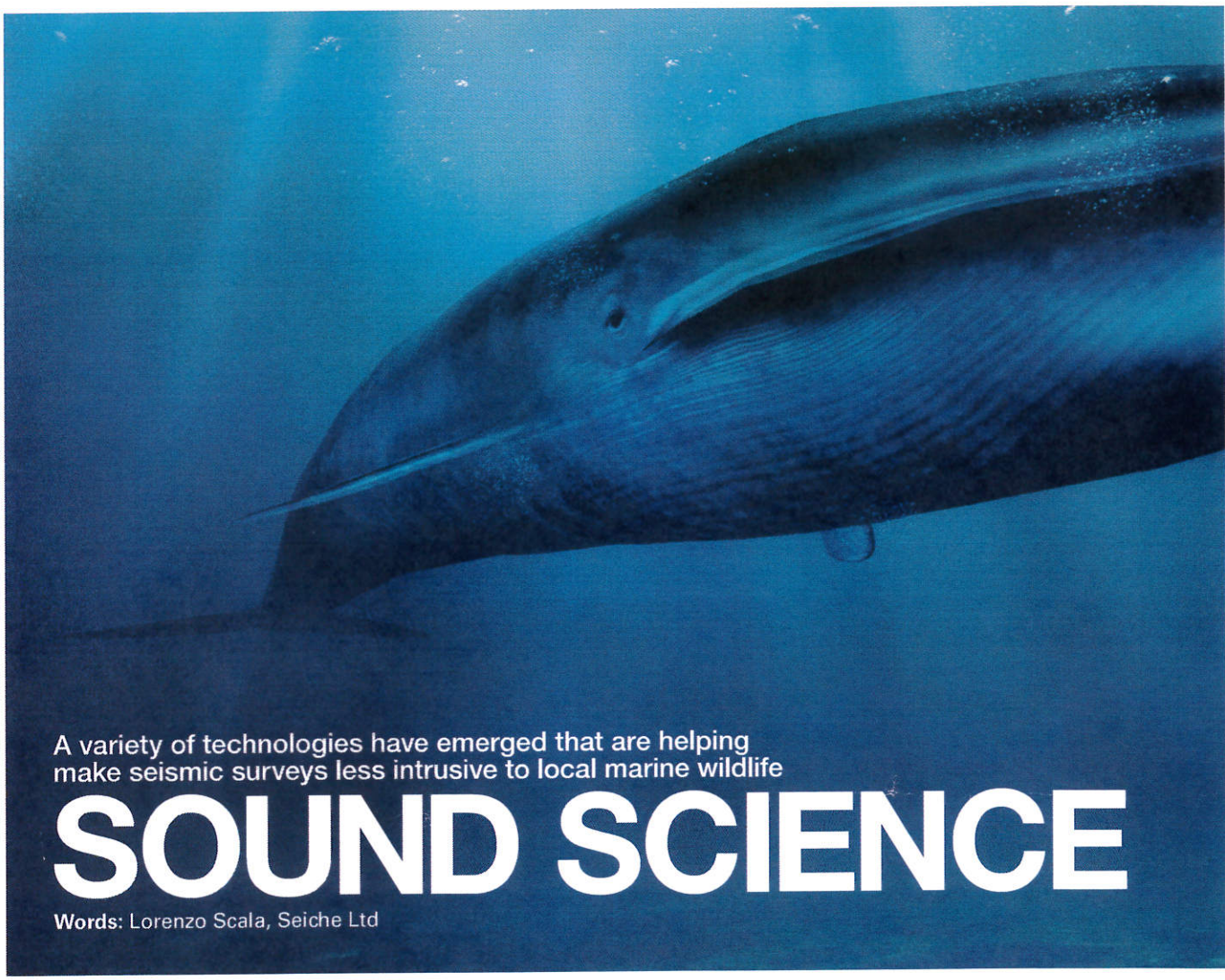


A variety of technologies have emerged that are helping make seismic surveys less intrusive to local marine wildlife

SOUND SCIENCE

Words: Lorenzo Scala, Seiche Ltd

Seismic surveys to hunt for fossil fuels below the seabed produce high impulse broadband energy in the auditory range of many marine species – particularly mammals but also fish and invertebrates. In mammals, sound is vital for navigation, foraging, social interactions, breeding and for in-group communication. The effects of underwater noise can affect behaviour and cause permanent damage to hearing. As a result, environmental regulators worldwide are showing increased interest in monitoring and reducing aquatic sound.

Survey projects now have a dedicated marine mammal observer (MMO) who will advise the delay in start-up or the shut-down of the sound if an animal enters the exclusion zone surrounding the seismic source. Moreover, soft-starts, whereby the source outputs are raised gradually to give marine mammals the opportunity to disperse, are now becoming common practice in surveys.

Passive monitoring

The use of passive acoustic monitoring (PAM) to detect and classify vocalising marine mammals in real time is also growing, particularly for deep diving evasive species, and during periods of low visibility and darkness. Vocalisations produced by mammals vary in frequency and according to species. For PAM systems to be effective, they must detect the very low frequency tonal calls of baleen whales (*mysticetes*) to the ultrasonic pulses emitted by some toothed whales and dolphins (*odontecetes*).

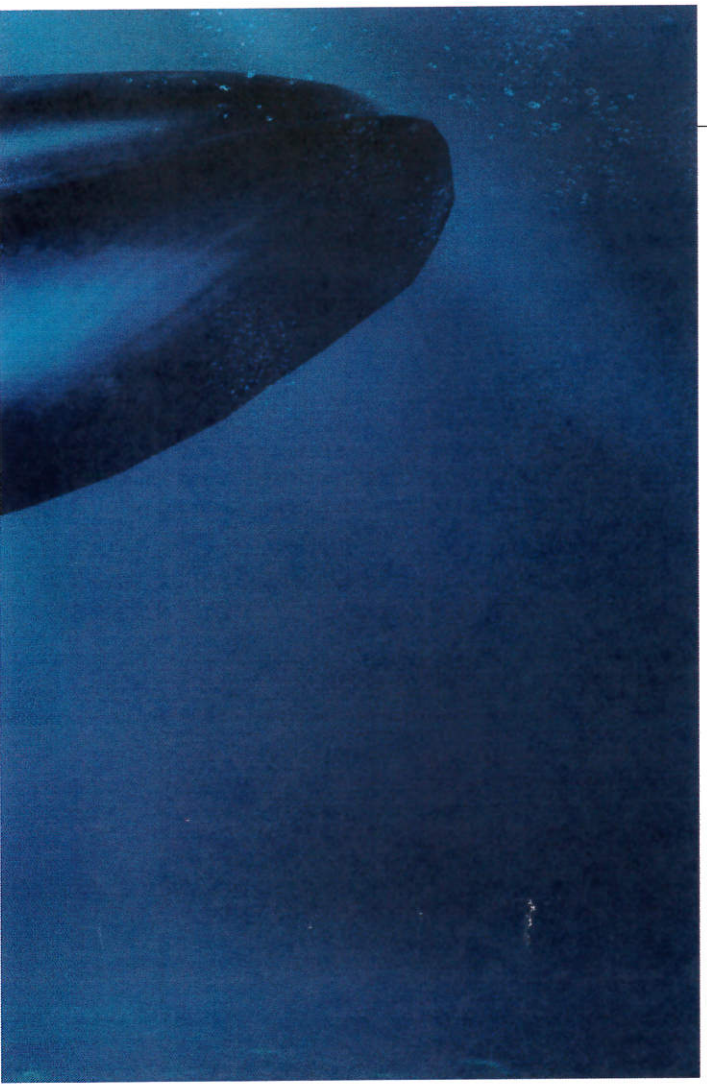
PAM systems comprise an array of hydrophones towed astern of the vessel, some electronics to process the pressure signals received by the hydrophones, and a PC to display the output. When a vocalising marine mammal is detected, the system's operator will determine its bearing relative to the seismic source and inform the surveyors how close the animal is to the exclusion zone. The operator will then determine the necessary action to ensure the survey remains compliant with mitigation protocol, while logging vocalisation characteristics of detected animals.

In daylight hours the MMO and PAM operator will corroborate sightings and acoustic detections to verify species classification. In low visibility and at night, generally, the PAM operator will be solely responsible for determining the appropriate mitigation action.

Remote support

More advanced solutions have emerged in recently to support PAM operators. Seiche is using satellite backhaul to transmit acoustic signals from vessels to shore-based sites at Devon, UK, or Houston, US, where trained operators can assist in the monitoring effort. This enables around-the-clock support for seismic surveys while providing experience for trainee PAM operators in preparation for the more isolated experience of working offshore.

Multi-vessel link (MVL) systems enable a PAM hub station on one vessel to monitor PAM systems on other ships working in



a given range. The ability to monitor several systems simultaneously means fewer MMOs are required and mitigation actions can be synchronised and managed from a single location.

Sound modelling

Tighter regulations are also driving a need for higher quality underwater sound modelling. The seabed bathymetry, sediment stratigraphy, conductivity, temperature, depth and flow of the water are just some of the dynamic variables that influence how the sound is absorbed, reflected and refracted within the water column and which must be incorporated into the model to predict the sound field generated by a source. The predictive models are verified by measuring the intensity and propagation of a real sound source. Data is collected by subsea recorders, digital hydrophones and drift buoys for seismic survey source arrays prior to full operations commencing. The results of the analysis, together with the acoustic sensitivity of expected marine life, may then be used to determine the shape and size of mitigation zones (MZD) to satisfy the prevailing local regulations

MMO

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Drift buoys

Drift buoys offer a dynamic approach to ambient sound and source monitoring compared to conventional seabed recorders and towed arrays. The buoys are lightweight, easily deployed from a small support vessel or from the source vessel itself and permitted to drift through the survey location.

As the sensors are travelling with the current, noise associated with water flow and drifting debris impact is eliminated, providing an improved signal-to-noise ratio. The buoys are typically equipped with hydrophones, an electronic sampling and data storage unit, a GPS, and batteries for 20 hours of operation.

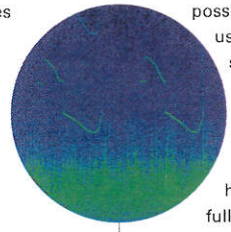
Visual inspections

Camera surveillance is also finding a role. Dual systems combining high-definition and thermal-imaging cameras mounted on a pedestal with 360-degree view can maintain a look-out for marine mammals, small vessels, debris, and ice etc. For seismic survey mitigation, the cameras are typically positioned facing towards the source array.

Special software provides accurate distance estimation and overlays the mitigation zone. It can also be set to automatically detect marine mammals using pixel recognition algorithms. Cameras are helpful in low light conditions and in areas where marine mammals with low vocalisation rates are present.

Unmanned possibilities

Autonomous surface vehicles (ASVs) bring a range of exciting possibilities and their use as a platform for sub-sea acoustic monitoring looks set to grow. ASVs fitted with towed hydrophone arrays have been successfully trialled. Sound recordings can be processed on board for later download and analysis. Alternatively, a wireless link to a nearby support vessel enables monitoring by a PAM operator in real time.



Signal vs noise: Dolphin whistles displayed on a spectogram. MMOs must learn to recognise different sound signatures

The manoeuvrability of ASVs allows them to cover a mitigation zone at offset or scope ahead for sensitive species (e.g. baleen whales). They can also be GPS-programmed to carry out an autonomous survey and collect baseline acoustic data for later analysis, providing a cost-effective solution for investigation of ambient and sound sources at sea.

Operator standards

With increasing requirements for marine sensing tools, it is important to ensure field operators have the skills to deploy and operate proprietary systems to a professional standard. In addition to training for new operators, an internationally recognised industry standard with a clear pathway for career progression may provide an incentive for operators to pursue supplementary certification to validate competence with use of proprietary systems.

Refresher courses may then be completed periodically, alongside other mandatory offshore courses, such as safety training and survival refresher courses. This would ensure operators are consistently equipped with the latest mitigation and reporting requirements adopted by industry regulators. ■