Humpback whale calls detected by autonomous Wave Glider in tropical ocean basin between known Hawaii and Mexico breeding assemblies

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Marine Mammal Commission
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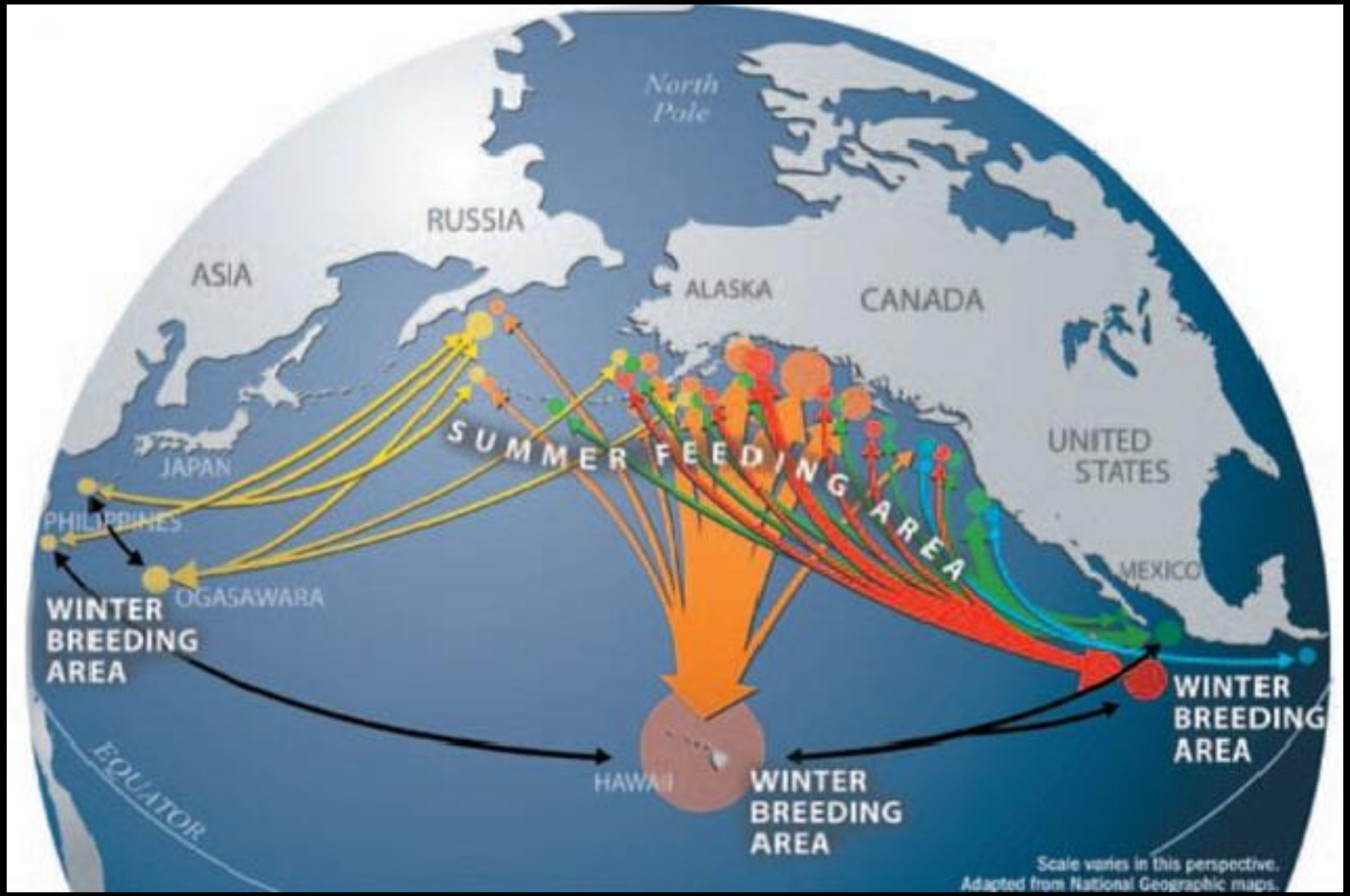
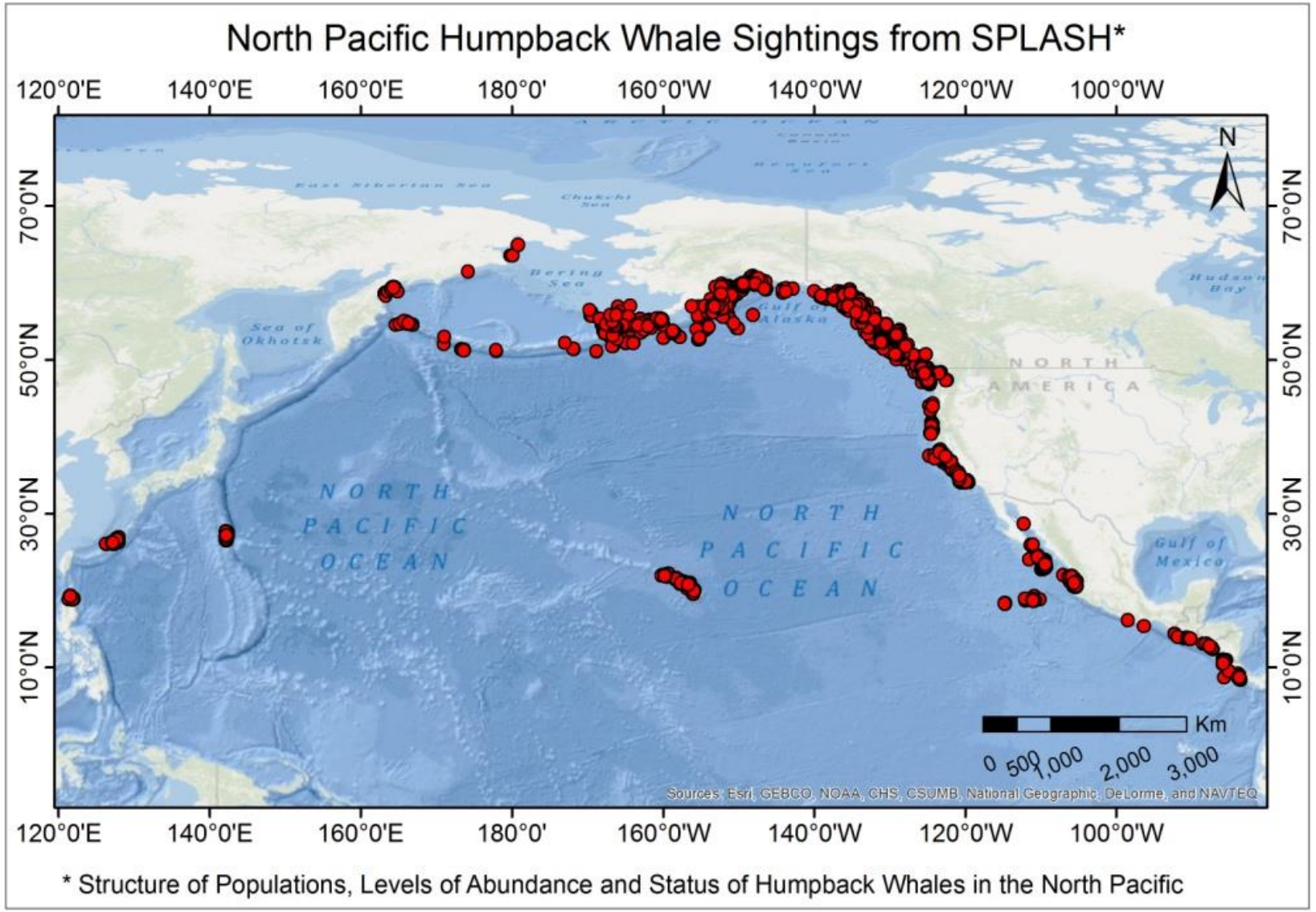
SPLASH Study 2004-2006



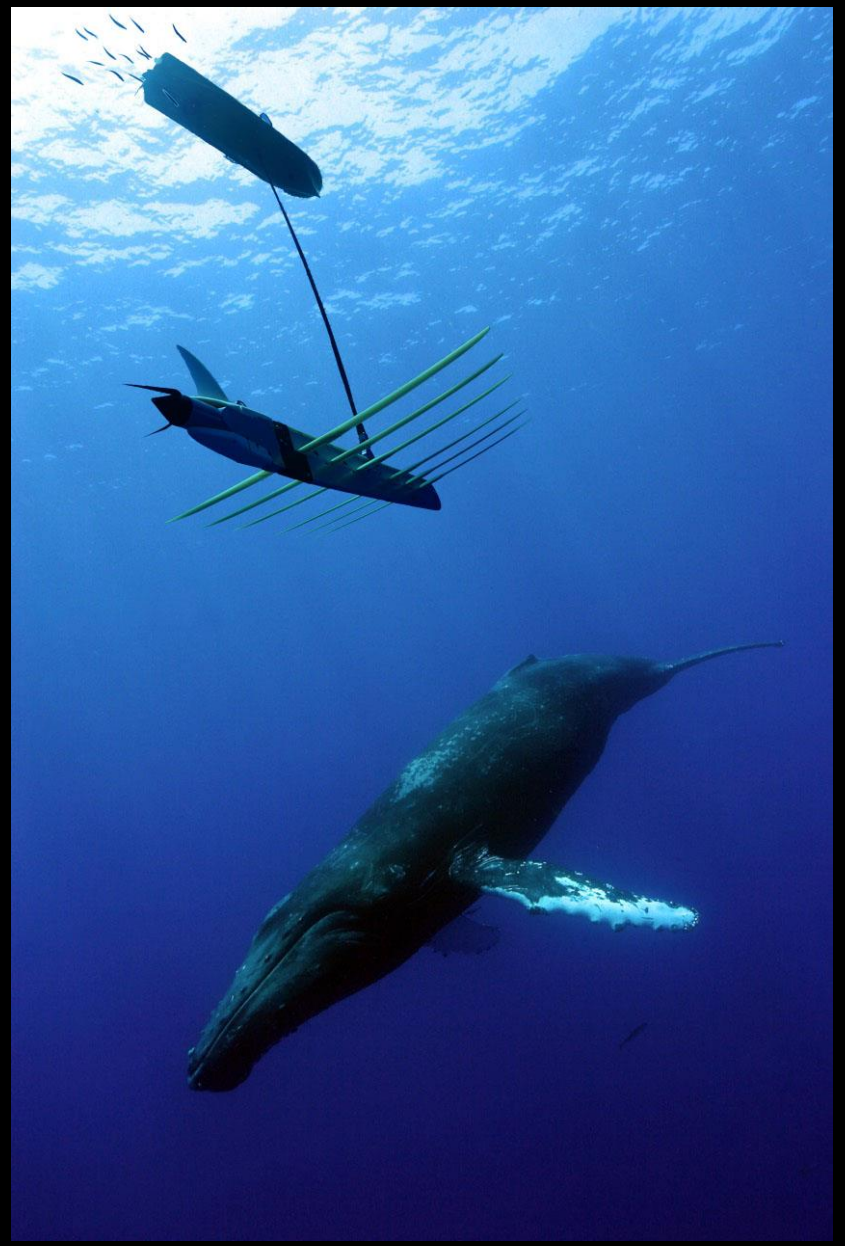
Both song data and Photo-ID matches shows there is a close connection between all the "Areas". Of note, the lines do not indicate migration routes.



North Pacific humpback whale sightings from SPLASH 2004-2006. The data include > 18,000 photo-identification records and 2,700 DNA profiles for 8,000+ unique individuals (red dots). Winter surveys in the breeding grounds have only been conducted close to shore, not in the offshore waters between the grounds. (http://blogs.oregonstate.edu/geo599spatialstatistics/2013/05/06/my-spatial-problem-non-systematic-whale-sightings-genetics-and-environmental-variables/#)

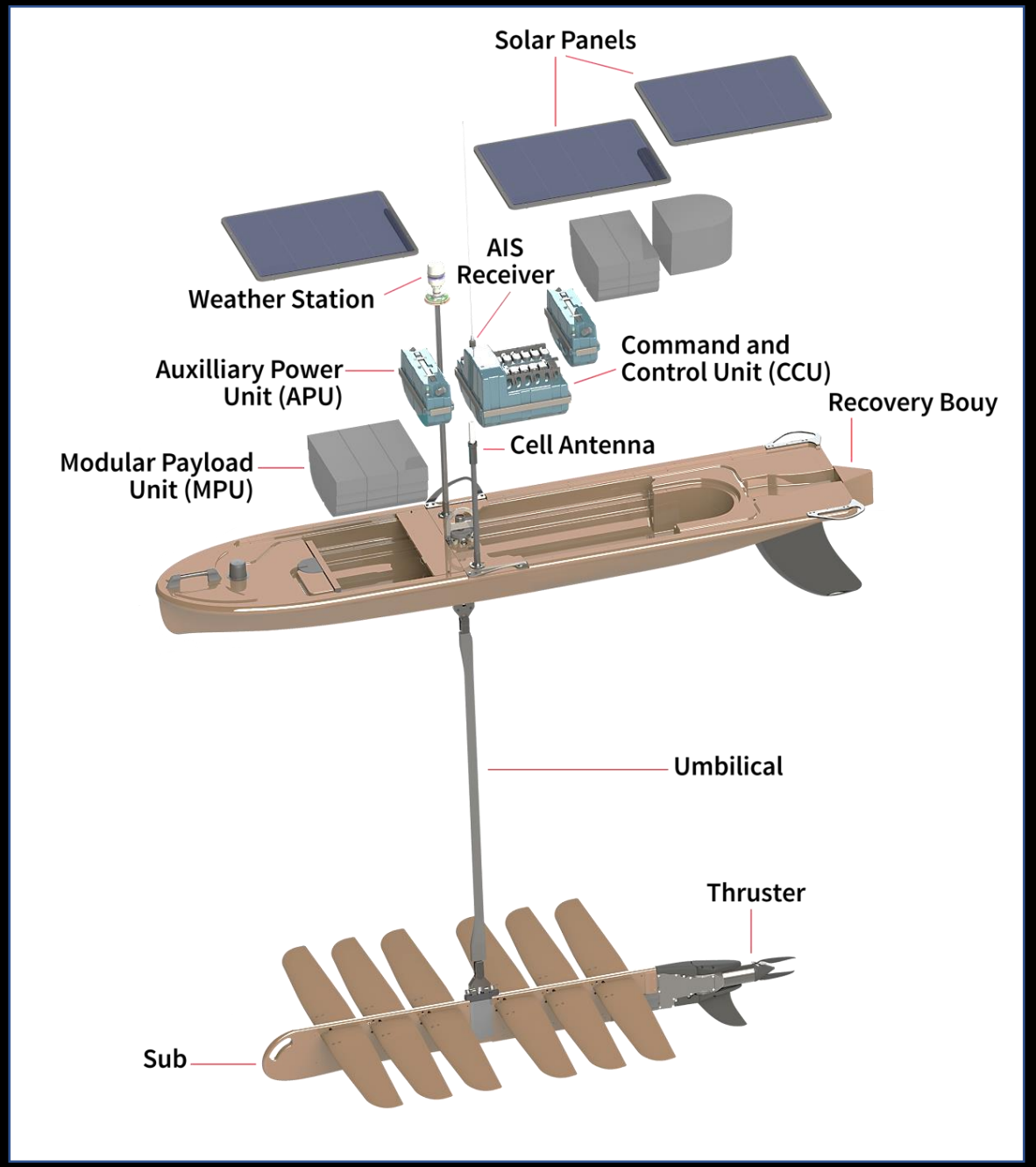
HUMPACS: Humpback Pacific Survey

The purpose of this study was to investigate if whales were present in the offshore waters between the breeding grounds. Jupiter having co-developed the Wave Glider and having spent years streaming live whale songs from it, felt it was the perfect platform for such a survey.

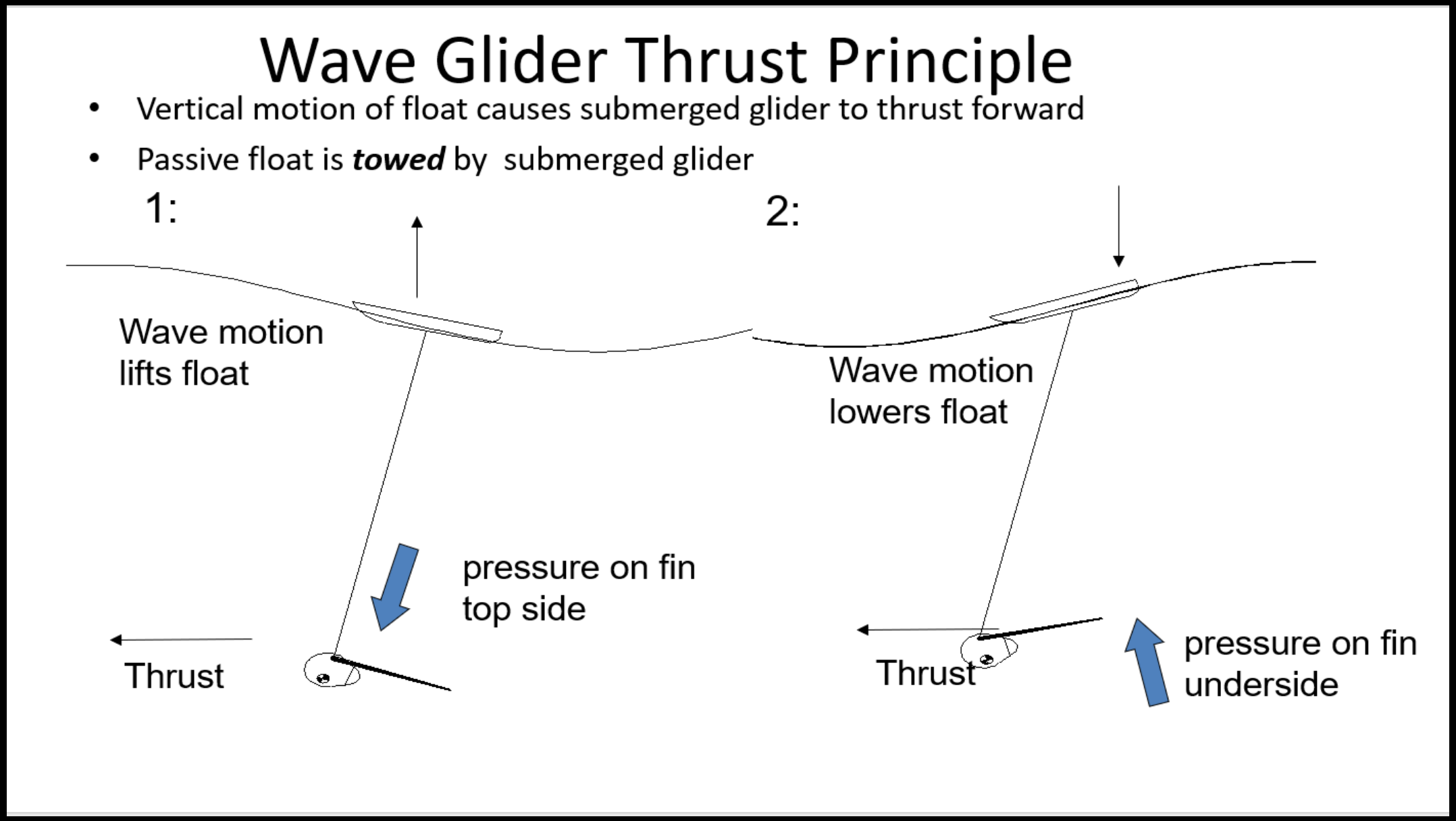


Ed Lyman / HIHWNMS / NOAA
Fisheries Permit #782-1719
(Original image has been altered to include Wave Glider)

SV3 Wave Glider: includes three user-configurable payload bays, cell and sat coms, solar power, and many other features including vessel collision avoidance.

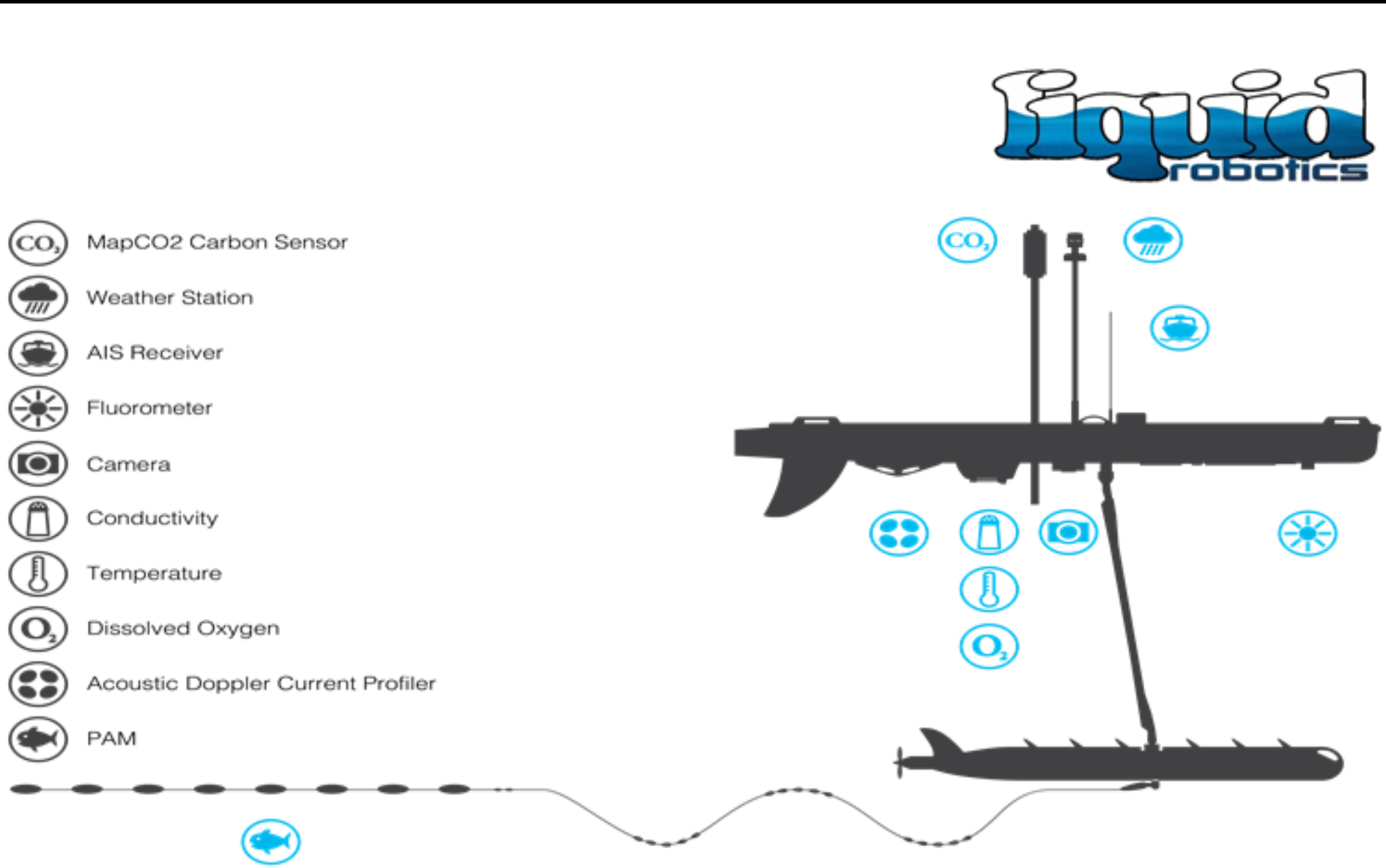


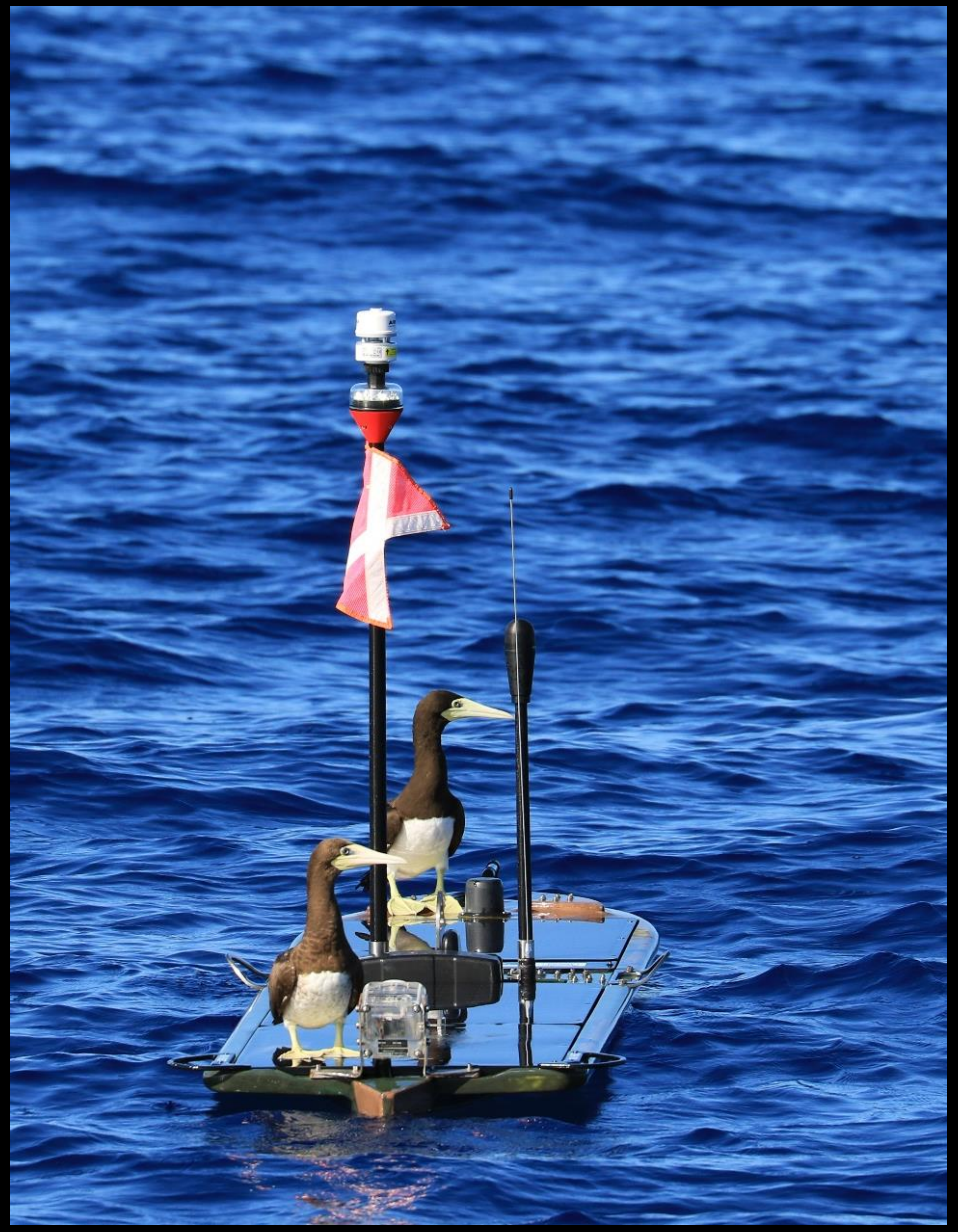
How it works


Wave Glider Thrust Principle
• Vertical motion of float causes submerged glider to thrust forward
• Passive float is ***towed*** by submerged glider
1:
2:
Wave motion
lifts float
Wave motion
lowers float
pressure on fin
top side
Thrust
Thrust
pressure on fin
underside

Types of payloads the vehicle can carry

- MapCO2 Carbon Sensor
- Weather Station
- AIS Receiver
- Fluorometer
- Camera
- Conductivity
- Temperature
- Dissolved Oxygen
- Acoustic Doppler Current Profiler
- PAM



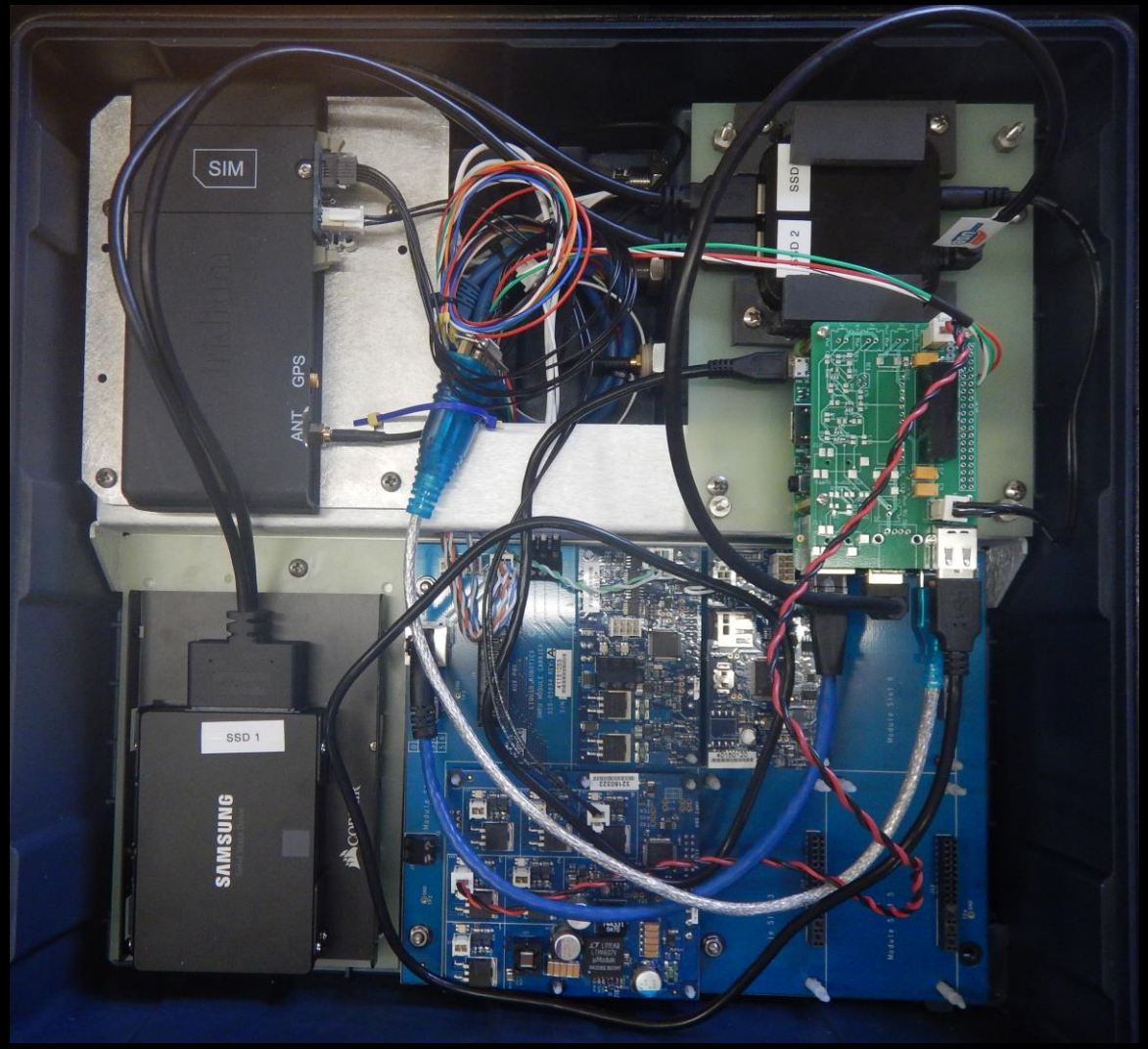


However, what it mostly carries is boobies!

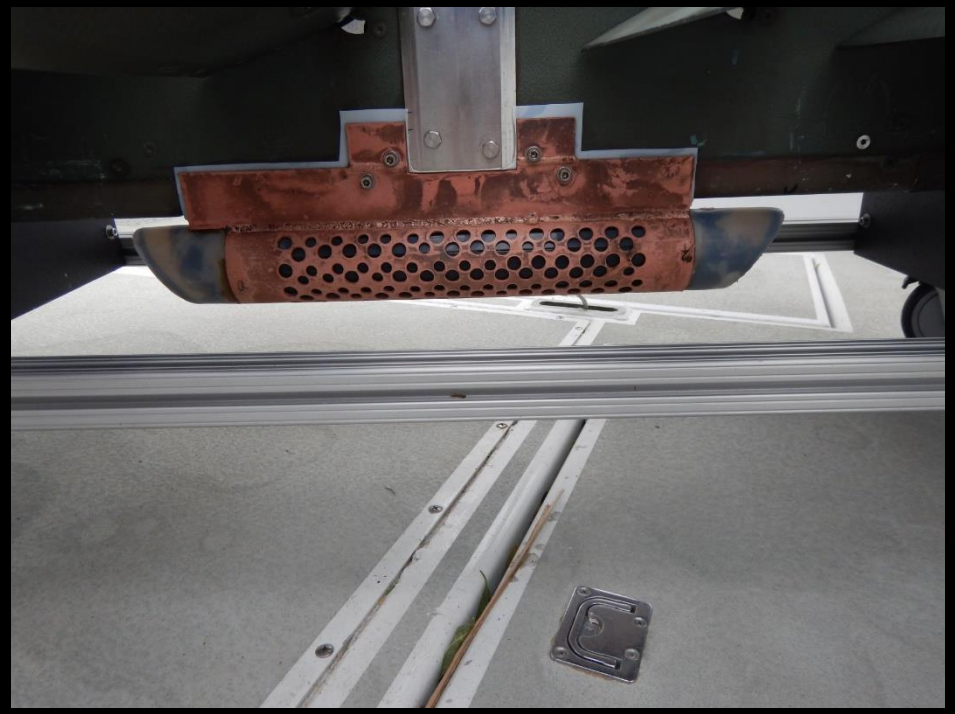
HOW DO YOU SEARCH FOR A NEEDLE IN A HAYSTACK?

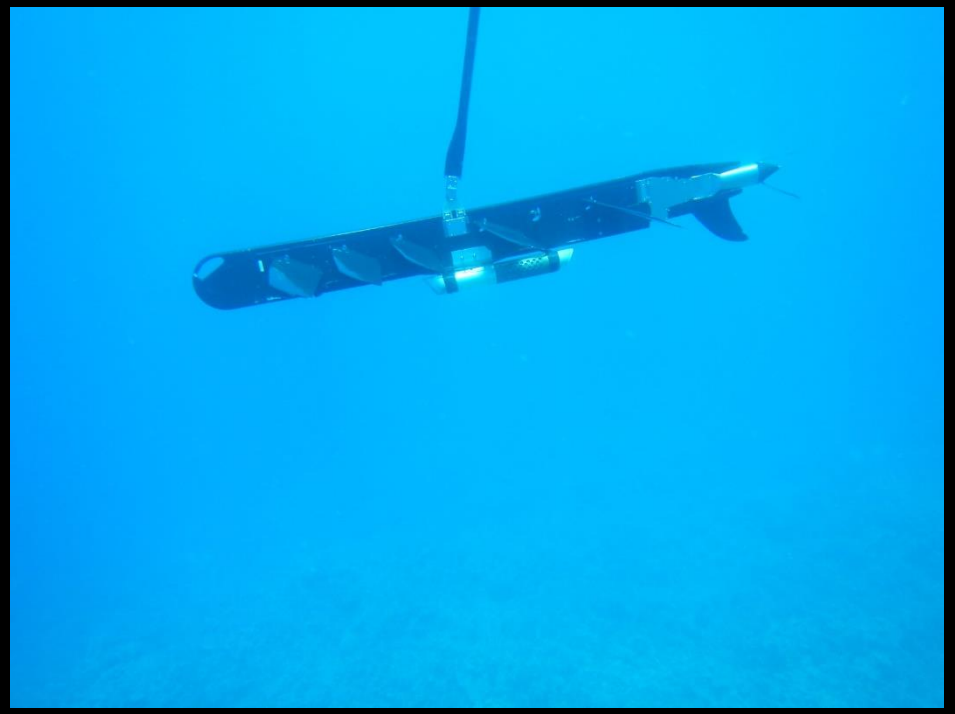
You build sophisticated payloads and keep your fingers crossed, luckily our needle is a loud one!

- Ocean Sonics icListen 200 kHz calibrated digital HP
- Sampling at 32kHz at a bit depth of 24bits



- Audio Payload with 24/7 duty cycle and 4TB storage
- Ability to download 30 sec audio during mission

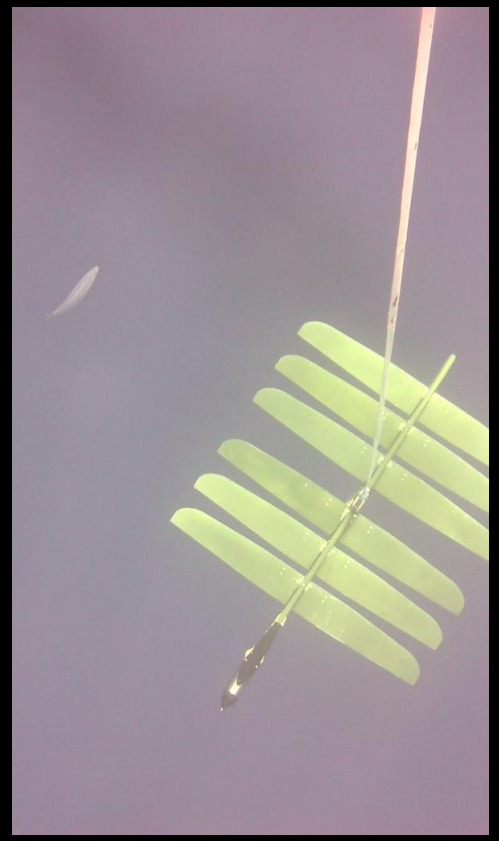




Copper hydrophone housing
hard mounted to sub with fairings to reduce flow noise

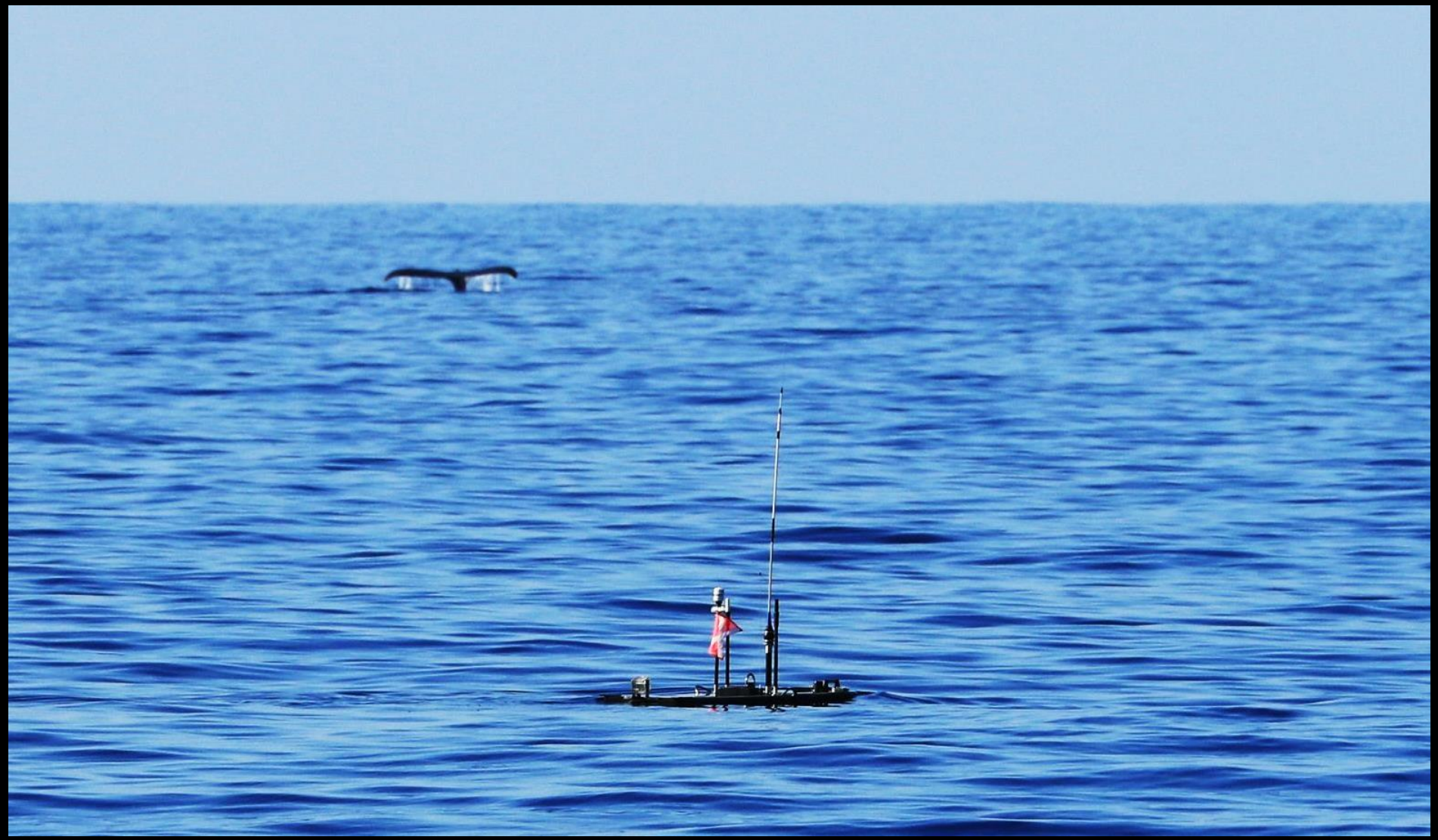
We also mounted cameras on the float to monitor the health of the antenna's and the sub

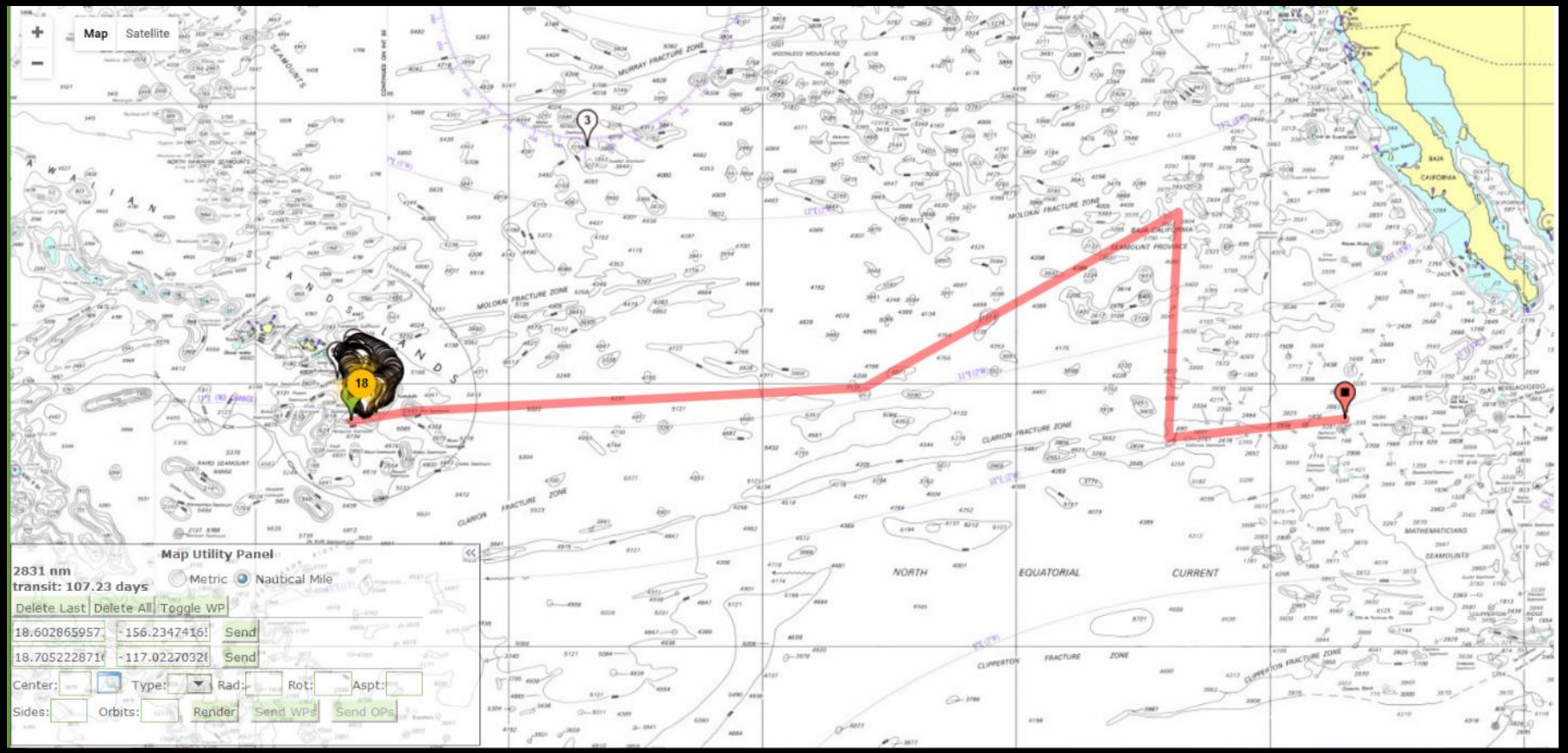
SUPER, BLUE, BLOOD MOON



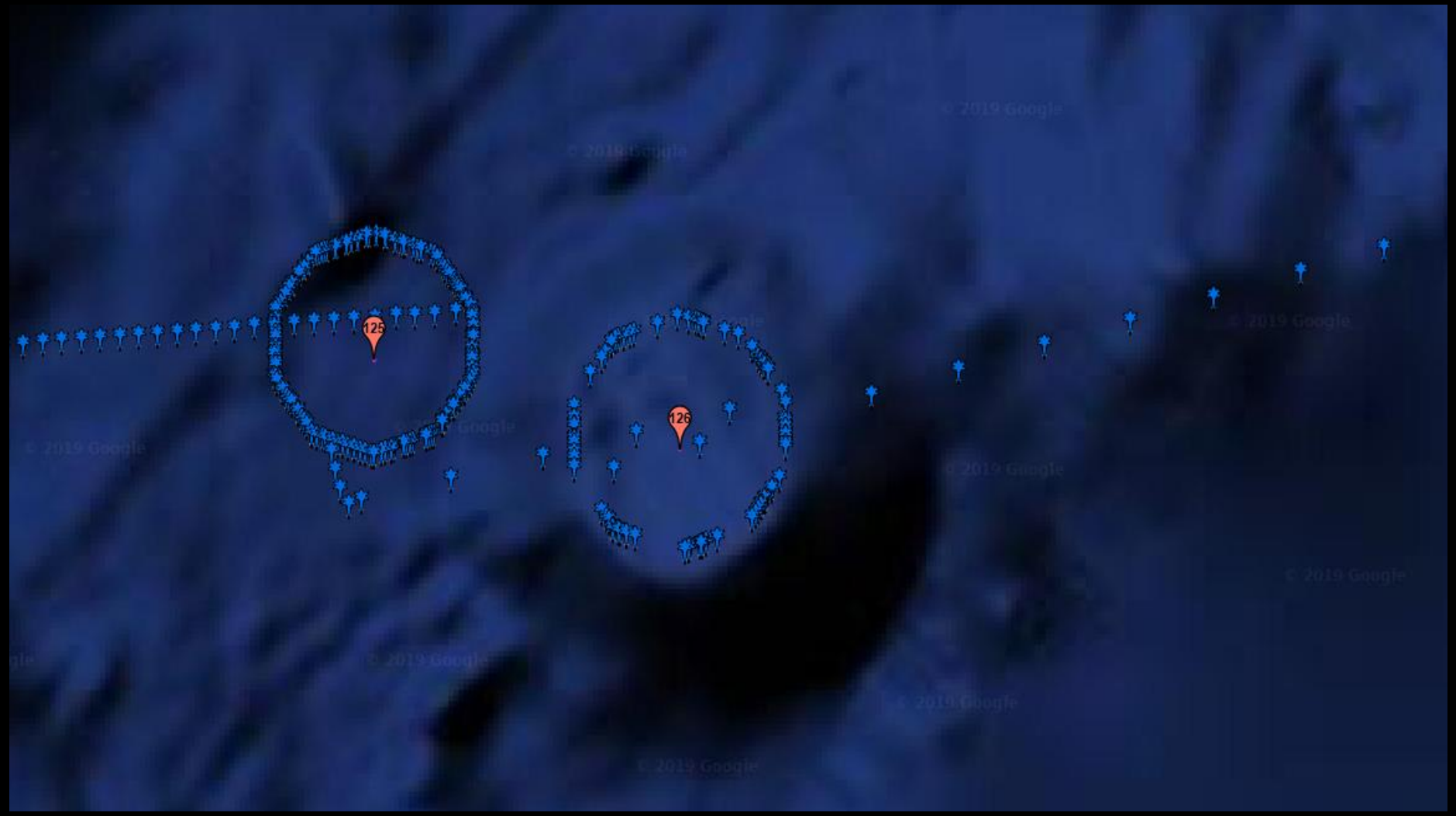
Sub and Umbilical

Launch Day, as if the whales knew our mission!



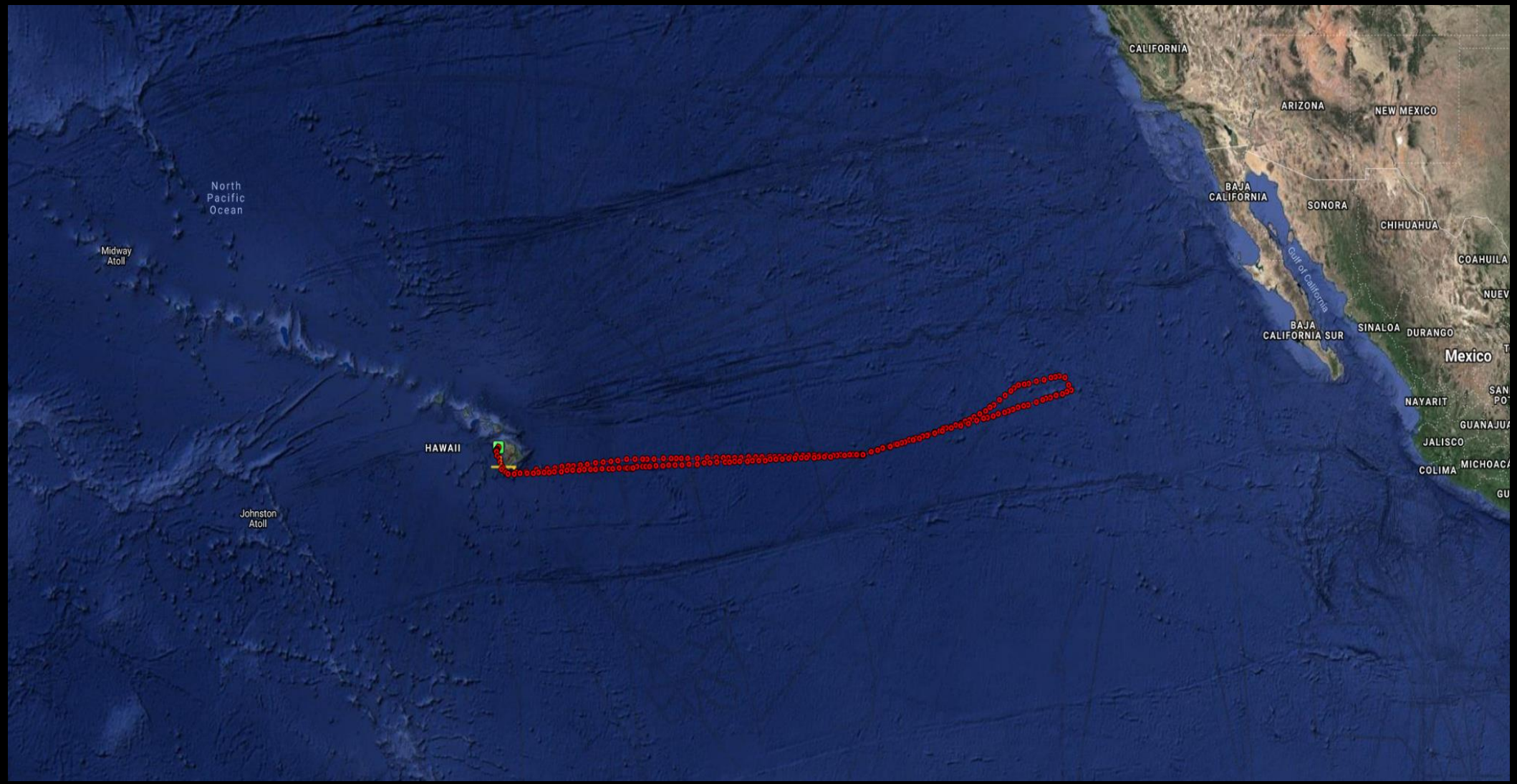


Approx. 2,000 nm from Puako, HI to Baja California Seamount Province, Mexico to circle around. From here we could go south to Alphecca Seamount or north to San Diego or back to Hawaii for recovery. With the wave glider we could decide on the fly.



The intent being that anytime there was a seamount, or we heard something of interest we would give Europa a command to circle around.

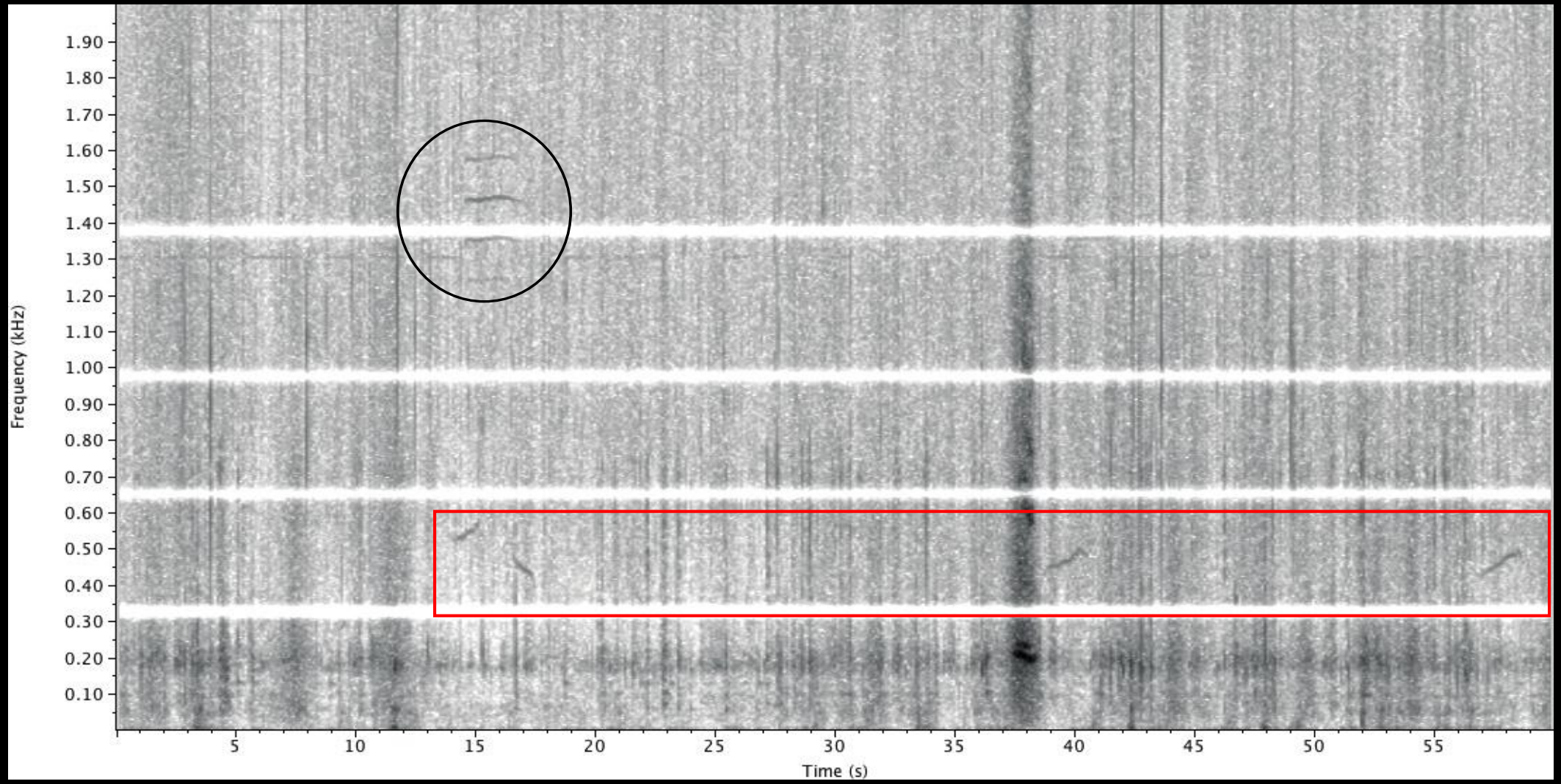
HUMPACS: Hawaii to Baja CA and back: 3,761 nm in 100 days at 1.5 knots



This type of survey had never been done before.

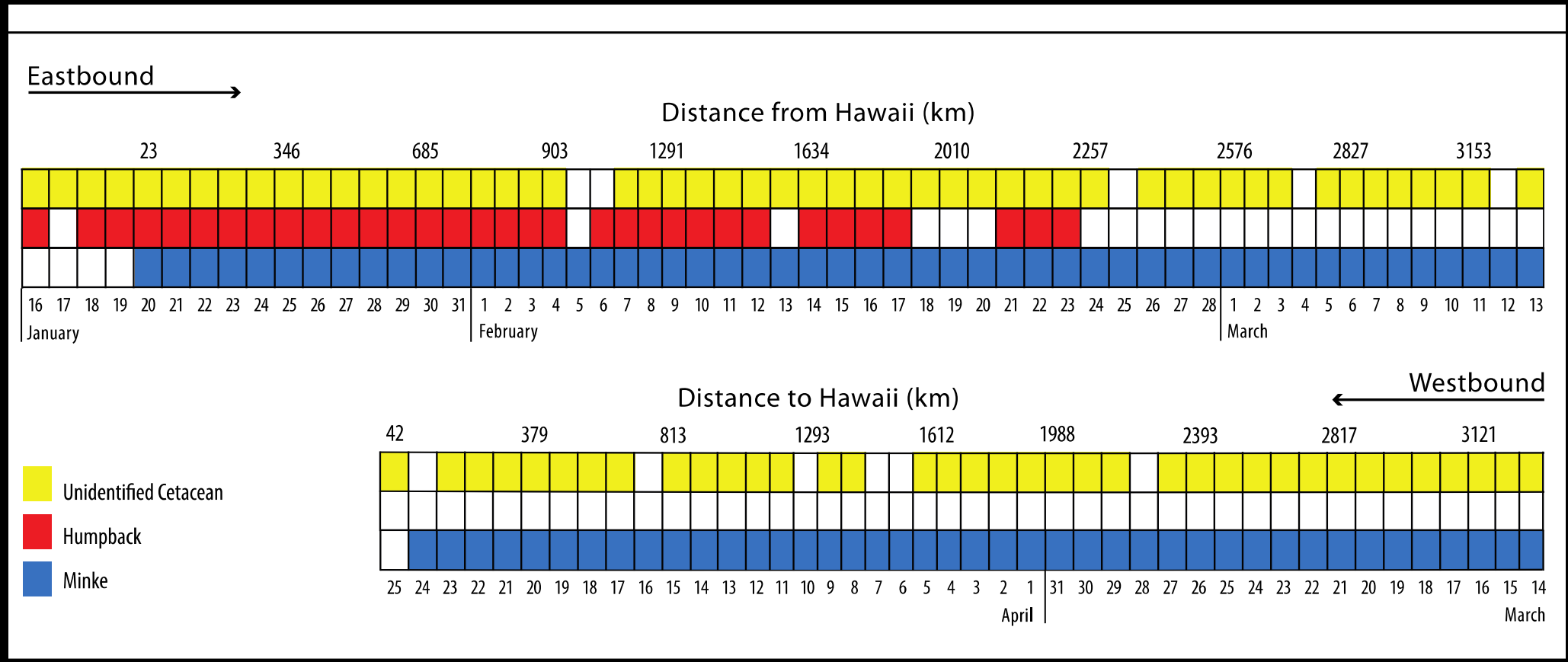
Once recovered, the real work began!!!

- Total Audio Hours Recorded and Reviewed (3x): ~2, 300hrs; or 755GB
- It took four people 8 hrs/day for 6 weeks to analyze the data
- Sounds were categorized into humpbacks, minke, odontocetes, vessel, mechanical and unknown

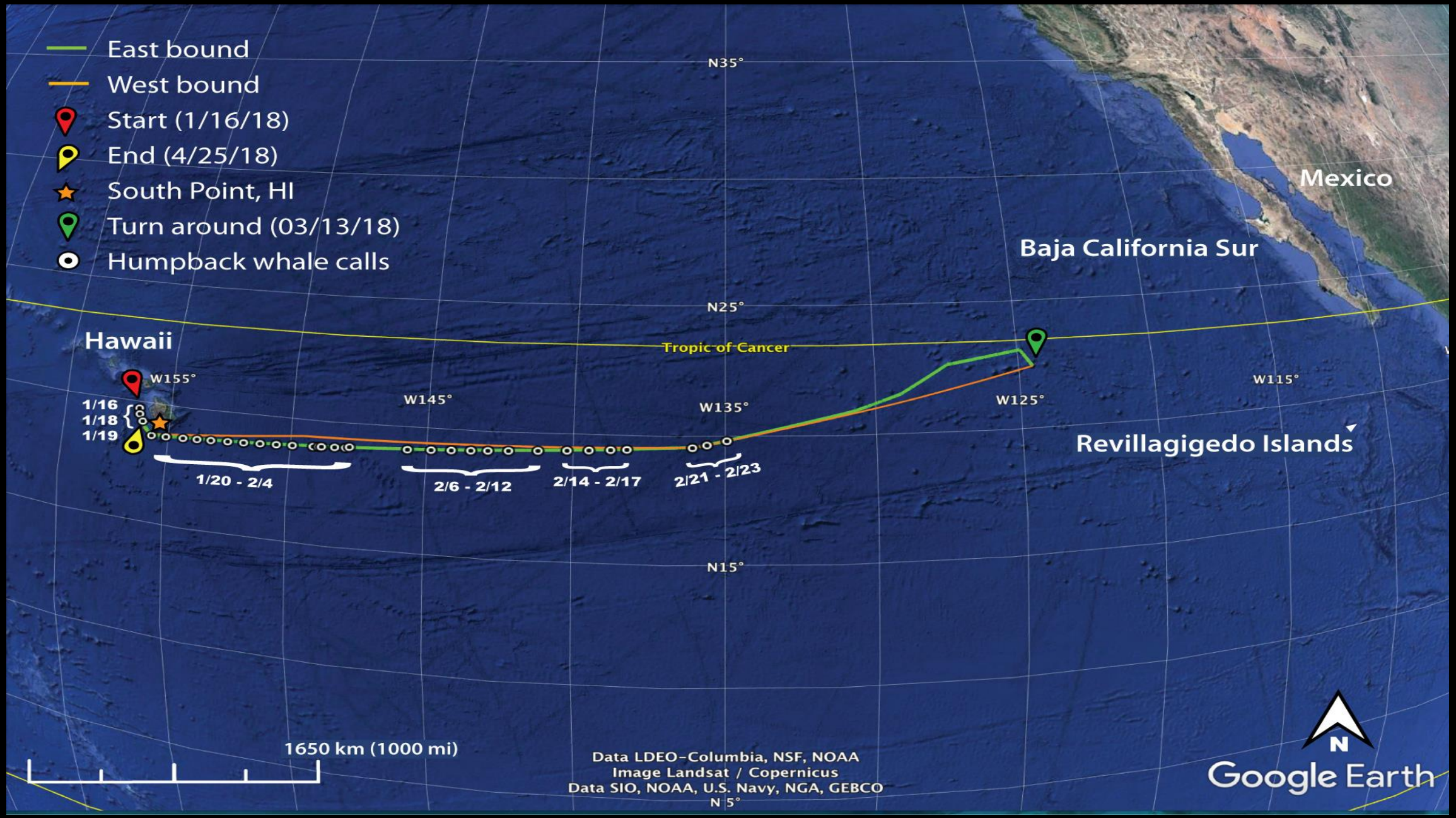


- This is an example of sounds recorded on 14 February 2018, at 5:43 (UTC) 1,634 km offshore
- The circled sound is a minke whale boing, the most common sound heard over the survey
- The box indicates a series of humpback whale calls
- We heard over 5000 Cetacean calls and over 2,048 Humpback whale calls
- We used a low-pass filter at 4kHz and a band-pass filter to reduce the rudder noise at 325 Hz and its harmonics (white lines)

Summary of call encounters throughout the 100-day survey: date and distance from Puako, Hawaii, eastbound above and westbound below. South Point rounded 20 January 2018.



The red indicates confirmed humpback whales, which we heard 33 out of 100 days. The yellow are unidentified cetaceans, which we heard 88 out of the 100 days, some of which could have been humpbacks, and blue are minke whales which was 100% of the days. Likely distance of whale calls was within 5-10 nm away, no greater than 60nm away.



We identified humpback calls out to 1,200 nm from Hawaii, approximately midway to Mexico.

These are published tracks of tagged humpback whales. We are aware of other similar data that has not yet been published. However, to our knowledge humpback whales have not been documented in the mid ocean basin between Hawaii and Mexico (orange star).

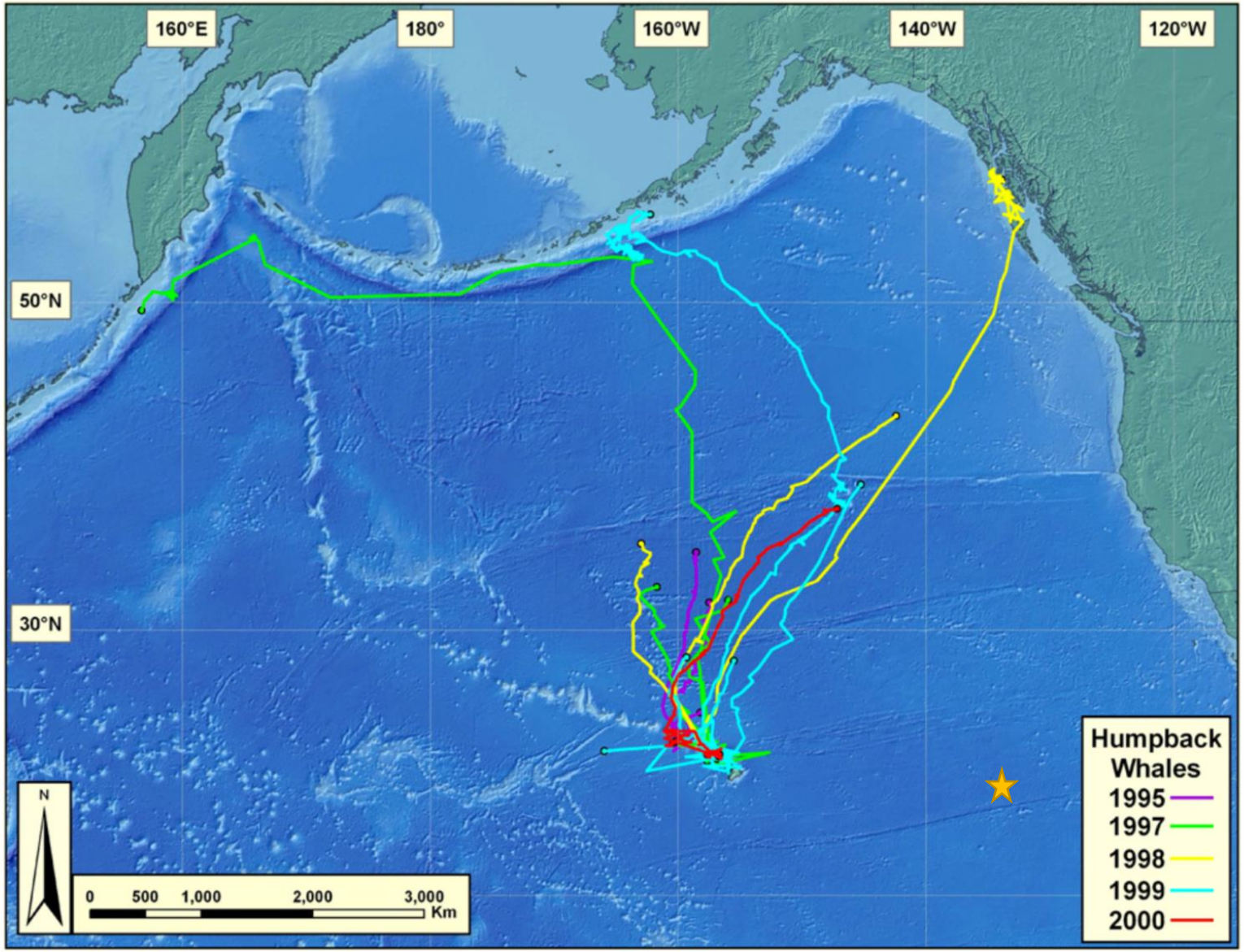
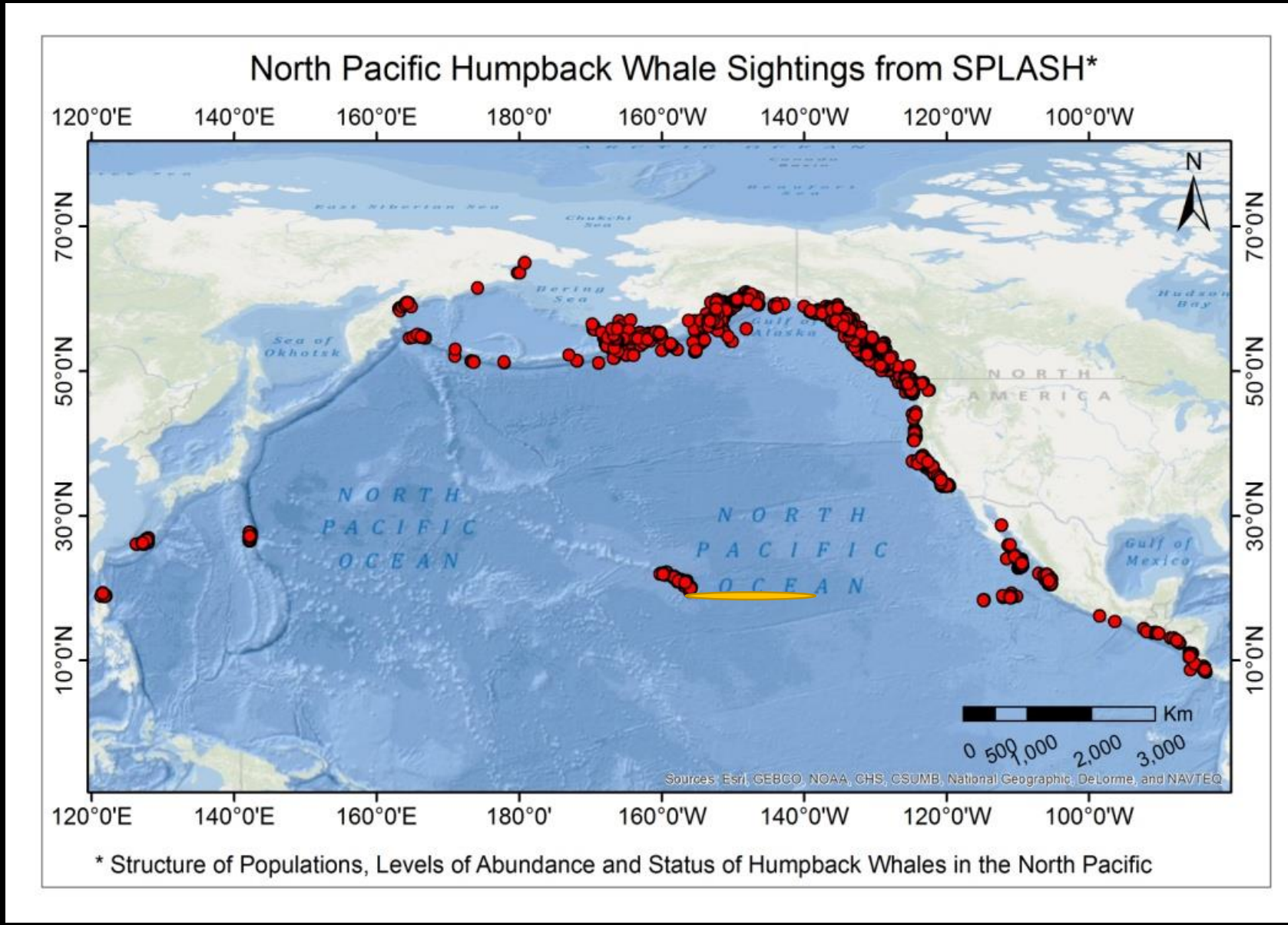


Fig. 7. The spring migratory tracks of humpback whales tagged in Hawaii between 1995 and 2000.

Possibilities

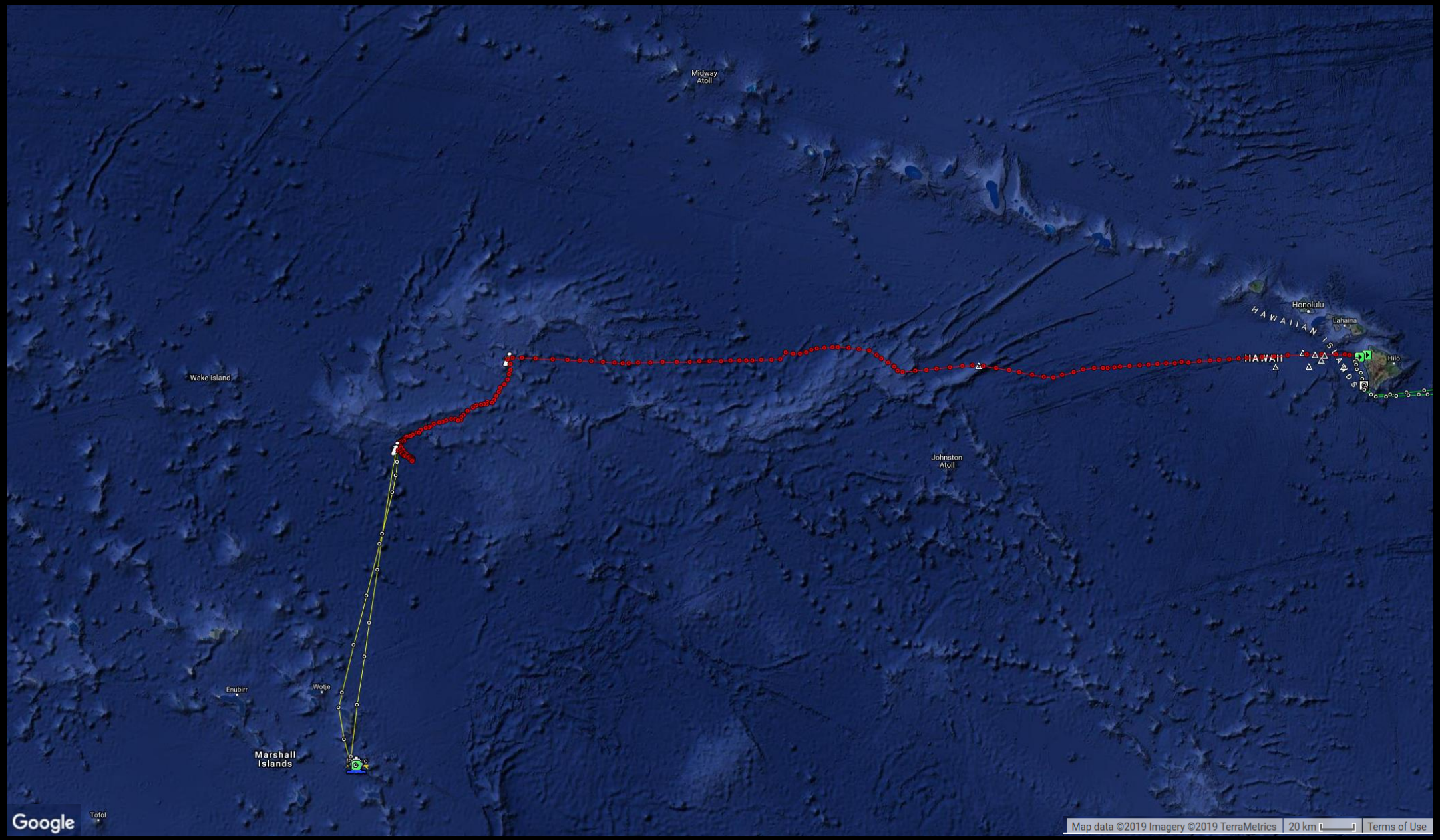
1. Lost whales
2. Undocumented migration route
3. Offshore assembly
4. Mexico – Hawaii same season connection



Our findings of humpbacks ~1,200 nm east of the Hawaiian breeding grounds, lead us to explore west

(http://blogs.oregonstate.edu/geo599spatialstatistics/2013/05/06/my-spatial-problem-non-systematic-whale-sightings-genetics-and-environmental-variables/#)

HUMPACS WEST..... Analysis is underway



Mahalo

Thanks to Jupiter Research Foundation (Joe Rizzi, Beth Goodwin, Kevin Rea, Murray Taylor, Adam Taufmann, Maya Goodoni and Mike Holt) and Whale Trust (Dr. Jim Darling) for their support of this project. As without them, this would have never happened. We'd also like to thank the Marine Mammal Commission for inviting us to present our findings.