Rigs as artificial ree

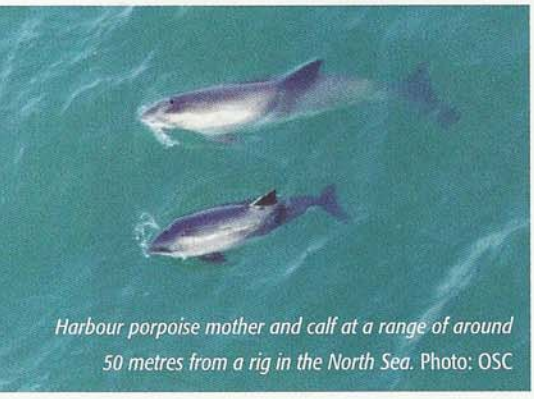
Rigs may provide vital habitat for endangered marine mammals and their prey

Scientists from Scotland-based Ocean Science Consulting (OSC) were the first in the world to eavesdrop on the acoustic activity of marine mammals around the legs of North Sea offshore oil and gas installations. From 2004 to 2010, OSC used autonomous underwater echolocation click-detectors called T-PODs and C-PODs to monitor acoustic activity of harbour porpoises (*Phocoena phocoena*) around oil and gas installations in the German sector of the North Sea. Under the supervision of Dr Victoria Todd and Ian Todd, OSC initially assessed the underwater noise regime of rigs, to determine if drilling and operational sounds were likely to be audible to porpoises. The next stage of the research was to find out if porpoises were present around rigs, and to what extent.

Example of a jack-up rig and associated supply vessel. Photo: OSC

ANTHROPOGENIC UNDERWATER NOISE

The European Commission's Marine Strategy Framework Directive has identified the measurement of underwater noise as a priority. The problem is that underwater noise measurement (and analysis) is an extremely complex branch of science that is currently carried out in many different ways. Moreover, there is great variability in transmission of sound in the marine environment, and measured signals depend on many factors such as: receiver-induced self-noise, signal source level, frequency, duty cycle (intervals), reflection, refraction, absorption, water depth, temperature, salinity, seabed properties (bathymetry, substrate type/grade, etc.), wind speed, current speed, bubble content, turbidity, rain, wind, ambient noise regime and a plethora of other factors. As a general rule of thumb, in deepwater high-frequency sounds transmit less effectively (fine spatial scale), whereas lower frequency sounds have the potential to travel further (broad spatial scale).



Harbour porpoise mother and calf at a range of around 50 metres from a rig in the North Sea. Photo: OSC

NOISE AND MARINE MAMMALS

Marine mammals, particularly cetaceans (whales, dolphins and porpoises) use sound for orientation, communication, hunting and catching prey. All species of baleen whale (Mysticetes) produce low-frequency sounds (thumps, knocks and moans) in the 10Hz–200Hz range, and some species also produce pulses, chirps and 'songs' at higher frequencies of up to 10kHz. Toothed whales, dolphins and porpoises (Odontocetes) produce an assortment of sounds for echolocation and communication, including broadband sonar clicks (0.25kHz–220kHz), burst pulse sounds, and narrow-band frequency-modulated (FM) continuous tonal whistles (0.5kHz–80 kHz). The hearing range of cetaceans is less well understood, but it is assumed generally that they hear over similar frequency ranges to the sounds that they produce.

The exact effects of anthropogenic sound upon marine mammals are unknown, but research indicates that elevated background noise levels and specific sound sources might impact marine mammals in several ways: (1) masking of important sounds such as echolocation, communication signals, other sounds associated with finding prey or avoiding

fs in the North Sea

predators and human threats such as collision with ships; (2) alterations in behaviour – including displacement from feeding, migration, and breeding habitat; (3) hearing loss – temporary or permanent; (4) chronic stress; and (5) indirect effects such as displacement of prey species.

HOW NOISY ARE RIGS AND CAN PORPOISES HEAR THEM?

Using various hydrophone systems optimised to record over a broad frequency range, underwater sound recordings were made from around a jack-up rig's legs. The aim was to document received levels, characteristics, and range-dependence of sounds produced by the rig's site installation and drilling operation. These sounds would then be compared to the signals that porpoises are likely to hear underwater based on known porpoise hearing (audiogram) data.

Sound pressure levels (SPLs) generated by the rig were similar to published studies of measurements from other metal-legged bottom-founded rigs, both in level (120 dB re 1ìPa) and in frequency range of dominant tonals (2Hz-1400Hz). The rig's high-frequency SPLs dropped rapidly above 8kHz.

Porpoises produce narrow-band, high-frequency click components between 110kHZ–150kHz. While we do not know if porpoises can hear as low as 2Hz (as it is technically difficult to play such signals back to a porpoise in a shallow pool), porpoise audiograms have shown that they can hear over a wide frequency range (16kHZ to 140kHz); however, their maximum hearing sensitivity occurs between 100kHz and 140kHz (i.e., five orders of magnitude higher than the lower frequencies produced by drilling rigs). Consequently, while aspects of drilling (and operational) noise are likely to be heard by porpoises, the main drilling frequencies are highly unlikely to interfere with porpoise hearing or mask the sonar signals that they produce.

Above: Three-tonne buoy used to moor T-PODs, C-PODs and other oceanographic equipment at a control location. Below: Marine life colonisation on the legs of a rig. Photos: OSC

PORPOISE ACOUSTIC ACTIVITY AROUND RIGS

The next stage of the research was to determine if porpoises were present around rigs. To this end, OSC placed several autonomous underwater porpoise echolocation click detectors called T-PODs around the legs of the installation and left them to log for over six months. Porpoises were detected within two minutes of the jack-up rig's legs touching the seafloor. Accounting for porpoise signal propagation, it could be deduced that the animals were present within 200 metres of the installation. Subsequently, there was also a pronounced diel (24-hour) pattern in echolocation activity; specifically, the number of porpoise acoustic encounters (visits) was greater by night than by day, and a greater proportion of those clicks at night could be associated with feeding behaviour (doi: 10.1093/icesjms/fsp035).

Do porpoises prefer rigs to the open sea?

The million-dollar question arising from this research was whether porpoises were present in greater acoustic densities around rigs compared to the open sea; therefore, in 2010, OSC co-funded a further study, which involved placing T-PODs and C-PODs around another jack-up rig and at a control (open ocean) location away from the rig. Again, porpoises were detected as soon as the rig's legs touched down and, as predicted, the PODs recorded greater acoustic activity of porpoises around the rig compared to the open sea. While the results are only preliminary at this stage (and would require replicated studies to put the theory to bed), there is now strong evidence that porpoises target rigs as feeding stations compared to the open sea.

RIGS AS ARTIFICIAL REEFS

Offshore installations act as artificial reefs, and their three dimensional structure, which can extend vertically down the entire water column, is effective in aggregating benthic, demersal, and pelagic fish along with a whole host of other marine life. Moreover, in the North Sea, fishing is not permitted within the 500-metre exclusion zone around each installation, further enhancing the properties of these "reefs" as miniature reserves for marine life. In fact, rigs have long since been recognised for their ability to attract fish to the extent that, in 1986, the USA's National Marine Fisheries Service (NMFS) developed a rigs-to-reef policy in the Gulf of Mexico based on the creation of artificial reefs from decommissioned offshore installations left in situ. Those rigs now support a thriving red snapper (*Lutjanus campechanus*) industry, and are on the whole, supported by the various marine stakeholders, in particular fishermen. Although the rigs-to-reefs concept has not yet been adopted in the North Sea, the few rigs-to-reef studies undertaken there all report similar reef effects. Fishermen regularly scoop-up the fish "overspill" from around offshore installations, sometimes deploying fishing gear within the exclusion zone (usually at night, to avoid conflict with platform watchmen). This is a risky strategy to employ within the immediate vicinity of an operational platform, where nets can be snagged on active pipelines, so the benefits of increased catches clearly outweigh the costs.

Until now, rigs-to-reef studies have focused predominantly on quantifying aggregations of fish and invertebrates, so this is the first work that has considered the potential of offshore installations as foraging habitats for top predators such as marine mammals. It is assumed that areas in the near vicinity and between the legs of such structures probably serve as reefs for potential prey, hence the attraction of porpoises to the rigs. The fact that porpoises are present so soon after a jack-up rig is towed onto location, may suggest that the animals either follow the rig when on-tow or associate the rig's noise signatures with a reliable food source (the so-called "dinner gong" effect). Platforms that have been in place for a number of years may also serve as predictable and reliable foraging locations for porpoises. Indeed, both mothers and calves (which need to feed more regularly than lone adults) have been seen foraging regularly between the legs of North Sea rigs located more than 200 kilometres offshore, further supporting this "feeding station" theory.

SHOULD RIGS BE LEFT IN SITU AFTER DECOMMISSIONING?

There are arguments for and against decommissioning that are well beyond the scope of this article, but on the basis of this and ongoing research, the scientists at OSC believe strongly that, for porpoises at least, cleaning-up and leaving rigs in situ at the end of their operational lifetime would be beneficial. While the research has received overwhelming support from the scientific community, certain non-governmental organisations have argued that artificial reefs change the seabed from one type of "natural" habitat to another; however, the majority of shallow-water North Sea rigs are located in trawling zones, where the seabed has been changed, in the majority of cases, beyond recognition, and can certainly no longer be considered as "natural" habitat. Considering the historical effects of overfishing in the North Sea and elsewhere, OSC believes that this research should be considered whenever offshore installations reach the end of their operational lifetime and decommissioning is planned. Given that porpoises are subjected to unsustainable rates of bycatch in fisheries, threatened with pollutant accumulation in tissues and starvation due to overfishing of their prey species, enforced marine nature reserves are virtually non-existent (e.g. less than 1% of UK waters – in effect, too little and too late). Several other North Sea species are either extinct (e.g. angel shark, *Squatina squatina*), or have been categorised by the International Union for Conservation of Nature (IUCN) Red List as "critically endangered" (e.g. common skate, *Dipturus batis*), so rigs may very well serve as one of the last protected habitats for threatened harbour porpoise populations in the North Sea.