UNDERWATER ACOUSTIC DISPLAYS BY MALE HARBOR SEALS (PHOCA VITULINA): INITIAL RESULTS

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INTRODUCTION

Underwater vocalizations have been studied for a number of the phocid pinnipeds. Weddell seals (Leptonychotes weddellii) produce a wide variety of vocalizations that include chirps, trills, whistles and chugs (Schevill and Watkins, 1965; Thomas and Kuechle, 1982). These vocalizations have been classified by Thomas and Kuechle (1982) into 12 underwater calls with 34 call types. They used descriptive terminology to identify these vocalizations, i.e., what-chunk, guttural glug, mew, jaw claps, and found that male Weddell seals have a larger, more complex repertoire than females, which they appear to use in underwater territorial displays during the breeding season. Weddell seals are an excellent example of the correlation between a highly polygamous breeding system and large vocal repertoire size (Evans and Bastian, 1969).

Another polygamous phocid, the harp seal (Phoca groenlandica), maintains underwater territories (Møhl, Terhune, and Ronald, 1975) and is also very vocal, with 15 vocalizations in its repertoire. Other species of phocids have social systems which range from solitary, but promiscuous, to monogamy and their vocal repertoire size varies accordingly (Gailey-Phipps, 1984).

An increase in both aerial and underwater vocalizations during the breeding season is common among many pinnipeds. This was first quantified by Schusterman in captive studies of male California sea lions (Schusterman and Balliet, 1969; Schusterman and Dawson, 1968; Schusterman and Gentry, 1971). Later studies of both captive and wild pinnipeds included the ringed seal (Stirling, 1973), bearded seal (Burns, 1981), harp seal (Møhl et al., 1975), walrus (Ray and Watkins, 1975), and spotted seal (Gailey-Phipps, 1984) among others. These vocalizations appear to be used as a way to attract females and/or establish dominance or territoriality among males. Until recently, harbor seals (Phoca vitulina) have been considered to be one of the least vocal pinnipeds with only aerial grunts, growls, and snorts making up their repertoire (Bigg, 1981). Sullivan (1981) suggested that harbor seals are poly-
gynous and males establish breeding privileges through dominance rankings resulting from fighting and visual aquatic displaying at the water surface. He also stated that although many phocids produce underwater vocalizations as part of their aquatic displays, the context is unclear and he did not look into underwater vocalizations of harbor seals.

To our knowledge, Schevill, Watkins and Carleton (1963) made the first underwater recordings of a male harbor seal (Phoca vitulina concolor) which were "hard to hear and harder to analyze." These recordings were made in captivity in January, outside the breeding season. A few underwater vocalizations of a captive male harbor seal were later recorded by Schusterman, Balliet and St. John (1970). These vocalizations were primarily low frequency and had pulsed characteristics, which varied in speed emitted from slow pulse repetition rates to extremely rapid, loud and roar-like. The same sounds were also produced in air and often associated with visual displays such as foreflipper waving and posturing indicative of a threat display. In contrast, another captive study on harbor seals examined aerial vocalizations and vocal mimicry (Ralls et al., 1985). One male seal named "Hoover" produced a wide range of aerial vocalizations, including mimicry of human words, especially during the breeding season. This surprising vocal ability, along with the known breeding behavior of harbor seals, and personal observations by one of us (RJS) in June 1988 of a four-year old male harbor seal named "Stanley" who was housed with two immature females at the Northwind Undersea Institute in the Bronx, New York, led us to hypothesize that male harbor seals in the wild use underwater acoustic displays in conjunction with visual aquatic displays to establish dominance hierarchies and/or to attract females. This paper documents the basic vocal repertoire of natural living male harbor seals during the breeding season and examines the structural variability within each vocalization type.

METHODS

We recorded underwater vocalizations and made observations of harbor seals at Moss Cove, Point Lobos State Reserve, California for three days a week during the breeding season (May through July 1991). Moss Cove is an approximately 183 meter X 91 meter cove with rocky outcroppings and cliffs on either side of a pebble beach. Harbor seals hauled out primarily on about ten rocks separated from the shoreline in the southern part of the cove with the closest rock approximately 1.5 meters from land. Five of these rocks and the rocky shoreline formed a circular border around a small area of water, which we called the arena. The arena varied in depth from approximately one to 4.6 meters with an uneven substrate. On the north shore of the cove and in another adjacent cove to the south there were also harbor seals, but these seals were not part of the group we observed. The maximum number of seals in our area was approximately 55 and included animals of all age classes and both sexes. We counted five pups on May 1, 1991, our first day at Moss Cove, and this number increased to six within the following week after which time no more pups were born. Since the only marine mammals seen in this area were harbor seals we are confident that our recordings were from this species.
We suspended a hydrophone into the center of the arena by attaching it to a 6.1 meter long PVC pipe which floated at the water surface and was attached to the rocks on shore. The hydrophone was part of a RS301A Acoustic Listening System made by Acoustics Systems Inc., Goleta, California) and tape recordings were made using a Sony TC-D5M stereo tape recorder, system frequency response 0.03 kHz to 17 kHz ± 3 dB. Underwater recordings were made on one channel while the other channel was used for narration. We began recording when we heard the first vocalization or when a seal entered the arena and behaved in a manner which suggested to us that it would start vocalizing. Such behaviors included milling around the arena, floating, orienting and then swimming slowly in and out of the area. At other times two seals would interact aggressively by rolling over each other, biting and clasping then separating and one or both would perform some visual displaying, i.e., fore- or hindflipper slapping, lobtailing (Sullivan, 1981). The tape recorder was left on for the entire time the seal vocalized. We defined this as a vocalizing bout, which ended when the seal stopped vocalizing for several minutes or when it had left the arena. We also made recordings when no seals were in the water as a baseline for background noise. We did see seals submerged, visual aquatic displaying and interacting outside of the arena, but we were unable to pick up any vocalizations. This does not imply that the seals were not vocalizing, more likely, the animals were too far away or behind a rock barrier for the hydrophone to pick up any of their sounds. In the arena, we could identify the vocalizing seal for all vocalizing bouts recorded by observing which seals were in the water, who was at the surface or under water at the time of the vocalization and the synchronicity of submerging and vocalizing. All vocalizations were produced under water with the exception of the typical threats. On most days, the vocalizing seal was visible enough while it was submerged so that we could note the sex and the body orientation.

Sonograms of vocalizations of five adult male harbor seals were made using the MacRecorder and MacPaint programs on a Macintosh IIci. Vocalizations were classified based on their structure and on their sound to the human ear. Vocalizations were categorized into tonal and non-tonal calls. Tonal calls showed harmonic structure and were probably produced in the larynx, whereas non-tonal calls were non-harmonic and may have been made by muscle contractions of the pharyngeal region (Gailey-Phipps, 1984).

RESULTS

Behavior associated with vocalizations

We have analyzed underwater vocalizations of five adult male harbor seals. We did not hear females vocalize at all except when threatening other seals on the rocks. Aerial threats were produced by both sexes and will not be discussed here. Adult males produced only two other sounds in air: huffing - a strong exhalation of air through the nasal passages and/or mouth, either on land or at the water surface, which appeared to be a way of clearing the throat; short grunt - a short duration aerial vocalization that seemed to be a
remnant of an underwater vocalizing bout as the seal surfaced. This vocalization was very uncommon.

In May, males vocalized under water while there were females with their pups in the water nearby. Later, in June and July, males vocalized regardless of whether or not there were females in the water. However, there were almost always other males in the water and both sexes occupied the rocks surrounding the arena. When males put on their underwater acoustic displays, females did not appear to react strongly to them. At most, they watched the male and sometimes submerged when he did as he began vocalizing. The vocalizing male did not physically interact with the females after acoustic or visual displaying. Indeed, we saw no copulatory behavior between the sexes. The only contact between males and females was an occasional foreflipper scratch when one seal would venture too close to another while they were hauled out.

Prior to submerging and vocalizing, a male would behave in one of several different manners: a) enter the arena and swim about slowly by himself and then slip under water and begin vocalizing; b) perform visual aquatic displays, such as fore- or hindflipper slapping on the water surface; c) interact with another adult male. Such interactions included rolling over one another, biting necks and heads, and clasping bodies with foreflippers. These behaviors were aggressive and after the seals separated they often had fresh wounds on their heads, necks and bodies. After these fights terminated and also between fights, one or both males would perform some aquatic displays and/or one would submerge and vocalize. This sequence of vocalizing, visual displaying and fighting continued for one to two hours after which the non-vocalizing male disappeared and the vocalizer either hauled out or also disappeared. Only one male vocalized at any given time and on only one occasion did the other interacting male vocalize after the first one. The primary body posture for underwater vocalizing was ventral side up with either the head slightly higher than the tail or a completely horizontal position. Due to surge and wind disruption of the water surface, we could not see the vocalizer at all times so he may have vocalized in other positions, however, whenever we could see him, he was belly-up.

Description of vocalizations

Each type of underwater vocalization is described by its physical characteristics and by its sound to the human ear. The physical parameters used were duration, frequency and general pattern of the vocalization and onomatopoetic names were given to aid in classifying each sound.

ROAR. Figure 1 shows the roars of two males. This was one of the primary vocalizations used by the male harbor seals. This vocalization has little, if any, tonal quality and to the human ear sounds like an animal roaring, but in actuality may be the sound of air being blown out through the mouth or nostrils. The duration of this vocalization varies from two sec to more than eight sec. The frequency of the most intense part of the vocalization ranges from 400 to 800 Hz with additional, less intense bands, at regular intervals up to 3000 Hz. Part of the roar may extend up to 4000 Hz. I:
general, the beginning of the roar sounds breathy and then becomes harsh and higher in amplitude and has a raspy quality. All males produced this vocalization, but the durations and frequencies varied between them.

![Graph](image1.png)

**Fig. 1.** Roar vocalizations from two male harbor seals.

**BUBBLY GROWL.** This vocalization often precedes the roar. The quality is normally non-tonal, but for one animal there was some tonal variation. To the human ear, it sounds as if the seal is blowing bubbles. The duration ranges from one to more than eight sec and this vocalization is very low in frequency - <100 to 250 Hz (see Figure 2 for examples from two males). When water conditions were good, we could see bubbles rising to the surface during this vocalization. This low frequency vocalization does not show much variation between males.

![Graph](image2.png)

**Fig. 2.** Bubbly growls from two males (labeled a and b).
GRUNTS. This category includes an assortment of very short vocalizations, ranging from 0.1 to 0.5 sec. The frequency range begins at approximately 100 Hz and may peak above 4000 Hz. The aural sounds include "waap", "rurrh", "wahwap", "hhuh", and a pulsed growl. Some of these have a tonal quality showing numerous harmonics when the time axis is extended. Figure 3 shows a variety of these vocalizations produced by two different males.

![Graph of GRUNTS](image)

Time (in 2 sec intervals)

Fig. 3. Various grunt vocalizations produced by two males.

CREASE. Figure 4 depicts examples of the creak vocalization from two males. It is tonal, showing harmonics from approximately 700 to 2000 Hz with another component above 4000 Hz. The duration ranges from 0.5 to six sec and the longer creaks fluctuate in frequency as they progress. To the human ear, it sounds as if a door with rusty hinges is opening. Although most of the males produced this vocalization, only one used it frequently.

![Graph of CREASE](image)

Time (in 2 sec intervals)

Fig. 4. Creak vocalization from two males. Note the fluctuation in frequency over time.
DISCUSSION

Until recently, harbor seals in the wild were considered to be one of the least vocal pinnipeds (Bigg, 1981). In this study, we have found that this is not an accurate portrayal for this phocid. If one only observes these seals on land, particularly outside the breeding season, then it is not surprising that the consensus would be they are not vocal. To get a complete picture, it is necessary to follow them into their undersea environment, and when one does, a whole new story unfolds. This species is far from silent. Adult male harbor seals produce a variety of unique vocalizations. All males showed some similarities, for example, all produced the roars and bubbly growls. They also all used the short vocalizations, which we called grunts, but these were variable and each male sounded different. Most males produced creaks, but there was a great deal of variability, including fluctuations in frequency and duration. Each male appeared to have a distinctive style. For example, the male we named Streak Ear primarily roared; Grizzly roared but also produced many grunt vocalizations and some creaks; Right Eye Dot produced many more creaks and bubbly growls. Our findings are similar to those of Deane Renouf and her colleagues who studied captive harbor seals and found that there was variation in vocalizations between individuals (personal communication to EBH).

These underwater acoustic displays by male harbor seals could function as a means to establish a dominance hierarchy and/or to attract females. At Point Lobos, males vocalized in at least one specific area, the arena, and there were always other males and sometimes females in the water near them. Acoustic displays could be a way to indicate fitness to females, although we never saw females acting as if they had much interest in displaying males. Rather, other males interacted with the vocalizing male and vocalizing bouts were often interrupted by fighting between males and by elaborate visual displays, such as flipper slapping, lohctailing, and leaping out of the water. This indicates that males are attempting to establish dominance hierarchies. Since we recorded 15 different males vocalizing in the same small location, aquatic territory establishment does not seem likely. This is supported by the fact that after displaying, the male either disappeared or hauled out on one of the rocks in the cove. Our first impression is that males display in the arena and adjacent areas, make themselves "known" to other males and females and later probably copulate with females in other nearby locations.

We are currently analyzing vocalizations of the remaining males previously recorded. This should give us a better understanding of the function of these sounds and perhaps even increase what we now know to be the vocal repertoire of male harbor seals. We plan further studies to determine the relationship between male displays and their reproductive activities and possibly their reproductive success.

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LITERATURE CITED


