MASTS Small Grants Report, £3k cutting-edge research

Autonomous underwater vehicle (AUV) range-testing of a passive acoustic telemetry array: a proof-of-concept

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As far as we are aware, our MASTS pilot study is the first ever to field-trial the effectiveness of an autonomous underwater vehicle (AUV) for range-testing a passive acoustic telemetry array.

Rationale

The latest advances in passive acoustic telemetry technology make it possible to track the movements and habitat use of individual fish for months to years. A crucial step in study design is in the understanding of how far away tagged animals can be detected based on the planned mooring layouts.

Most aquatic telemetry studies still fail to conduct robust trials (Kessel *et al*., 2014). However, even retrospective studies can still benefit from range-testing before larger-scale arrays of acoustic stations are deployed to track predators over the scale of e.g., a proposed Marine Protected Area. Ideally, sentinel “test” tags should be deployed at fixed distances from the acoustic receiver to assess detection range and understand how environmental variables might influence detection range variability over space and time (Kessel *et al*., 2014). Techniques vary from divers placing sentinel tags along the array, inclusion of sentinel tags in the array itself, to drift buoys with a GPS tracker attached and acoustic tags in the water column at set depths. These methods work well for arrays in shallower water, but these methods are rarely effective for range-testing in deeper water.

Robotics now offer a dramatic step-change in the continuity and performance of range-testing tasks, with some having enhanced sensor capabilities to map environmental variables that influence range detection. While standard mobile range-testing work at fixed depths with movement along the horizontal plane, the AUV also offers the potential for fully variable 3D range-testing.

Loch Etive Array and spurdog

An acoustic array of 10 stations on the west coast of Scotland in Loch Etive was deployed in summer 2016 as part of a collaborative effort between Scottish Natural Heritage, Marine Scotland, the MASTS Community Project SIORC and the Canadian Ocean Tracking Network. A total of 55 spurdog (the IUCN-listed Critically Endangered *Squalus acanthias*) across all size and maturity classes were tagged with internal transmitters. A total of 20 temperature loggers were also deployed across the array. The Etive array and temperature loggers allows residency and fidelity of sharks to be measured, in order to understand whether the species could benefit from spatial management (e.g. MPA) in Loch Etive, as well as environmental drivers of their movements which could be temperature-dependent (Thorburn *et al*., 2015).

Methods

MASTS Small grant funds were used on a 3-day charter of SAMS' RV *Seol Mara*, all other costs being contributed in-kind. On 1–3 November 2016, team members Abernethy, Boswarva, Henry and Thorburn boarded *Seol Mara* with SAMS' AUV "*Freya*". *Freya* is a Teledyne Gavia Offshore AUV depth-rated to 500 m, and is fitted with a Geoswath+ 500kHz interferometric bathymetric sonar collecting swath bathymetry, sidescan and photo mosaic data. *Freya* uses a Keufortt T24 Inertial Navigation System (INS) combined with Doppler Velocity Logger for bottom-tracking, together providing navigational accuracy of 0.1% error. The navigation and data collection capabilities of *Freya* offered us the cutting-edge technology we needed to operate and range-test the Etive array.

Two acoustic tags (operating at 69 Hz) were attached to the AUV on deck. Each tag is 13mm diameter and 36mm long with a water weight of 6g. An acoustic receiver was also attached to the AUV (308 mm long x 73 mm diameter with a water weight of 50g) to provide a control for acoustic signals from the transmitters by providing a time and date stamp for each transmission. On board *Seol Mara*, an active tracking unit (VR100) with a transmitter attached was used to monitor acoustic transmissions at a depth of approximately 20m. This acted as a secondary range-testing unit as the VR100 provided a GPS location for each transmission received. Due to the nature of acoustics in the water, it was important to get an accurate representation of the true detection range of the receivers that all unnecessary acoustic disturbances are removed or turned off, including: depth sounder on the *Seol Mara*, *Seol Mara*'s engine, any non-crucial onboard acoustic-based navigation aids on the AUV. *Freya*'s mission flew a lawnmower square path cutting across a 1500 m distance with the acoustic receiver station centered in the middle of the square, and covering several depth zones. In total, 8 stations were range-tested.

Outcomes and future work

Detection data are being analysed to determine each station range, and these will be related to environmental variables to better understand how mooring location may have affect spurdog detection by the array. The success of the proof-of-concept pilot study perfomed here is now being considered for the larger passive acoustic array in the Firth of Lorne/Sound of Mull Marine Protected Area for common skate (*Dipturus batis* complex). The utility of AUV-based range-testing makes this method a tractable option for future work on shark habitat use in deepwater sites where environmental sensitivities such as occurrences of fragile cold-water coral habitats must be considered, and which demand a minimal number of acoustic stations placed on the seafloor.

References

Kessel *et al*., 2014. Rev. Fish. Biol. Fisheries 24, 199-218.
Thorburn *et al*., 2015. Mar. Ecol. Prog. Ser. 526, 113-124.
Possible images




S.W.L 500kg