

## **FINAL REPORT**

### **Utilizing Pro-bono Commercial Assets for Marine Mammal Surveys In High Naval Activity Area in Hawaiian Waters**

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#### **LONG-TERM GOALS**

The waters surrounding the State of Hawaii are high U.S. Navy activity regions and include Pearl Harbor on the island of Oahu, the FORACS (Fleet Operational Readiness and Accuracy Check Site) acoustic range operated by the Hawaii Detachment of NUWC-Newark along the Waianae coast of Oahu, and PMRF (Pacific Missile Range) in the waters off the island of Kauai and the shallow waters of west Maui. Furthermore, the RIMPAC exercises (Rim of Pacific Exercises) that occur on a regular basis involve considerable Naval resources operating close to and within Hawaiian waters. The Pacific Navy is under considerable pressure from environmental groups that have initiated up to five lawsuits to curtail the Navy's use of active sonar for training. Perhaps the best approach in combating the various environmental concerns expressed in the different lawsuits is to gather scientific data and obtain important information on the abundance and distributions of marine mammals in the high Navy activity area of Hawaii. The cost of negative encounters with marine mammals is disproportionately high in terms of negative publicity and lawsuits so it would be prudent to take steps to increase the odds against any encounters. Basic information on the biology, natural history, and behavior of dolphins and whales that frequent waters of high Navy activities are needed in order to avoid encounters.

Marine mammal surveys around the Hawaiian Islands have been infrequent and localized. In 2002, the National Marine Fisheries Services conducted a visual and acoustic survey within the Hawaiian archipelago (Barlow et al., 2004; Rankin and Barlow, 2007). Another NMFS cruise took place in February of 2009, almost 7 years since the previous one. The 2002 and 2007 surveys also took place within a limited time periods and the data, while useful, does not give information about temporal and spatial patterns in terms of season, month or year. Aerial surveys have been conducted in conjunction with the North Pacific Acoustic Laboratory Program from 2001 to 2004 (Mobely, 2002, 2003, 2004a,b). However, these aerial surveys focused around the island of Kauai, and during the humpback whale winter season in Hawaii. The results were limited seasonally and occurred in relatively localized areas. Furthermore, aerial surveys are limited to daylight hours and relatively calm seas. Robin Baird from Cascadia Research has conducted brief marine mammal surveys for several years, usually once a year (see Baird et al., 1008a, b, c, d, e). His surveys tend to be short; two weeks to a month in calmer, leeward waters. Certainly, more information is needed over all four seasons and in a broader geographic region that is not restricted only to daylight hours.

The goal of this project was to perform regular, but relatively inexpensive acoustic surveys in the deep waters between Oahu and Hawaii and Oahu and Kauai on a seasonal basis using the assets of the Young Brothers Shipping Company, Hawaii's largest interisland shipping company. Young Brothers offered to participate by allowing us to board their tugboats and use our acoustic instruments to collect data, on a pro-bono basis. The goal was to establish a robust database of information that currently does not exist in the deep waters between islands.

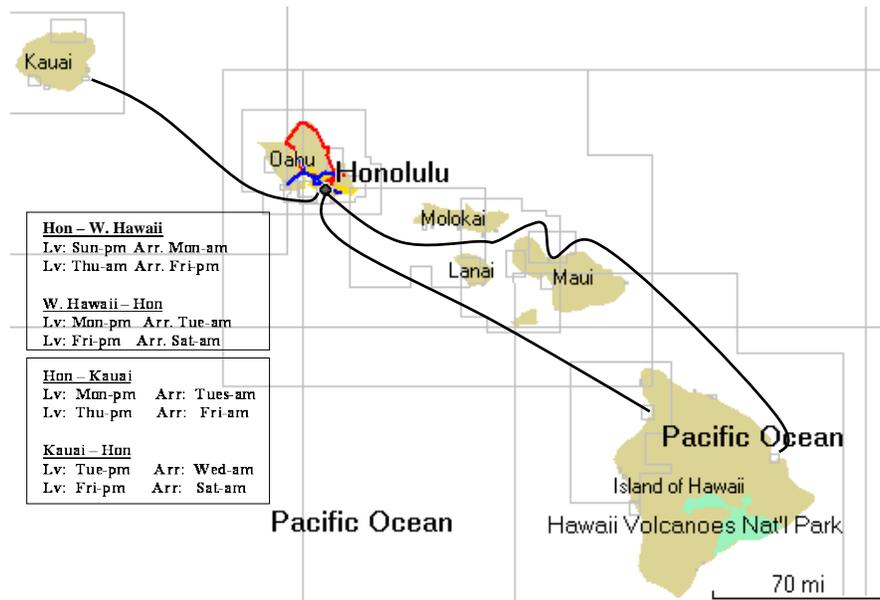
## **OBJECTIVES**

The objective of this study was to map the distribution and abundance of whales and dolphins in the deep waters between the island of Oahu and Hawaii and the island of Oahu and Kauai.

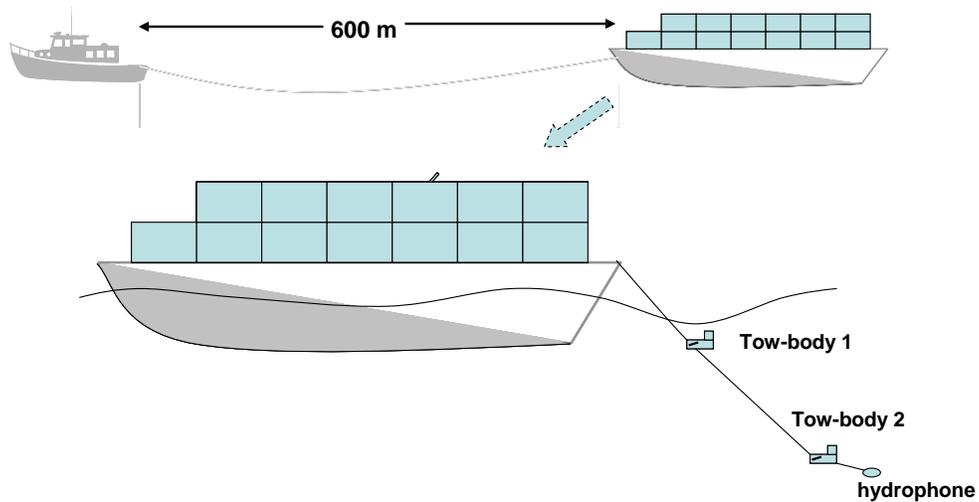
## **APPROACH**

The basic approach was to use the assets of Young Brothers. Tugboats towing large barges make regular runs from the economic and business center of the State of Hawaii, the city of Honolulu. Mr. Mark Houghton, Vice President of Maritime Operation of Young Brothers, has agreed to allow acoustic monitoring equipment to be located on some of their barges without charging the University of Hawaii. Such a project has allowed Young Brothers to perform an interesting public service. A map of three shipping routes between Honolulu and W. Hawaii, between Honolulu and E. Hawaii and between Honolulu and Kauai is shown in Figure 1.

The original concept was to use a 2-hydrophone array attached to the barge, which is usually about 300 m behind the tugboat, to collect acoustic data that would be telemetered to the tugboat via a wireless link. However, after much discussion with the barge foreman it was decided that this concept was not workable. This design was changed to a down-planing tow body (called a towfish) that is attached to the barge with a hydrophone attached to the towline. A picture of the tow body is shown in Figure 2 and other pieces of equipment are shown in Figure 3.



**Figure 1. Map of the main Hawaiian Islands and three different Young Brothers barge route along with typical schedules between Honolulu and West Hawaii and Kauai.**



**Figure 2. Experimental geometry showing towfish behind barge. The hydrophone is attached to the towline.**

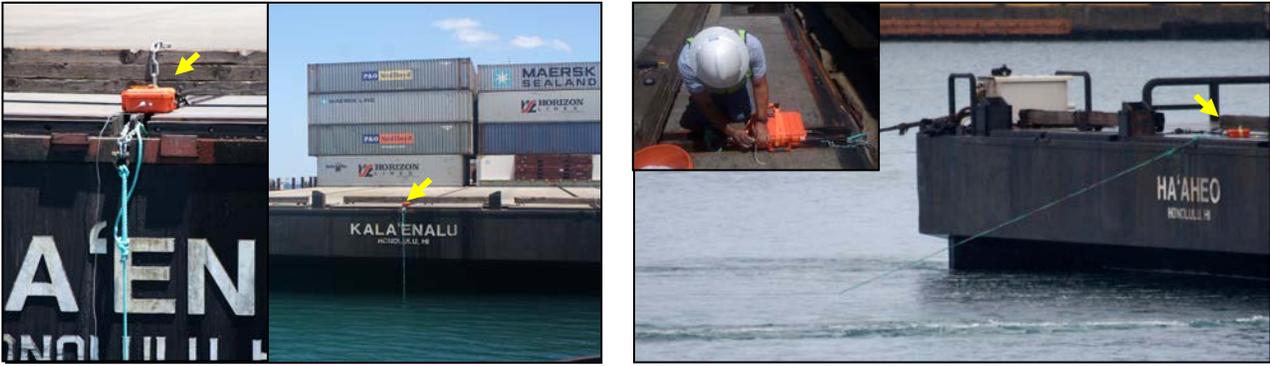


*Figure 3. Equipment used to monitor for marine mammals.*

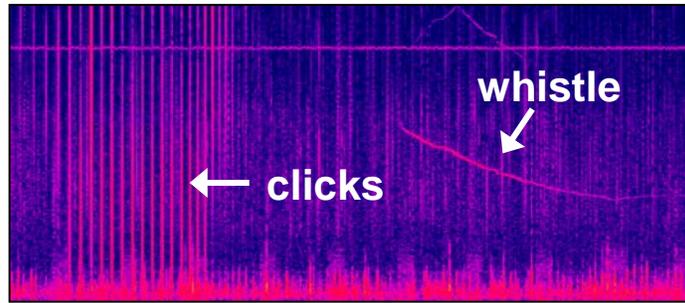
## **WORD COMPLETED**

Towing system was modified in which two tow-bodies are being used as shown in Figure 2. The two-tow body configuration allow us to get the hydrophone deeper below the barge which resulted in reduced noise level so that current results are much better after this modification. The tow bodies are constructed out of 4-in aluminum tubing with dive planes to force the tow bodies to dive as deep as possible. The two tow-body concept has been working well but required considerable time to develop.

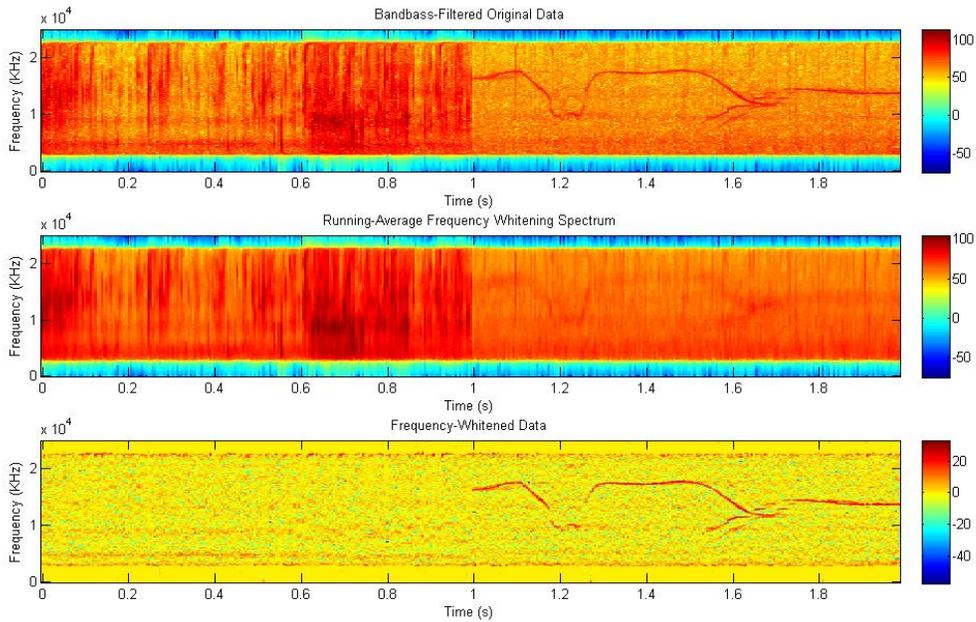
The equipment was easily secured to the deck of the barge as shown in Figure 4 and we successfully collected data for fifty-two round-trips from Honolulu of Oahu to Kawaihae Harbor on the Big Island and from Honolulu to Nawiliwili on Kauai. These trips covered a total distance of 9520 miles at an average speed of 8 mph. Beaufort sea state during these trips ranged between 1 and 5, most time spent at a 5 or above. The sea state highlights the importance of doing acoustic surveys in these areas of low visibility conditions. During these eighteen trips, we recorded more than 16570 hours of acoustic recordings. Of these recordings, 150 hours have been visually and aurally inspected for calls, with a total of 963 total calls from both odontocetes and mysticetes. These hand-analyzed calls were randomly distributed throughout the year so that we could use them to ground-truth automatic detection later. During some sightings, echolocation signals were also recorded as can be seen in Figure 5b. All the data collected so far has been synced with GIS, and will be compared to remotely sensed oceanographic data as shown in Figure 7. Custom matlab programs have been written to maximize data visualization. Once optimized, data will be automatically detected via the Osprey or Ishmael programs by David Mellinger (Oregon State University). Automatically detected data will be plotted and correlated with remotely sensed data such as depth, sea surface temperature, and wind speed. Although all data collected as part of this project has not been completely analyzed, it forms the major part of Alexis Rudd's PhD thesis and will yield extremely useful information when fully analyzed.



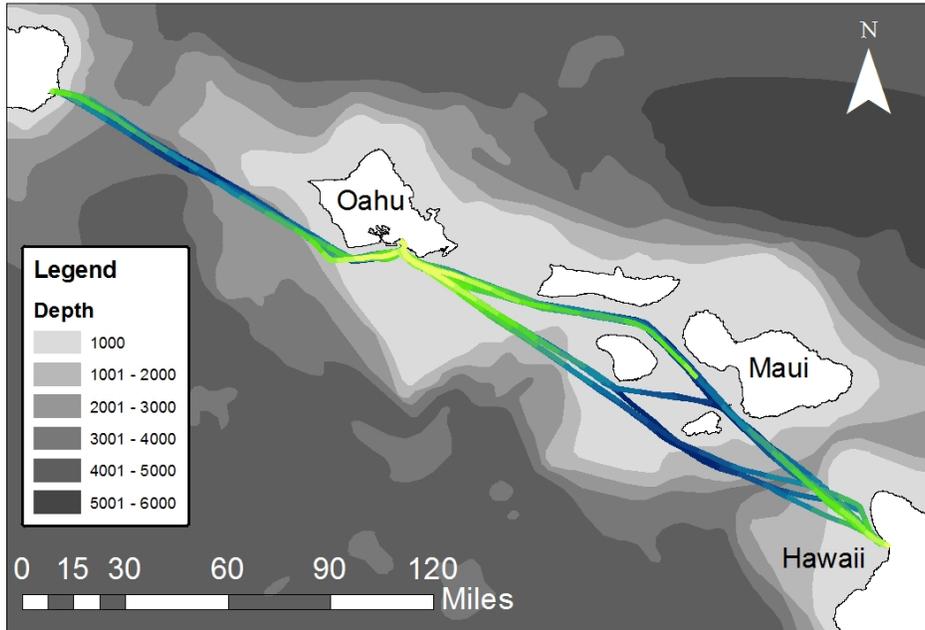
**Figure 4.** Acoustic recording equipment deployed on the Young Brothers barges *Kala'enalu* and *Ha'aheo* in port (A,B). Acoustic recording equipment being secured on deck and underway at a speed of 5 knots. Yellow arrows point to the onboard electronics.



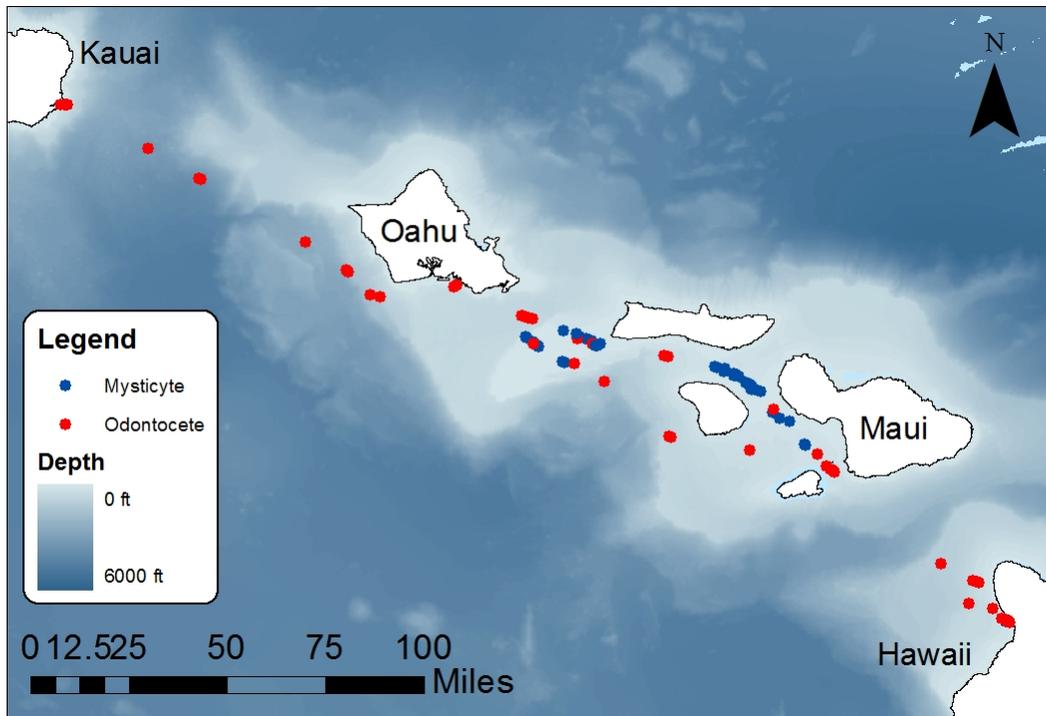
**Figure 5.** Acoustic recordings of bottlenose dolphin whistle.



**Figure 6:** Gaussian filtering optimizes visualization of data. Top: unfiltered “noisy” data region. Middle: gaussian filter data. Bottom: filtered data.



*Figure 7. Acoustic tracklines between the Hawaiian Islands. Dark blue indicates night-time surveys and yellow indicates daylight survey effort.*



*Figure 8: Acoustic and visual detections (both mysticete and odontocete) from the survey effort analyzed so far, with wind speed data from the Hawaii Wind Project.*

In addition to completing a full year of data collection, we completed construction of a new acoustic system. This system uses a timer to operate a winch, which lowers the recording equipment into and out of the water once the barge has exited the harbor. All recording and data storage has been moved to an underwater capsule, which will still be kept at depth with a towfish. We anticipate that this new system will decrease ambient noise and lead to increased detections and increased survey efficiency. The new system is currently being tested before being tried out from the barges.



*Figure 8. Timered winch and housing for the new acoustic recording system.*

## CONCLUSIONS

The concept of using interisland barge to collect acoustic data has been shown to be a workable one. Very important long term data in areas of the ocean within the main Hawaiian islands that would not usually be collected can now be collected. However, there are some important obstacles that need to be overcome. One is the noise in the electro-acoustic system needs to be lowered. A scheme must be derived to get the hydrophone deeper in the water column. The present limitation of having the hydrophone at a depth of 20 feet so that it will not drag on the harbor bottom must be overcome. A winch system is being configured and will be tested so that once the barge leaves the harbor the hydrophone will be automatically lowered to a deeper depth.