



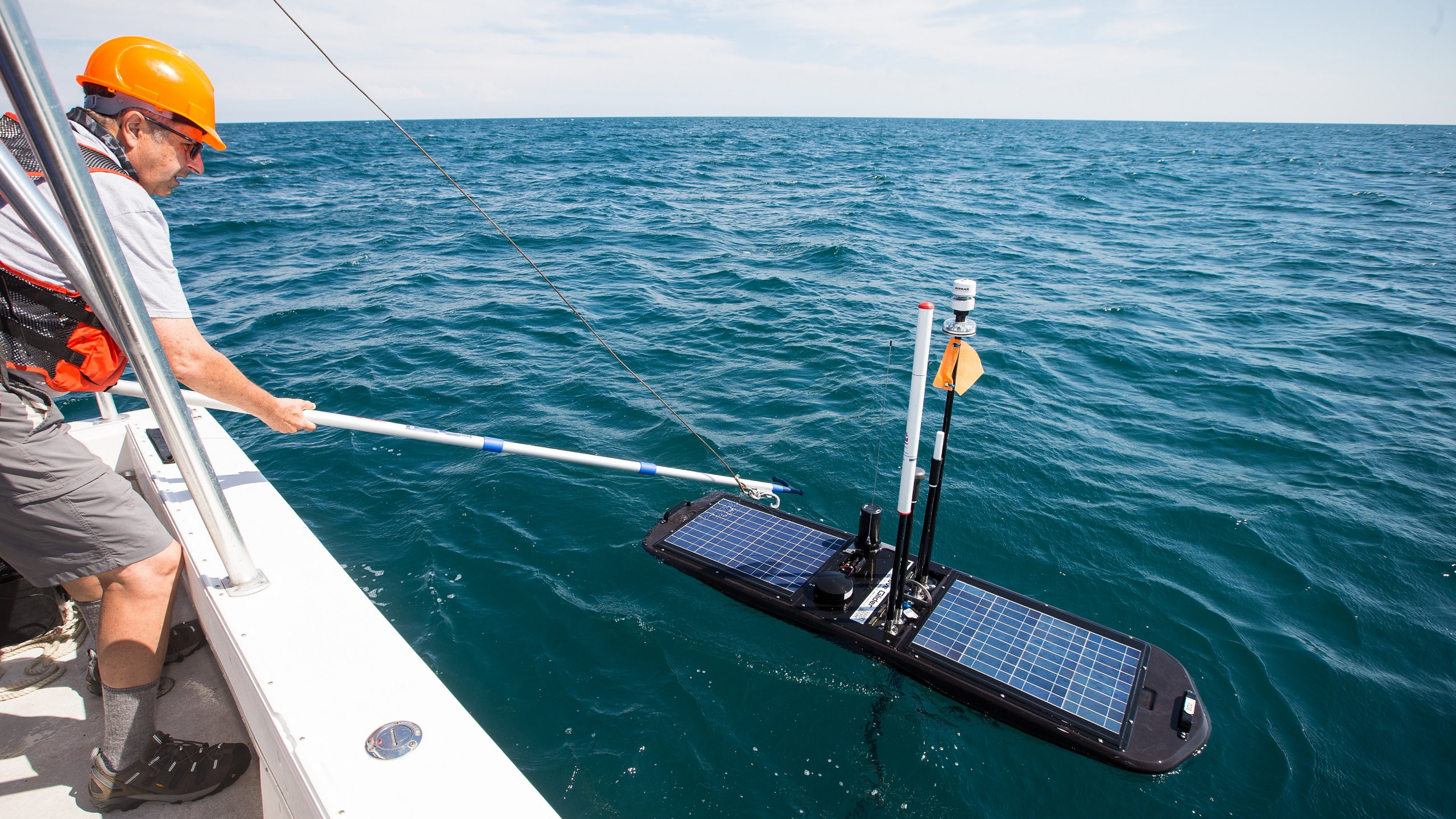
MONITORING FISH SPAWNING LOCATIONS AND MARINE MAMMAL SOUNDS WITH PASSIVE ACOUSTIC RECORDER ON A WAVE GLIDER

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Acoustic Wave Glider NSF MRI Grant

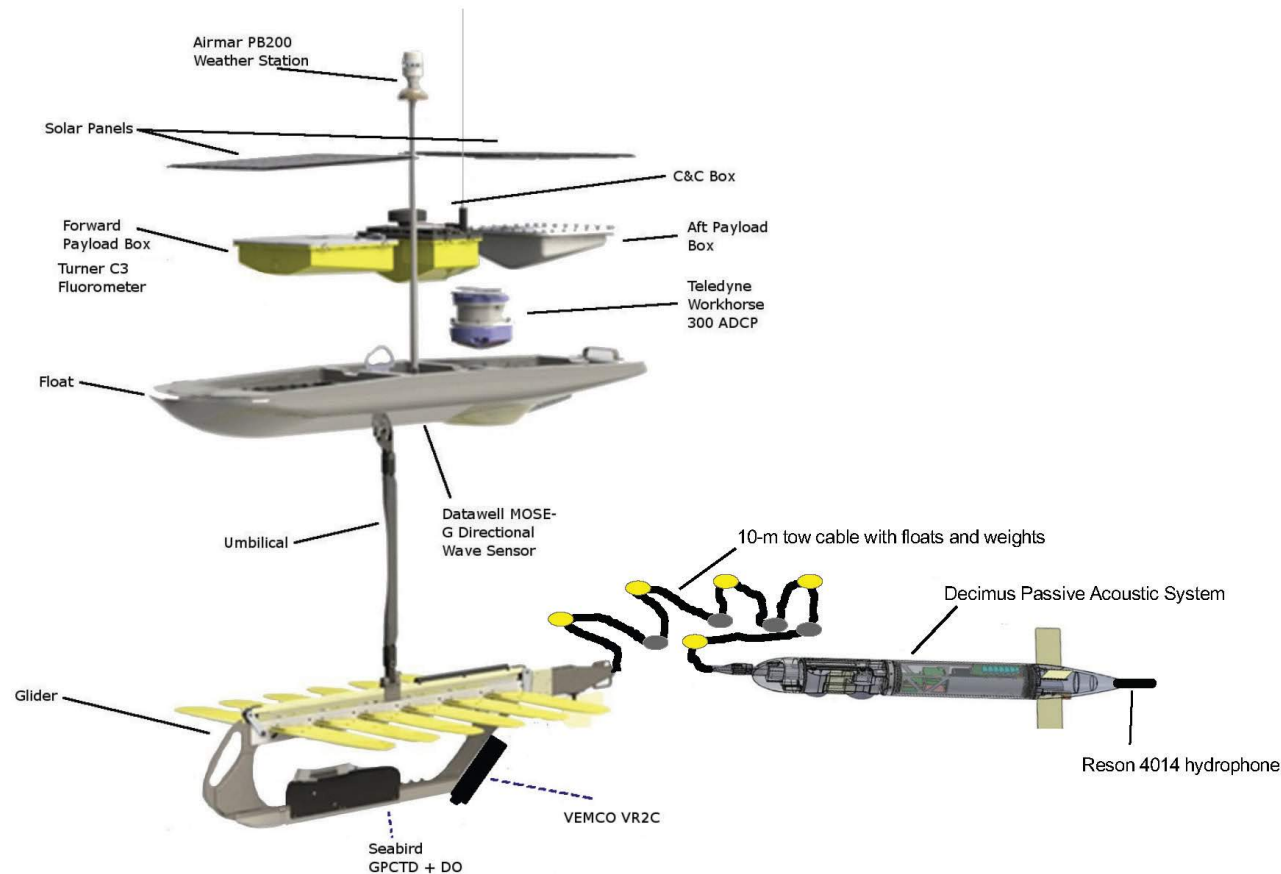
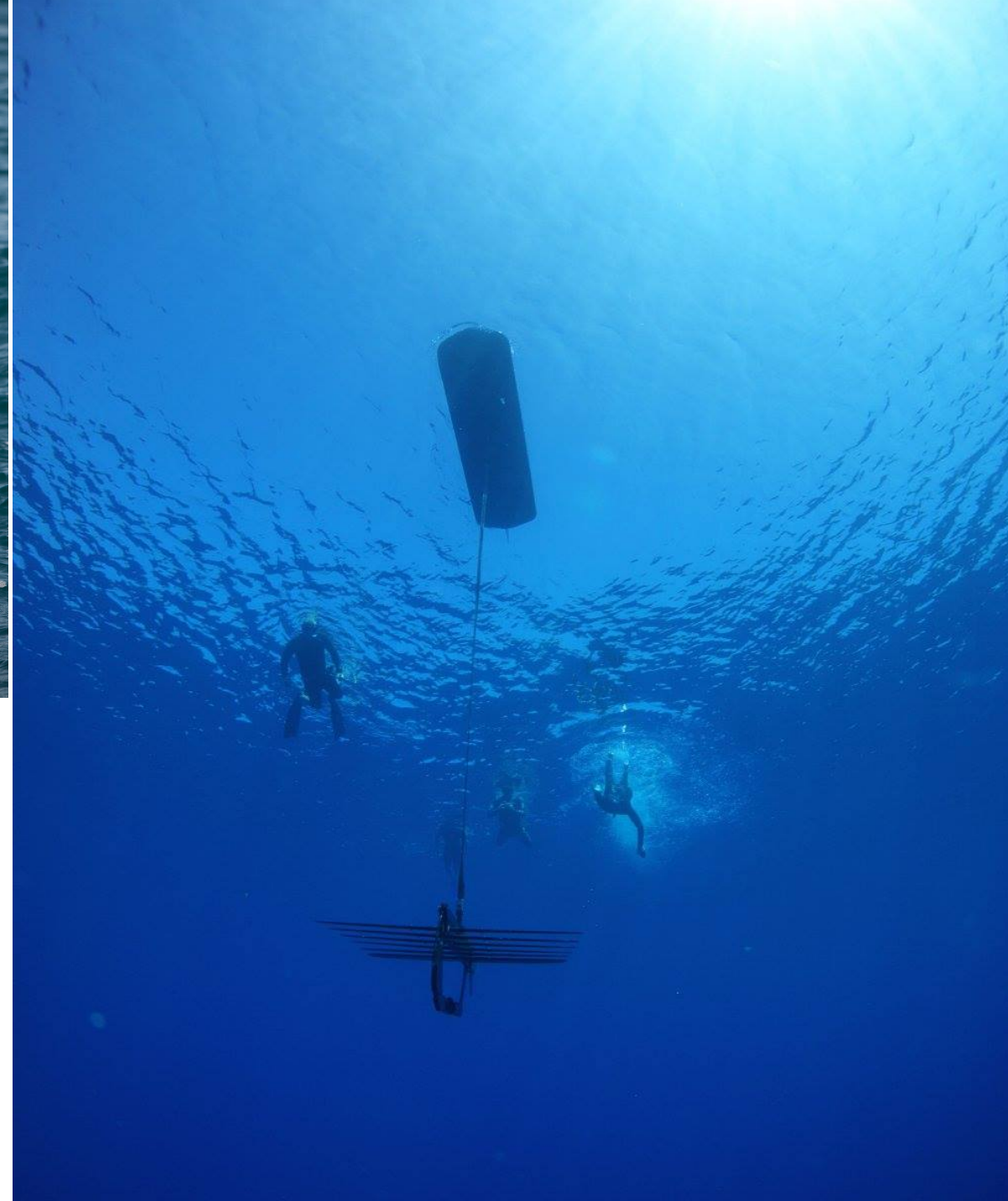
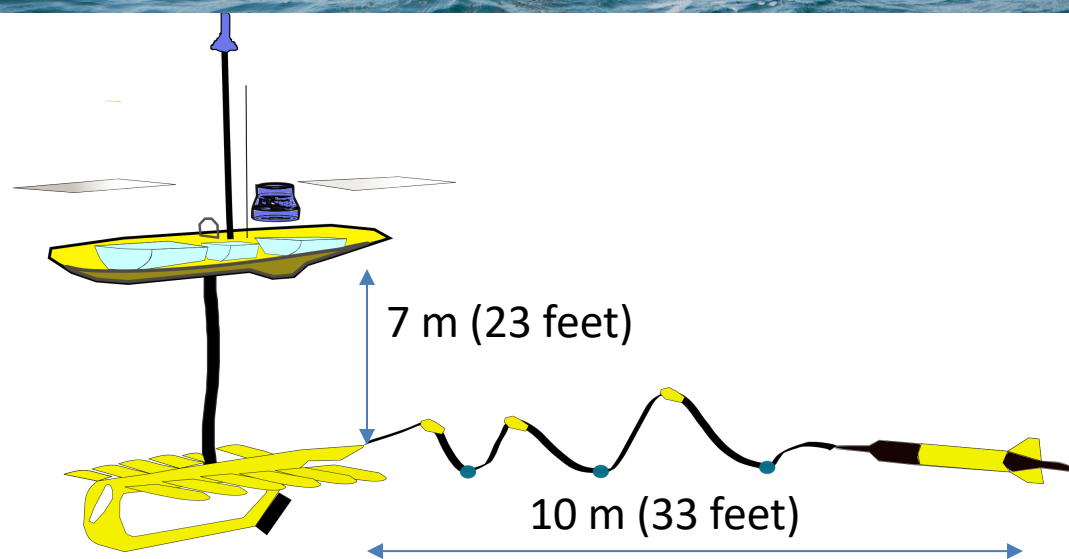
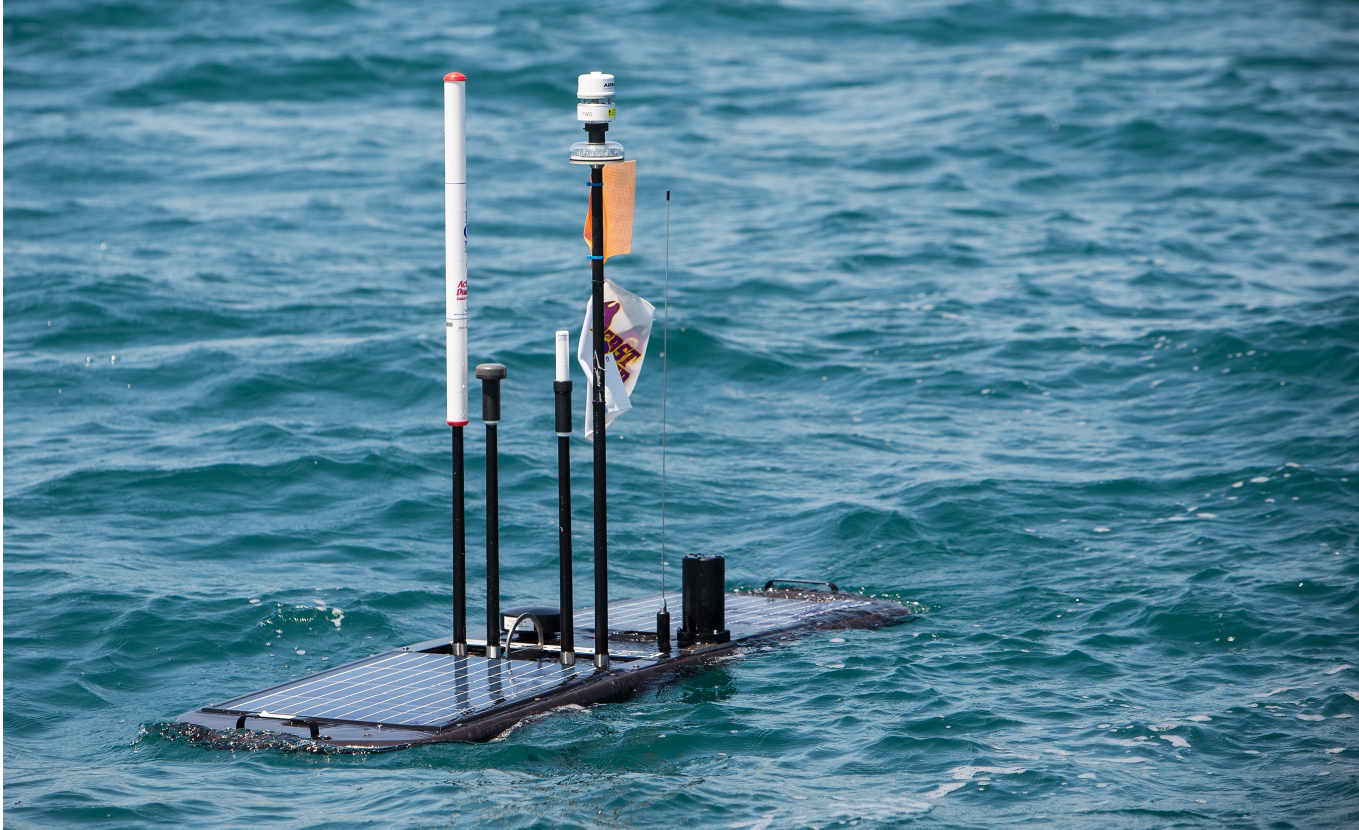


Fig. 1 Acoustic Wave Glider instrumentation. The 10-m long tow cable separates the DECIMUS passive acoustic recording hydrophone from the wave glider and surface noise.

AWG Components: AWG consists of a surface unit (wave glider float) and a submarine unit (glider). It comes standard with several components and sensors. Standard surface components (wave glider float) include a command and control (C&C) computer, an AIS (Automatic Identification System) marine traffic receiver, Airmar CS4500 Ultrasonic Water Speed Sensor, Airmar PB200 weather station, Datawell MOSE-G Directional Wave Sensor, Iridium satellite data modem, two solar panels (each 80 W). Sensors to be included in the surface float are a Turner C3 fluorometer and an Acoustic Doppler Current Profiler (ADCP, Teledyne RDI WHM300). A Seabird Conductivity Temperature and Dissolved Oxygen sensor (GPCTP) will be mounted on the underwater glider and the VEMCO VR2C active tag-acoustic receiver. Mounted in a tow body behind the glider will be the Pambuoy Passive Acoustic Module (PAM) Decimus® consisting of Reson TC-4014-5 (high-frequency) hydrophone, solid state hard drive, and integrated digital processor to be programmed for event detection using RTDC software. (by SAIL, St. Andrews Instrumentation Laboratory).





Decimus Passive Acoustic Module – 50 kHz sampling rate used here;
We can record up to 256 kHz rate to a 1 GB micro SD card;
Decimus uses DAQ from Saint Andrews Instrumentation Lab (SAIL)
Tow body encloses Decimus with Reson TC-4014-5 hydrophone

Soundscape Studies Using the Wave Glider and Decimus Passive Acoustic Module

Ocean soundscapes – what sounds do fish and whales make and are humans impacting that soundscape? Our objectives are:

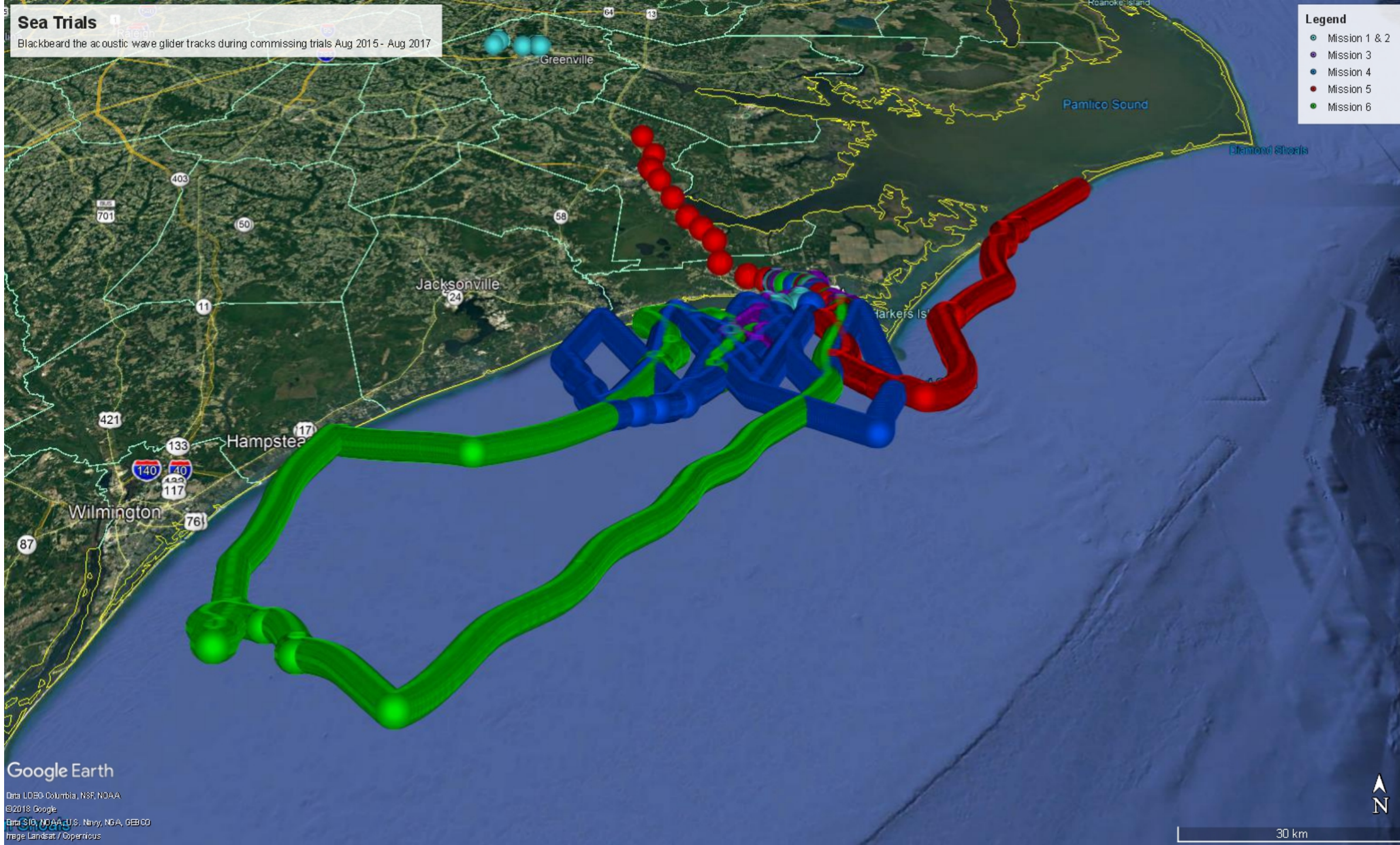
- Investigate the environmental correlates with fish sound production (depth, currents, water temperature, bottom structure, natural and artificial reefs).
- Is there an impact of vessel noises on fish sounds and spawning? Do they avoid noisy areas?
- Do fish use proposed wind energy areas off NC? What might be the effect of pile-driving?
- Will there be an impact of seismic surveys on the biological soundscape?
- Mobile glider platform: survey wide areas along transects or can be used to hold at a station. Can follow animals like migrating whales.
- Glider is under control of pilot at all times. Moves at 1 knot (wave power).
- Real-time reports from instruments and passive acoustic module; marine mammals (small file size); wav files available at end of mission for confirming ID.

Sea Trials

Blackbeard the acoustic wave glider tracks during commissioning trials Aug 2015 - Aug 2017

Legend

- Mission 1 & 2
- Mission 3
- Mission 4
- Mission 5
- Mission 6



Google Earth

Data: LDBO-Columbia, N8F, NOAA

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Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image Landsat / Copernicus

Blackbeard Wave Glider

Reef comparisons completed with Blackbeard on Mission #6.
We completed the survey of artificial and natural reefs that occur in our ops area, Blackbeard measured the wind, weather, temperature, currents, plankton, and recorded the sounds of Onslow Bay, Atlantic Ocean.
Current Speed (knots) plotted along track.

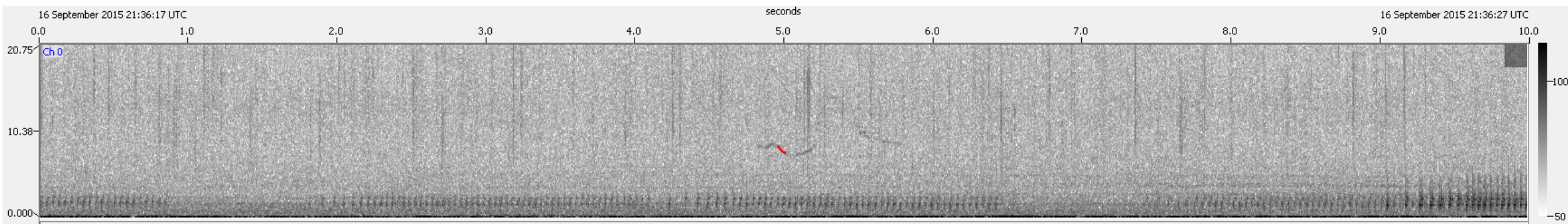
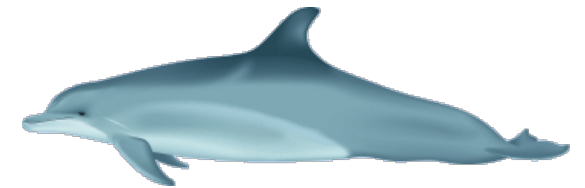
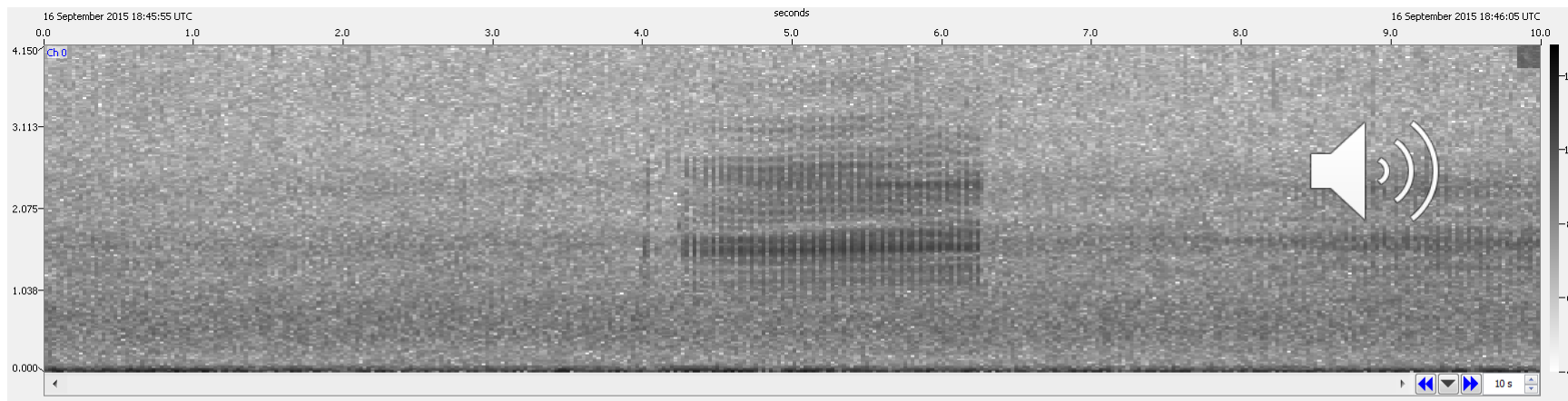
Legend

Blackbeard Position



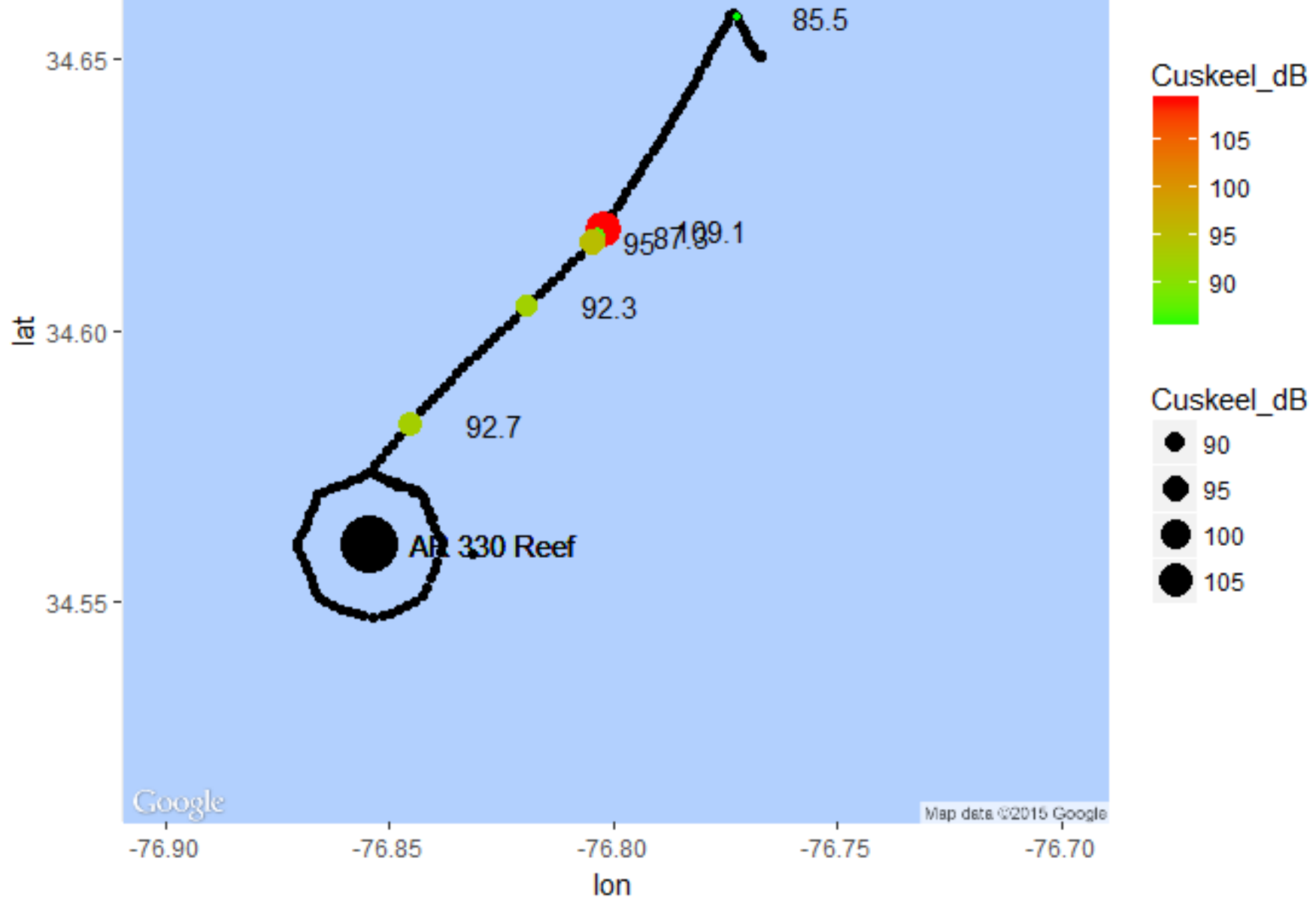
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO

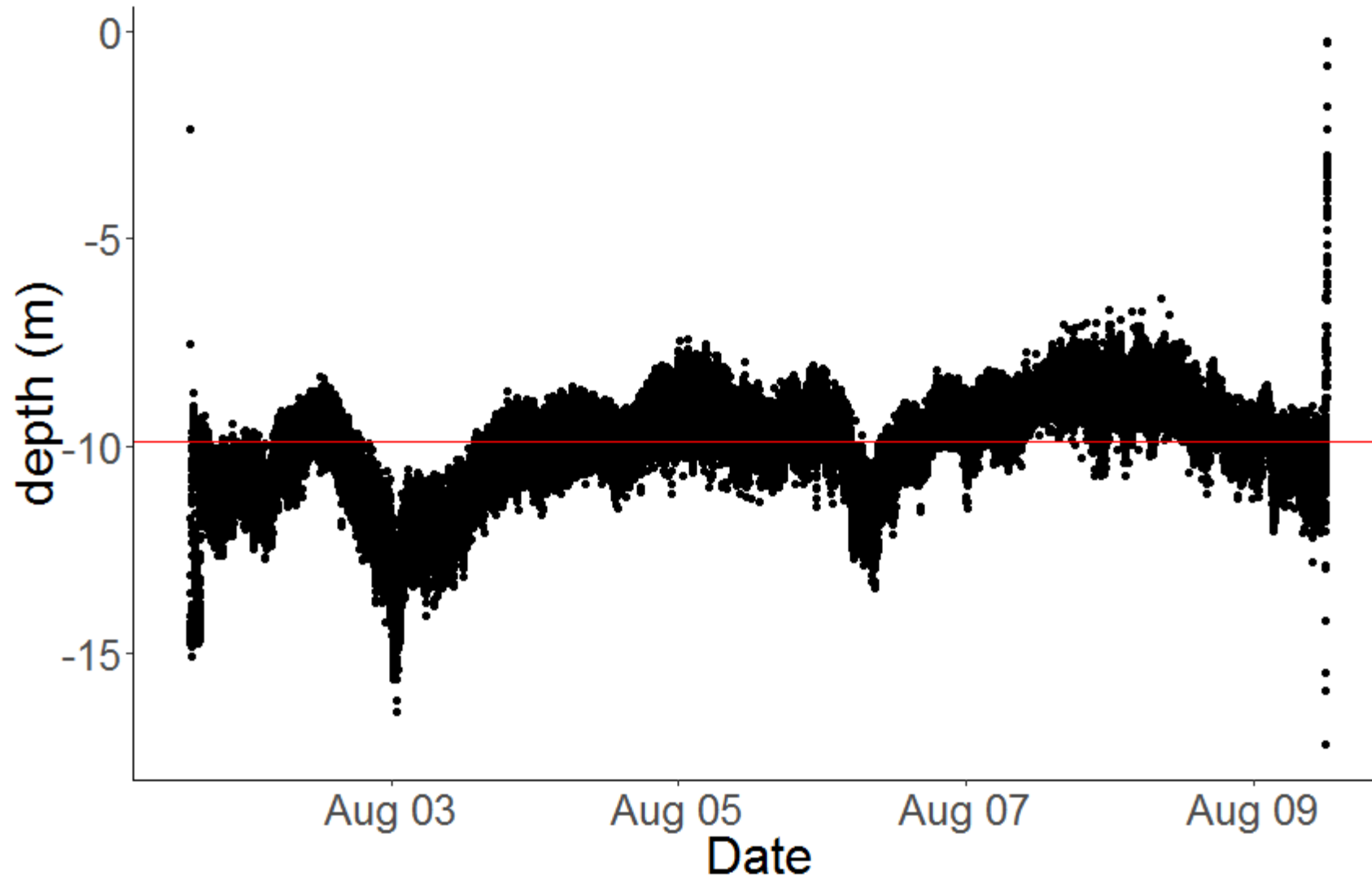


Mission 3: Spectrograms of striped cusk eels “chatter” sounds recorded along transect from inshore to AR 330; (top) Striped cusk eel *Ophidion marginatum* “Chatter”; (bottom) bottlenose dolphin (*Tursiops truncatus*) “whistles” detections and striped cusk eel sounds recorded with Decimus system.

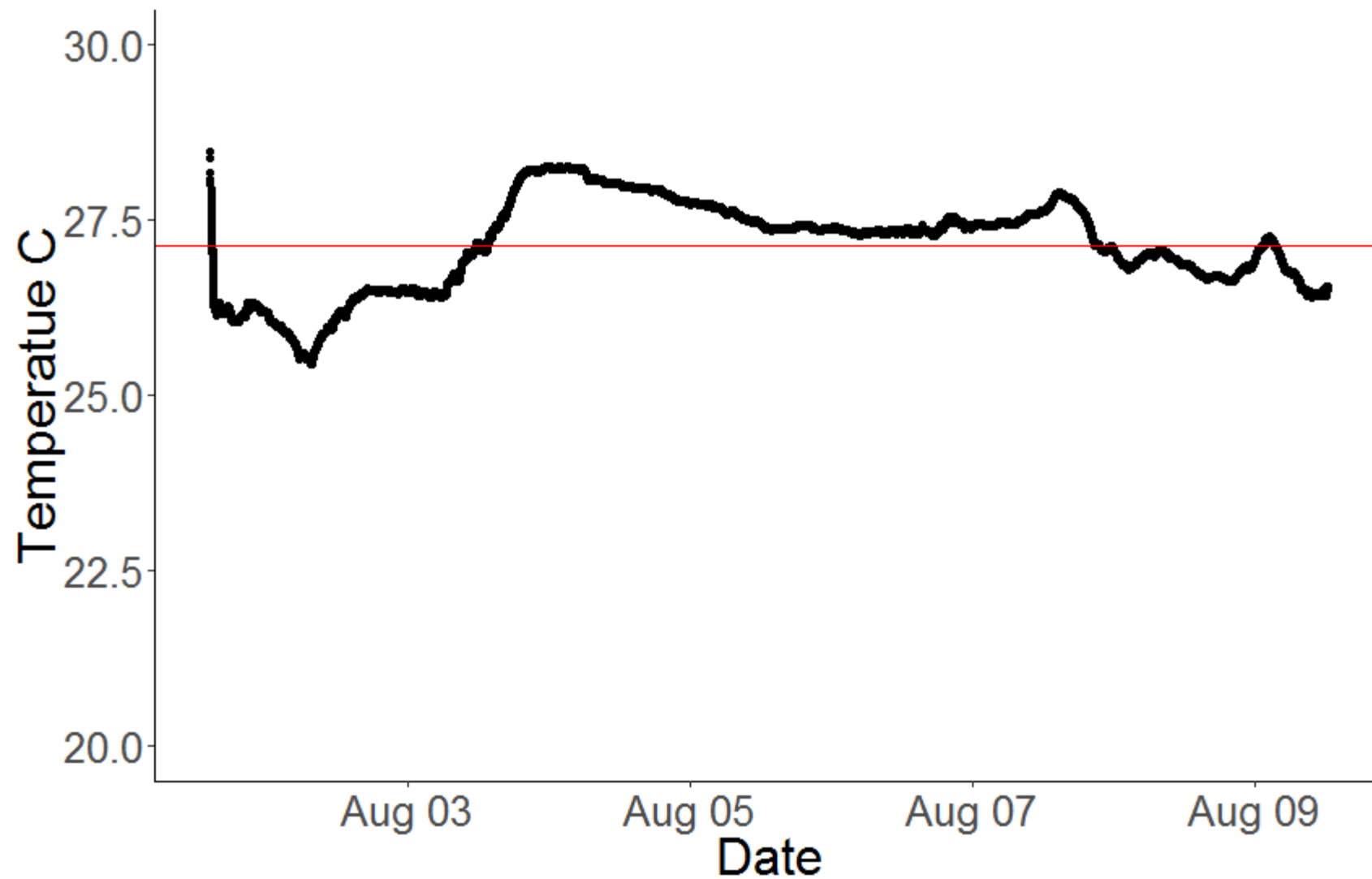
Mission # 3 Transect to AR 330

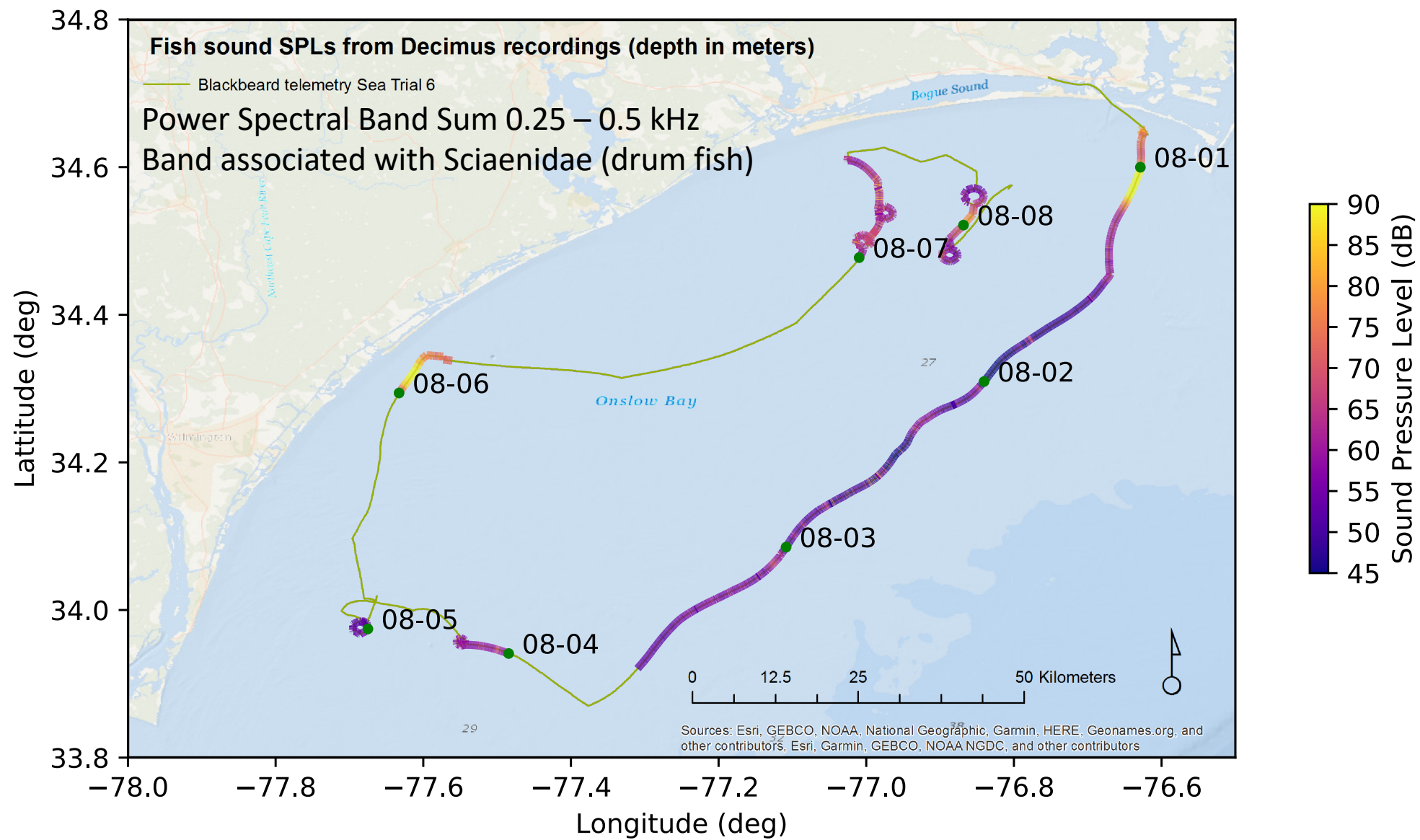


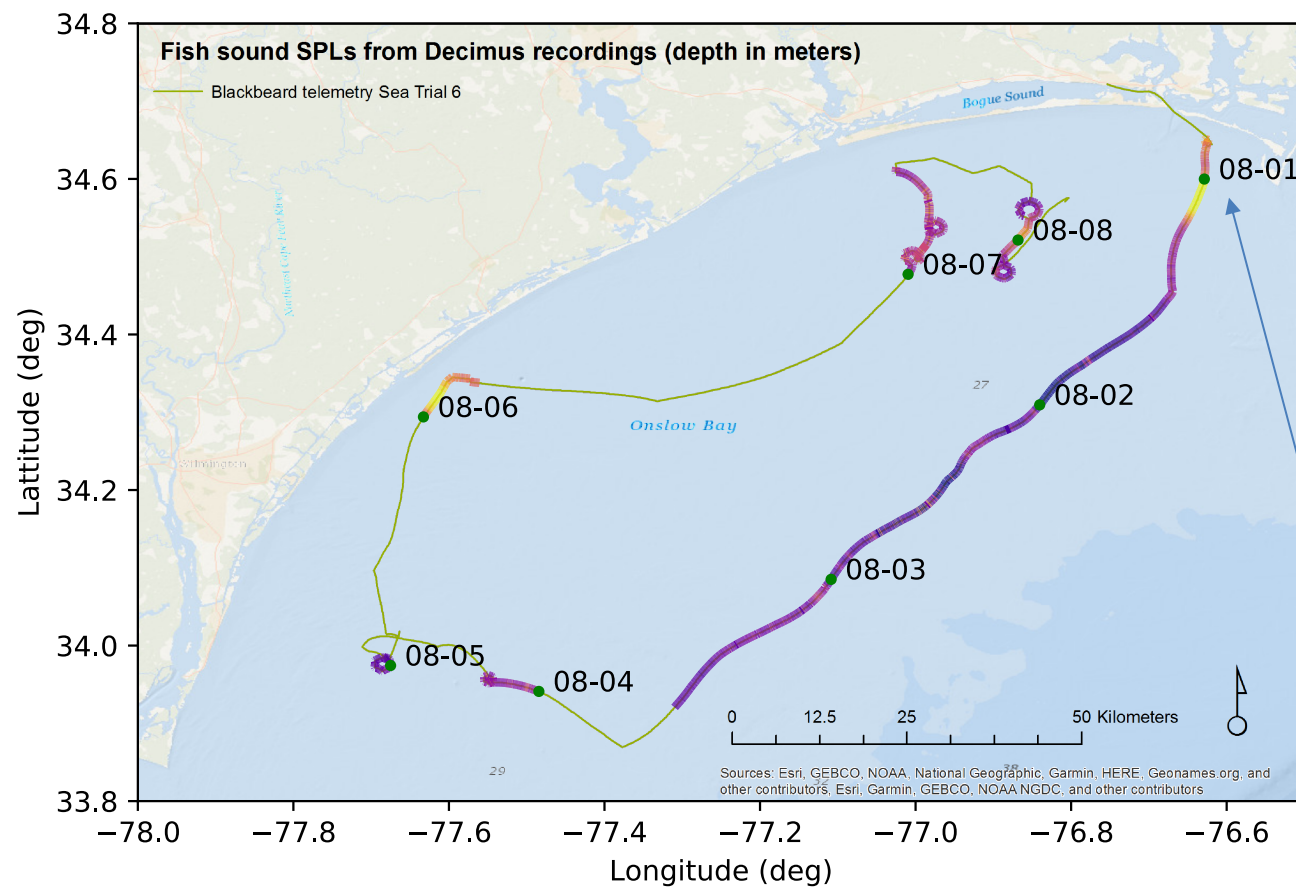
Depth of Towbody on Mission 6



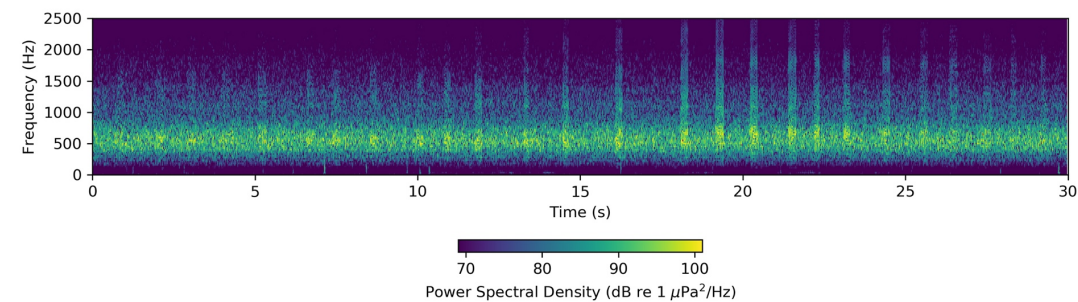
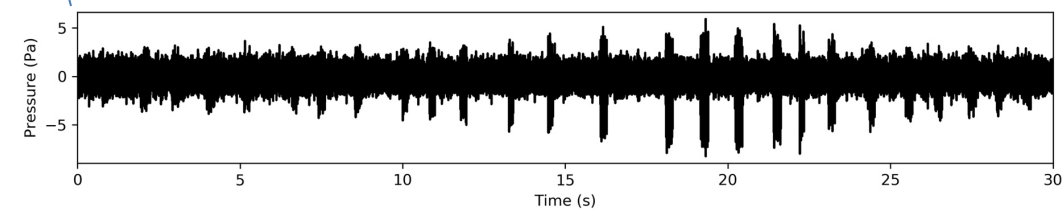
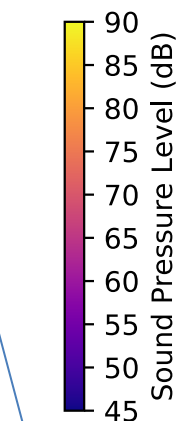
Temperature at Decimus towbody

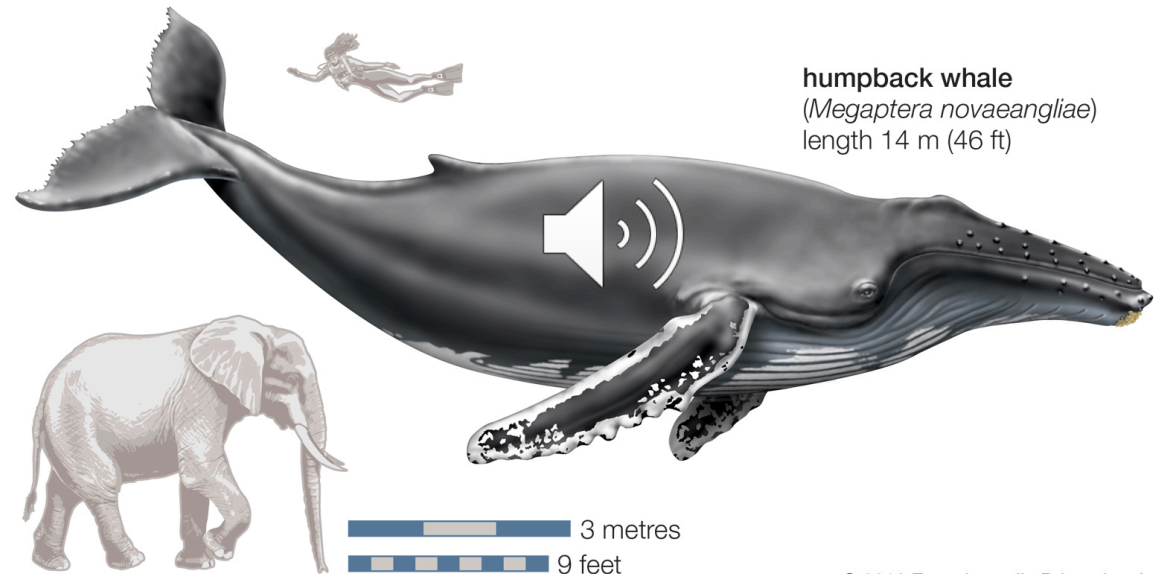
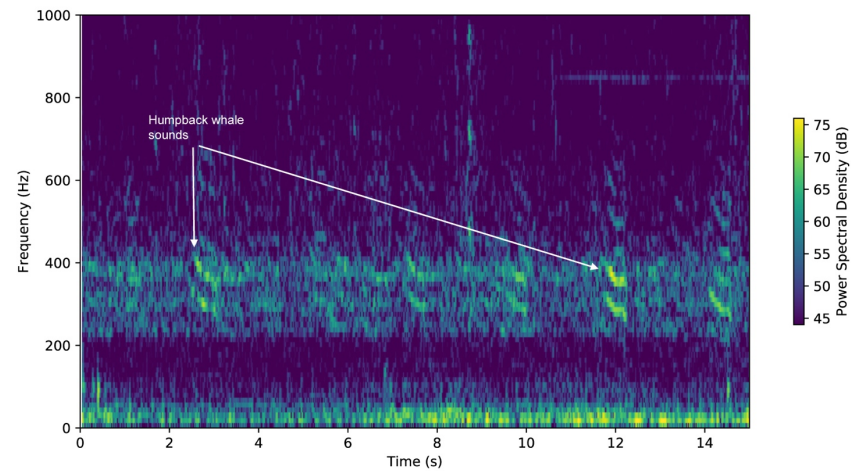
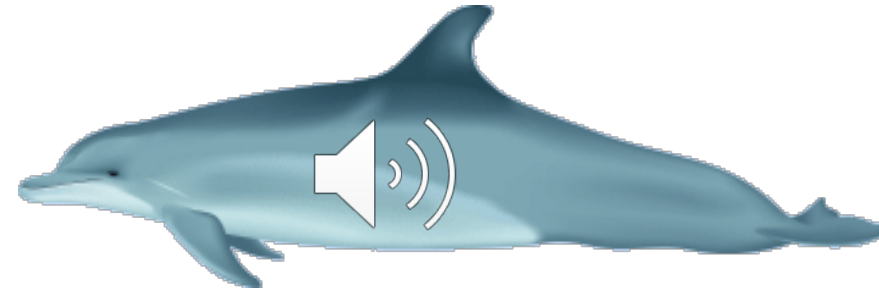
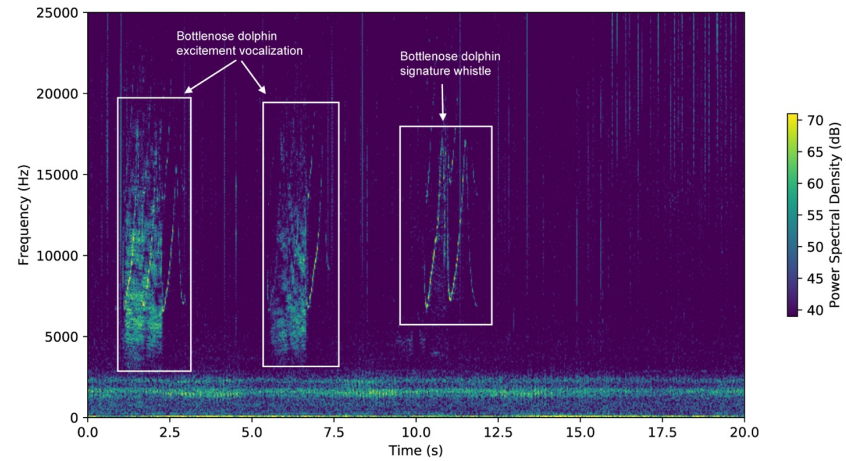
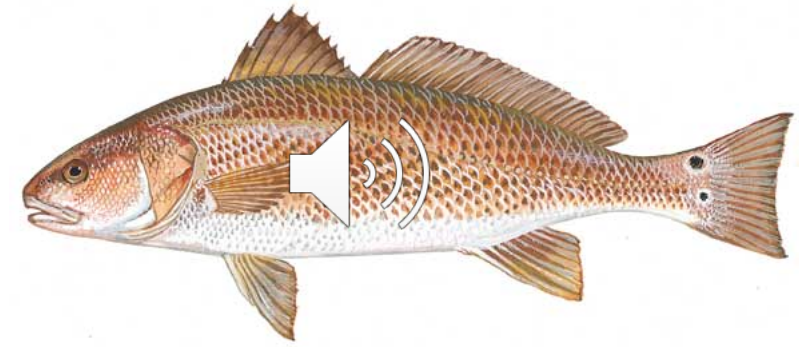
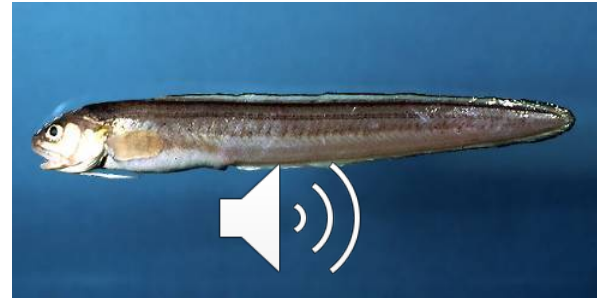
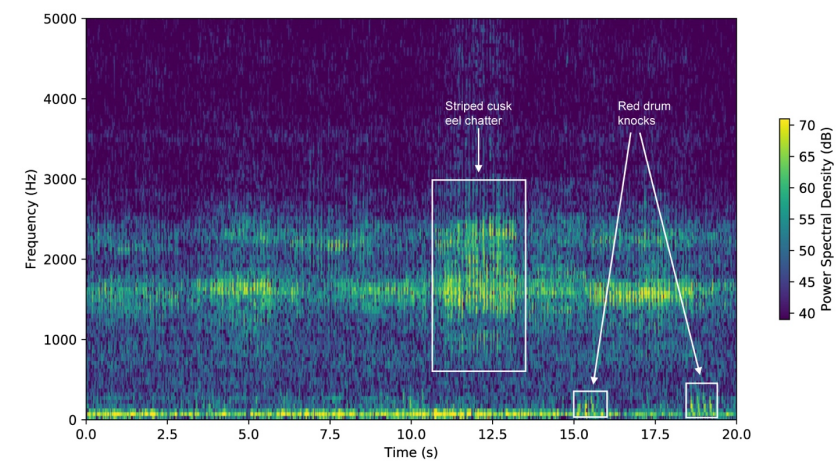




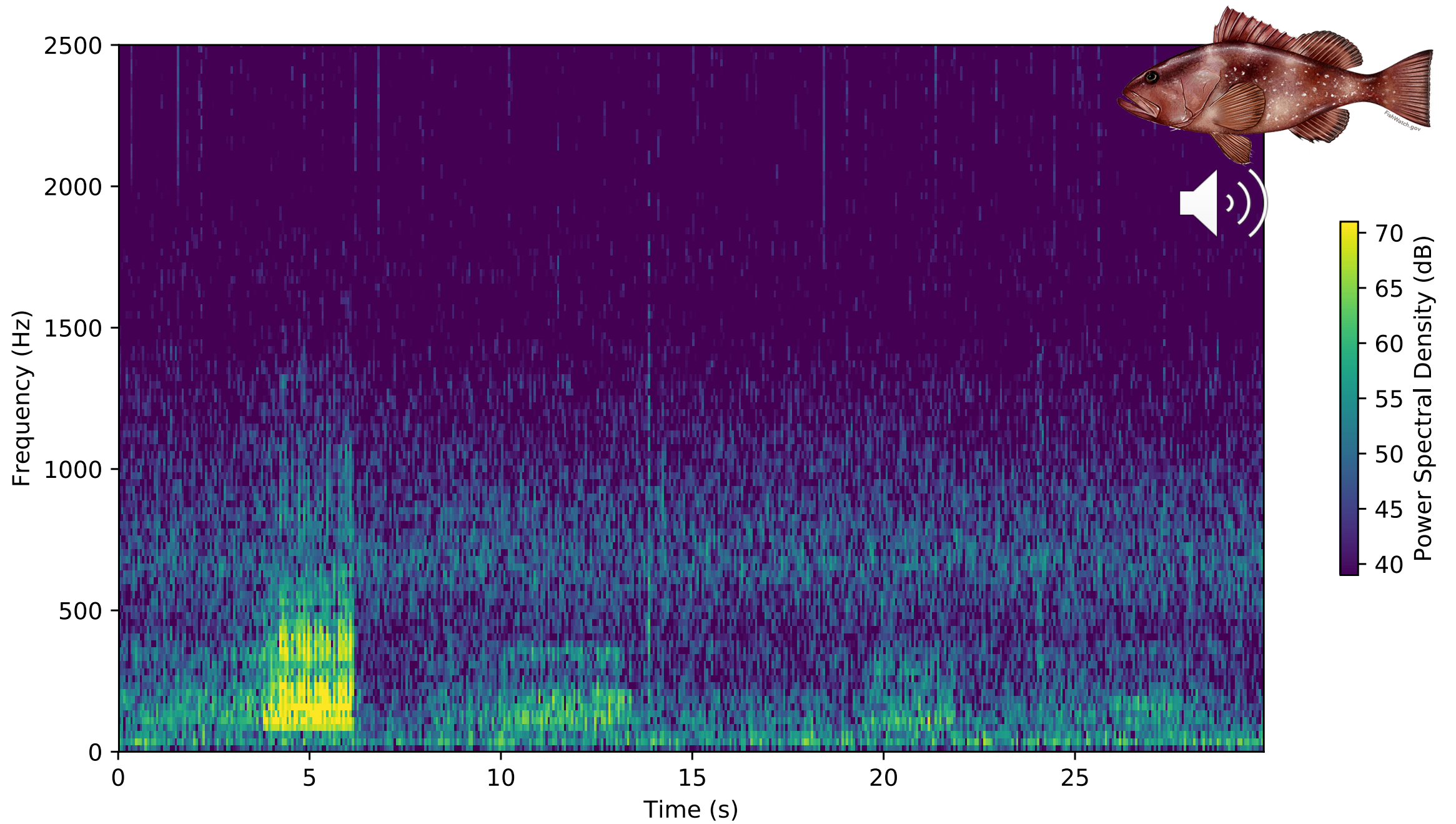


Spotted Seatrout





humpback whale
(Megaptera novaeangliae)
 length 14 m (46 ft)

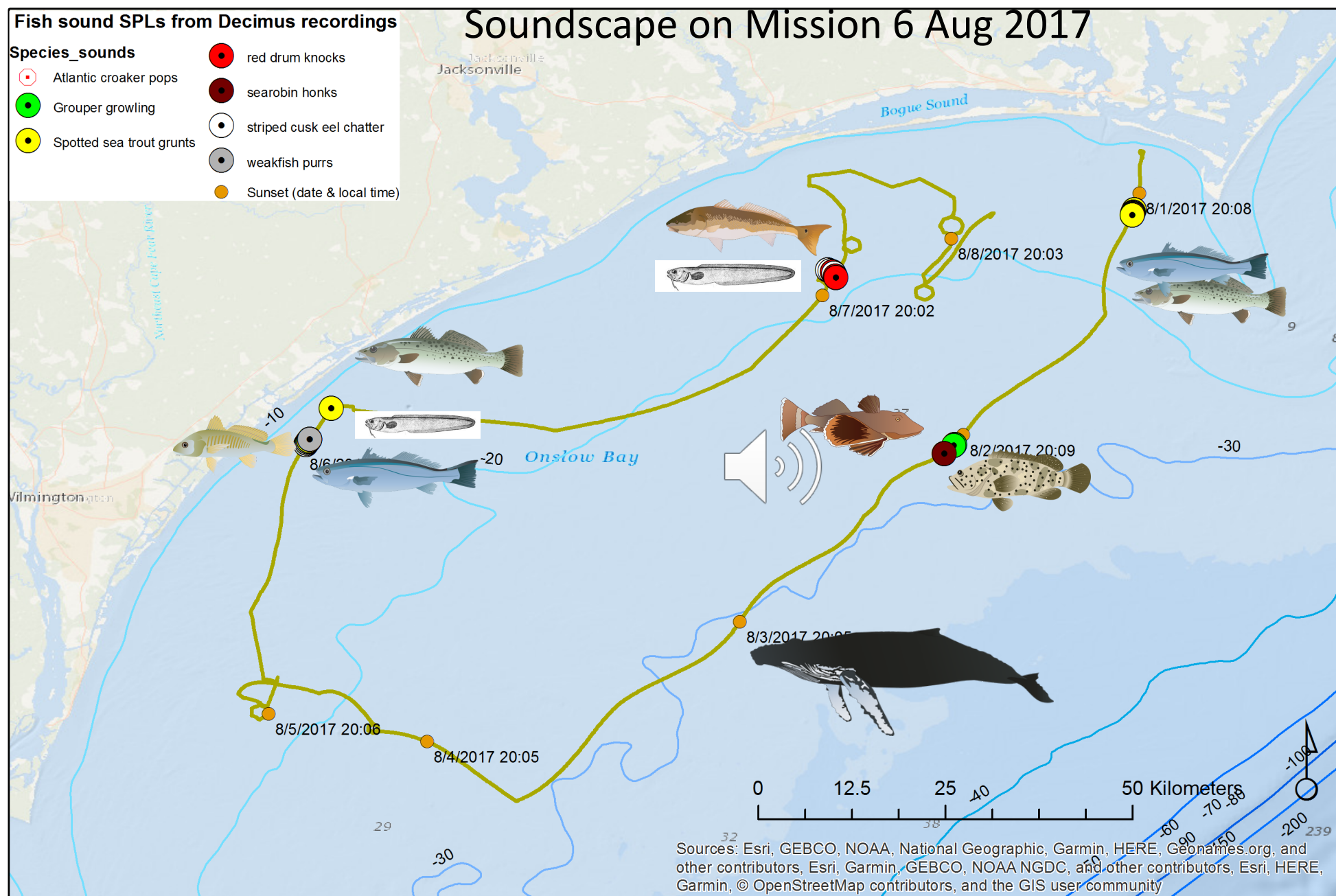


Fish sound SPLs from Decimus recordings

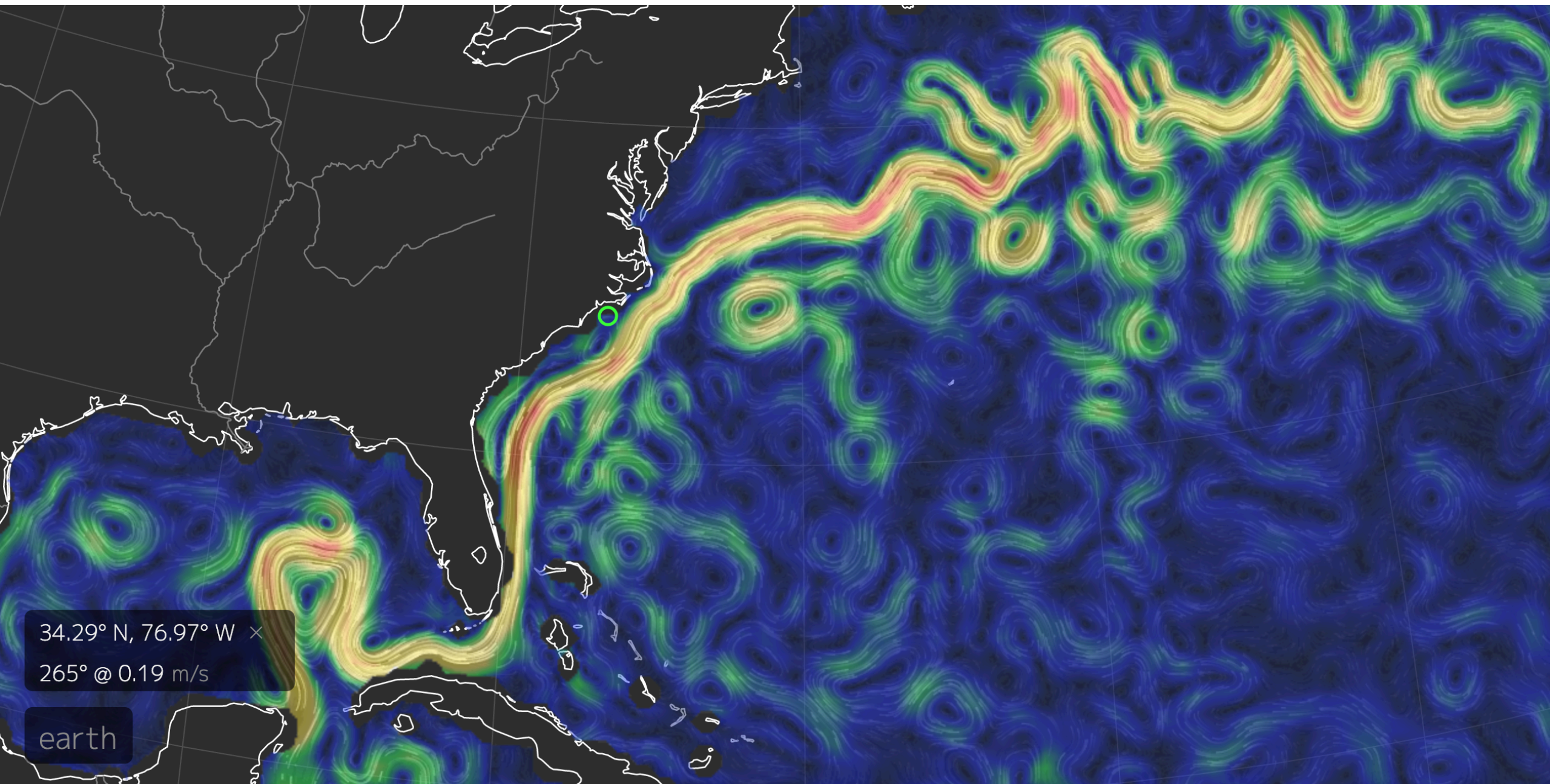
Species_sounds

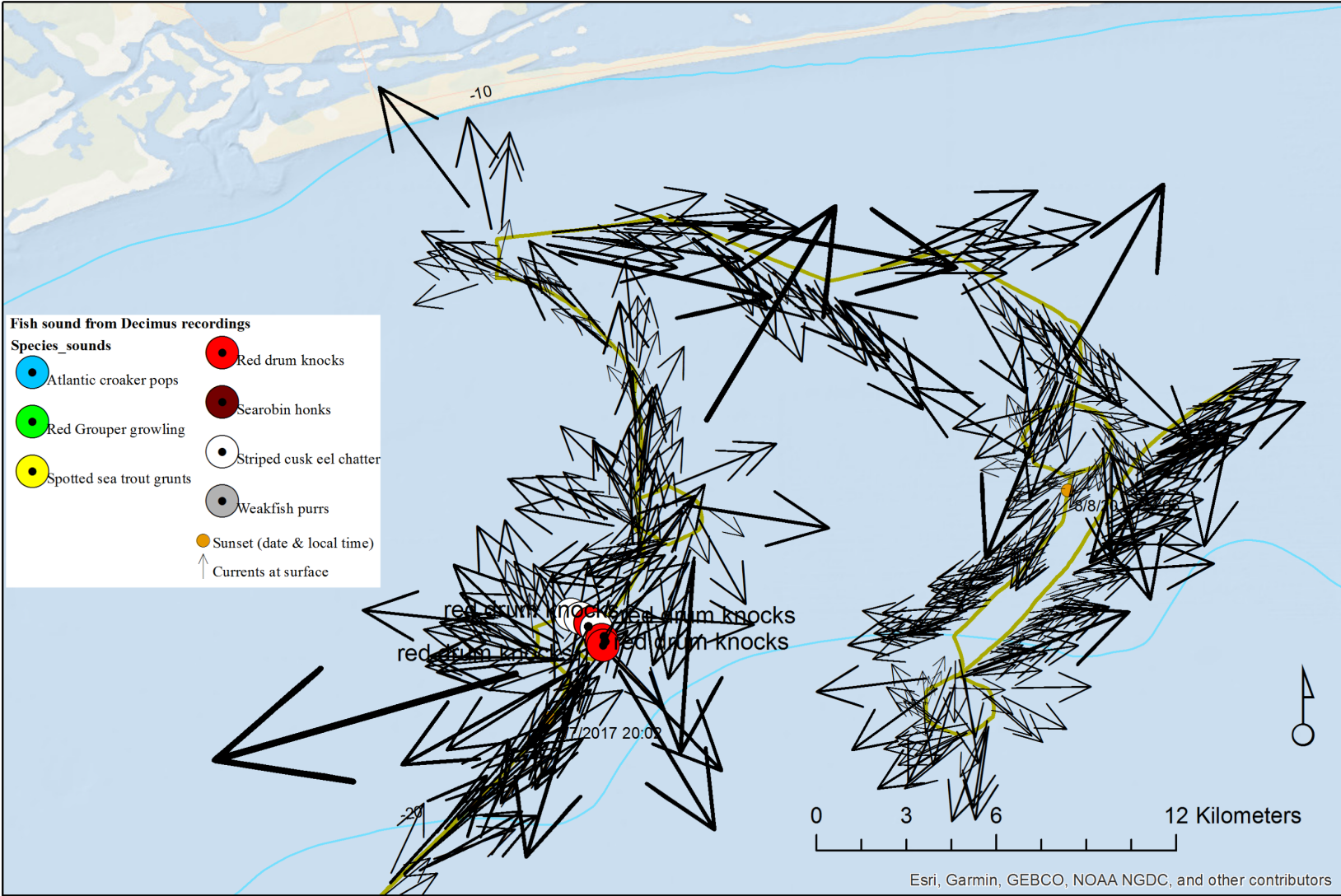
- red drum knocks
- Atlantic croaker pops
- Grouper growling
- Spotted sea trout grunts
- searobin honks
- striped cusk eel chatter
- weakfish purrs
- Sunset (date & local time)

Soundscape on Mission 6 Aug 2017

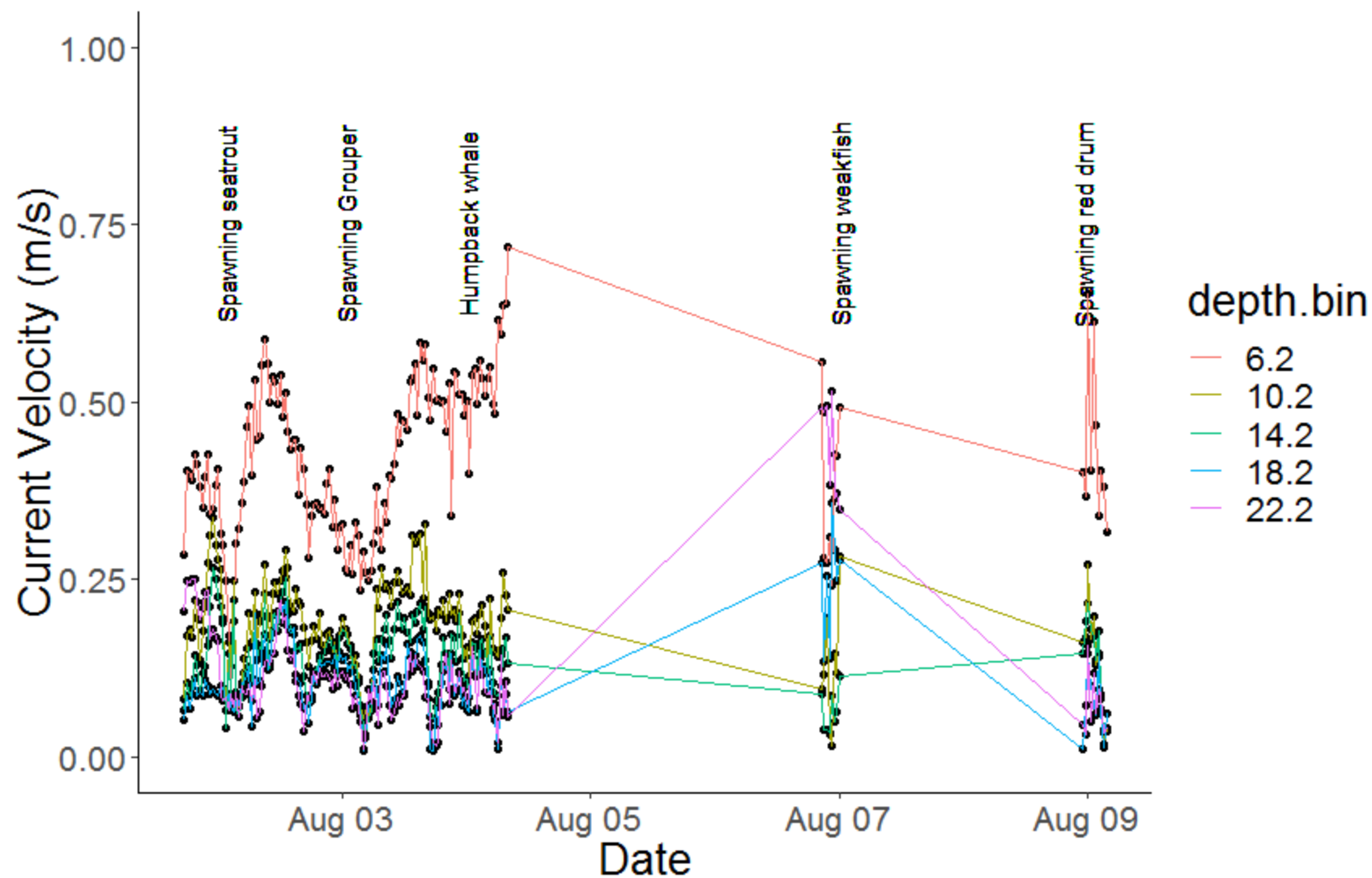


Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors, Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

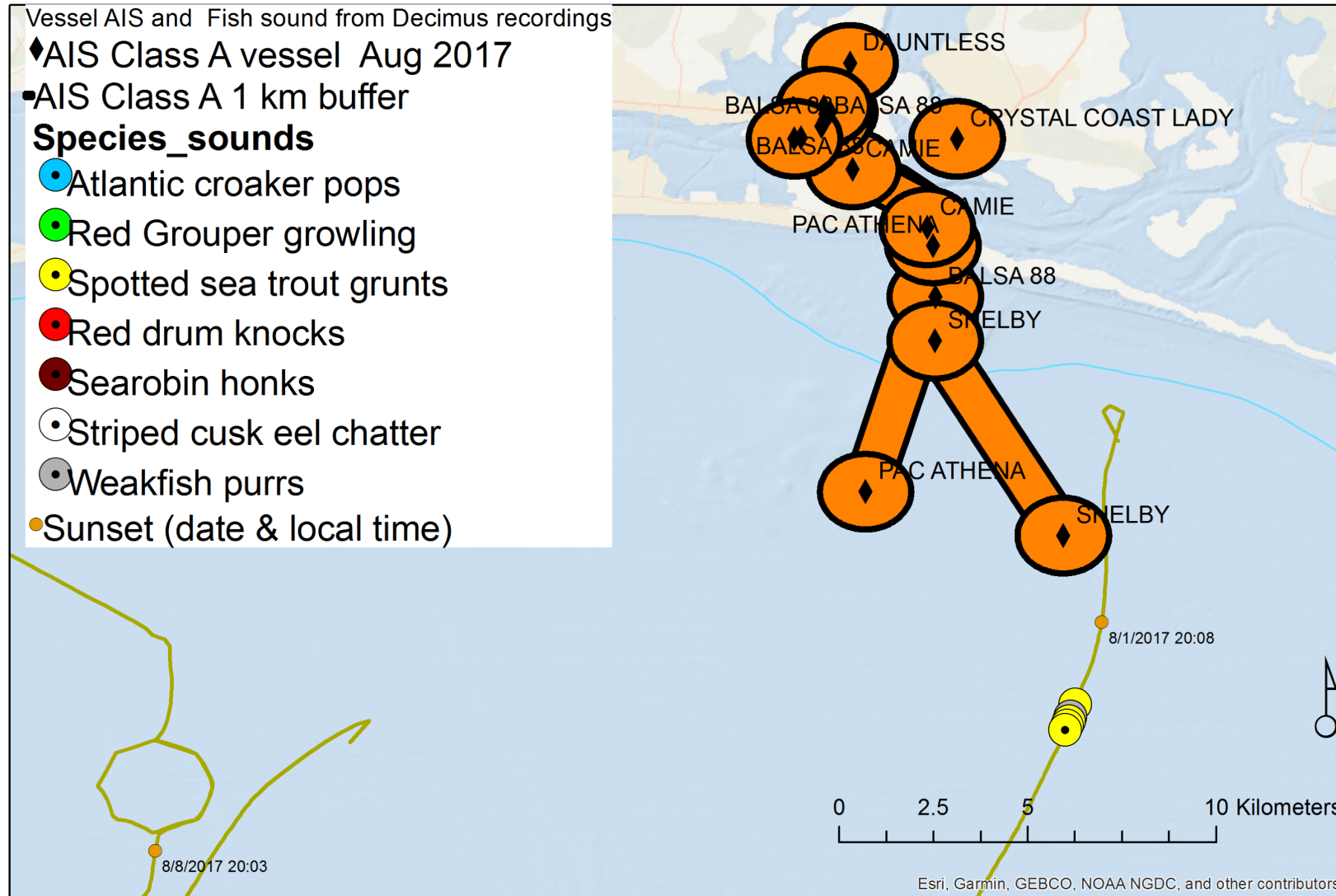




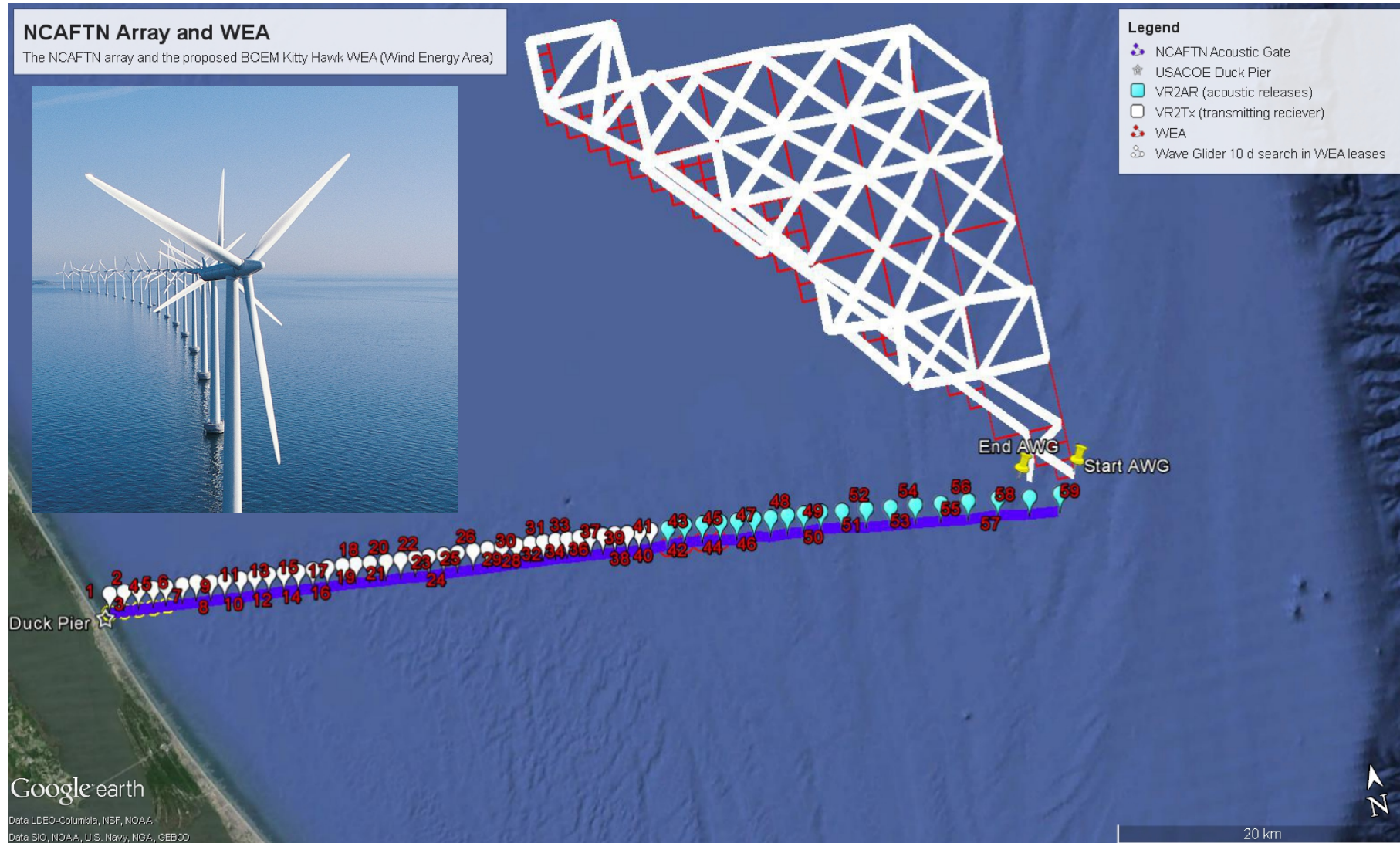
Currents and Spawning Areas



AIS Detections to Monitor Vessel Noise



Survey in Proposed Kitty Hawk Wind Energy Area



Conclusions and Future Work

- **Soundscape characterization** with a mobile calibrated passive acoustic system: They don't all "call" in the same place. The **acoustic niche** is part of the ecological niche that has evolved.
- **Sciaenidae** (croaker, weakfish, seatrout, red drum) are **spawning near inlets** (10-20 m depth) where currents will transport larvae into estuaries.
- **Red grouper spawning** in deeper water (~30m) and currents move larvae southwest.
- Are fish avoiding high vessel noise areas? **It appears to be true.**
- What happens to spawning fishes pre- and post-seismic surveys?
- Right whales – the **Decimus** has a **autodection** algorithm for these endangered whales. We can follow them during their migration.

**We are looking for
users and
collaborations.**

- NSF MRI especially wants us to recruit users outside of ECU.



Wave Glider Pilots and Deployment team (above, L to R)
J. Luczkovich, E. Diaddorio, M. Sprague, R. Rulifson, T. Peacock, M.
Keusenkothen, C. Krahforst. Others R. Asch, C. Bangley, P. Harris, J.
Smith, R. McKenzie. **See latest issue of Seatechnology.com**

Questions?

