bathymetric data, the more precise the Aspect calculation.

4.1.3 AutoInc

AutoInc

AutoInc attempts to increment the value to a number 1 value higher than any other present in the current column. Non-number values count as zero (so the next AutoInc'd number will be 1).

There are no parameters.

4.1.4 Brg

Brg(Bearing, Position)

The Brg formula attempts to parse the textual bearing value found in the Bearing column, and, using the GPS heading at the time the Position value was stamped, convert to an absolute bearing.

For example, entering "33R" in the Bearing column will cause the Brg function to grab the heading at the time the Position was set. Say, for example, this heading was 142 Magnetic. The Brg function will return the value 175 Magnetic (33 degrees to the right of the heading).

4.1.5 CopyPrev

CopyPrev

CopyPrev has no arguments. The CopyPrev function simply copies the previous entry in this column down from the previous row.

Pro Tip: Talk directly with Dave before you even think of using the DifarBrg formula. It is very specific to its task and requires a lot of setup in the entry sheets to function properly.

4.1.6 DifarBrg

DifarBrg(Channel, WaypointPos)

This formula is very specific to dealing with reading bearings from directional sonobuoys. This function will match a channel id to a previously entered drop id. When found, the position of the drop id (WaypointPos) will have a new bearing line added to the map.

4.1.7 Dist

Dist(Angle, Position)

Dist calculates the distance to a sighting based on declination angle and a position. Typically Position is set via Auto-Position Self or Auto-Position Others. If the column specified for Angle has the Reticle attribute set, the System Reticle conversion value will be applied (***Configure->System Options->System***). Otherwise Angle is assumed to be a declination angle.

4.1.8 DistA

DistA(Angle, Altitude)

DistA is similar to Dist, except that instead of using the current altitude from another column, it uses an altitude value from the Altitude column (typically, the Altitude column is set via the Altitude function).

DistA calculates the distance to a sighting based on declination angle and the Altitude. If the column specified for Angle has the Reticle attribute set, the System Reticle conversion value will be applied (***Configure->System Options->System***). Otherwise Angle is assumed to be a declination angle.

4.1.9 DistToShore

DistToShore(Position)

DistToShore calculates the distance to shore from Position. This is based on the highest resolution bathymetry/topography data installed. As with other bathymetric/topographic functions, the accuracy of DistToShore is only as good as the installed data. For example, if the best installed data has only 1 arc second of accuracy, that's all the accuracy this function can guarantee.

4.1.10 Elevation

Elevation(Position)

Calculates the elevation at the specified Position. Position is typically a sighting location cell. Positive is above sea level, negative below.

Note that this calculation is only as precise as the highest resolution bathymetry/topographic data installed at Position.

4.1.11 Inside

Inside(Position)

Calculates the set of Geo-Polygons the Position is contained within. If the Position is contained within multiple geo-polygons, they will be comma-separated (e.g. "Poly1,Poly2,Poly3")

4.1.12 Latitude

Latitude(Position)

This formula extracts the Latitude as a real number from a Position.

4.1.13 Longitude

Longitude(Position)

This formula extracts the Longitude as a real number from a Position.

4.1.14 PosFromLatLon

PosFromLatLon(Latitude, Longitude)

This formula synthesizes a GeoPosition from a latitude and longitude pair. The resulting altitude component of the GeoPosition is undefined.

4.1.15 PosFromLatLonAlt

PosFromLatLonAlt(Latitude, Longitude, Altitude)

This formula synthesizes a GeoPosition from a latitude, a longitude and an altitude cell.

4.1.16 Psd

Psd(Position, Sighting)

This formula calculates the perpendicular sighting distance from a GPS position to a sighting position. This takes into account the heading of the vehicle at the time of sighting.

This formula is especially important in density/abundance calculations in line transect surveys.

4.1.17 RelPos

RelPos(Angle, AngleDir, Position)

Calculates the position of a sighting, given a declination or reticle Angle, an Angle Direction (absolute) and a current Position.

4.1.18 RelPosDist

RelPosDist(Dist, Bearing, Position)

Similar to RelPos, RelPosDist uses a pre-calculated Distance and Bearing to determine the position of the sighting relative to the Position parameter. This function is frequently triggered off of a Distance column being filled in via Dist() or DistA(). Alternatively, this function allows for an estimate distance to sighting to be entered and used.

4.1.19 Slope

Slope(Position)

Returns the Slope in degrees at the specified position.

Note that this calculation is only as precise as the highest resolution bathymetry/topographic data installed at Position.

4.1.20 TopoResolution

TopoResolution(Position)

Determines the highest resolution of topography/bathymetry installed at a given Position. If the current cell is a Real number, the number is entered in degrees (e.g. 0.00677777). If the current cell is Text, the value is entered with units information (e.g. “3 arc-seconds”).

4.1.21 TowedArrayBearing

TowedArrayBearing(Time, Bearing)

Given where the ship was at a specified Time, a bearing line will be drawn uni or bi-directionally from a distance behind the ship (distance is specified in System Options), in the direction(s) given by Bearing.

4.1.22 TrackOnOff

TrackOnOff(OnCommand, OffCommand, Interval)

This function is different in that it does not register a value in the cell when evaluated. Instead, any time the value of this cell changes, it is compared to the OnComand or OffCommand, and turns tracking of the active vehicle on or off. The Interval parameter specifies the tracking interval if being turned on.

Pro Tip: Mysticetus can be told to explicitly turn tracking on and off via the Tracking data panel.

For example, TrackOnOff(Engine On, Engine Off, 10) denotes that when the user enters "Engine On" in this field, tracking will be enabled at a 10 second interval. When the user enters "Engine Off", tracking will be turned off.

5 Mapping

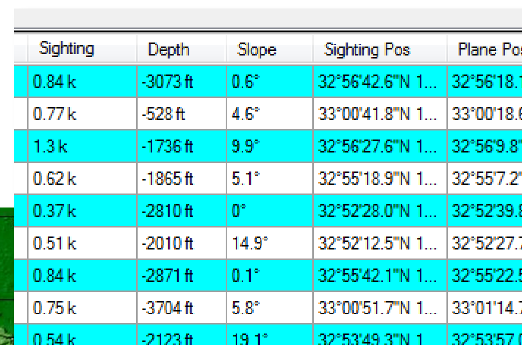
The Mysticetus mapping interface provides a quick and easy way to visualize where you are, where you've been and what you've seen. On a map. Sweet, huh?

Maps are indispensable for keeping geo-spatial track of a multitude of sightings and the observers own track. Mapping can be broken down into three components:

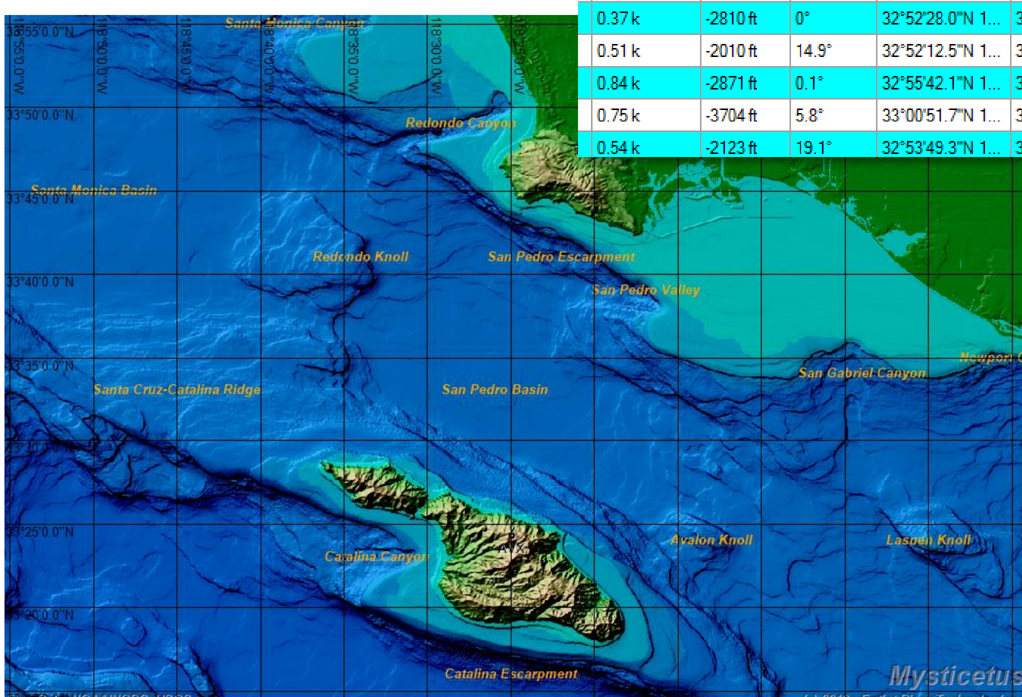
1. Bathymetry / Topography
2. Shapefile Maps
3. Geo-Spatial Objects

5.1 Bathymetry / Topography

Mysticetus uses detailed bathymetry and topography information from the NOAA National Geodesic Data Center and the USGS to paint shaded relief backgrounds in the map window. Mysticetus also uses this information to determine depth, slope, aspect and distance to shore characteristics of sightings.



Sighting	Depth	Slope	Sighting Pos	Plane Pos
0.84 k	-3073 ft	0.6°	32°56'42.6"N 1...	32°56'18.1'
0.77 k	-528 ft	4.6°	33°00'41.8"N 1...	33°00'18.6'
1.3 k	-1736 ft	9.9°	32°56'27.6"N 1...	32°56'9.8"N
0.62 k	-1865 ft	5.1°	32°55'18.9"N 1...	32°55'7.2"N
0.37 k	-2810 ft	0°	32°52'28.0"N 1...	32°52'39.8'
0.51 k	-2010 ft	14.9°	32°52'12.5"N 1...	32°52'27.7'
0.84 k	-2871 ft	0.1°	32°55'42.1"N 1...	32°55'22.5'
0.75 k	-3704 ft	5.8°	33°00'51.7"N 1...	33°01'14.7'
0.54 k	-2123 ft	19.1°	32°53'49.3"N 1...	32°53'57.0'



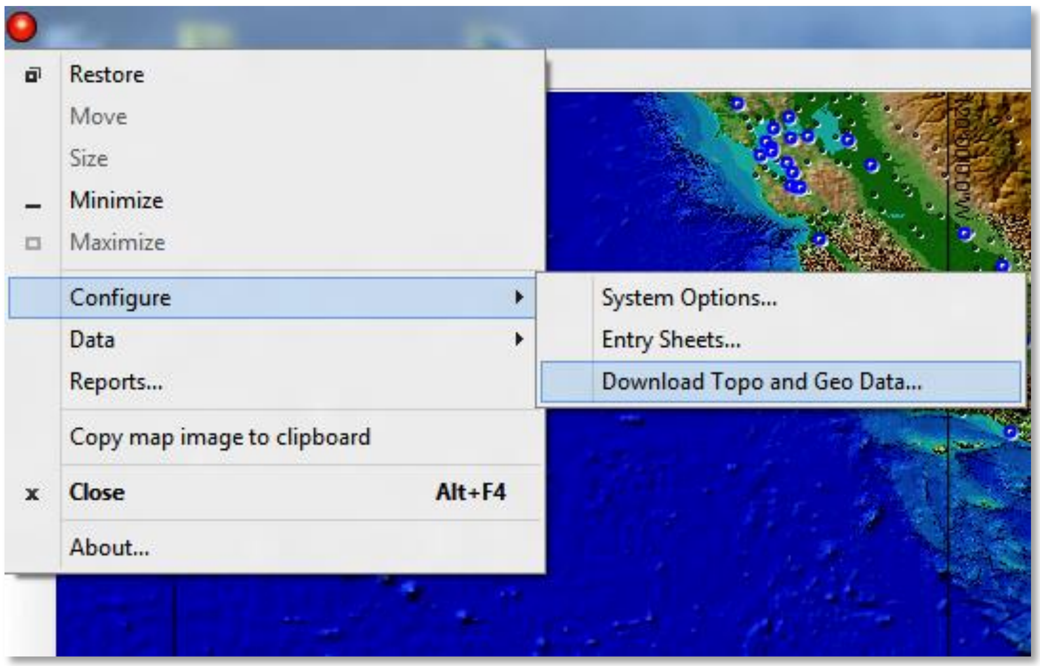
Bathymetry can be obtained in two different ways:

1. Automatic download via Download Manager

2. Download it yourself from the USGS or NOAA/NGDC websites

5.1.1 Automatic Download / Download Manager

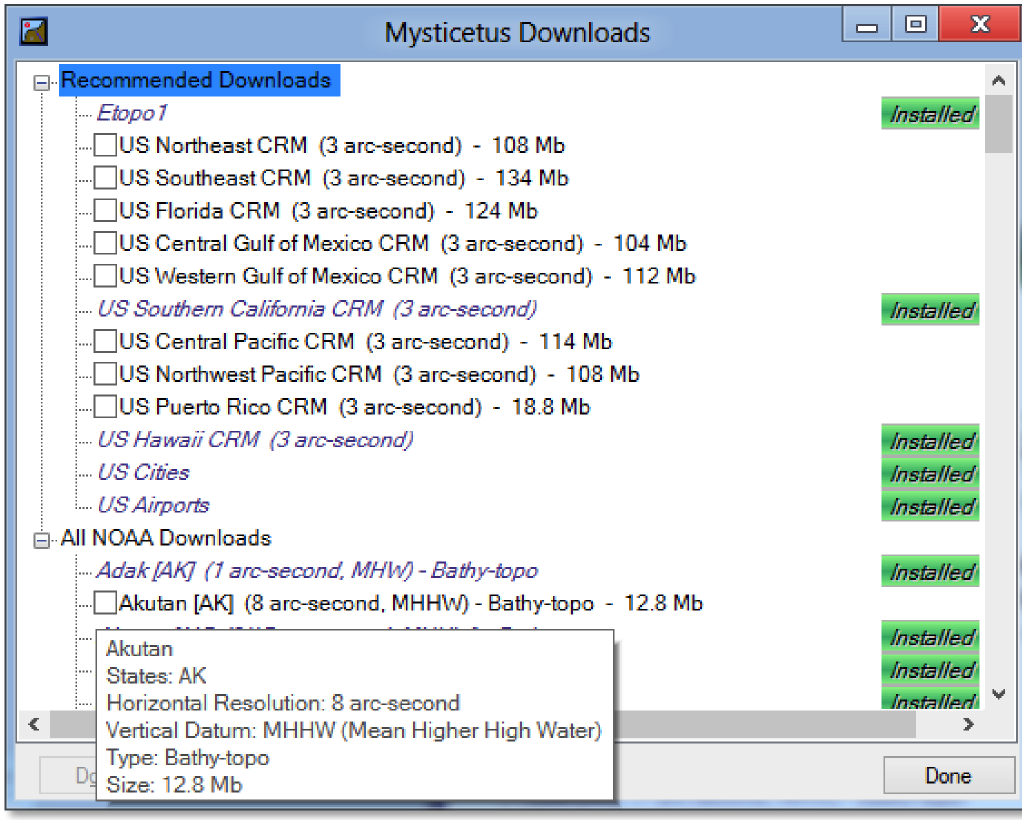
The Download Manager is available via the ***Configure->Download Topo and Geo Data*** menu item.



This will bring up the following dialog:

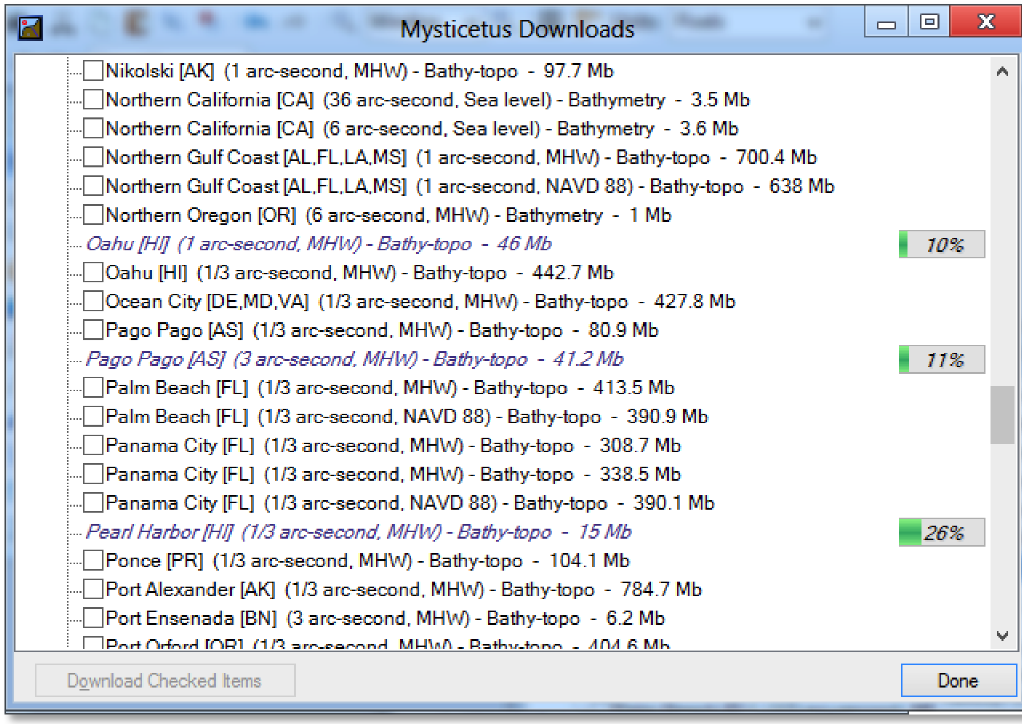
Pro Tip: You're going to want at least ETOPO1. This is a 1 arc-minute worldwide bathy/topo dataset. While it is fairly useless as an analytical dataset (too coarse), it serves as a nice backdrop for everything else.

Pro Tip: Hover your mouse over an item to get all sorts of detail about the item to help you decide whether or not to download it.



Simply click the checkboxes for the items you wish to download, select the "Download Checked Items" button and Mysticetus will download and install them for you.

Here is a picture of the Download Manager in action, downloading and installing some items:



Pro Tip: It is a good idea to unzip or untar Bathymetry / Topography files yourself – that will dramatically speed up load time.

5.1.2 Custom Bathymetry / Topography

You can create and download your own custom bathymetry and topography data from NOAA, the USGS or other sources. The data needs to adhere to the following requirements:

1. The data can be archived in a zip, gz, or tar.gz file, but all contained data files will be extracted into a folder with the same name as the original archive the first time Mysticetus uses it. This makes future access faster.

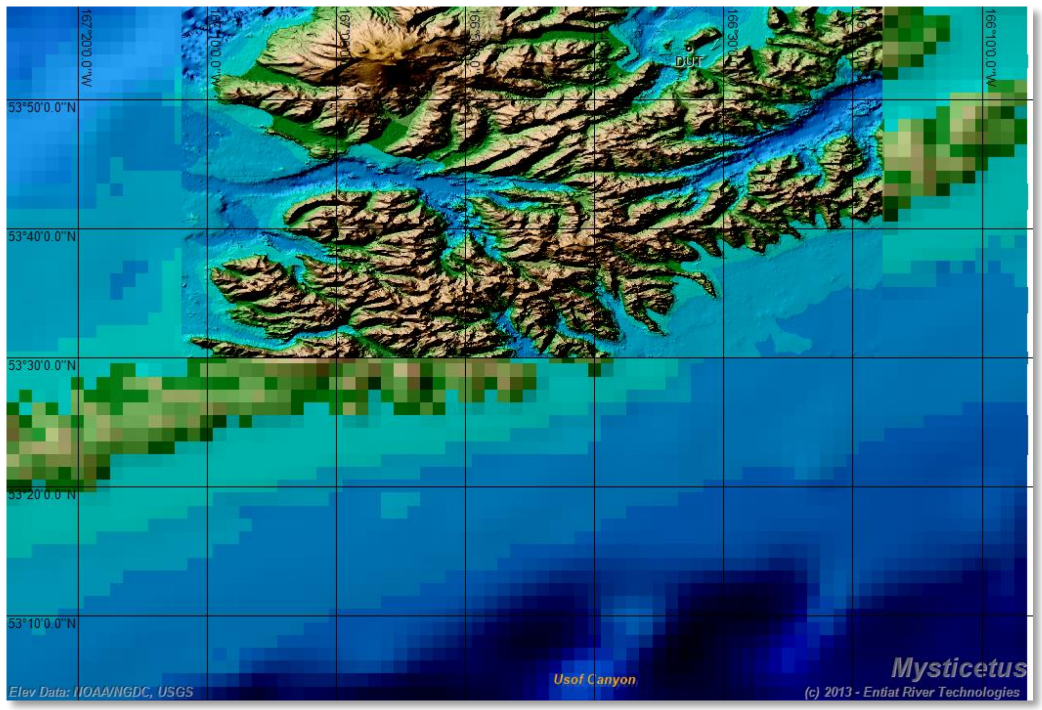
2. The contained data files must be in the hdr/bin or hdr/flt formats. The hdr file contains header information, the bin or flt files contain the actual data. Mysticetus supports either I2 or F4 data formats (also sometimes known as int16 or float4).

3. Alternatively, the contained data files must be in the asc file format. This file format is a text format; the header portion is at the start of the file, followed by text rows of ASCII data. The first time Mysticetus uses an asc file, it will be converted to a equivalent hdr/flt set of files (for faster access in the future).

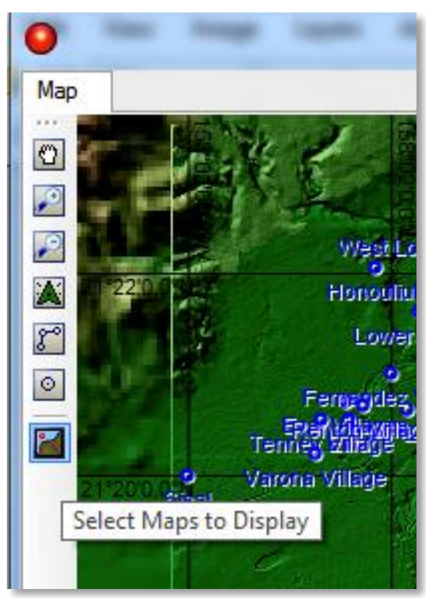
Mysticetus will use the filename (without extension) of the hdr or asc file as the primary name of the bathymetry / topography data displayed in the program. Thus you should name these files something useful; that is, name it something "Southern Island (1-9 arc second).asc" rather than "12749342.asc".

5.1.3 Bathymetry as Maps

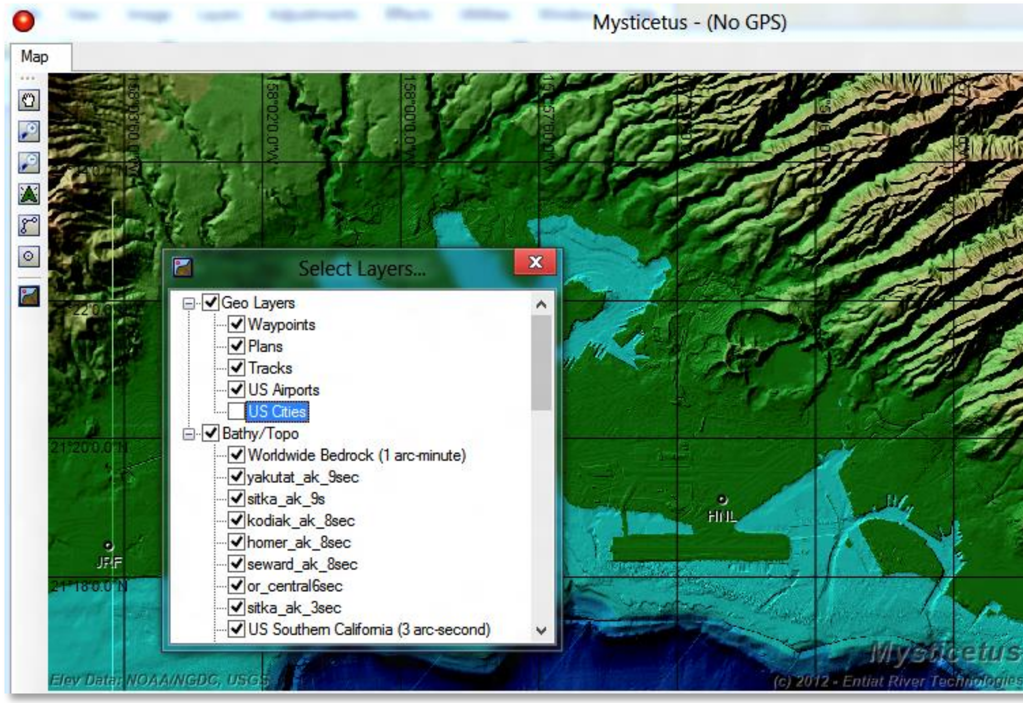
Mysticetus "quilts" bathymetry together; that is, it displays the highest resolution bathymetry on top of lower resolution data. Here is an area around Dutch Harbor, AK. You can clearly see the high resolution bathymetry and topography plotted “on top” (or “inset”) within the very coarse ETOPO1 data:



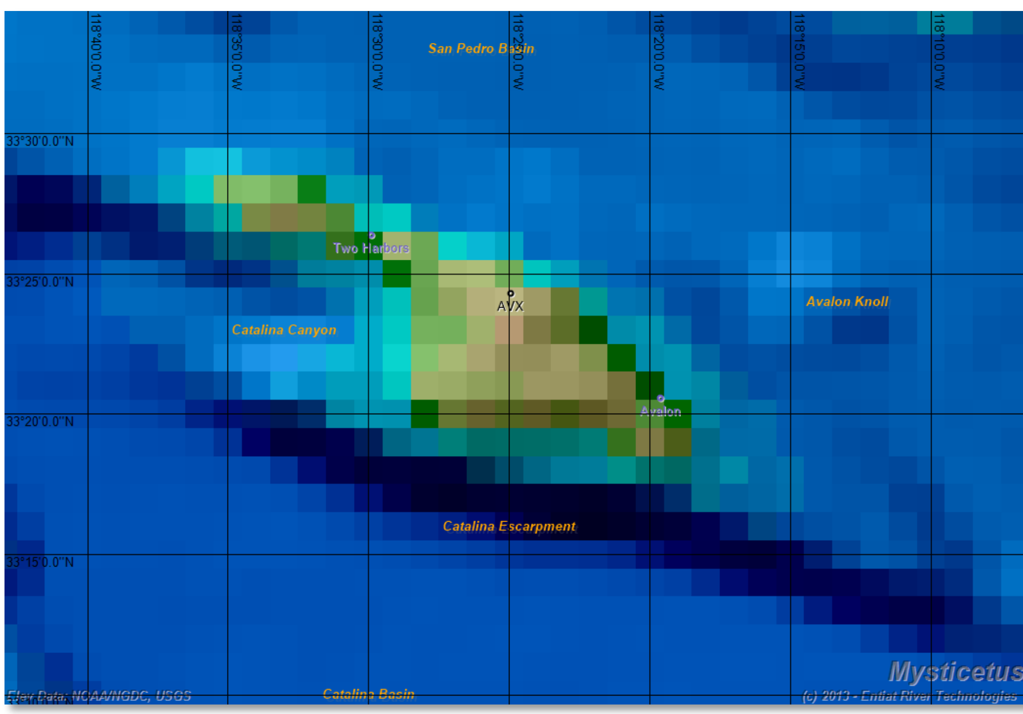
Display of these layers are controlled via the Layer Selection dialog (which controls display of every layer type on the map, not only bathymetry / topography):



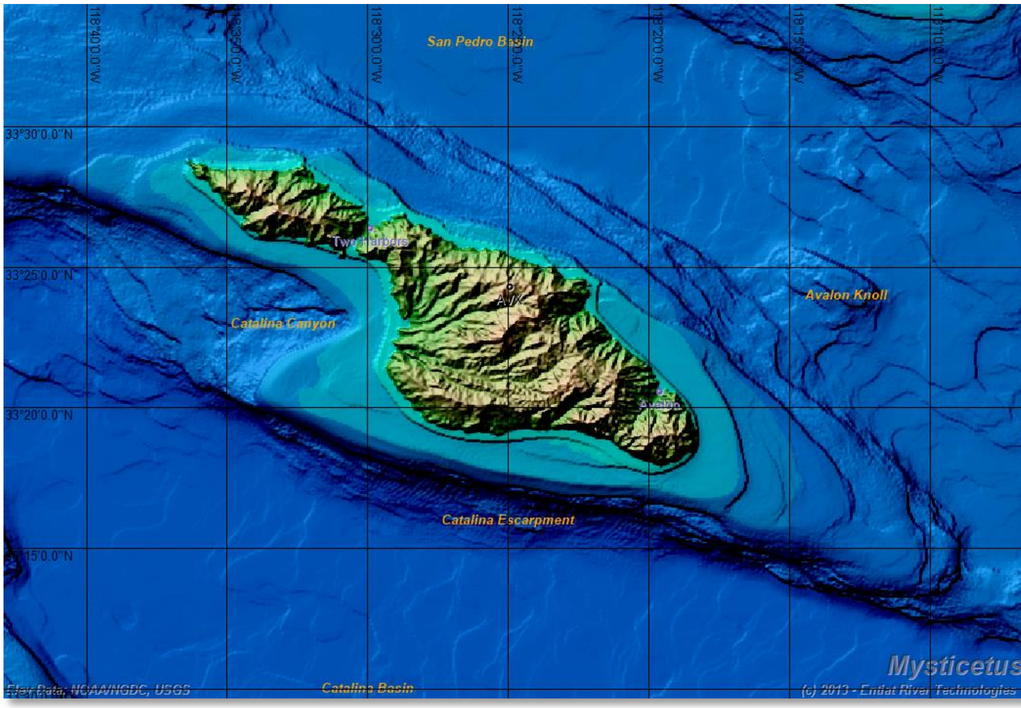
The select the layers you wish to display



Here is Catalina Island, as it is rendered via ETOPO1 (coarse 1 arc-minute)

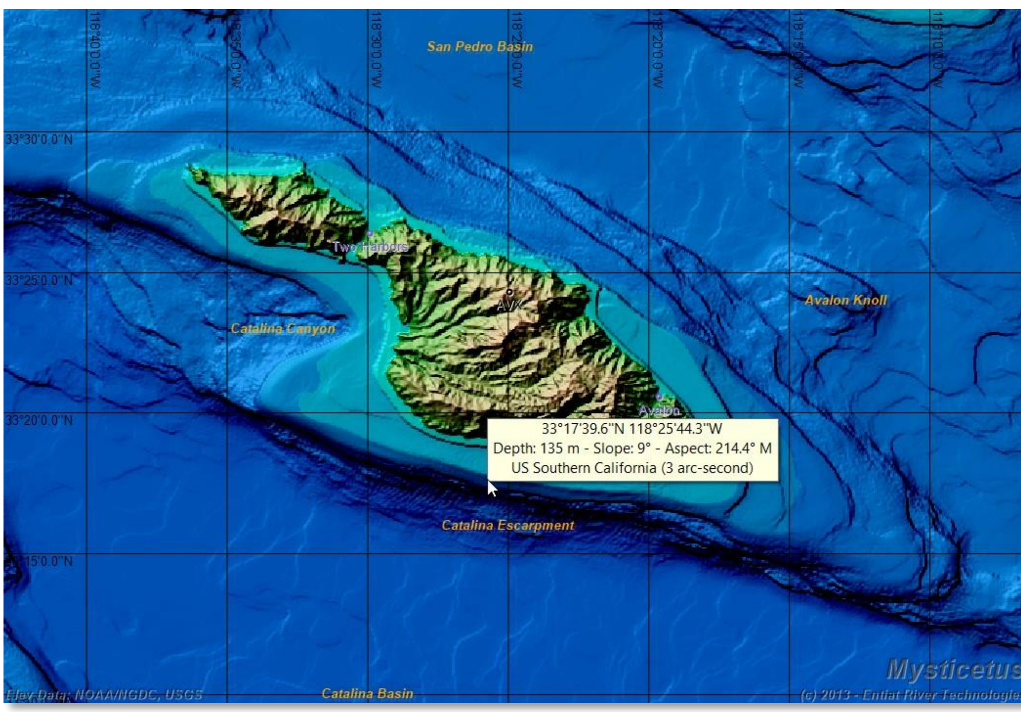


Simply choosing the Southern California 3 arc-second data brings the island into a much better focus (and there is even better data available for select coastal regions, down to 1/9th arc-second):



5.1.4 Bathymetry / Topography Instant Information

Holding the mouse steady over the map for a second will cause a “tooltip” to pop up and display interesting information about that point, including the Depth, Slope, Aspect and the highest resolution bathymetry available at that point (in this case US Southern California 3 arc-second).



5.1.5 Bathymetry / Topography Analysis

Bathymetry is also used for analysis of the seafloor (or land) at sighting location.

Sighting	Depth	Slope	Sighting Pos	Plane Pos
0.84 k	-3073 ft	0.6°	32°56'42.6"N 1...	32°56'18.1'
0.77 k	-528 ft	4.6°	33°00'41.8"N 1...	33°00'18.6'
1.3 k	-1736 ft	9.9°	32°56'27.6"N 1...	32°56'9.8"N
0.62 k	-1865 ft	5.1°	32°55'18.9"N 1...	32°55'7.2"N
0.37 k	-2810 ft	0°	32°52'28.0"N 1...	32°52'39.8'
0.51 k	-2010 ft	14.9°	32°52'12.5"N 1...	32°52'27.7'
0.84 k	-2871 ft	0.1°	32°55'42.1"N 1...	32°55'22.5'
0.75 k	-3704 ft	5.8°	33°00'51.7"N 1...	33°01'14.7'
0.54 k	-2123 ft	19.1°	32°53'49.3"N 1...	32°53'57.0'

In addition to the Depth and Slope shown in the example above, Aspect and Distance to Shore can also be automatically calculated. This is accomplished by applying a Formula to a cell, based on sighting position. See *chapter 4 - Formulas*, in particular the sections on Elevation, Slope, Aspect and DistToShore.

Once calculated, this information can of course be exported (see *chapter 9 - Data Export*) to Excel or a CSV file.

5.1.6 Apply Bathymetry / Topography Information to Pre-existing Data

This data can also be calculated from older sighting data. For example, if you have the locations of the sightings, you can create a new, empty entry sheet with columns for the sighting location, and then columns for the various attributes you want Mysticetus to calculate (with appropriate formulas applied to the cells). Import the old data, and Mysticetus will calculate this information for you. See the following chapters for more information:

- *Chapter 2 - Entry Manager*, for more information on configuring entry sheets.
- *Chapter 4 – Formulas*, for more information on Formulas. In particular, see the Elevation, Slope, Aspect, and DistToShore formulas.
- *Chapter 8 - Data Import,* for more information on importing pre-existing data.

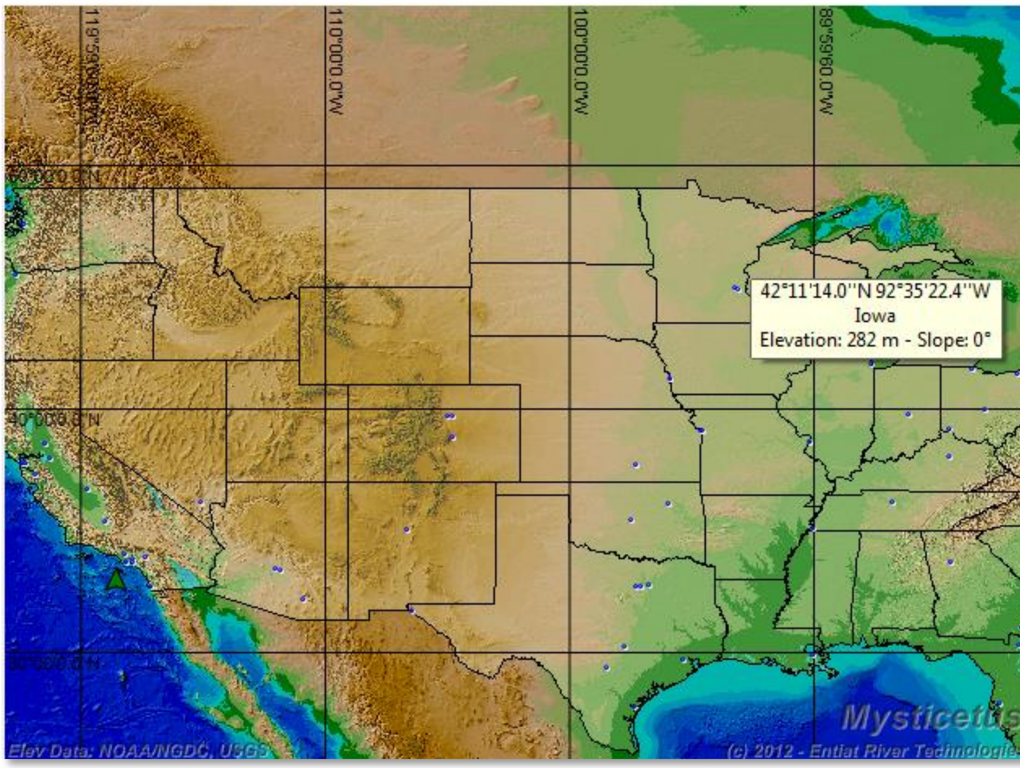
5.2 Shapefile Maps

You can use geo-referenced ESRI shapefiles as another mapping layer.

5.2.1 Overview

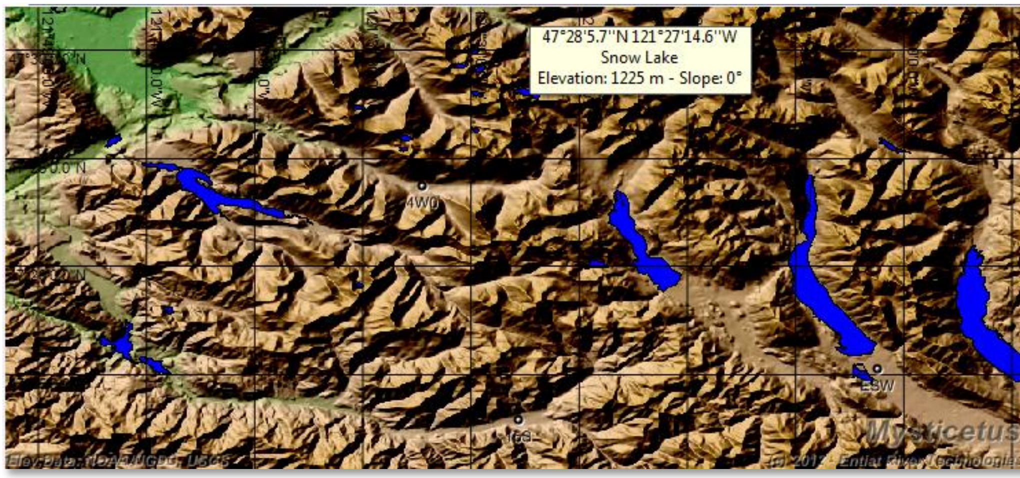
ESRI Shapefiles can also be displayed in Mysticetus as maps, provided the shapefile is geo-referenced to WGS84 coordinates (latitude/longitude). Unfortunately, some shapefiles simply use rectangular coordinates that Mysticetus cannot map to the earth, but for those that are geo-referenced, Mysticetus will overlay them on top of the bathymetry / topography.

Here is a United States shapefile over North America. If the shapefile has information about the geo-polygons within (such as state names), Mysticetus will display that if you hover your mouse over an area (such as Iowa, in this case).



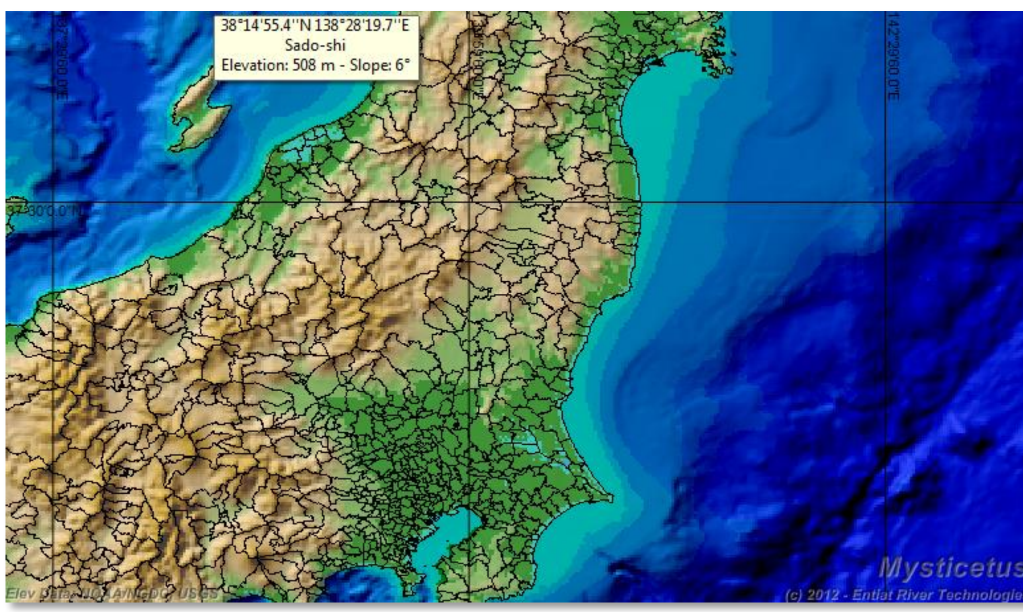
For another example, consider the following area in the Cascade Mountains of Washington state:

Now see what happens when a shapefile containing lake outlines is displayed (this shapefile was found at the Washington State Department of Ecology's website):



As usual, you can point at a feature and Mysticetus will tell you what it is if that data is embedded in the shapefile. All of these are controlled via the Layer Display dialog discussed in the previous section.

As a final note, shapefiles have been around for a long time and are available for regions around the world. The following shapefile was found at a Japanese language site and blindly downloaded (shapefiles cannot contain viruses). Turns out it was a set of Japanese city/state boundaries:



Pro Tip: Unlike bathymetry / topography data, shapefiles are relatively small in size and do not generally need to be pre-unzippped. Let Mysticetus do that for you on the fly.

5.2.2 Download and Configuration

Shapefile maps can be downloaded from a million different sources around the internet. As previously noted, some of them are not geo-referenced and will not load into Mysticetus. Your best bet is to simply try.

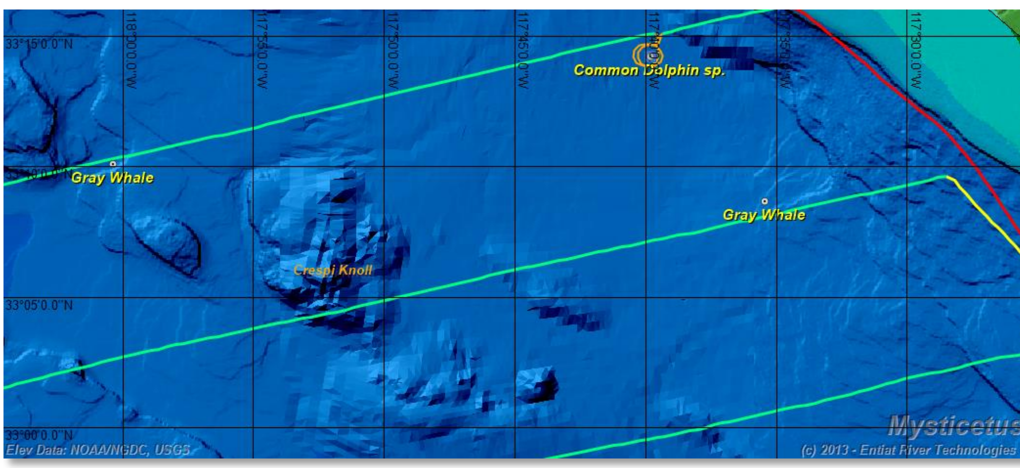
The shapefiles can be zipped (or tar.gz'd) or not. Place the file (or set of files) in a folder somewhere under [DOCUMENTS]\Mysticetus\Maps, where [DOCUMENTS] is your documents folder (this is typically something like C:\users\YourNameHere\Documents).

Thus a good place to put MyShapefile.zip would be in c:\users\dave\Documents\Mysticetus\Maps\MyShapefile\Myshapefile.zip.

Mysticetus searches the Maps subfolder (under [DOCUMENTS]\Mysticetus) and attempts to load all shapefiles, zipped or not, it finds.

5.3 Geo-Spatial Objects

Geo-Spatial objects round out the mapping features. They are things drawn on top of the bathymetry, such as routes, waypoints / sightings, polygons, GPS tracklines, bearing lines, and so on.

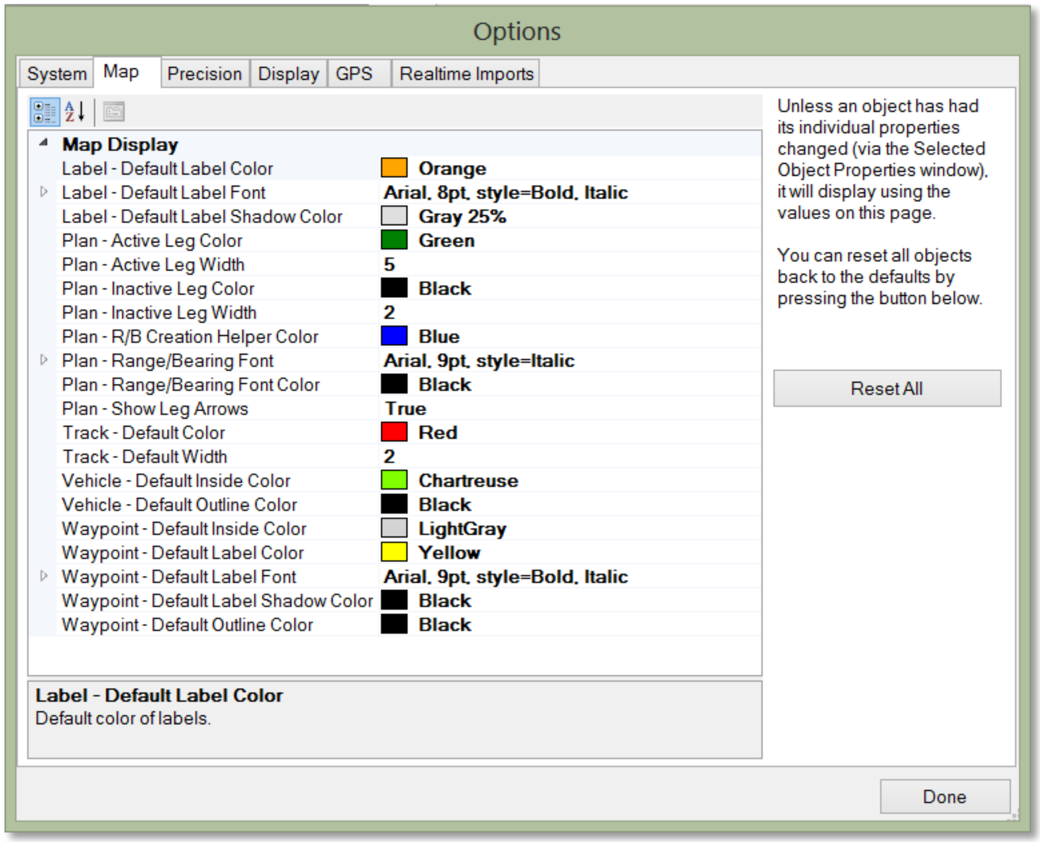


The above picture shows some sightings (which are automatically recorded in the mapping system as waypoints) and a GPS trackline, colored by effort (see *section 5.3.9 - Track line Coloring*). In this case, systematic legs are green, connector legs are yellow, circling legs are orange, and all else (transit, off-effort, etc.) are red.

All of these options (fonts, colors, line widths, etc.) are controllable via the System Settings.

5.3.1 Configuration

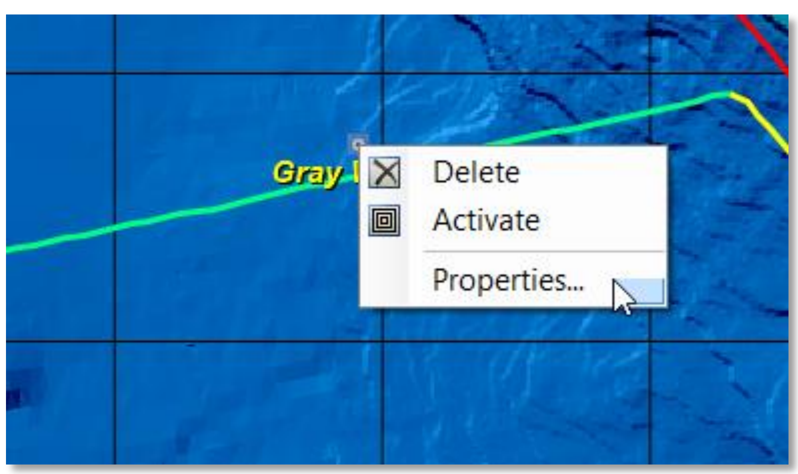
The colors, widths and icons displayed for various objects in the system is controlled via the ***Configuration -> System Options -> Map*** menu item:



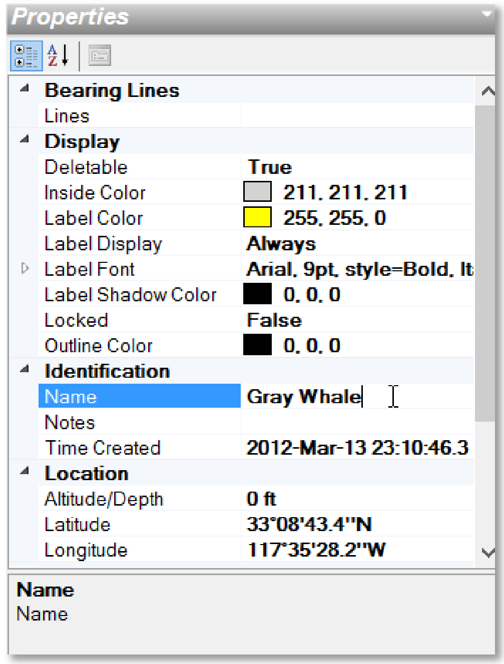
Waypoint fonts, Plan Colors, Track Colors, Line Widths, etc. are (almost) all controlled here.

The exception is Trackline Effort Leg configuration – if enabled, it is controlled as describe in *section 5.3.9 - Track line Coloring*. If Track line coloring based on effort is not enabled, then all GPS tracklines are set here as well.

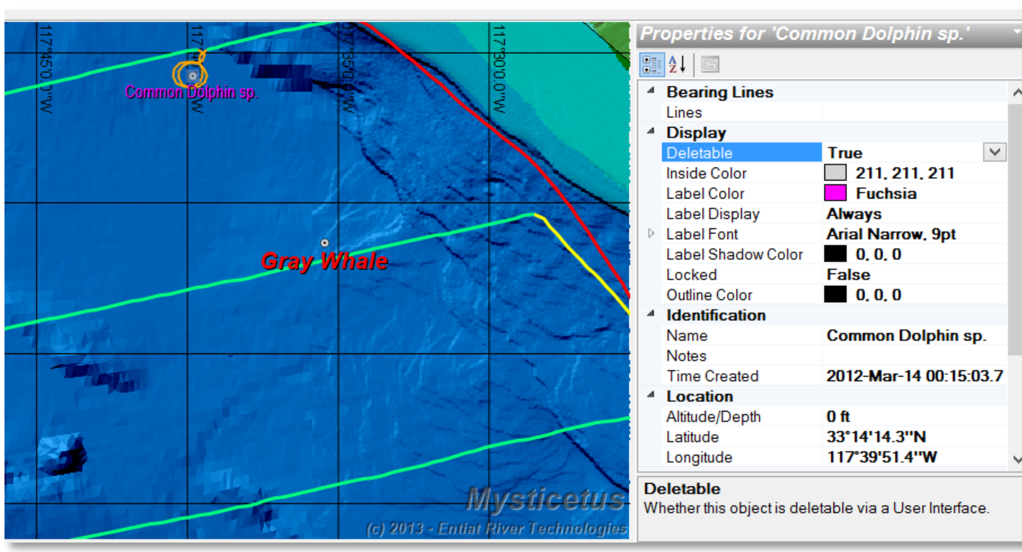
Note that individual components on the map can be configured separately from the defaults by right clicking on them and choosing “Properties…”.



This brings up a Properties window for the selected object where its individual characteristics can be altered:

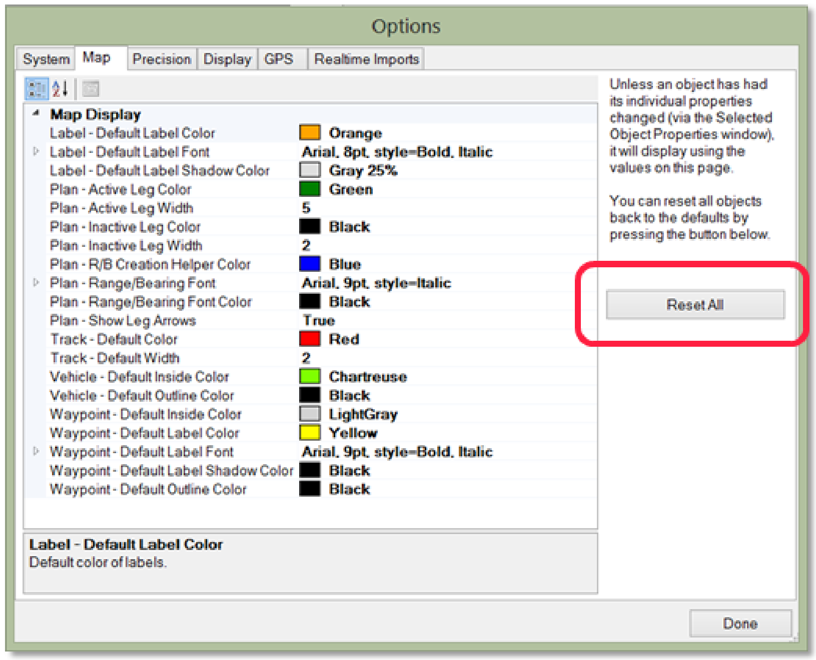


Different objects can have widely differing individual settings. In this example, the Gray Whale has been told to display in a larger Red font, while the Common Dolphin has been told to display with a smaller, Fuschia-colored font.

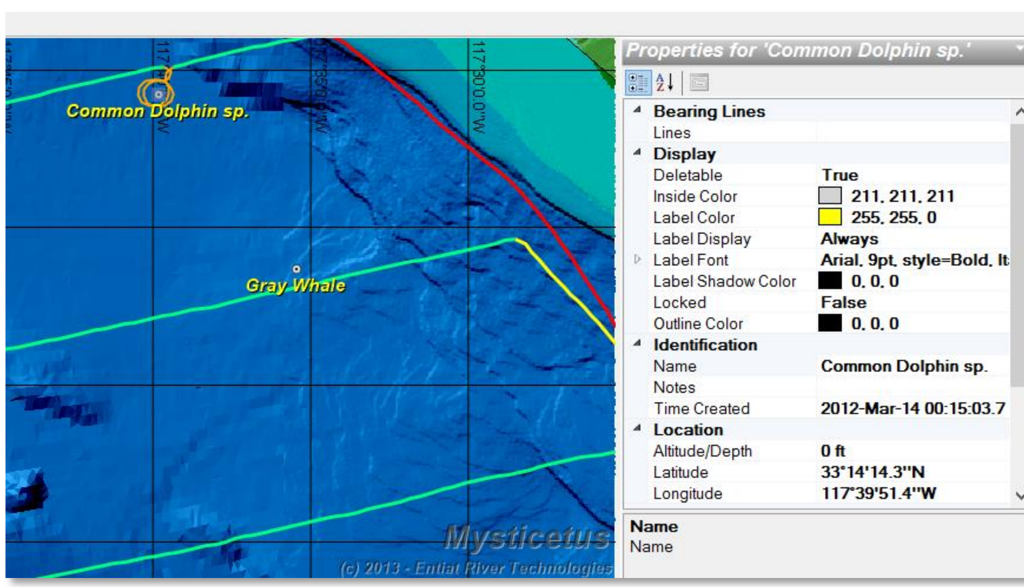


All objects, including Vehicles (aircraft, vessels), planned routes, waypoints, and polygons can be individually controlled by right clicking and choosing to bring up their Properties window.

Back in the Map Options, clicking on the Reset All button resets all Geo-Spatial objects to their defaults as specified on that page:



Leads to



5.3.2 Importing from Google Earth

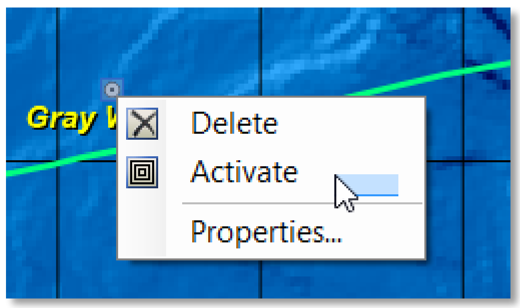
If you already have objects created in Google Earth, they can be easily imported via ***Data -> Import -> From Google Earth***. Plans (Google Earth "Paths"), Waypoints (Google Earth "Places") and Polygons will import to the equivalent Mysticetus geo-spatial objects. See *Chapter 8 - Data Import* for more details on this method.

5.3.3 Manual Creation

Although many objects, such as tracklines, sightings (as waypoints), and vehicles (vessels, aircraft) are created automatically by Mysticetus as events unfold, some are left for the user to create (or Import from sources such as Google Earth or Shapefiles, see *Chapter 8 - Data Import*). In particular, Plans (intended Routes), standalone Waypoints, and Polygons are created by selecting the appropriate toolbar button on the left side of the map window:

5.3.4 Activation (Plans, Waypoints/Sightings)

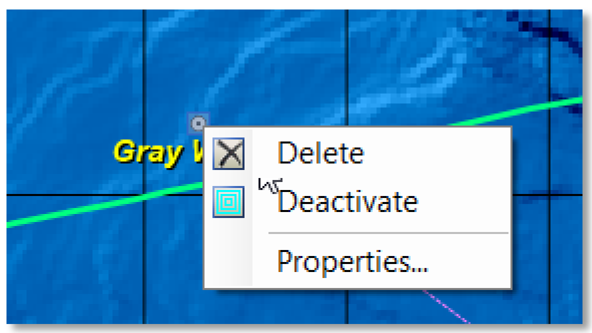
Plans and Waypoints (Sightings) can be activated by right clicking on them and choosing "Activate"



Mysticetus will draw a line from the active vehicle (vessel/aircraft) to the active waypoint and keep that updated at all times. In addition, the real-time navigation panel on the right side will be updated. Waypoints can also be activated by selecting them from the real-time navigation panel:

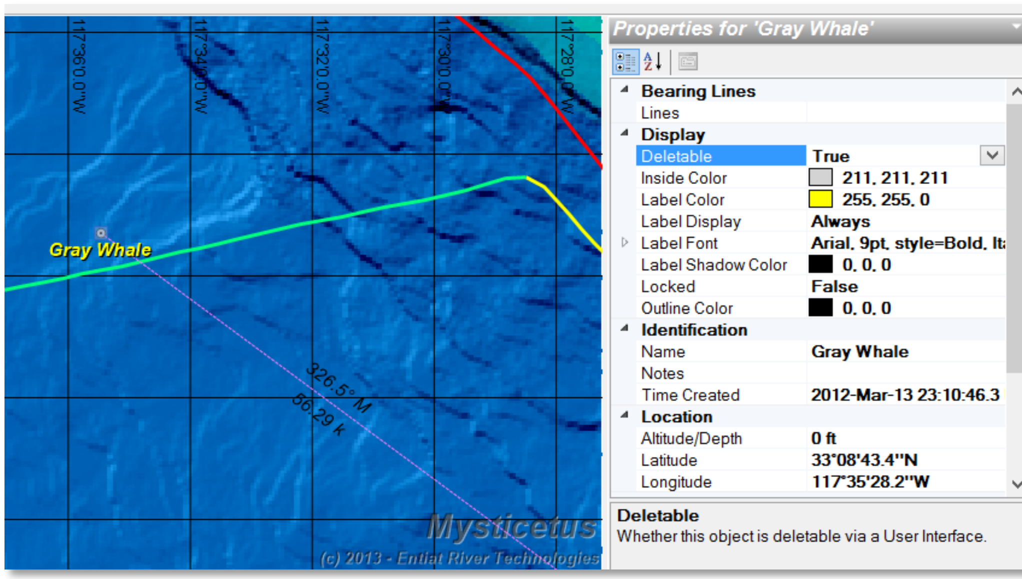
5.3.5 Deletion

All objects (Plans, Waypoints/Sightings, Tracks, Polygons) can be deleted by right clicking on them a choosing Delete.



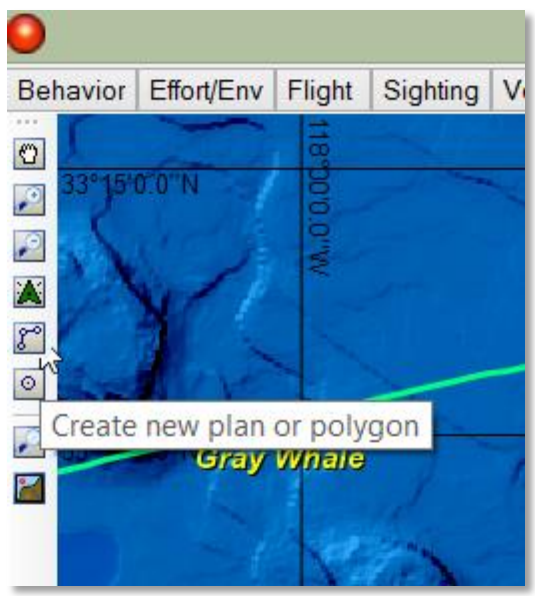
Note that some objects are marked as "Not Deletable". To see (or change) this setting, right click on the object, choose Properties… and then check the Properties window for the "Deletable" setting:

s



5.3.6 Plans (Intended Routes)

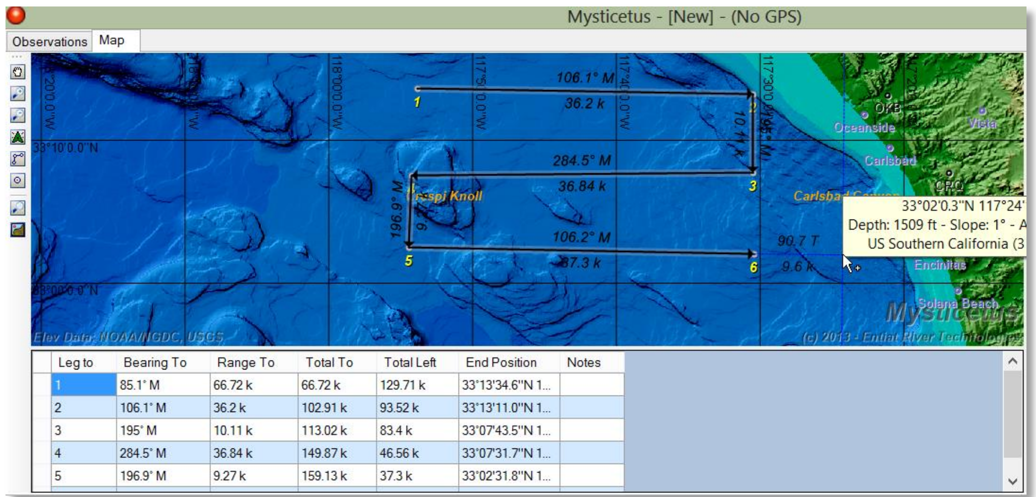
Plans (aka intended Routes) are created by clicking the Create New Plan or Polygon button in the map window:



Pro Tip: The size of the Planning window, just like everything else in Mysticetus, can be changed by clicking on the "splitter" between it and the map window, and dragging it to whatever size you want.

Select Create New Plan, and start clicking on the map. Each time you click a new Waypoint will be added to the Plan. Stop adding waypoints by either right clicking, or by pressing the Escape key on your keyboard.

While creating or editing a plan (left click on an existing plan in the map window to edit it), the Planning window will be visible inside the map Window.

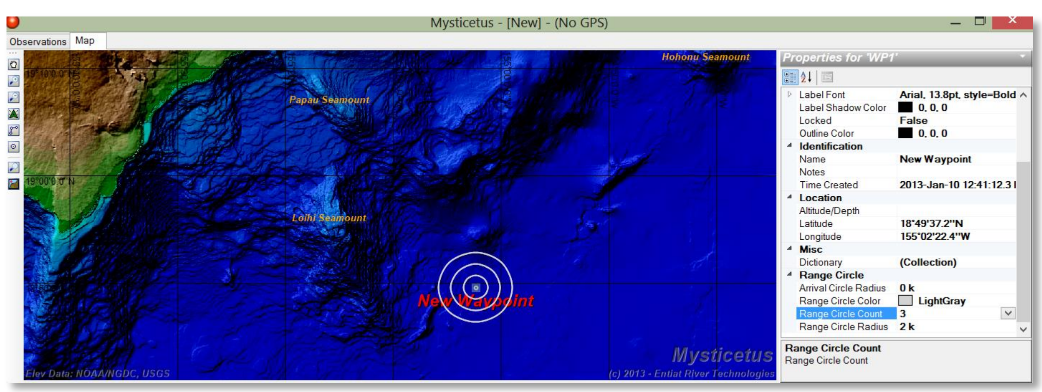


This window provides all sorts of good information about your Plan, range and bearing between waypoints, and so on. If your waypoint isn't in the exact correct location, you can edit the "End Position" cell to perfectly position it.

After a Plan has been created, the individual waypoints within the Plan can be dragged to new locations – the plan (and Planning Window) will be updated with the new information.

5.3.7 Waypoints

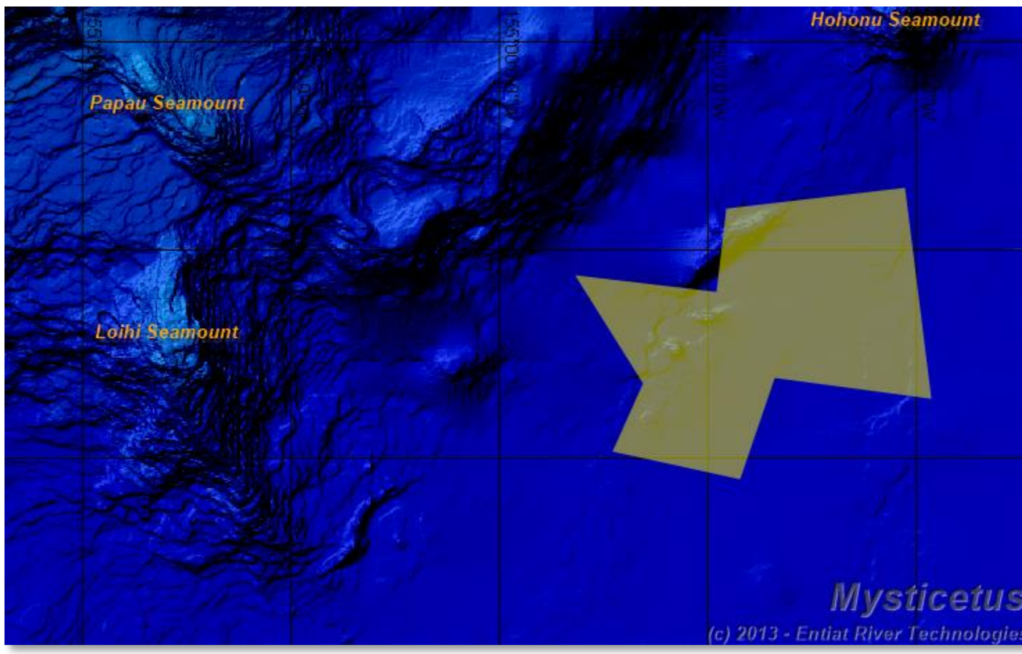
Individual waypoints can be created by clicking the New Waypoint button and then clicking on the map where you want the waypoint to be positioned. As with all objects, you can right click on the newly created waypoint, choose "Properties…" and edit things such as the precise location, label color and font, size and number of range circles, and so on:



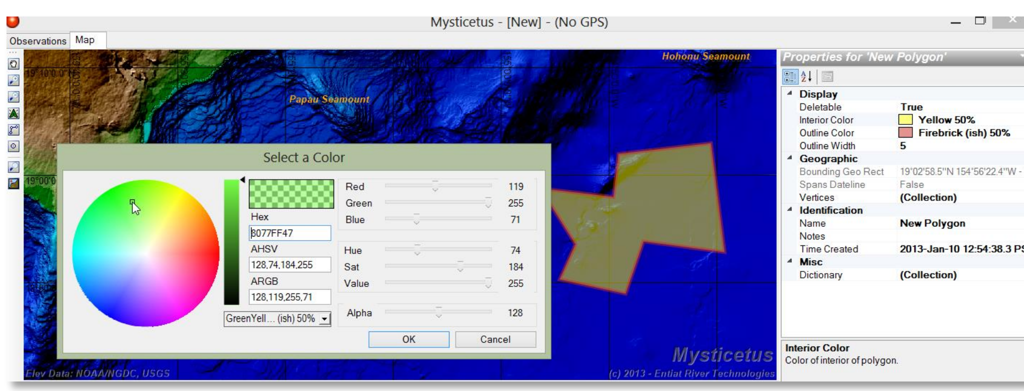
As mentioned in *section 5.3.4 - Activation (Plans, Waypoints/Sightings)*, waypoints can then be activated and a large amount of navigation information about range, bearing, time-to-go, and so on will be displayed.

5.3.8 Polygons

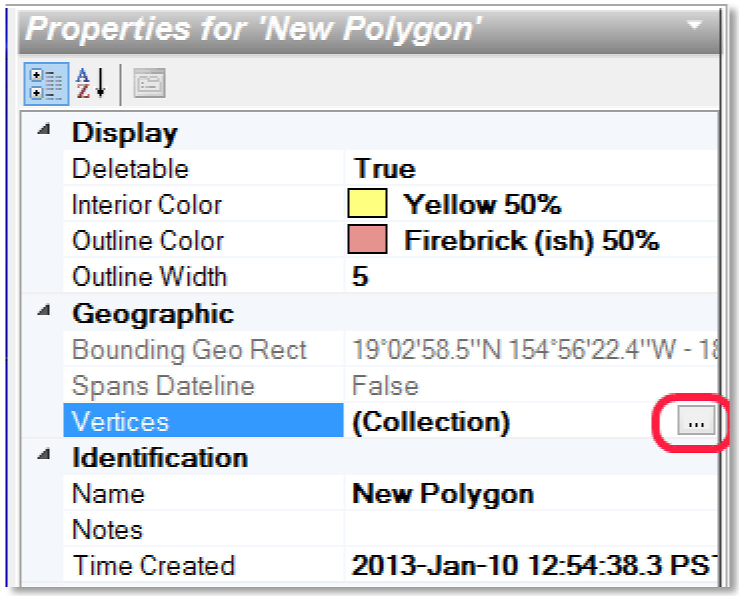
Polygons provide a method for delineating geographical regions. When coupled with the Inside formula (see *section 4.1.11*), Mysticetus can automatically calculate which, if any sightings are inside any of the Polygons in the system. Polygons are created by selecting the Create New Plan or Polygon button, and choosing Polygon. Then start clicking the points. After you have entered 3 or more points, Mysticetus will start drawing a polygon composed of those points:



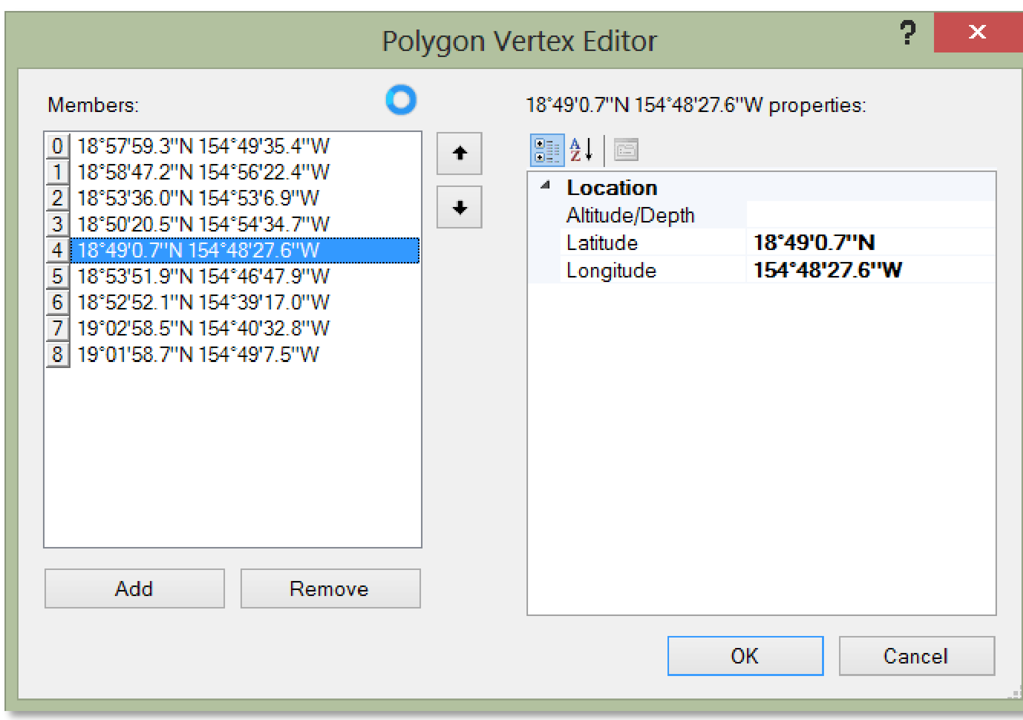
When finished, you can edit the various properties of the Polygon, including colors, transparency levels, and the details of the points, by right clicking on the Polygon and choosing "Properties..."



The vertices can be fine-tuned in the Polygon Vertex Editor. Select the ellipses next to the Vertices in the Polygon Properties:



And the vertex editor will pop up, where you can add, delete or precisely position any vertex in the Polygon.

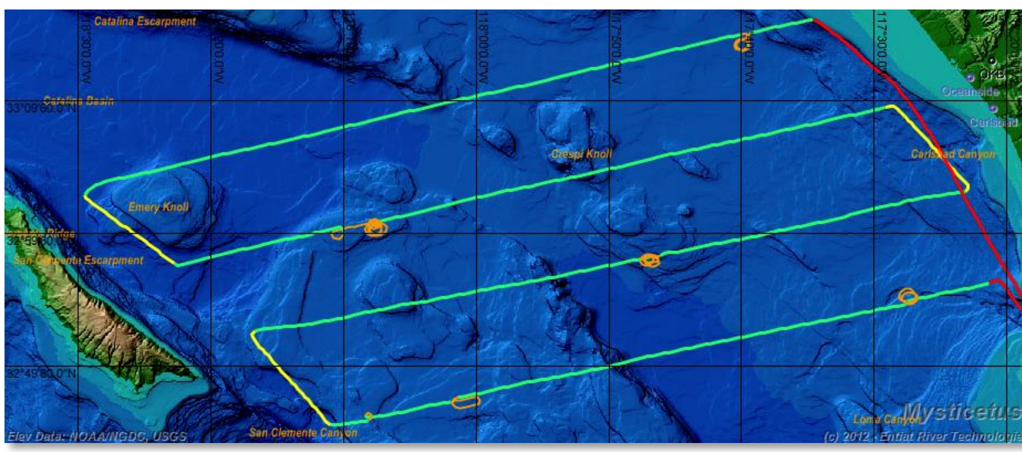


5.3.9 Track line Coloring

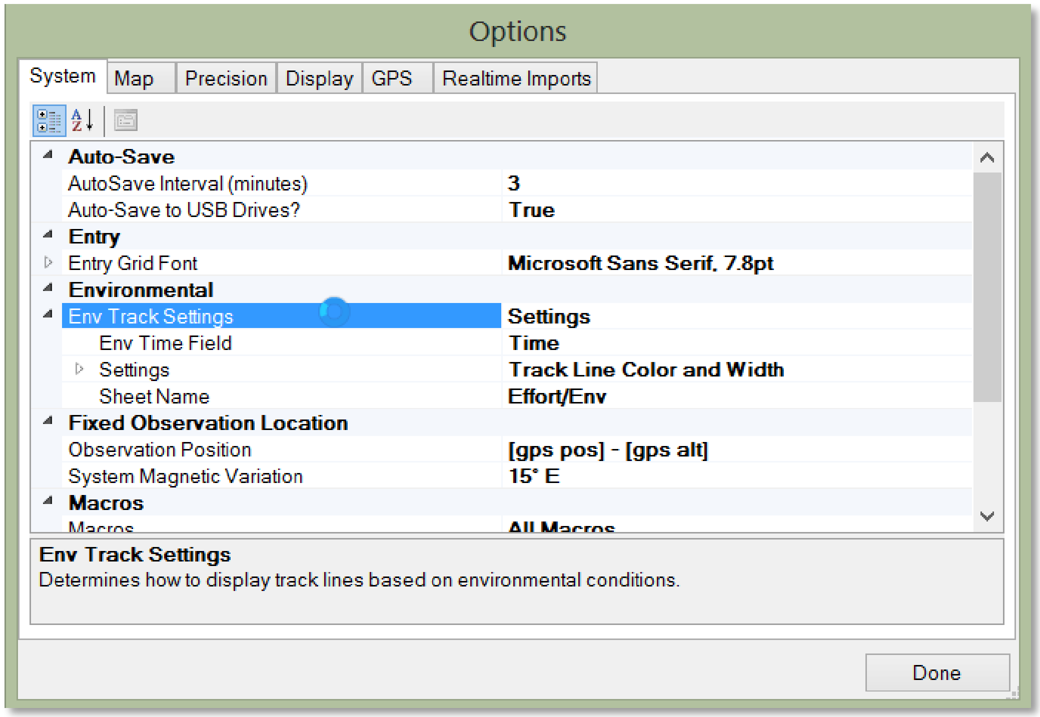
This relatively simple feature turns out to be one of the more useful tools in the application. With one glance you can see information chronologically spaced across an entire survey. And, while in the field, your data recorder can, in an instant, see possible data entry errors (for example, they forgot to note you went from a Systematic leg to a Circling leg). This feature brings these situations (and more) immediately to the screen.

GPS Track lines can either be a single color (controlled globally via ***Configure -> System Options -> Map***, or via the individual Track's Properties), or the track can be colored to match ongoing information in an entry sheet. Typically, this is Environmental information, such as which survey leg type is being traversed, or perhaps the current Beaufort Sea State. However, since Track Line Coloring is configurable based on any information in the sighting sheets, it could theoretically be used to display track lines based on which sighting was most recent.

Here is an example of a trackline colored based on survey leg type:



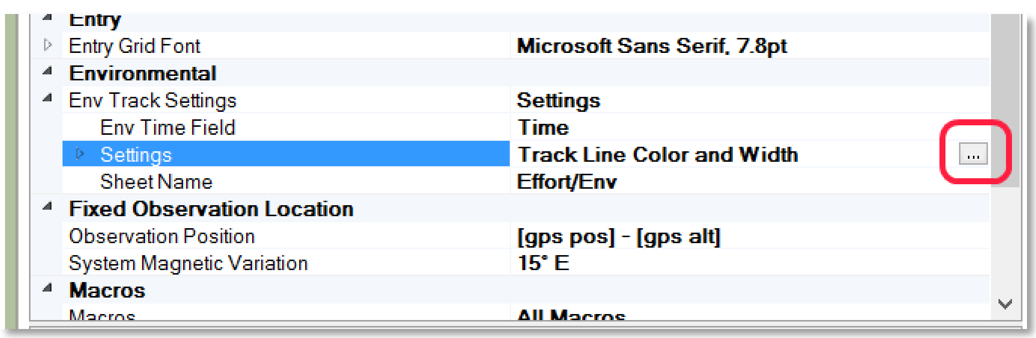
In this example from an aerial survey, Red indicates a transit or overland leg, Green indicates a Systematic leg, Yellow is a Connector and light Orange is Circling. Colors and line widths are configured by going to the System Options (***Configure -> System Options***), and expanding the Environment Track Settings entries:



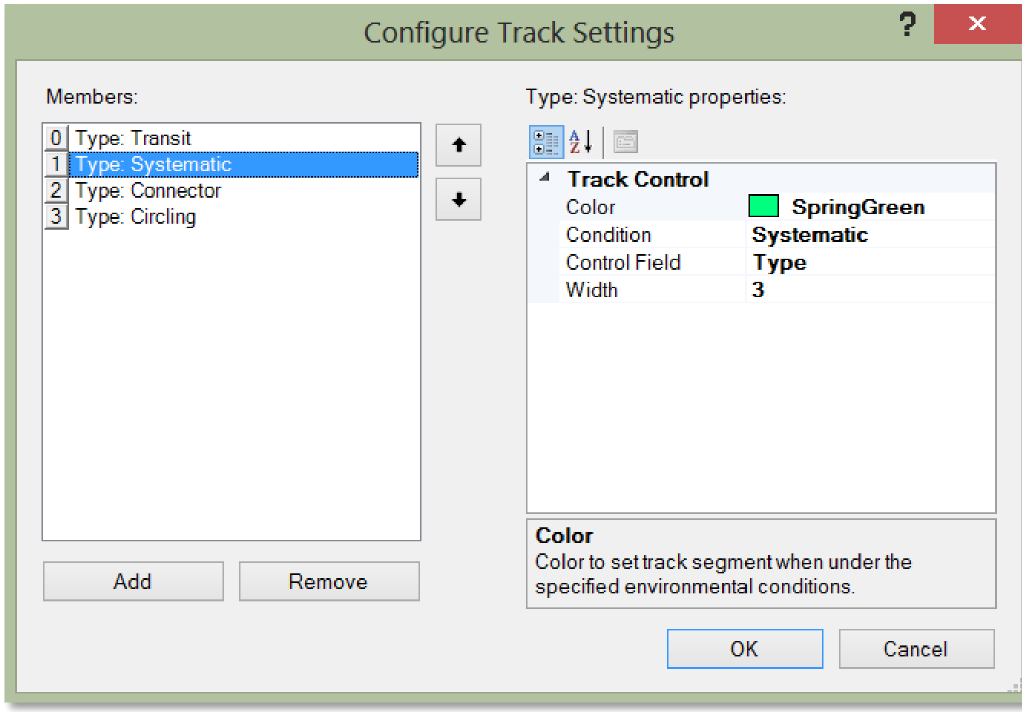
First, set the Sheet Name where the entry data is to be found. In this case, it is set to "Effort/Env".

Next, set the Time Field. In order to color the Track Line, Mysticetus needs to know how to match up the rows in the entry sheet with recorded track marks – this field does that. In this example, that field is simply named, "Time".

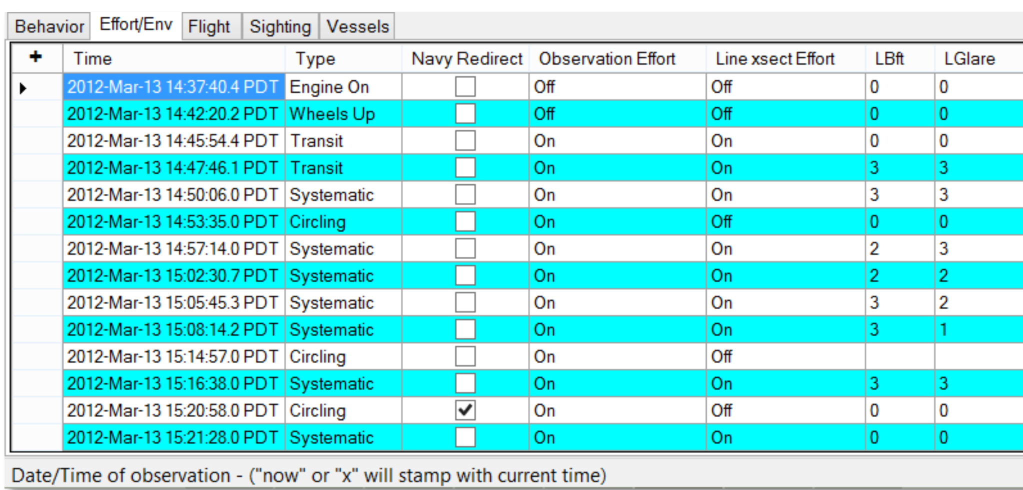
Select the Settings row and some ellipses will appear; click on those:



And the Configure Track Settings dialog will appear:



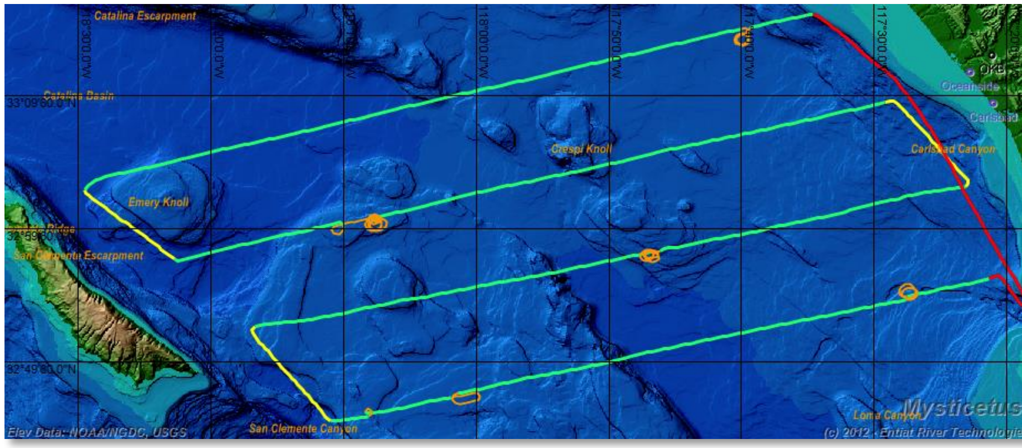
In here you control which fields will determine which colors (and widths) the trackline displays for various conditions. In this example, Mysticetus will match up the Type field with Transit, Systematic, Connector and Circling and set the colors as specified. You can, of course, choose different fields and different Conditions (and different colors, and different line widths). Here is part of the example Effort/Env sheet that drives the initial trackline image we saw earlier:



Time	Type	Navy Redirect	Observation Effort	Line xsect Effort	LBft	LGlare
2012-Mar-13 14:37:40.4 PDT	Engine On	☐	Off	Off	0	0
2012-Mar-13 14:42:20.2 PDT	Wheels Up	☐	Off	Off	0	0
2012-Mar-13 14:45:54.4 PDT	Transit	☐	On	On	0	0
2012-Mar-13 14:47:46.1 PDT	Transit	☐	On	On	3	3
2012-Mar-13 14:50:06.0 PDT	Systematic	☐	On	On	3	3
2012-Mar-13 14:53:35.0 PDT	Circling	☐	On	Off	0	0
2012-Mar-13 14:57:14.0 PDT	Systematic	☐	On	On	2	3
2012-Mar-13 15:02:30.7 PDT	Systematic	☐	On	On	2	2
2012-Mar-13 15:05:45.3 PDT	Systematic	☐	On	On	3	2
2012-Mar-13 15:08:14.2 PDT	Systematic	☐	On	On	3	1
2012-Mar-13 15:14:57.0 PDT	Circling	☐	On	Off		
2012-Mar-13 15:16:38.0 PDT	Systematic	☐	On	On	3	3
2012-Mar-13 15:20:58.0 PDT	Circling	☑	On	Off	0	0
2012-Mar-13 15:21:28.0 PDT	Systematic	☐	On	On	0	0

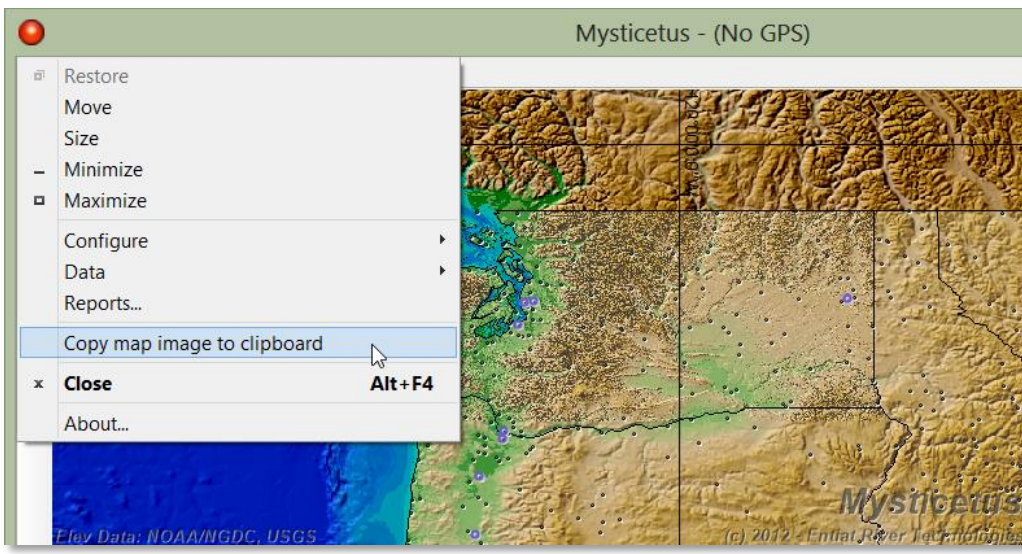
Date/Time of observation - ("now" or "x" will stamp with current time)

Of note, the "Time" field and "Type" field. As we configured it in this example, Mysticetus will scan through those fields to color the GPS track line



5.3.10 Copying a Map Image

One of the most useful features for creating presentations, or even just emailing information around, is the Copy Map Image to Clipboard menu item:

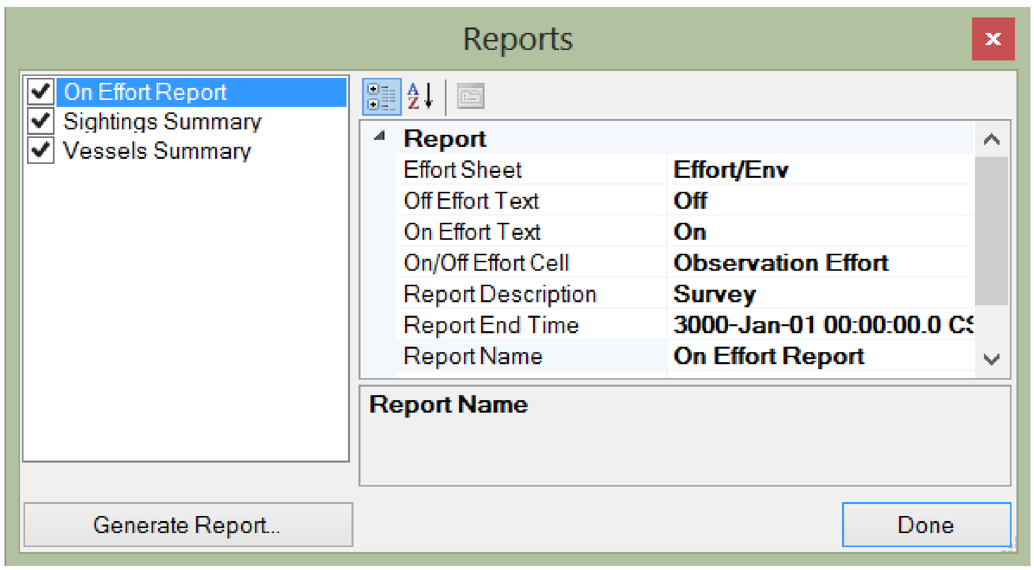


This will capture the contents of the Map Window, including all bathymetry, shapefile maps and geo-spatial objects (plans, GPS tracks, sightings, etc.) and copy it to the clipboard, where it can be pasted into any other Windows application.

6 Reports

Mysticetus provides a powerful suite of automatically-generated reports. You control what is output, you control where the input fields come from. You send an invoice for many, many hours of grunt work that Mysticetus did for you – and go hiking instead.

Reports are generated in Mysticetus by selecting the "Reports…" menu item.



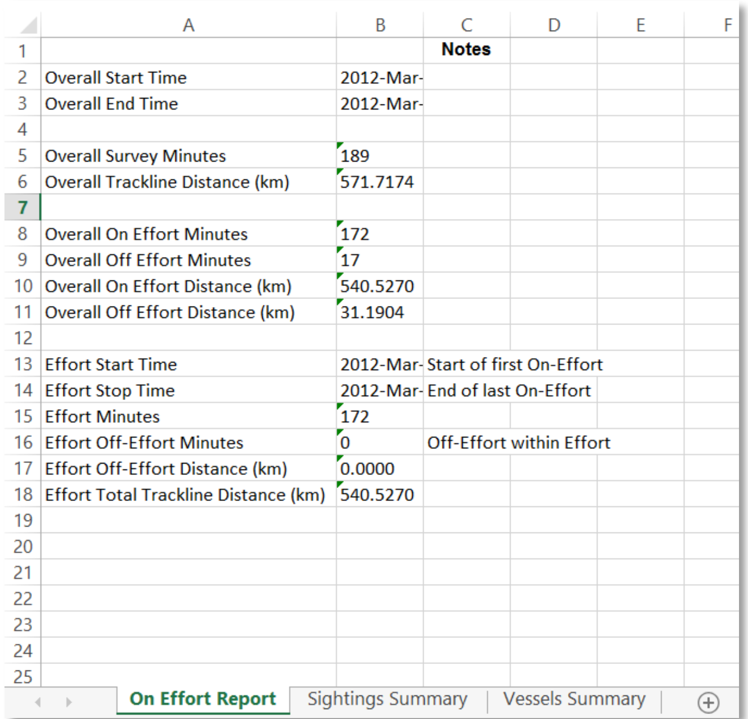
6.1 Report Types

There are three types of reports that can be generated:

- On Effort Report – details the times and distances spent On Effort over a survey.
- Sightings Summary – details the sightings counts, species and observers
- Vessels summary – details the other vessels recorded

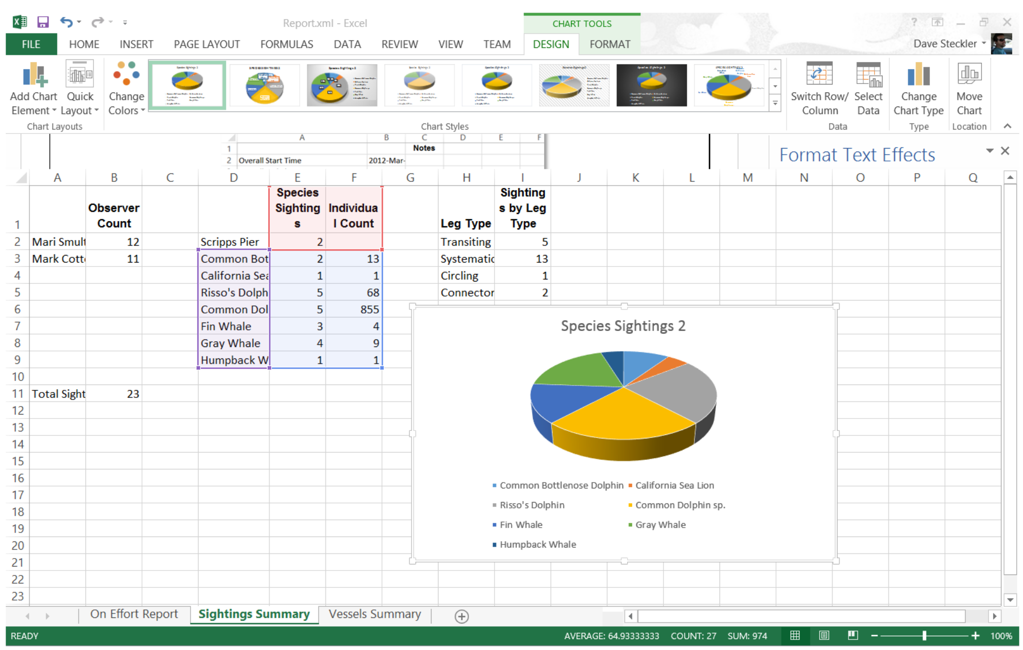
Assuming everything is configured correctly, check the reports you want to run, click Generate Report button, and an Excel XML file (a special type of Microsoft Excel file) will be generated, with a tab for each report type.

If Microsoft Excel is installed on the machine, Mysticetus will attempt to launch the report in Excel:



	A	B	C	D	E	F
1			Notes			
2	Overall Start Time	2012-Mar-				
3	Overall End Time	2012-Mar-				
4						
5	Overall Survey Minutes	189				
6	Overall Trackline Distance (km)	571.7174				
7						
8	Overall On Effort Minutes	172				
9	Overall Off Effort Minutes	17				
10	Overall On Effort Distance (km)	540.5270				
11	Overall Off Effort Distance (km)	31.1904				
12						
13	Effort Start Time	2012-Mar-	Start of first On-Effort			
14	Effort Stop Time	2012-Mar-	End of last On-Effort			
15	Effort Minutes	172				
16	Effort Off-Effort Minutes	0	Off-Effort within Effort			
17	Effort Off-Effort Distance (km)	0.0000				
18	Effort Total Trackline Distance (km)	540.5270				
19						
20						
21						
22						
23						
24						
25						

At this point, you can easily "spruce up" the report with graphs if you like (or perhaps insert a screen shot, as described in *section 5.3.10 - Copying a Map Image*). Simply select the cells in the spreadsheet and select Insert 3D Pie Chart (or whatever chart you want). In the following example, the Sighting and Species Count cells are charted.

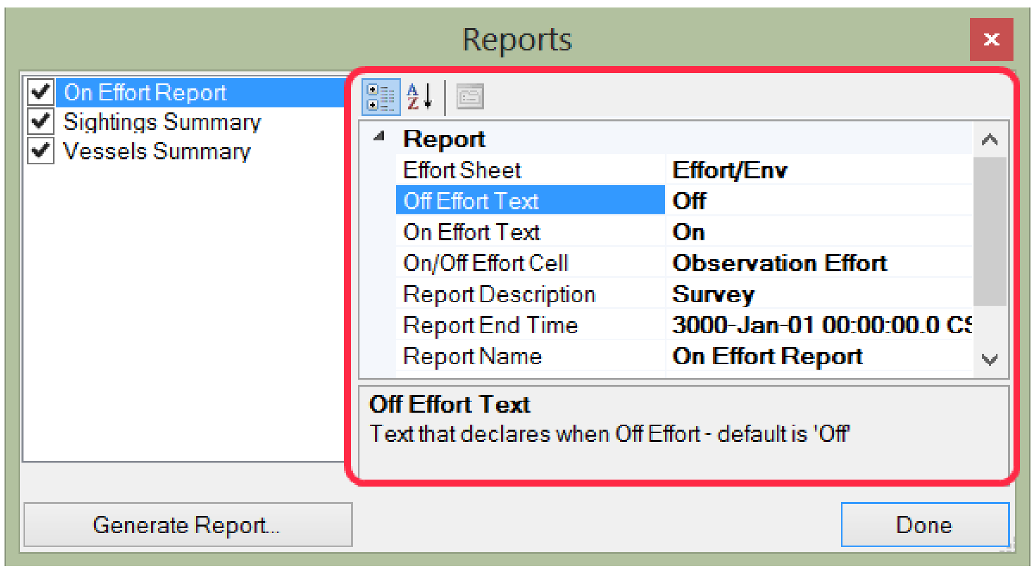


6.2 Report File Type

Since Mysticetus creates reports using Excel XML, the default file extension is XML – the default report name is Report.xml. When you save your edited report (with charts, screenshots, etc.) you should save it as an Excel Workbook (for example, report.xlsx).

6.3 Report Configuration

Like most things in Mysticetus, reports are highly configurable in terms of the fields they key off of. For the reports to work properly, Mysticetus needs to know which fields to draw information from. In the main report dialog, this information is contained on the right side for each report. Select the report you are configuring, and make sure all the cell names are correct for your setup. Mysticetus starts with some defaults that apply to the Sample.Mysticetus file found on the Mysticetus website (http://www.mysticetus.com/downloads). If your entry sheets have different names, or differently named fields, you will need to update these configuration values to match.

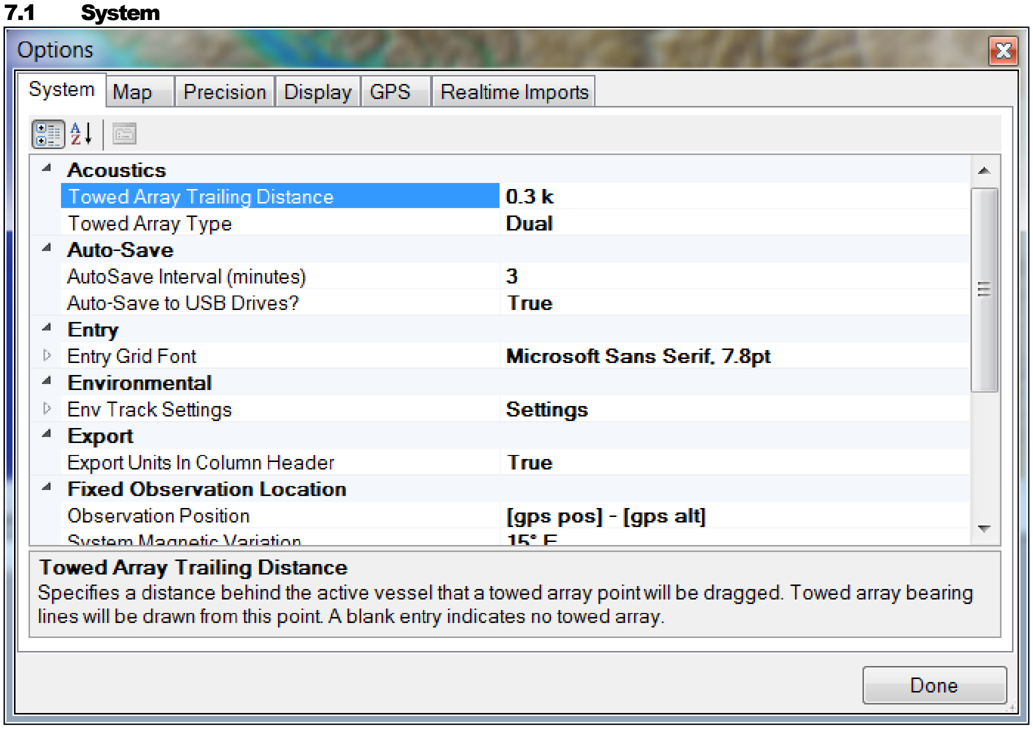


7 System Options

Here is where we provide some fine grained control over a host of things ranging from display settings, GPS interfaces and simulators, reticle settings and so on. This is important. Read this section.

The System Options dialog configures just about everything in Mysticetus. It is composed of a number of tabs, each of which controls a different aspect of the Mysticetus system:

7.1 System



The System tab controls a number of fairly disparate options. These either apply to the system at-large, or simply didn't have another good place to live (i.e. they could be filed under "Miscellaneous Options").

7.1.1 Towed Array Trailing Distance

Distance behind the vessel a towed array is located. As with any field in Mysticetus, this can be specified using any units ("300 m", "0.3 k", etc.). See *Chapter 12 - Acoustics* for more information on acoustics.

7.1.2 Towed Array Type

Type of array being towed, None indicates no array. This impacts the map information automatically entered when a TowedArrayBearing formula is invoked as the result of an acoustic bearing received or entered. For example, whether a single bearing line or dual bearing line (in the case of directional ambiguity) is created on the map.

See *Section 4.1.21 - TowedArrayBearing* for more information on how the formula interacts with acoustics bearing information. See *Chapter 12 - Acoustics* for more information on acoustics in Mysticetus, including how to set up automatic reception of bearing information from programs such as *Ishmael*.

7.1.3 Auto-Save Interval

Sets the interval at which Mysticetus will auto-save a copy of the current data. The auto-saved file is named ~AutomaticBackup.Mysticetus. Each time Mysticetus starts it looks for this file and, if found, Mysticetus will prompt to save the data (under the assumption that something crashed the last time the program was run, perhaps a battery died, a power button was erroneously pressed, etc.).

Setting this to -1 will disable auto-saving.

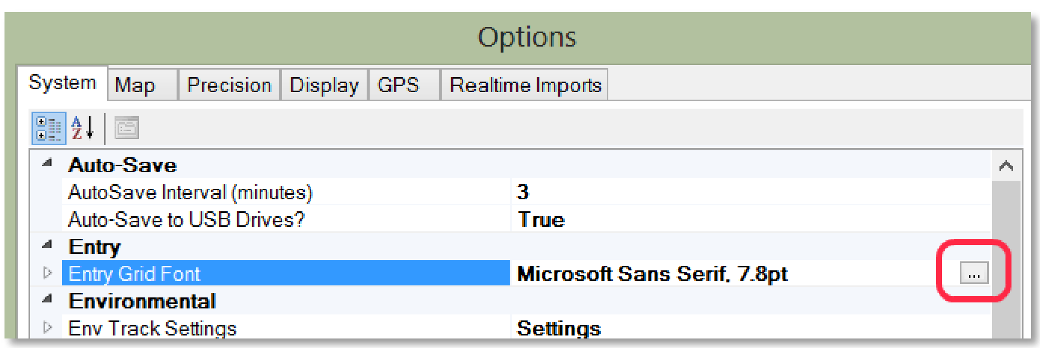
7.1.4 Auto-Save to USB Drives

Whether or not to make a copy of the Auto-Save to all attached USB drives. If True, each time Mysticetus Auto-Saves, it will also write a copy of the current data to any attached USB drives. This serves as another layer of data protection – you quite literally never know when a computer's hard drive will fail, it could happen ***now***…or ***now***…or ***next week***…

This option allows you to recover your data from the thumb drive when this happens.

7.1.5 Entry Grid Font

Selects the font used in the Entry Grid Sheets. Click on the ellipses to open the font selection dialog:



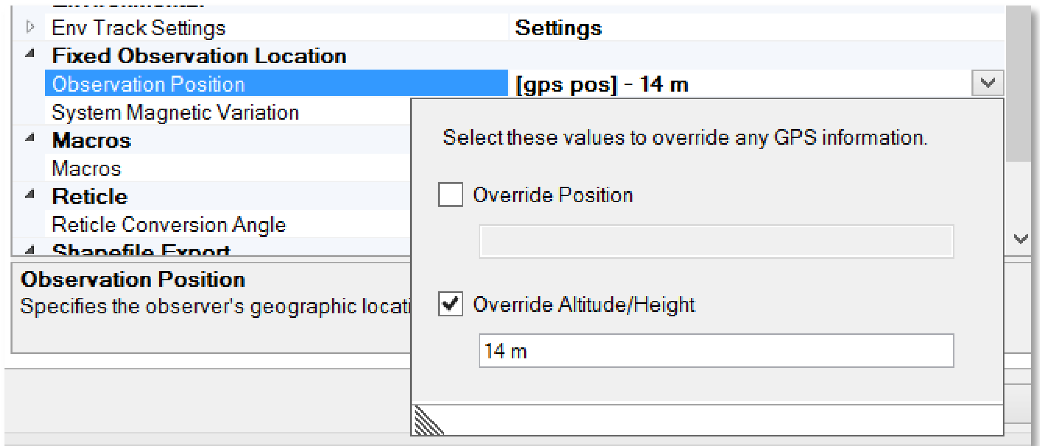
7.1.6 Env(ironmental) Track Settings

These options control GPS Track line coloring based on entry sheet data, especially targeted to Environmental conditions, but this can actually be based on any Timestamped entry sheet data.

This is discussed in detail in *section 5.3.9 - Track line Coloring*.

7.1.7 (Fixed) Observation Position

This opens the Fixed Observation Position control:



This control is used to specify overrides of any GPS information. You can specify a position override, a height override, or both.

The position override is useful for fixed location surveys (such as theodolite). The Altitude/Height override is useful for not only fixed location surveys, but also vessel surveys where the observation platform height above water is known (GPS altitude at those levels can be unreliable).

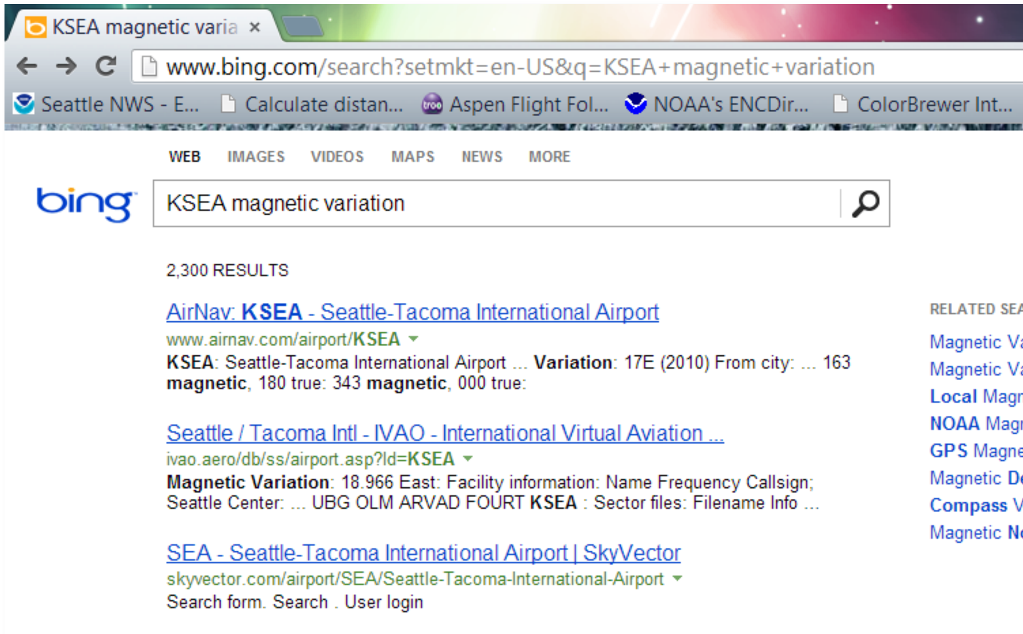
In the example above, Mysticetus will use the GPS position for its calculations, but will use 14 meters as the observer's altitude.

7.1.8 System Magnetic Variation

Pro Tip: It is critically IMPORTANT to set your magnetic variation here if your GPS does not output magnetic variation information.

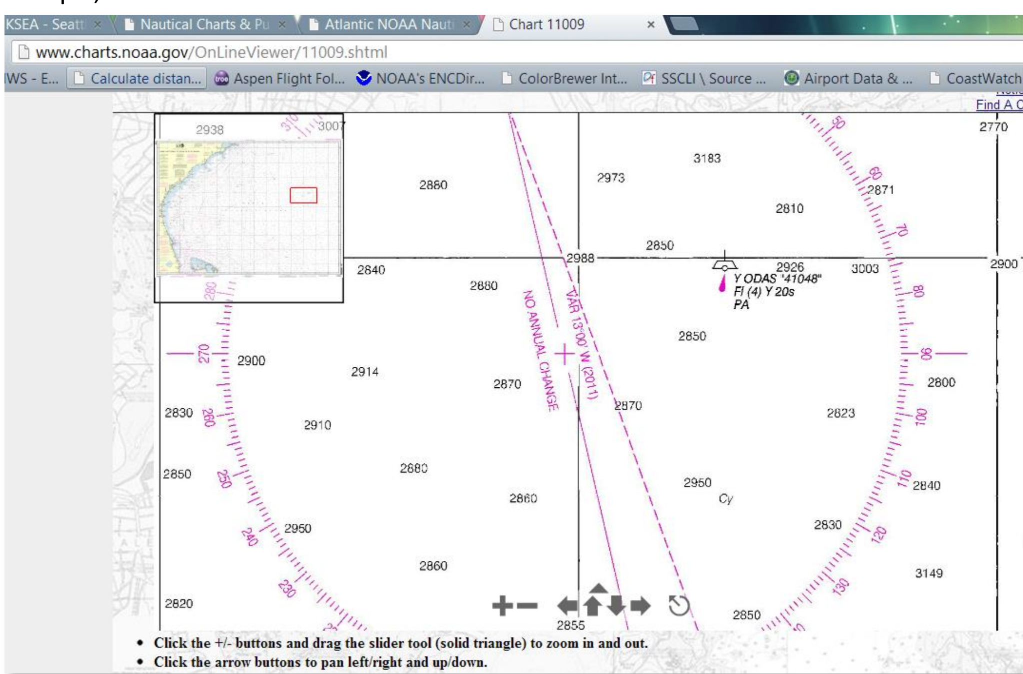
This sets the magnetic variation used throughout the system. While all internal calculations are performed using True values, Mysticetus can display bearings and headings in either True or Magnetic. This setting controls the Magnetic Variation in your area. It is of critical import to set this if your GPS does not communicate this to Mysticetus (most GPS's don't send this information, but check your GPS manual to be sure).

This value can be obtained from a number of different sources. One of the easiest ways is to do a web search (Google, Bing, etc.) for the variation at an airport near your survey area. For example, to learn the Magnetic Variation near Seattle, issue a web search such as "KSEA Magnetic Variation":



Right there in the first search result you can see the variation is 17E. That is, the magnetic north pole is 17 degrees to the east of true north at Sea-Tac airport.

You can also obtain magnetic variations from aviation maps or nautical navigation charts. For example, most NOAA nautical charts can be downloaded as images ("raster"), and they contain magnetic information. See http://www.charts.noaa.gov/OnlineViewer. Open a nautical chart of your area and look for the variation information in a compass rose. For example,



This shows a magnetic variation of 13.00 W for this locale.

Similarly, online aviation charts can be viewed at http://skyvector.com. Click on an airport and select the information about it and a page like the following will pop up. Magnetic variation is found in the Location Information panel:

7.1.9 Macros

Macros provide a useful way to reduce the number of keystrokes it takes to enter data. “Hot Keys” can be assigned to a sequence of events (such as data entry) and Mysticetus will repeat the sequence of events every time you press the Hot Key.

Macros are important enough to warrant their own chapter and are discussed in much more detail in *Chapter 10 - Macros*.

7.1.10 Reticle Conversion Angle

The reticle conversion angle is applied to Distance calculations when a reticle number is entered into an Angle cell. This value is only applied to Angle Cells.

See *section 2.3.9 - Angle* for more information about Angle cells.

See *section 2.5.3 - Angle Type* for how to set an Angle field to use Reticles.

7.1.11 (Shapefile) Environmental Fields to Export

If specified, this setting works with the Environmental Time Field (see next section) to determine which fields (if any) are associated with track lines when exporting to a Shapefile. If no fields are specified here, all the fields in the Environmental table will be exported to the attribute table in the shapefile, and associated with the appropriately timed track mark. Each entry in this field should be the name of a column in the Environmental table.

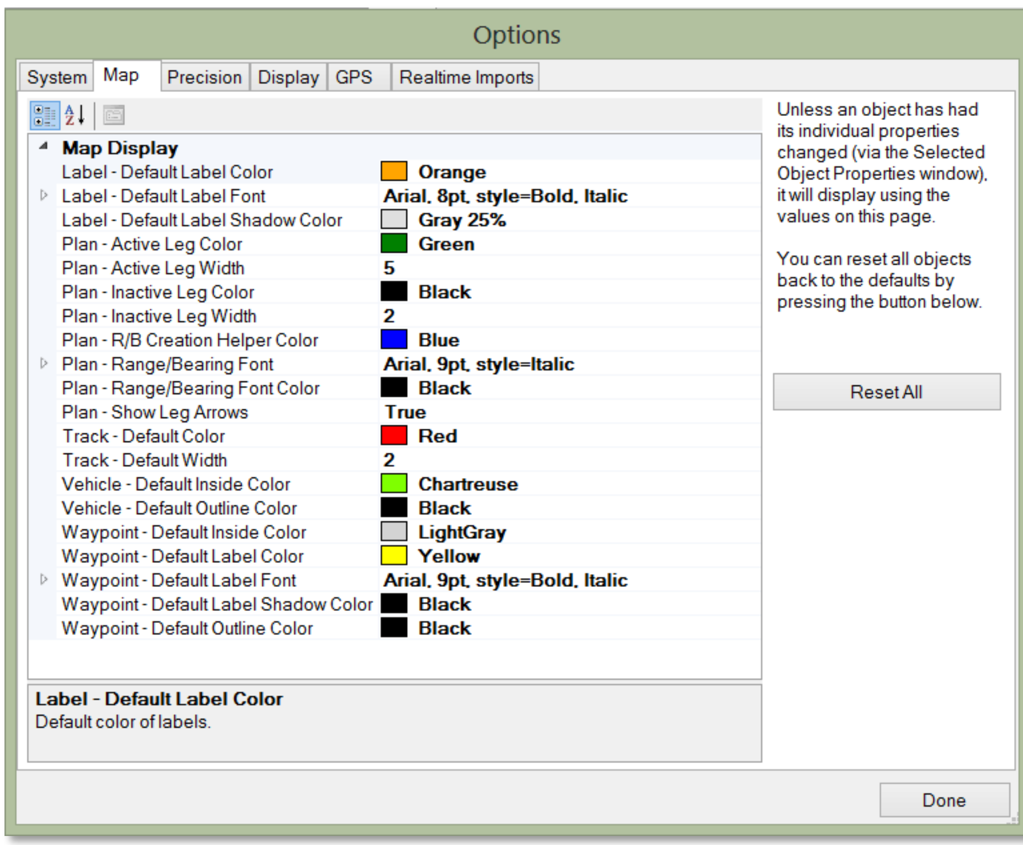
7.1.12 (Shapefile) Environmental Time Field

When exporting to a shapefile, this is the name of the sheet and the Time field within the sheet that will correlate Environmental entries with the GPS track marks. This is in the format **Sheet!TimeFieldName**. For example, **Effort/Env!Time** means to use the sheet named "Effort/Env" and the Time field is named "Time".

When exported to a shapefile, an entry will be created in the shapefile's attribute table for each GPS track mark, and the values in the attribute table will come from the appropriately timed entry in the Environment sheet.

7.2 Map

Map settings control how geo-spatial objects are displayed on the map.

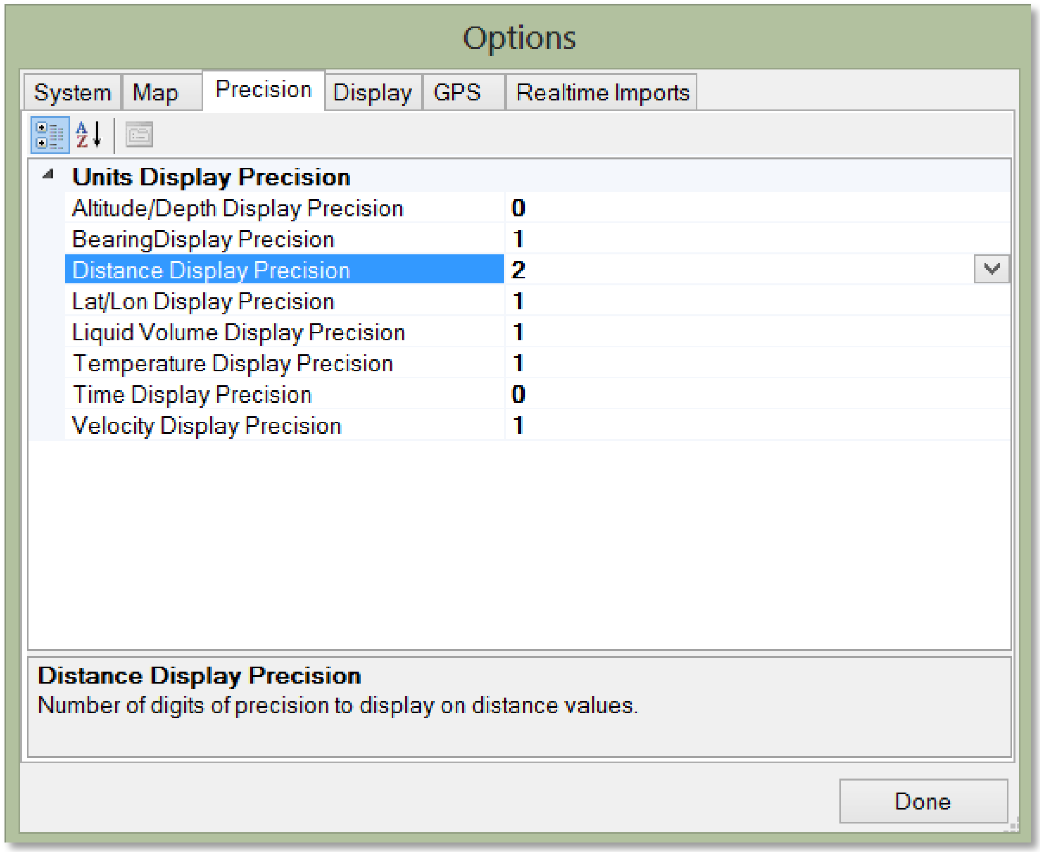


Note that individual objects can be configured separately from the system settings here (by right clicking on them in the map window and choosing "Properties..."). If you press Reset All, these individual settings will be replaced with the global system settings from this page.

7.3 Precision

The precision tab controls exactly how many digits of precision are displayed for certain data items:

Pro Tip: Mysticetus stores all data at the highest precision possible for the data type – these settings control how much of that precision is displayed.



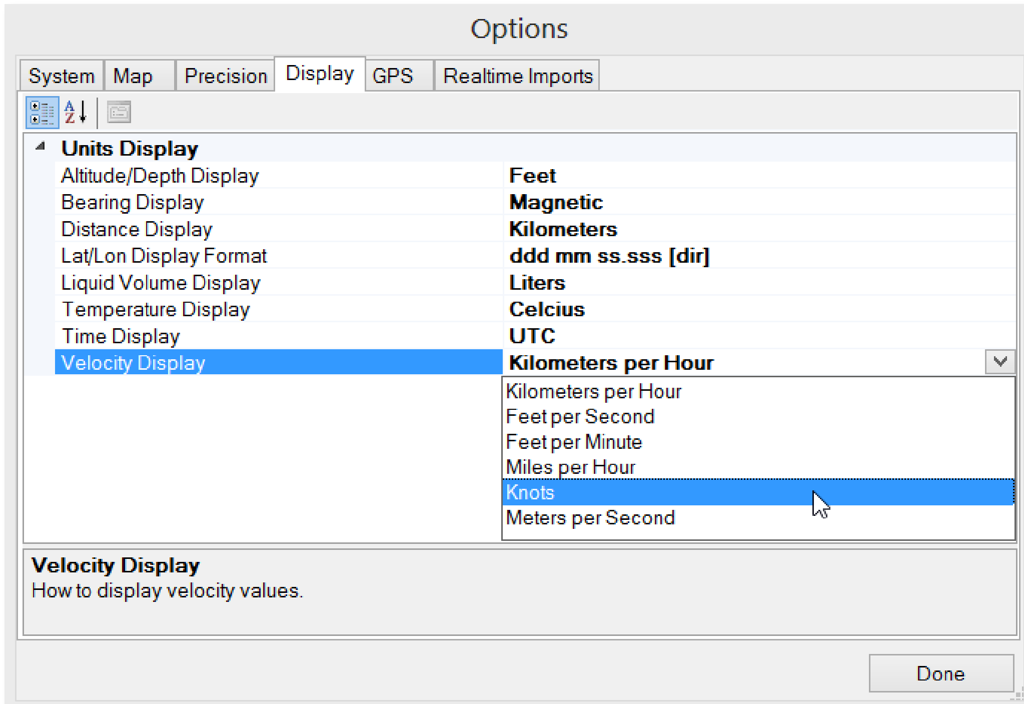
For example, a Distance Display Precision of 2 means Distance values will be display such as "123.45 km" (assuming Distance Units are set to Kilometers; see *section 7.4 - Display*).

Of special note, the Lat/Lon Display Precision setting controls the last item displayed. For example, if set to 1 digit of precision, and Lat/Lon is being displayed as Degree/Minutes, the minutes field will be displayed with 1 digit of precision, e.g. "12 14.2 N". Conversely, if Lat/Lon is being displayed as Degrees/Minutes/Seconds, the seconds field will be displayed with 1 digit of precision, e.g. "12 14 2.3 N"

7.4 Display

The display tab controls what units are used to display values.

Pro Tip: Mysticetus stores everything internally in Metric (or True in the case of Bearings), and converts as necessary when it needs to display it.

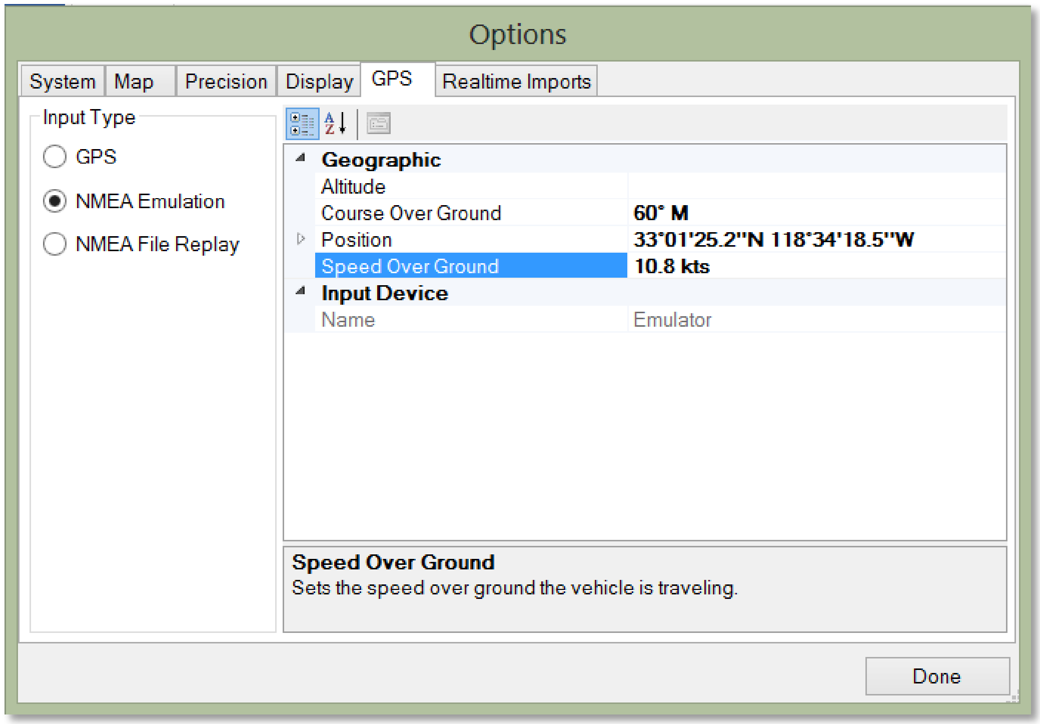


Note that this only applies to values output by Mysticetus (screen, reports, etc.). Input values can be in any format. For example, even if Mysticetus is configured to display distances in Kilometers, you can still enter “123 ft” and Mysticetus will detect that you really meant Feet and convert to the appropriate Kilometer value. Entering a value with a unit (such as “123”) tells Mysticetus to use the display value (“123 km”, in this example).

Of special note is the Bearing display. If set to Magnetic, Mysticetus will use the System Magnetic Variation value, which is either set manually (see *section 7.1.8 - System Magnetic Variation*) or possibly set by an attached GPS. Note that many GPS’s do ***not*** send magnetic variation information – it is important to set this correctly so check your GPS specification for more detail. When in doubt, set the Magnetic Variation manually – if your GPS does send variation information, Mysticetus will assume that is more correct than what you entered.

7.5 GPS

The GPS tab controls where positioning data is coming from



Selecting **GPS** tells Mysticetus to connect to any GPS it finds. There are no configuration options – Mysticetus automatically scans all external ports looking for GPS data and latches on to whatever it finds.

Selecting **NMEA Emulation** causes Mysticetus to run in an emulated fashion. In the above screenshot, you can see how to control the speed, course, starting position, etc.

Selecting **NMEA File Replay** will prompt for a text file containing NMEA 0183 strings to feed into the system. You can also set the rate at which the strings are parsed.

7.6 Real-time Imports

Mysticetus can be configured to import various information in real-time, usually from the output of other applications, including acoustics applications such as *Ishmael*. Real-time imports are ***not*** the usual way to import historical data into Mysticetus for further analysis – see *Chapter 8 - Data Import* for more information on this topic.

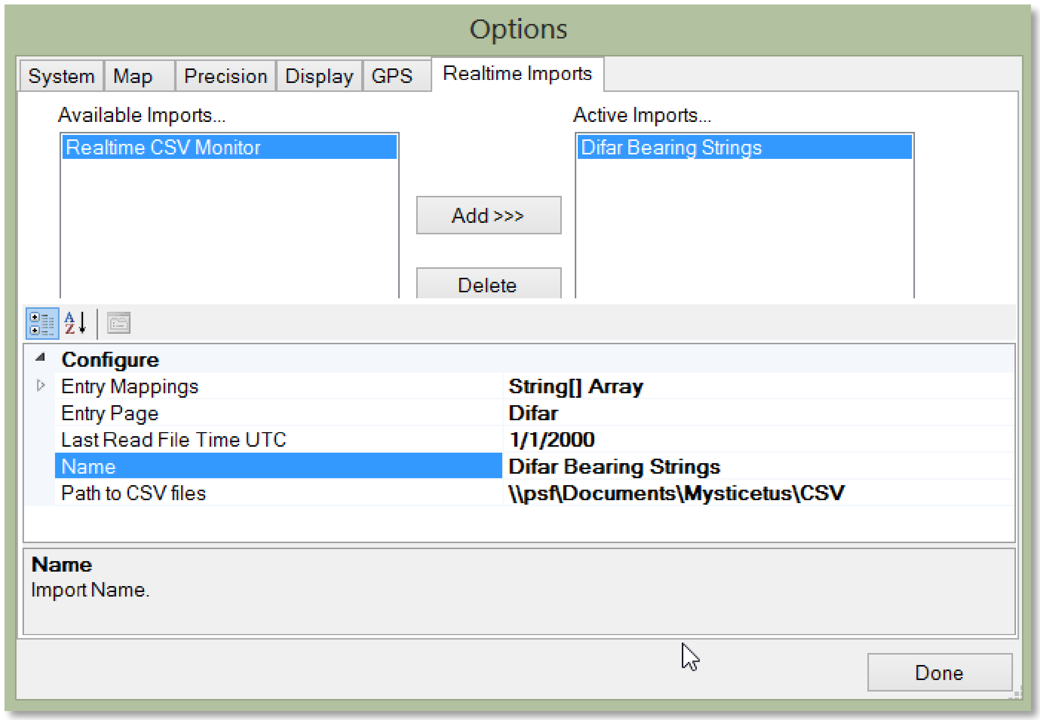
7.6.1 Real-time UDP Import

TBD – in progress (includes directions for setting up UDP port number to receive information from Ishmael, and mapping parameters into entry sheets) – in the meantime, contact davidsteckler@gmail.com for help.

Pro Tip: Real-time imports are a fairly advanced item – probably a good idea to give Dave a call before attempting to use them. See the next chapter on Data Imports – it is much more likely that's what you are looking for.

7.6.2 Real-time CSV Import

Mysticetus can be configured to monitor a single directory for new CSV files that appear there (written by other applications, or by others across a network share). The contents of these files can be parsed, and data can be entered automatically into the Mysticetus system



The controls for these imports includes specifying which entry page to add values to, as well as the mappings the data should take (Entry Mappings).

Note: this is **NOT** the general way to import CSV files into Mysticetus – this is intended for real-time data updates from other applications and, as such, is a fairly involved and complex operation. Chances are good this is not the Import function you are looking for.

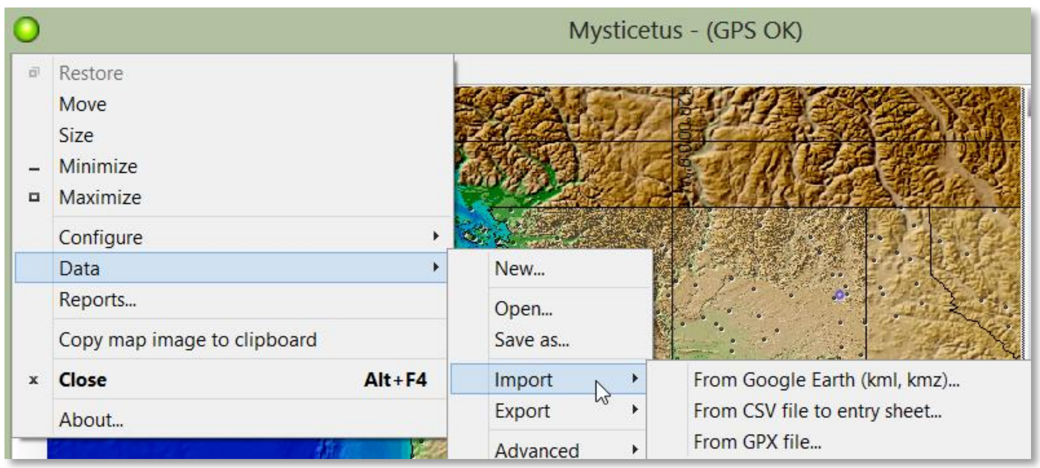
To import pre-existing CSV data into Mysticetus, see *Chapter 8 - Data Import*.

8 Data Import

Mysticetus can import data from a number of different formats, including CSV, Shapefiles and Google Earth™

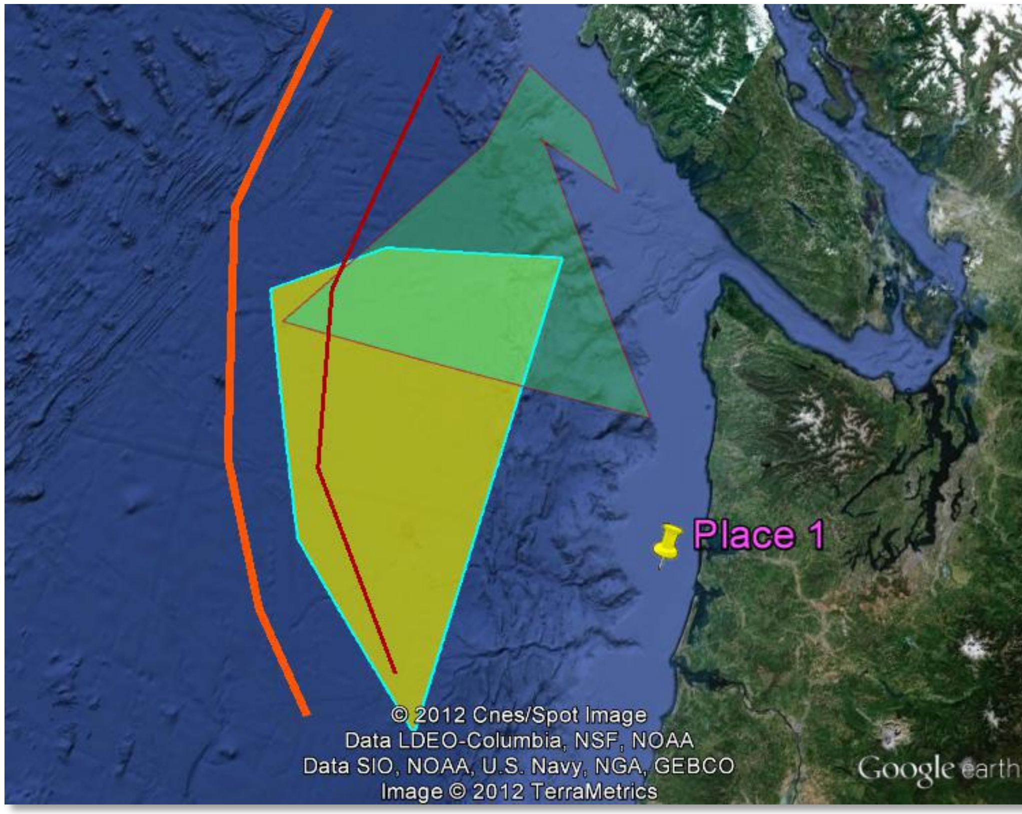
Import of data is a method for either (a) bringing data previously recorded or created into the Mysticetus system or (b) using an application better suited for the particular data creation task and then bringing it into Mysticetus for further analysis.

All Data Import is triggered from the ***Data -> Import*** menu item:

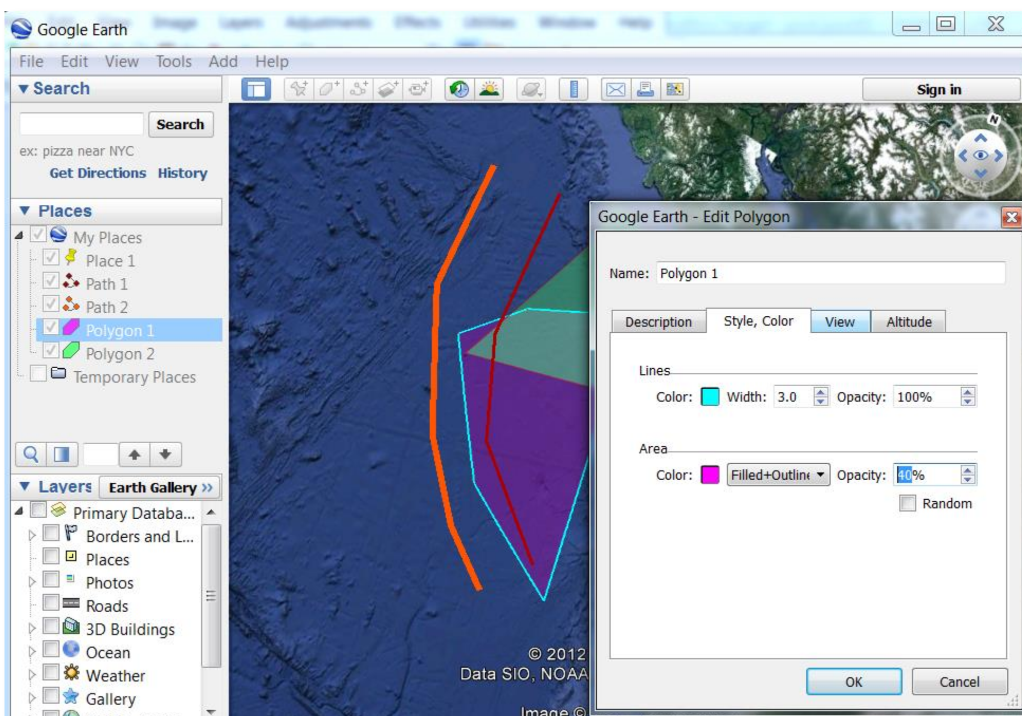


8.1 Google Earth

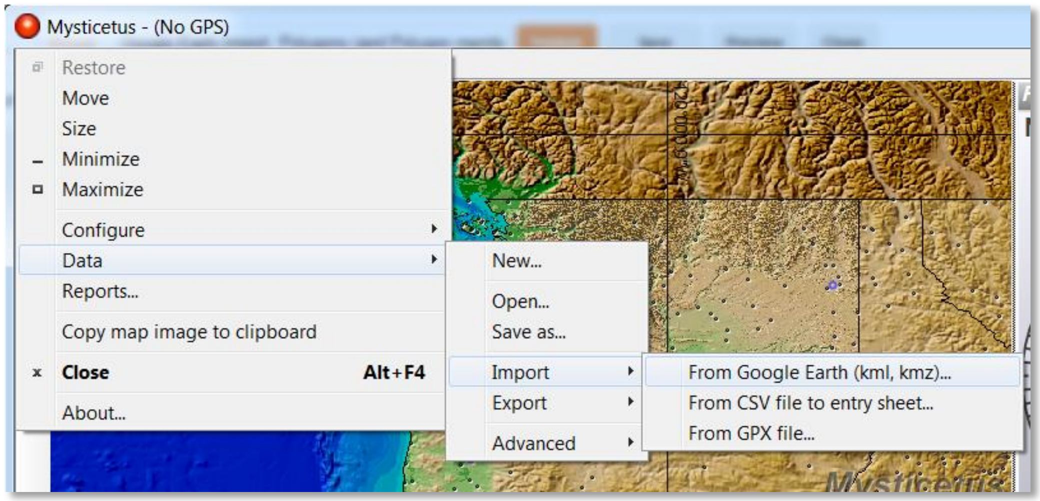
Mysticetus can import all standard Google Earth shapes, including Paths, Places and Polygons. For example, create whatever you want in Google Earth:



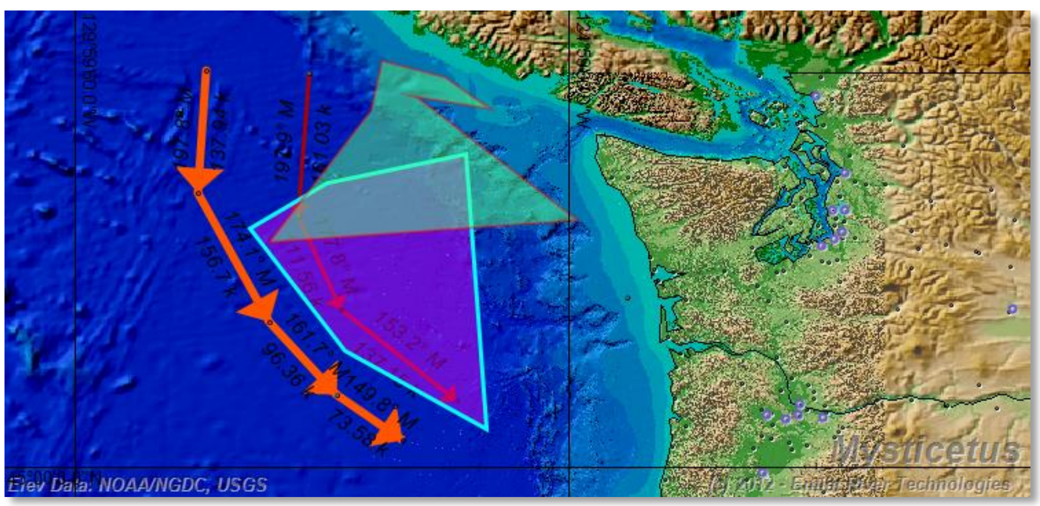
You can set colors, line widths, etc.



Save your places as either a KML or KMZ file. In Mysticetus, choose ***Data -> Import -> From Google Earth***.



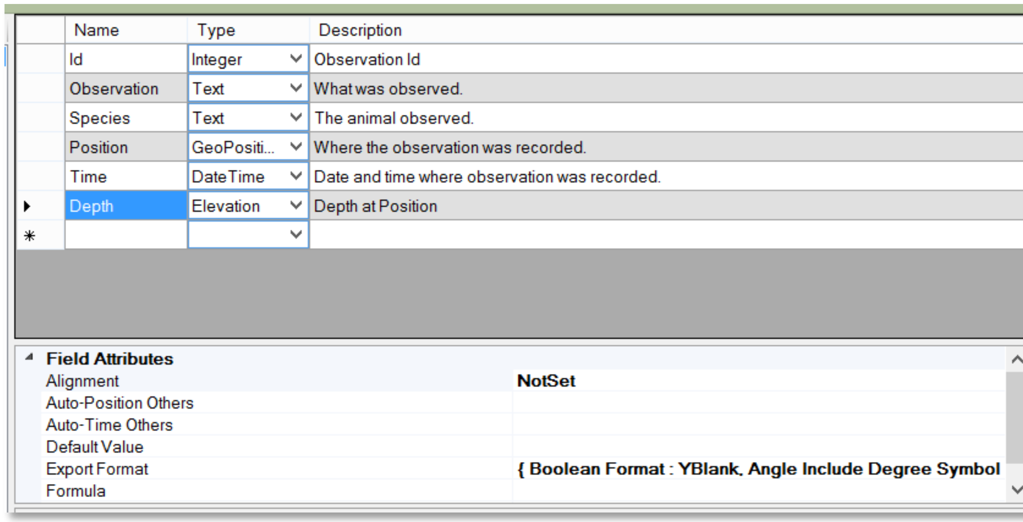
Select your KML or KMZ file and Mysticetus will bring it into the Mysticetus system:



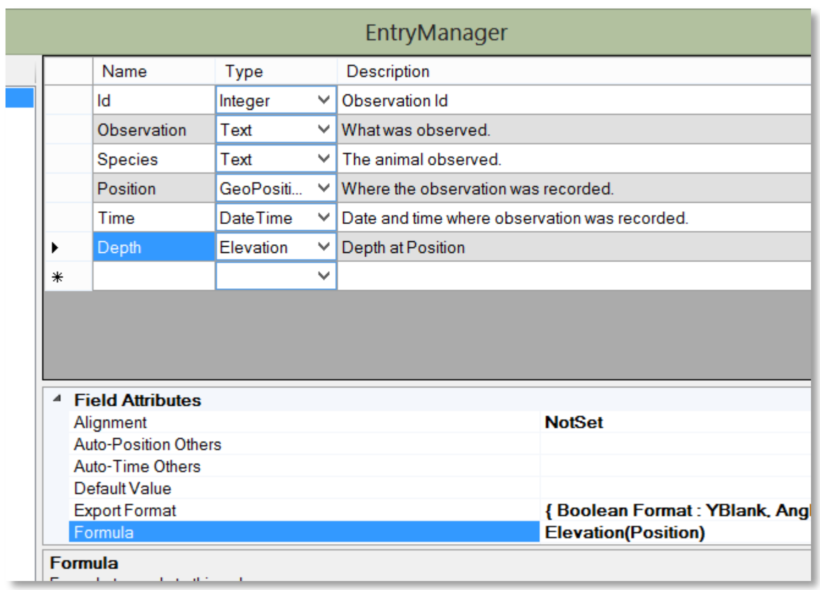
8.2 CSV (Comma-Separated Value) File

Comma-Separate Value is a very common tabular interchange data format. It contains a header row that specifies the columns, and then rows of data. Each column is separated by a comma. Excel, Access and every GIS system on the planet can output tabular data in this fashion. Similarly, it can be imported into Mysticetus' entry sheets.

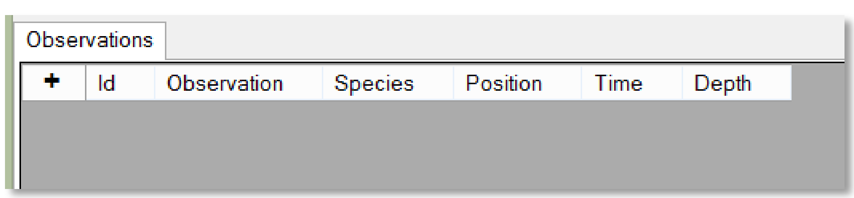
For example, say you wanted Mysticetus to calculate the depth at sighting position for a previously entered set of geographic positions. The first step is to create an entry sheet with the appropriately named columns. For example,



Next, make sure the Depth column uses the Elevation formula (see *section 4.1.10* for more information on this formula).



This creates an empty entry sheet



Assuming the columns in your CSV file match this (if not, rename things so they match), choose ***Data -> Import -> From CSV File to Entry Sheet***. For this example, I used the following made-up CSV file:

```
Id,Observation,Position,Species,Time
99,Blow,23.34 N 117.12 W,Blue Whale, 1:02:03
888,Fluke Up,12.34 N 17.24 E,Gray Whale, 3:04:05
```

Which leads to the following representation in the Entry Sheet after Import:

Observations

+	Id	Observation	Species	Position	Time	Depth
	99	Blow	Blue Whale	23°20'24.0'...	2013-J...	-13077 ft
▶	888	Fluke Up	Gray Whale	12°20'24.0'...	2013-J...	991 ft

Yes, that Gray Whale has apparently (d)evolved, very rapidly, some feet. ☺ Recall that this is just some made up data, so a Gray Whale at 991' above sea level isn't that strange.

Pro Tip: Garmin's MapSource program can be used to convert various other formats, including GDB, to GPX. From there, Mysticetus can extract the information from the GPX file.

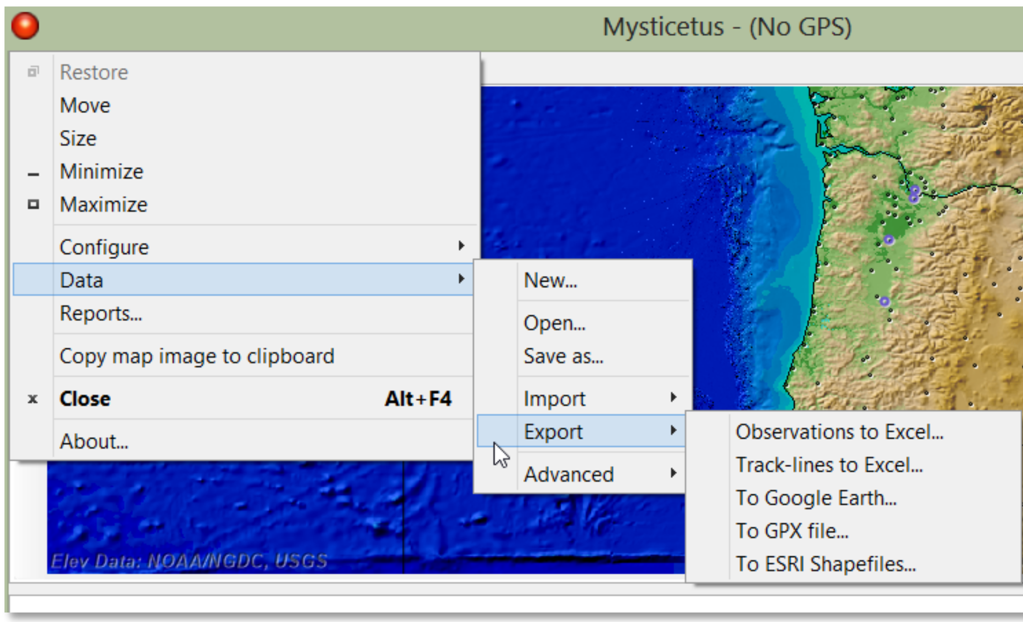
8.3 GPX (GPS eXchange) File

Tracks can be imported from GPX files. This is handy if you want to re-run environmental reports from old data, and you have GPS tracklines stored in a GPX file. Choose ***Data -> Import -> From GPX File…***, select the GPX file to import and Mysticetus will bring in the track data

9 Data Export

Mysticetus can easily output your data into a number of different formats, including Microsoft Excel ™, ESRI Shapefiles, GPX, and Google Earth™

Exporting your data allows you to manipulate it in other programs that can provide even more advanced editing and/or analysis techniques.



9.1 Excel (Observations)

Excel Export saves all current data in all entry sheets to an Excel Spreadsheet in Excel XML format. Each entry sheet becomes a sheet in an Excel workbook. Simply chose ***Data -> Export -> Obervations to Excel***, choose a filename to save into and Mysticetus will do the rest. If Microsoft Excel is installed on your computer, Mysticetus will even try to launch it with your new spreadsheet.

9.2 Excel (Track Lines)

In this case, Mysticetus exports all GPS track lines to an Excel XML spreadsheet.

Choose ***Data -> Export -> Tracklines to Excel***.

9.3 Google Earth

Mysticetus will export all Planned Routes, Polygons, Waypoints/Sightings and GPS track lines to a Google Earth KML (Keyhole Markup Language) file. If Google Earth is installed on your machine, Mysticetus will attempt to launch it and load the new file into it.

Choose ***Data -> Export -> To Google Earth***.

9.4 ESRI Shapefile

Mysticetus will export all Planned Routes, Polygons, Waypoints/Sightings and GPS track lines to an ESRI shapefile. In addition, if configured (see *section 7.1.12 - (Shapefile) Environmental Time Field*), Mysticetus will add appropriate environmental information about each GPS track mark into the track's attribute table. In this way, GPS track marks in exported shapefiles can be loaded into other GIS applications and analyzed with respect to environmental conditions such as survey leg type, Beaufort sea state, etc. at the time of that track mark record.

Choose ***Data -> Export -> To ESRI Shapefile***.

9.5 GPX

Mysticetus will export Planned Routes, Waypoints/Sightings and GPS track lines to a GPS eXchange (GPX) file. This file is a standard format used by many GPS's, especially Garmin, to exchange information.

This is the ideal way to send a Planned Route from Mysticetus to your GPS.

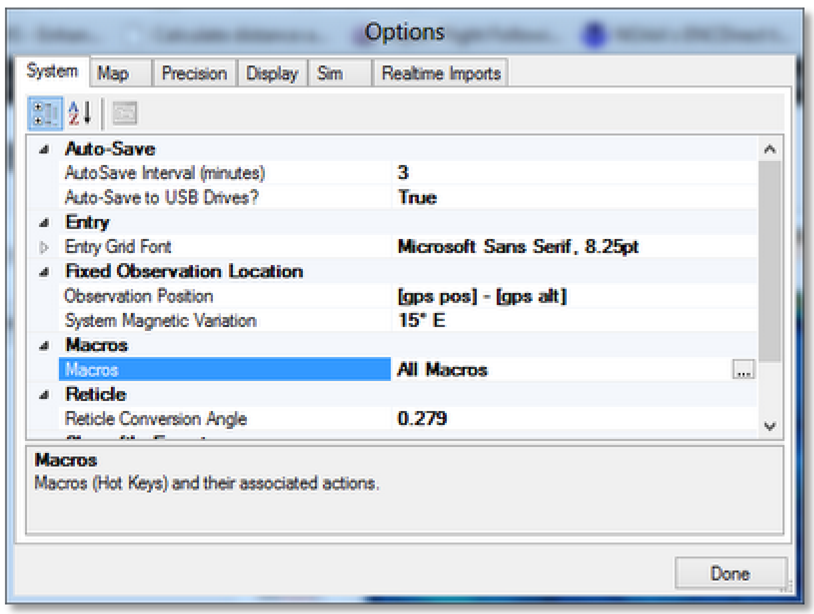
Choose ***Data -> Export -> To GPX File***.

10 Macros

Macros allow the user to perform complex operations at the touch of a single key. By assigning a "Hot Key" to a macro, Mysticetus can automatically fill in large quantities of entry data, simplifying data entry even further.

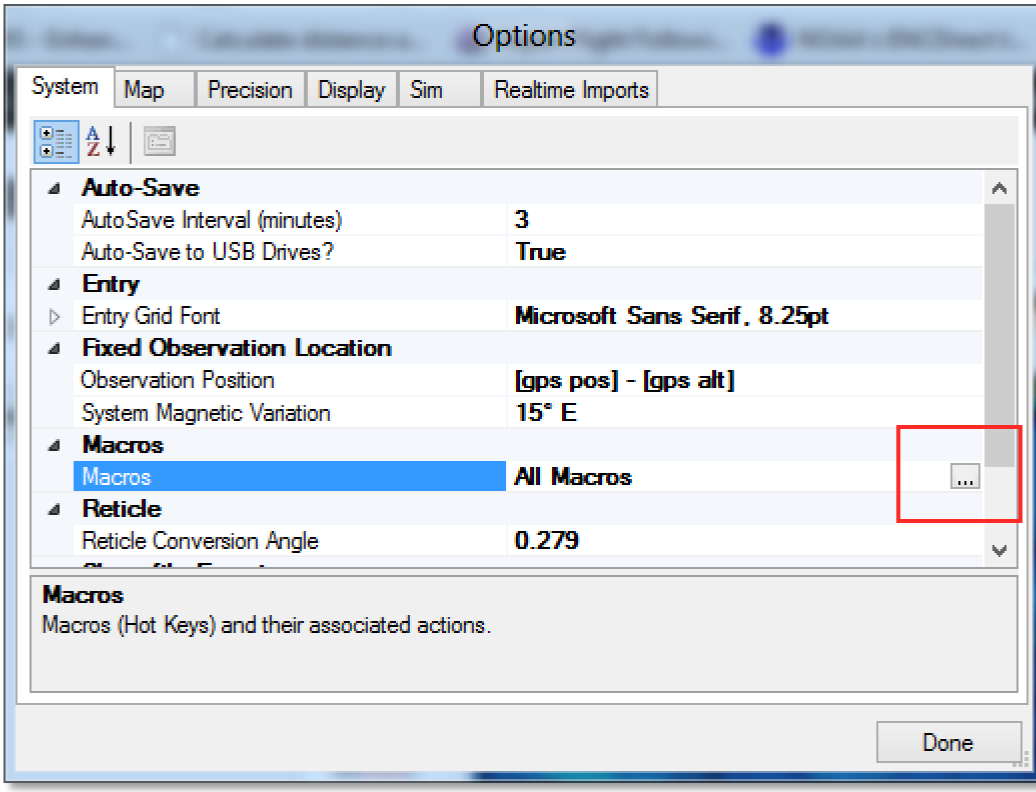
Macros are configured in the ***Configure -> System Options*** page, in the Macros area.

10.1 Macro Configuration



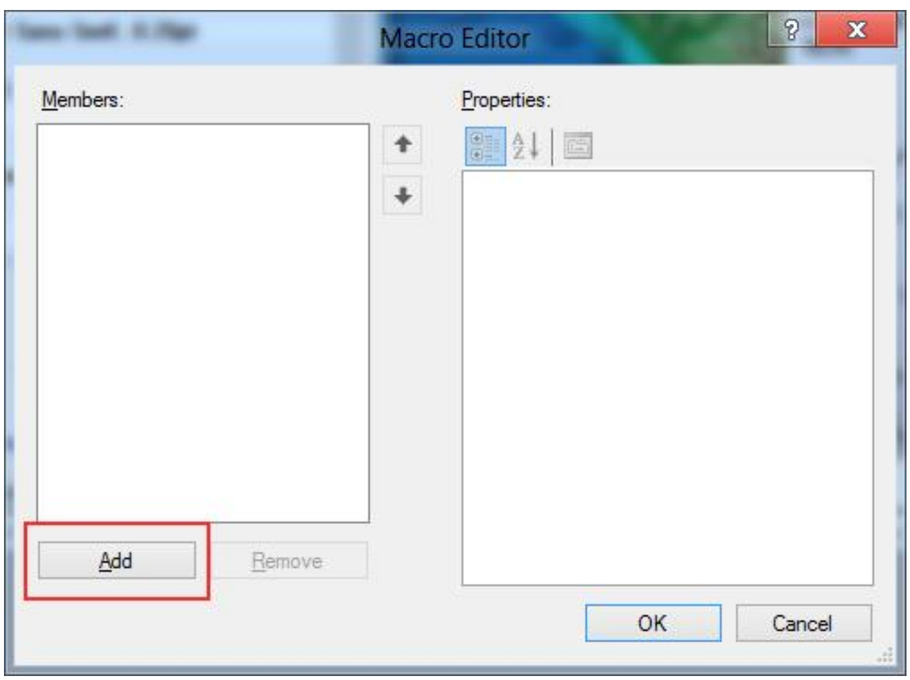
A Macro is a sequence of events that happen when you press a "Hotkey". A Hot Key is a pre-defined key press, for example by holding down the Ctrl key and the 'L' key at the same time (denoted "Ctrl+L"), it causes Mysticetus to do something useful, like record the position of a sighting. Macros and Hot Keys in Mysticetus can be configured to do just about anything you want.

To configure Macros, press the ellipses on the right side...

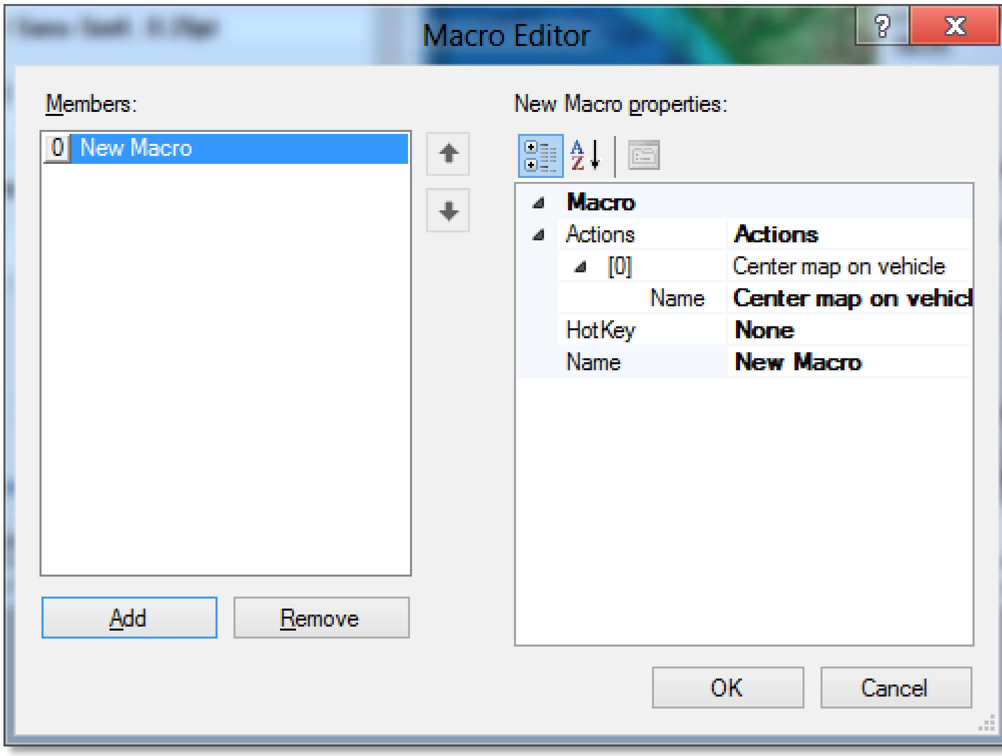


10.2 Macro Editor

Here is the Macro Editor that pops up. Press the Add button to create a new Macro:



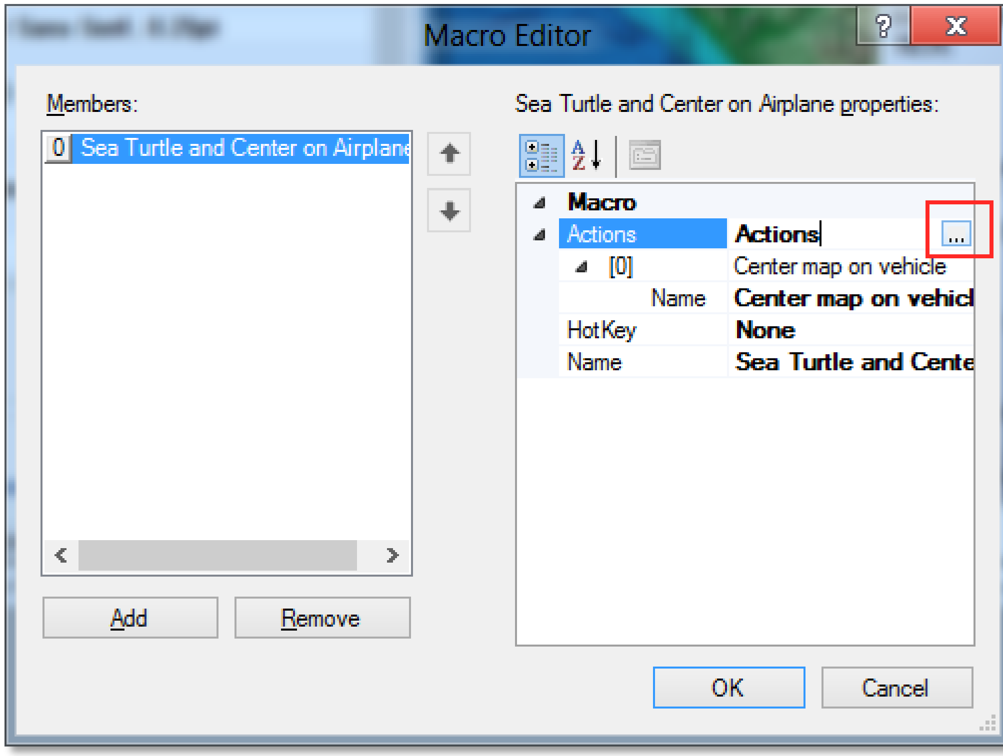
The Macro Editor controls the functions of the Macro and its associated Hot Key:



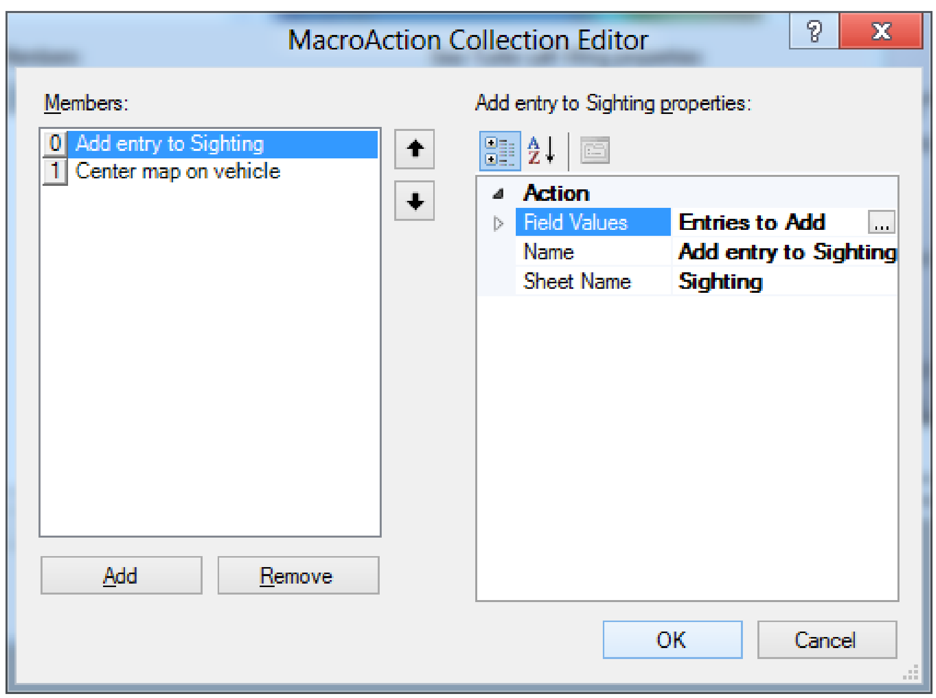
Next, you need to change the fields to tell Mysticetus what you want to do and which Hotkey you want associated with this sequence of actions. You can specify multiple actions (1 or more) that happen each time you press a Hotkey.

10.3 Macro Creation Example

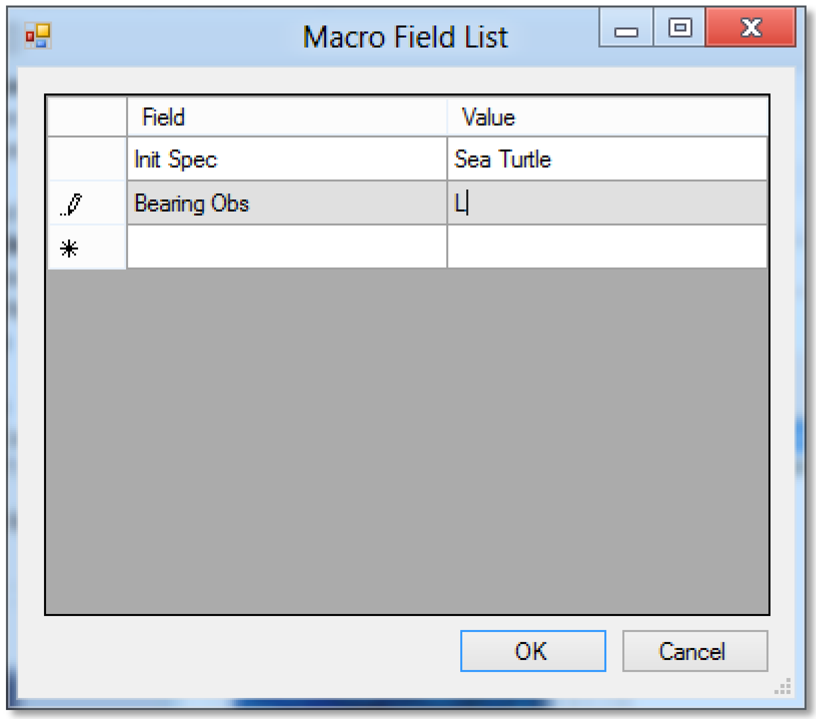
In the following example, we're going to perform two actions: add an entry for Sea Turtle off the left wing to the Sightings page, plus Center the Map display on the Vehicle. We've already changed the "Name" field, now we're going to change the Actions that happen:



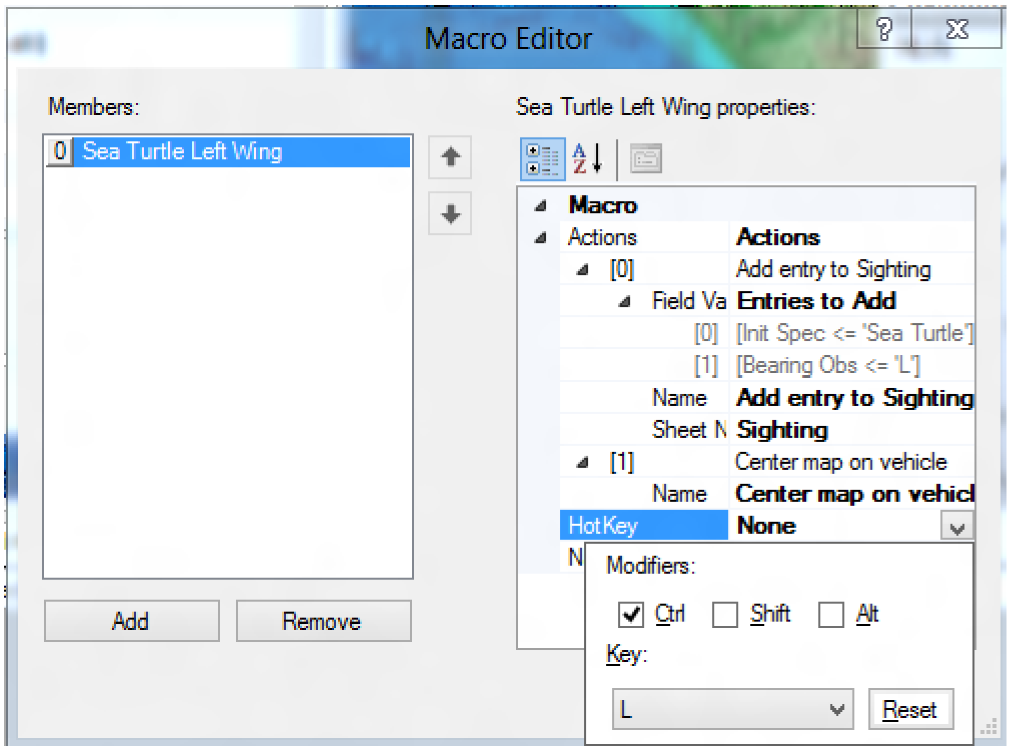
Clicking on the ellipses next to Actions pops up the Actions editor, where we define two actions for this Macro. One to add a Sea Turtle sighting, and another to center the map on the vehicle:



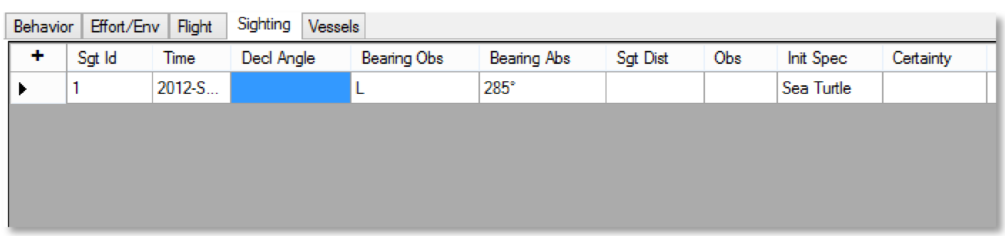
For the Sea Turtle sighting action, we define the fields we want to add. In this example, we want the Species to be "Sea Turtle", and the Observed Bearing to be L (for "Left" - Mysticetus will subtract 90 degrees from the vehicle's heading).



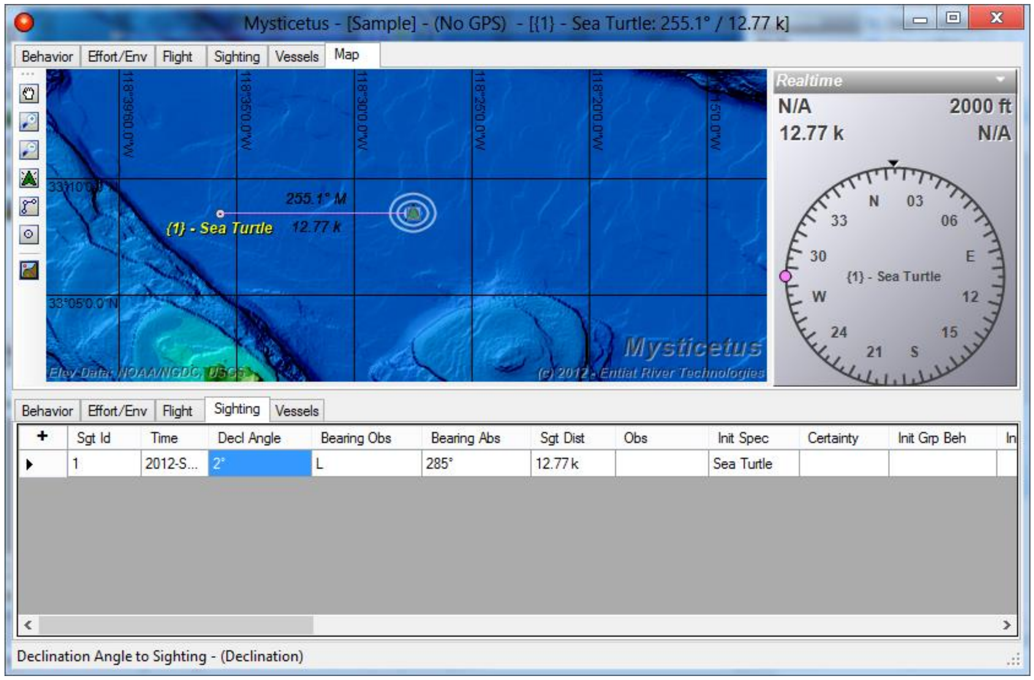
The final product in the Macro Editor looks a little complicated - it is actually a "language" of sorts - that tells Mysticetus what to do and when to do it. In this case, when the user presses CTRL+L, Mysticetus will add a Sighting entry for a Sea Turtle, and it will be 90 degrees to the left of the nose of the vehicle. In addition, the map window will be re-centered on the vehicle.



Now that we have all this set up, the recorder in the airplane (in this example – it works equally well in a vessel, and for other data types) can simply click Ctrl+L and:



A new sighting record with all the fields filled in is created. In this example, we just need to type in the Declination Angle to the sighting and the observers can move on to the next Sea Turtle, or whatever else swims by. Here is the Sea Turtle sighting as Mysticetus creates it on the map:



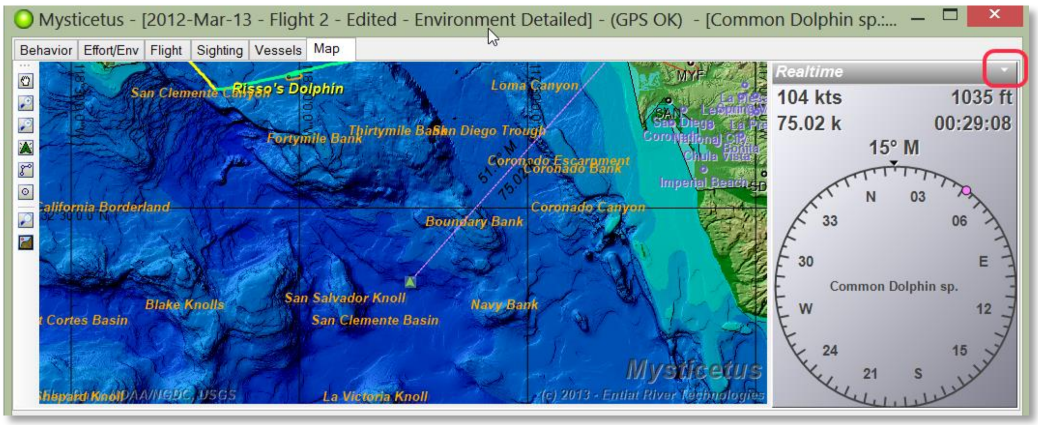
(yes, if you can see a sea turtle almost 13 kilometers away from 2000' in the air, you've got super-eyes…this is just for illustrative purposes…)

As you can see, this significantly reduces the number of keystrokes necessary to record information in Mysticetus. The possibilities of what can be filled in with HotKeys/Macros is endless.

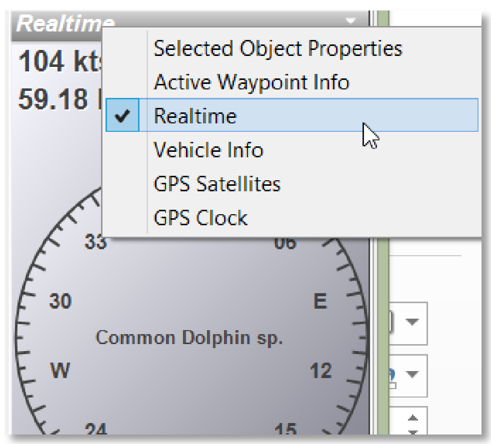
11 Data Panel

The Data Panel is a set of controls off to the side of the Map Window – you can select the display that makes the most sense for your current needs.

Data panel elements are selected by clicking the dropdown arrow in the upper right corner of the panel.



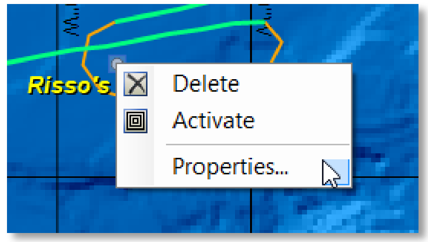
From there you can select a number of different panels to display.



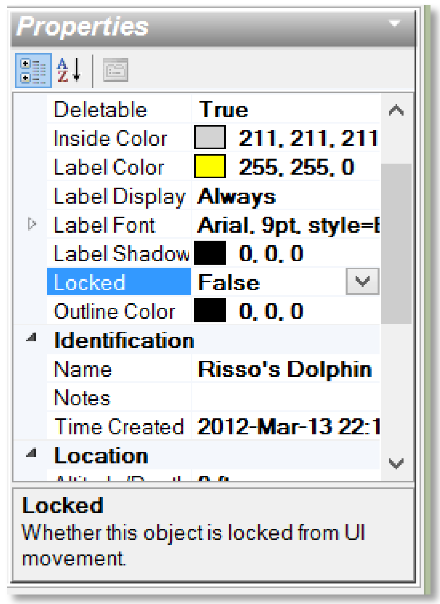
11.1 Selected Object Properties

The Selected Object Properties panel displays information about the last object clicked on in the Map window.

Alternatively, you can right click on an object in the Map window, choose “Properties…”

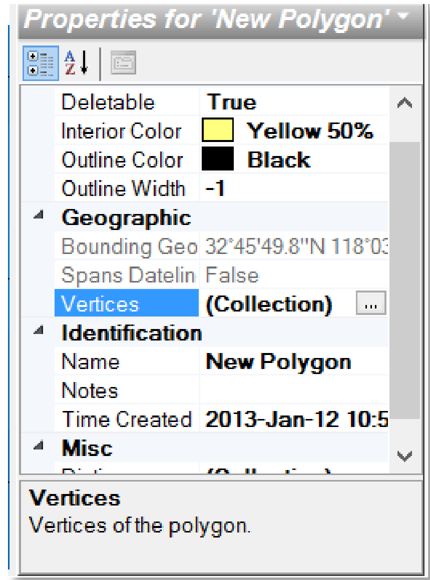


and Mysticetus will switch the data panel to the Selected Object Properties for that object

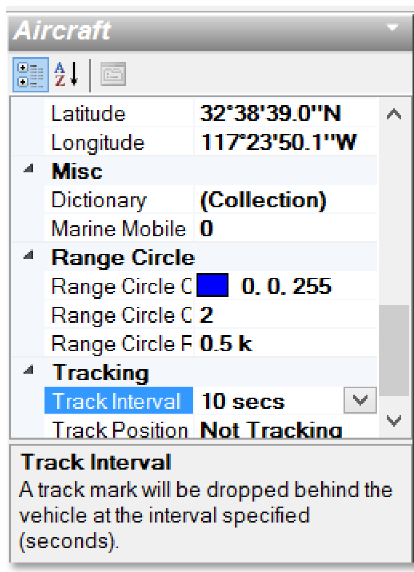


Use the Selected Object panel to control the display of the object, including individual label color, font, whether range circles are display, and so on. (To control settings for all objects, use ***Configure -> System Options -> Map*** as discussed in *section 7.2*)

Note that different objects will have different properties that can be set. For example, polygons have their set of vertices that can be precisely configured:

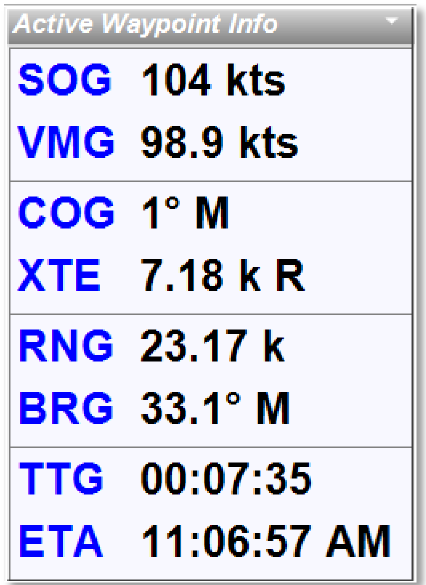


And when a vehicle (aircraft, vessel) is the Selected Object, you can control things like Tracking Options



11.2 Active Waypoint Info

The Active Waypoint Info panel displays graphical information about the Active Waypoint (if any).

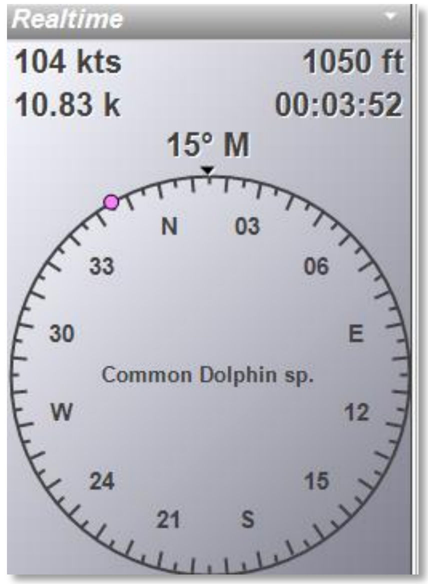


Items displayed include

- **SOG** - Speed Over Ground
- **VMG** - Velocity Made Good (speed over ground vector in the direction of the Active Waypoint)
- **COG** - Course Over Ground
- **XTE** - Cross Track Error (either from the planned route, if the active waypoint is part of the active plan, or from a temporary route created when a standalone waypoint is activated).
- **RNG** - Range to the Active Waypoint
- **BRG** - Bearing to the Active Waypoint
- **TTG** - Time to Go to Reach the Active Waypoint at current Velocity Made Good
- **ETA** at the Active Waypoint at current Velocity Made Good

11.3 Realtime

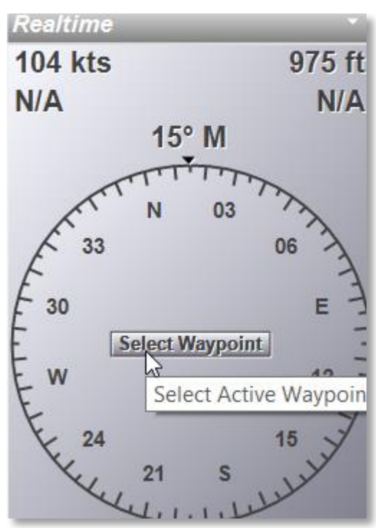
Realtime is the default panel displayed. It contains a quite a bit of information.



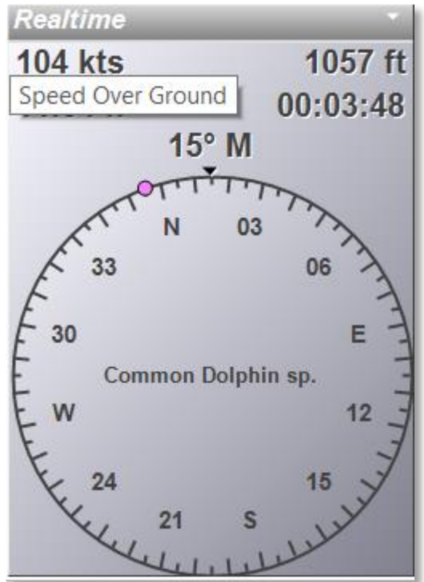
This panel displays

- Speed Over Ground
- Altitude
- Range to Active Waypoint
- Time to Go to Active Waypoint
- A compass rose indicating current heading
- A "heading bug" to indicate bearing to the active waypoint
- Name of active waypoint (in the middle of the compass rose).

You can select the active waypoint by clicking on the active waypoint name in the middle of the panel. If no waypoint is active, it will display "Select Waypoint" – either way, a dropdown with all waypoints (and sightings) will allow you to select the one you want.



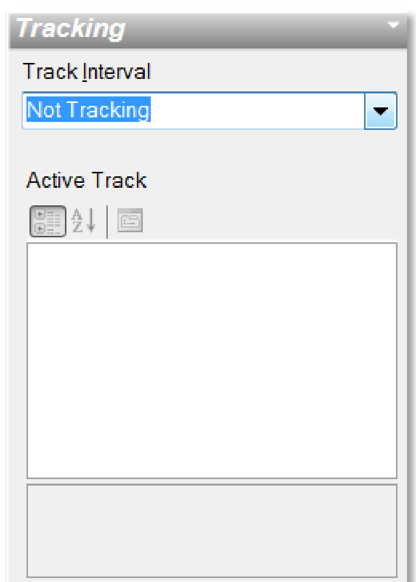
Holding your mouse over any part of this panel will display a tooltip with information about what you are pointing at



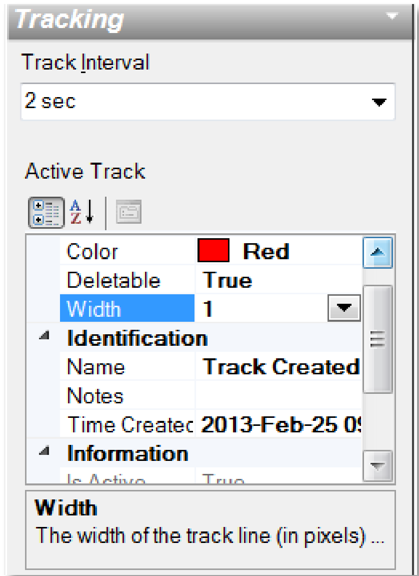
11.4 Tracking

Tracking controls your track settings, including how often to drop a track mark and what color and width the track displays.

The initial display will look like this (tracking is not enabled):



Pull the dropdown to select a tracking interval. Once tracking starts, color and width parameters can be entered:



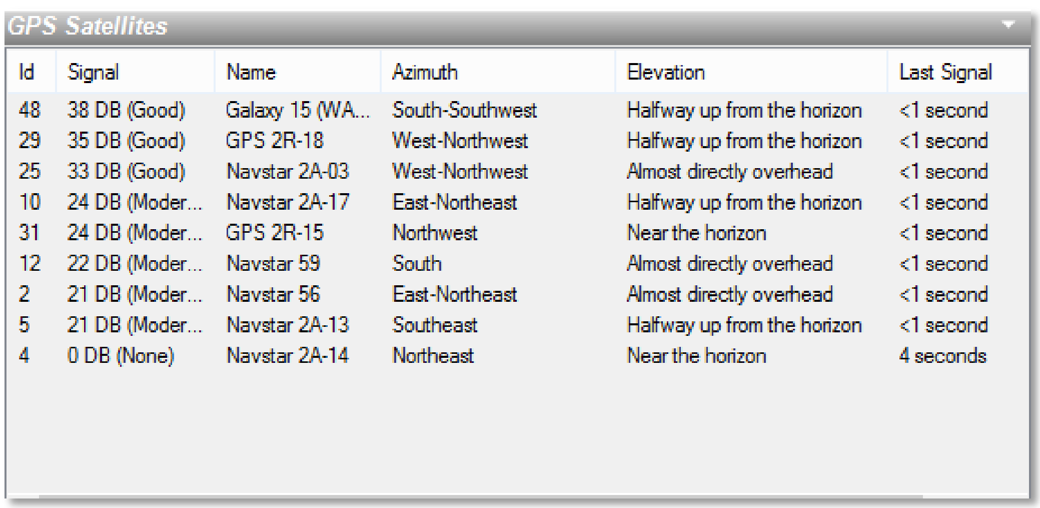
Other information, such as the current length of the trackline is displayed in this window.

11.5 Vehicle Info

Vehicle Info contains the same information you would get by right clicking on the Active Vehicle (vessel/aircraft) and choosing “Properties...” – this is a shortcut for that.

11.6 GPS Satellites

The GPS Satellites panel displays information about the satellites in view by your GPS, including signal strength, where the satellite is, and when information from that satellite was last received.

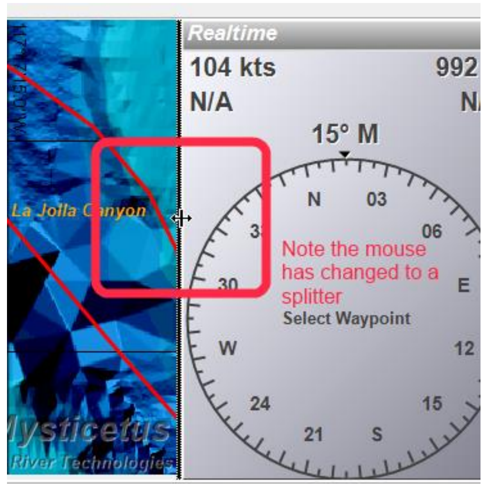


GPS Satellites

Id	Signal	Name	Azimuth	Elevation	Last Signal
48	38 DB (Good)	Galaxy 15 (WA...	South-Southwest	Halfway up from the horizon	<1 second
29	35 DB (Good)	GPS 2R-18	West-Northwest	Halfway up from the horizon	<1 second
25	33 DB (Good)	Navstar 2A-03	West-Northwest	Almost directly overhead	<1 second
10	24 DB (Moder...	Navstar 2A-17	East-Northeast	Halfway up from the horizon	<1 second
31	24 DB (Moder...	GPS 2R-15	Northwest	Near the horizon	<1 second
12	22 DB (Moder...	Navstar 59	South	Almost directly overhead	<1 second
2	21 DB (Moder...	Navstar 56	East-Northeast	Almost directly overhead	<1 second
5	21 DB (Moder...	Navstar 2A-13	Southeast	Halfway up from the horizon	<1 second
4	0 DB (None)	Navstar 2A-14	Northeast	Near the horizon	4 seconds

Note that some GPS’s do not send satellite information, so this panel may be blank, even if your GPS has a valid position.

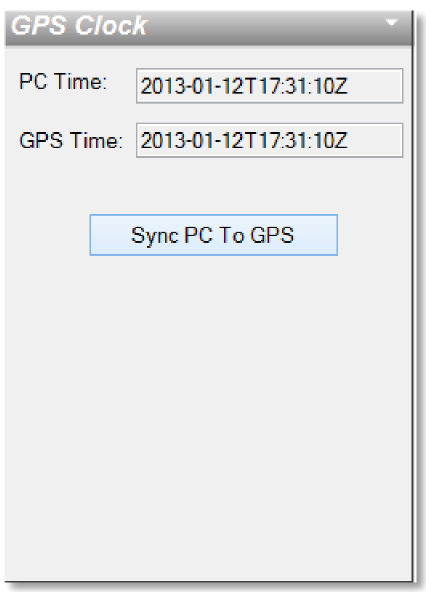
In order to see all the information presented in this panel, it may be necessary to expand the panel via the splitter control just to the left of the Data Panel. As mentioned elsewhere in this document, all panels in Mysticetus can be resized by simply clicking on the resize splitter and dragging:



11.7 GPS Clock

The GPS Clock panel displays two pieces of information: the PC System Clock time, and the clock time from the GPS, if the GPS has a fix. You can also direct Mysticetus to synchronize the PC clock from the GPS clock if they are out of sync.

Pro Tip: Setting your PC clock requires Administrative privilege. If you are not running as an administrator (and you should NOT be), Mysticetus will prompt for an administrative password before synchronizing PC to GPS time.



12 Acoustics

In progress...

13 AIS – Multi-Vessel Tracking

Mysticetus can leverage AIS (Automated Identification System) to track multiple survey vessels.

AIS is very easily used in Mysticetus. Simply hook up the AIS device to a USB port on your machine. Mysticetus will detect the AIS data stream and plot any position updates it receives.

The only configuration options are if you would like to change the color of the other vessels. Simply right click on them on the map, choose “Properties…” and change their color in the Selected Object Properties data panel.

14 Credits and Thanks

Mysticetus was created by Dave Steckler. Entiat River Technologies is my Washington State Sole Proprietorship. Mysticetus is currently many tens of thousands of lines of (mostly C#, some C) code and has taken over two solid years of sweat and lost sleep to run it from initial concept, through various prototypes (some successful, others not so much), into the commercial-grade product it is today.

Of course, there are a number of other people and entities that deserve thanks and credit for help and encouragement over the past couple years as Mysticetus has evolved. If I missed anyone, feel free to send me a nasty piece of flame mail and I will not only profusely apologize and include you in the next version of this document, I will buy you a drink next time I see you.

Original idea, first customer, ongoing support and feedback: **Mari Smultea**. Without Mari's input and guidance, this project would have never been started, never (quite literally) gotten off the ground, and would never have progressed to the complete system Mysticetus is today. I could almost imagine naming this software "Mari-cetus" in her honor…almost.

Initial prototype testers include **Bernd Würsig**, **Kate Lomac-MacNair**, and **Jenelle Black**. Critical feedback provided in the early stages of a project of this magnitude helped shape the overall direction Mysticetus has taken. **Bernd**, in particular, has continued to provide additional guidance over the years Mysticetus has been under development.

As Mysticetus matured into a solid product, **Tom Jefferson, Tom Norris**, **Mithriel MacKay, Mark Cotter** and **Cathy Bacon** all provided much needed support, feedback and help with ideas and bugs. **Cathy** deserves a specific shout out for surviving some of the early bugs in the system.

Various Navy personnel, including especially **Chip Johnson** and **Joel Bell**, have provided incredibly valuable feedback, suggestions and guidance.

HDR employees, notably **Dan Englehaupt** and **Kristen Ampela** deserve many thanks for support, suggestions and guidance.

NOAA's **Barry Eakins** deserves a nice glass of wine or two for his help as I stumbled through displaying various types of topographic/bathymetric data.

Finally, Mysticetus leverages the DotSpatial library for its GPS interactions as well as certain shapefile loading and saving operations. A shout out to the open source development community at **http://dotspatial.codeplex.com**.

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APPENDIX D. Observer Guide to Dolphin Behavior

I. School Behavior

A. *Traveling* – the movement in a given direction of an individual or school, at approximately 3 knots or greater. Movement of school is polarized (all individuals are moving in the same direction) and coordinated (moving at the same pace). Aerial activity may be observed. Can be:

i. *Fast traveling* – characterized by rapid, directed swimming with many porpoising individuals; school is highly polarized.

ii. M*oderate traveling* – some of the individuals are porpoising; school is traveling at medium speeds.

iii. *Slow traveling* – few or no individuals porpoising; school is traveling at slower speeds; movement of the school is less directed and school may be less polarized.

B. *Milling* – animals remain in the same general area; school is not polarized. Movement of individuals is characterized by frequent changes in direction over a small spatial scale; speed approximately less than 2 knots. Aerial activity may be observed.

II. Associations

***Associated-swimming* –** swimming/diving in association with birds and tuna. Generally, individuals are moving slowly, diving and spending less time at the surface. The school is not polarized. It is not known if the dolphins are feeding at this time, even if there is evidence that the birds and tuna are feeding, so this term should be used only with direct evidence of feeding dolphins. *Note: animals can be associated-swimming while traveling or milling.

III. Individual Behavior

A. *Lob tailing* – one or more individuals slapping the surface of the water with the tail flukes. This behavior makes splashes on the water.

B. *Aerial activity* – one or more individuals are seen leaping, spinning, breaching, tail walking, roto-tailing, head slapping, etc. These activities usually associated with splash entries into the water.

A. *Porpoising* – smooth arching leaps clear out of the water while traveling; entry into the water is splashless and rostrum first.

B. *Other* – describe behavior.

IV. Behavior Relative to the Research Vessel
{Please note the distance from the ship at which the behavior first occurs (reticle or estimate by eye)}

A. *Approach the boat* – individual/s alter course to swim directly towards the vessel, approaching but not bow riding.

B. *Bow riding* – diving and surfacing in the bow wave of the boat.

C. *Wake riding* – diving and surfacing in the wake of the boat.

D. *Running from the boat* – swimming at high speed directly away from the boat. This means that the school has changed direction and/or increased speed.

E. ***School splitting* –** a larger school breaks up into smaller groups, which are spatially segregated clusters of animals. Subgroups may vary in size but they are always smaller than the initial school. Please describe how the school splits up and the species composition of the school before and after splitting. "Shattering" describes a special case when dolphins move away in all directions, singly or in small groups.

i. When the school first splits, do the individuals/subgroups:
   a) move off in different directions.
   b) continue to move in the same direction.

ii. During your final observation of the school, is the composition:
   a) *mixed* – different species in the same subgroup.
   b) *single species* – subgroups are species-specific.

F. ***School coalescing* –** after initial sighting, a more scattered school closes ranks and becomes more tightly aggregated, cohesive, and polarized.

G. ***Low swimming* –** only the dorsals or small patches of back are visible at the surface, making the animals very difficult to see.

H. ***Other "evasive," "attractive," or "neutral" behaviors* –** describe any other behaviors that you think may indicate that the dolphins are attracted to, are avoiding, or are not responding to the research vessel.

V. Spatial Distribution of Individuals

A. ***Aggregation* –** the distance between individuals within the school.

i. *tight* - most animals are within one body length of each other. School has easily discernible shape; the beginning and end are well defined.
ii. *loose* - most animals are distributed greater than one body length apart. School shape is difficult to discern; the beginning and end are not well defined.

B. Clumping – the degree of clustering within the school.

i. *uniform* – ca. equal amounts of space between all individuals in the school.
ii. *clumped* – the school is divided into subgroups, with more space between subgroups than among individuals in each subgroup.

VI. Composition of Schools

A. Note the presence or absence of neonates, calves and/or juveniles in the school.

B. Note the species composition of the school at the beginning and end of the sighting.