Invited Speaker

The Secret (and not so silent) Lives of Seals and Other Amphibious Marine Mammals

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It was not so long ago that the sound emissions of many marine mammals were recorded and described for the first time. Pioneers of marine bioacoustics—Bill Schevill, Bill Watkins, Carleton Ray, Melba and David Caldwell, Roger and Katy Payne, Bill Evans, Ken Norris and others— revealed in the 1960s and 70s that 'the silent world' was not so silent after all. Most fully and semi-aquatic mammals emitted underwater sounds and all seemed keenly adapted to perceive their underwater worlds in large part by listening. Dolphins were shown to possess specialized sonars, ultrasonic sensitivity, and the tendency to produce frequency-contoured identity signals, while whales were shown capable of communicating with infrasound across vast distances and learning intricate songs. Compared to the cetaceans, the acoustic umwelts of amphibious marine mammals may have seemed less extraordinary. However, these animals also have an audio-story to tell that connects their facility to produce sounds in air and under water with their ability to detect biological and environmental sounds in both of these media. It is their uniquely amphibious natures, after all, that pose intense and often conflicting constraints on their acoustic sensory-communication channels.

What do we know about acoustic communication in the amphibious pinnipeds (true seals, sea lion, fur seals, and walrus) and other marine carnivores (sea otter, polar bear)? Early research revealed that sea lions and fur seals could bark under water as easily as they could in air, and produce click trains that sound much like creaking doors. More impressively, some seals were shown to emit underwater vocalizations that sound entirely otherworldly. These include the laser-light-show calls of Weddell seals signaling beneath the ice, the choruses of thousands of harp seals chirping and honking in the springtime, and the ethereal frequency-swept trills of bearded seals which descend in drawn out frequency steps like a science fiction movie soundtrack. The song of the walrus in the high Arctic winter may be the most spectacular of all: a sharp, slamming percussive rhythm capped with clanging punctuation—these mechanical, metallic noises sound like a heavy ax striking an iron pipe. At the other side of the spectrum are the sea otters, who apparently do not produce sounds under water but who emit piercing broadband shrieks at the water's surface, and polar bears, who have a limited repertoire of airborne vocalizations and sound much like other bears.

The selective pressures giving rise to the specialized vocalizations of seals and their relatives are somewhat mysterious. Acoustic signals are strongly associated with annual reproductive cycles, with contact calls exchanged between mothers and their dependent pups on land or ice, and calls emitted by males spanning the interval of female estrous. Male calls produced during the annual breeding season are of particularly interest. These vocalizations are loud and highly redundant, with other features that make them difficult to ignore. While shore-breeding species use their vocalizations to support male territorial or female defensive strategies, species that mate aquatically have the additional challenge of monopolizing access to—or physically controlling—females in the 3-dimensional open environment of the sea. As it happens, the same species that mate beneath the water's surface also are the species that produce stereotyped underwater acoustic displays and songs. While these signals have been recorded and examined, the social and spatial contexts surrounding their production remain largely unexplored.

Sound production in seals and their kin relates to only a portion of the sensory-communication channel. Amphibious mammals have also experienced selective pressures (both direct and indirect) that have modified their ability to perceive airborne and waterborne sounds. Until quite recently, these animals were considered to trade-off specialization for acoustic sensitivity in one medium for better sensitivity in the other; it did not seem possible for the mammalian auditory system to operate effectively in both. We now have a better understanding of the auditory sense of amphibious marine mammals. Key auditory features that scale with degree of aquatic specialization include skeletal, soft tissue, and neural adaptation that support hearing and sound localization in water, but also protect animals from the detrimental effects of pressure, drag, and heat loss. Additionally, amphibious mammals somehow retain the conductive mechanism to support the efficient transmission of airborne sounds to the inner ear, while also possessing adaptations that compensate for reduction of air spaces and impedance mismatches when submerged. Finally, and perhaps most impressively, these animals have demonstrated auditory capabilities that can rival those of their terrestrial counterparts in air as well as those of fully aquatic cetaceans in water. Other derived features, like the extraordinary frequency range of acute underwater hearing in true seals, are evident, but harder to explain and yet to be fully explored.

Considered together, knowledge of sound production and sound reception highlights the importance of the acoustic channel in the lives amphibious marine mammals. Qualitative and quantitative information about caller and receiver characteristics has accrued gradually through the hard work of many individuals over the past half century. This information can now be integrated with environmental data concerning soundscapes and sound propagation to gain insight into the listening spaces that individuals occupy as they transition between the shore and the sea. Such a whole-animal approach enables an appreciation for the importance of sound to these animals that extends well beyond social communication.