MARINE MAMMAL SCIENCE, 14(2):310–316 (April 1998)

MODIFICATION AND DEPLOYMENT OF A SONOBUOY FOR RECORDING UNDERWATER VOCALIZATIONS FROM MARINE MAMMALS

Sonobuoys were originally designed over 50 yr ago for submarine detection (Horsley 1989, Brown 1994) and underwater monitoring (Fusillo and Richter 1988, Atkins 1994). They were built to receive underwater sounds *via* a hydrophone and transmit them to shore or aircraft by VHF radio. Since then, sonobuoys have been modified and developed for research on seismic activity (Houtz and Hayes 1984) and meteorological and oceanographic parameters (Kozak and Garrad 1985, Steele *et al.* 1994). Sonobuoys have also been used for acoustic research on marine mammals (sperm whales, *Physeter macrocephalus*, Watkins *et al.* 1985; bowhead whales, *Balaena mysticetus*, Cummings and Holliday 1985, Clark *et al.* 1986; bottlenose dolphins, *Tursiops truncatus*, Hunter and Morris 1987; humpback whales, *Megaptera novaeangliae*, Frankel *et al.* 1995). Horsley (1989) provided excellent details on the dismantling and electronic modification of sonobuoys; however, previous reports contain little information on the modification and deployment of equipment.

Marine mammal underwater vocalizations serve several functions, from long distance interherd communication (Payne and Webb 1971, Hoelzel and Osborne 1986), to close range social communication (Stirling *et al.* 1987, Smolker *et al.* 1993). Vocalization patterns may vary both in time (Thomas and DeMaster 1982, Shipley and Strecker 1986, Jacobs *et al.* 1993) and in space (Ford 1991; Terhune 1994; Van Parijs *et al.*, in press). Studies of acoustic behavior, therefore, are often required to be made over long periods and at a number of sites. While such recordings can be made directly from boats (Stirling *et al.* 1983, Cleator and Stirling 1990, Ford 1991), remote recordings from sonobuoys have clear logistic benefits. The use of acoustics can also com-

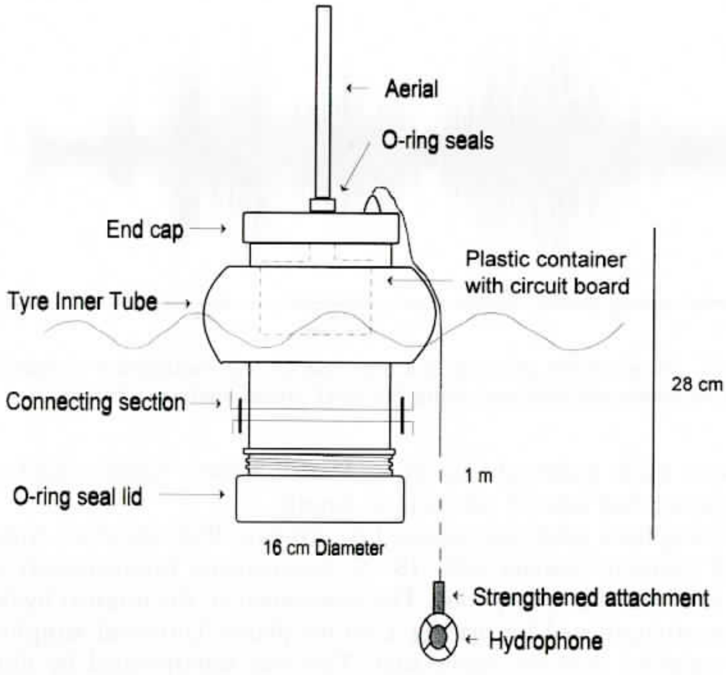

Figure 1. Modified sonobuoy unit.

plement a wide range of more general studies of marine mammal behavior and provide a useful tool in education and interpretation programs. However, such use has often been constrained due to the high cost of purpose-built acoustic equipment. This note describes the adaptation and use of a simple sonobuoy system which we developed for studies of harbor seal (*Phoca vitulina)* vocalizations and which could be used in a wide range of field situations.

The unit is based on DOWTY, SSQ906A(D) sonobuoys, with a flat frequency response from 1 Hz to 2,000 Hz. Under normal circumstances these sonobuoys have a maximum operational life of 8 h. However, we needed to design a low cost re-useable unit that could be moored and would allow us to make continuous remote recordings for at least 48 h.

We removed the sonobuoys from their original metal casings and made new casings using PVC pipe. The removal of the sonobuoy unit from its casing requires care, because each sonobuoy contains a 15-ml CO_2 gas cylinder connected to the release mechanism which may explode if not handled properly. A detailed description of how to dismantle the sonobuoy safely is given in Horsley (1989).

The replacement casing consisted of three 15-cm sections of 160-mm (diameter) 6D64 Terrain PVC-U drainage pipe (Fig. 1) (Appendix 1), consisting of an end cap, a central connecting section, and an O-ring-seal lid cap with 4.5-mm wide O-ring (R. S. Components International) (Appendix 1), each of

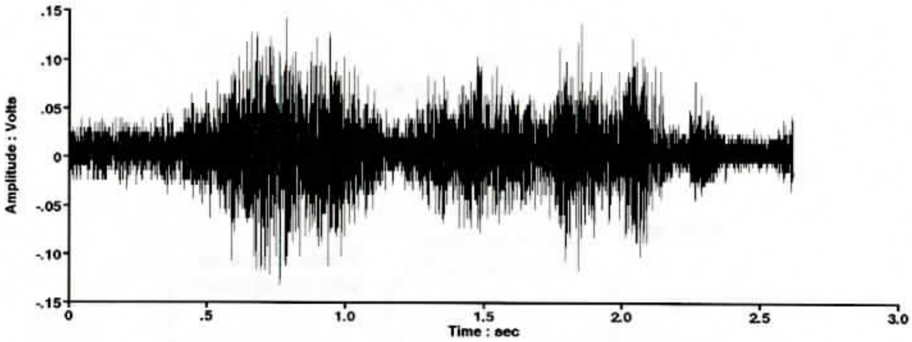

Figure 2. A waveform printout of a male harbor seal vocalization recorded using a modified sonobuoy and analyzed using SIGNAL sound analysis software.

which were made watertight by using Marley Solvent Cement KS4 glue, to make a casing that was 28 cm in total length.

The hydrophone cable was replaced by stronger PVC sheathed, 5-mm, 50-Ohm RF Uniradio coaxial cable (R. S. Components International) up to a point 3 cm from the hydrophone. The attachment to the original hydrophone cable was strengthened by placing a 30-ml plastic Universal sampling tube (Vetlab supplies) over the connection. This was waterproofed by filling the connection with black epoxy compound (100 g package; R. S. Components International). The (red/brown and black/blue) power leads on the circuit board were replaced with 50-cm, 1.5-mm silicone rubber wires with covered spade clips (power leads and spade clips; R. S. Components International).

The original circuit board was modified to prevent the built-in timing device from functioning (as per page 217, Horsley 1989) and placed in a plastic 12 × 5-cm watertight container also covering the aerial. These modifications had no effect on the frequency response of the hydrophone. Holes were made in the casing end cap for the 5-mm hydrophone cable and for the 36-mm aerial cover and were sealed using 12.5-mm and 54-mm cable glands, respectively (R. S. Components International). The hydrophone cable hung 1 m below the casing. The length could be adjusted according to water depth and surface level noise so as to obtain the best depth at which to record (Fig. 2).

Our unit was powered by a dry-fit 12-V, 7-Ah, 2.65-kg YUASA battery (R. S. Components International) which connected to the circuit board using the spade clips. The O-ring seal lid of the casing was placed at the underside and could be opened in order to replace the battery.

The complete unit weighed 5.65 kg and was neutrally buoyant. An inflated 11 × 7.4-in. automotive inner tube stabilized the unit in an upright position. We surrounded the sonobuoy unit with two 30-cm strips of 2-cm-wide aluminum metal plate, bent back the ends and fixed these in place using stainless steel bolts (Fig. 1). A 4-m length of floating rope with a 40-liter orange surface marker buoy was attached to the stainless steel bolt at each end. Two floating ropes between 5 and 15 m long, depending on the depth of water, were

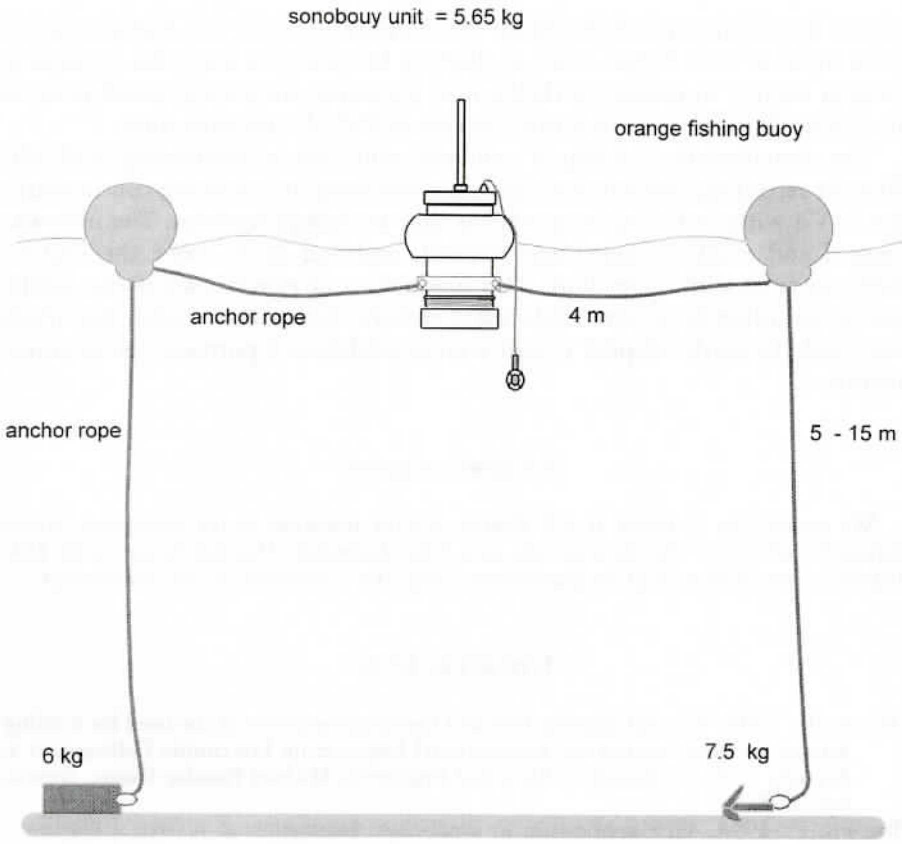

Figure 3. Sonobuoy unit and mooring.

attached to the surface marker buoys, and an anchor (7.5 kg) and a lead weight (6 kg) fixed the ropes to the sea bed (Fig. 3). The use of floating rope and two surface marker buoys kept the hydrophone fixed in one place even in strong currents and winds, ensured that no mechanical noise was generated by the mooring, stopped the hydrophone cable from becoming entangled in the anchor rope, and marked the sonobuoy unit for any passing vessels.

Each receiving station consisted of a three-element YAGI directional aerial and a YAESU FRG-9600 receiver (both available from South Midlands Communications Ltd.). The use of a domestic HiFi video cassette recorder with E-300 BASF VHS tapes allowed low-cost continuous recordings to be made on long play for up to 10 h. Receiving stations were set up at three sites in the Moray Firth 2–4 km from the sonobuoy unit, at heights 30–120 m above sea level. Sonobuoys were deployed in water of 5–15 m in depth, and the transmission range of the units was tested from two receiving stations. The modified sonobuoy unit was moored out at sea progressively at 2, 4, 6, 8, 10, 12, and 14 km from the receiving stations, until interference was too great to allow reception of a clear radio signal. Maximum transmission distance was

10–12 km. Units were deployed on 12 occasions in 1996, and batteries lasted for a mean of 65.5 h (SD ± 10.1). Battery life could be extended by adding another battery in parallel with the first. However, the casing would need to be enlarged using an extra central section of PVC-U drainage pipe.

The manufacture of a single sonobuoy unit cost approximately US$280. Remote recording enabled us to leave the sonobuoy unit running continuously for 2–3 d without having to access the unit to change batteries. The unit was rugged and easily deployed and moored, enabling us to move the unit to different areas with little effort. This sonobuoy unit provides a low-cost method for recording long-term underwater acoustic behavior of marine mammals and could be easily adapted to suit a range of different purposes and environments.

Acknowledgments

We would like to thank R.A.F Kinloss for the donation of the sonobuoys, Bruce Greig for advice on the construction, and Paul Anderson, Heather Corpe, John Hildebrand, Ben Wilson, and an anonymous referee for comments on the manuscript.

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Received 13 January 1997. Accepted 22 April 1997.

APPENDIX 1. ADDRESSES OF SUPPLIERS:

R. S. Components International, P. O. Box 99, Corby, Northants, NN17 9RS, U.K. Tel: 01536-201234, Fax: 01536-405678.

South Midlands Communications Ltd., School Close, Chandlers Ford Industrial Estate, Eastleigh, Hampshire, SO53 4BY, U.K. Tel: 01703-255111, Fax: 01703-263507.
Terrain PVC-U drainage pipe, widely available from plumbers merchants.
Vetlab supplies, Unit 13, Broomers Hill Lane, Pulborough, West Sussex, RH20 2RY, U.K. Tel: 01798-874567, Fax: 01798-874787.