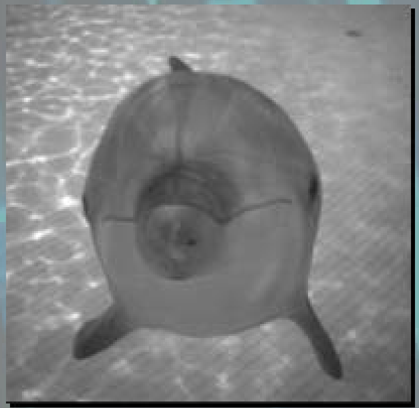


Acoustic enrichment for dolphins in pool environments

Malin Berglind, Masters Thesis 2004-2005
International Masters Programme in Applied Biology 2005
University of Linköping, Sweden

The bottlenose dolphin (*Tursiops truncatus*) has an advanced sonar system, which is used primarily for navigation, foraging and hunt. In whale and dolphin exhibits around the world, an artificial setting (i.e. pool environment) is the most common mode of display. Unfortunately, the bare and static environment in a pool does not provide many acoustic challenges for echolocating dolphins. A pool often has sufficient lighting, clear water and limited amount of obstacles; which enables dolphins to navigate solely using vision. For health and safety reasons the dolphins are usually hand fed dead fish which reduces the need for hunt.

In this study enrichment objects were introduced to encourage natural behaviors associated with sonar use and to test if objects with good acoustic reflection constitutes landmarks in a bare environment. The study was conducted at Kolmården Dolphinarium, Sweden.

The sonar system

The bottlenose dolphin has an advanced sonar system. Sound is generated in the nasal cavity area just below the blowhole. A large fat body called the melon directs the sound into a narrow beam (-3 dB beam width) with a beam axis 5° to 10° above the longitudinal axis of the skull. Sound is received through the acoustic window, which is a thin walled area on the lower jaw. From here the sound is transported and amplified through a fat-filled channel into the auditory bulla, which contains the middle and inner ear.

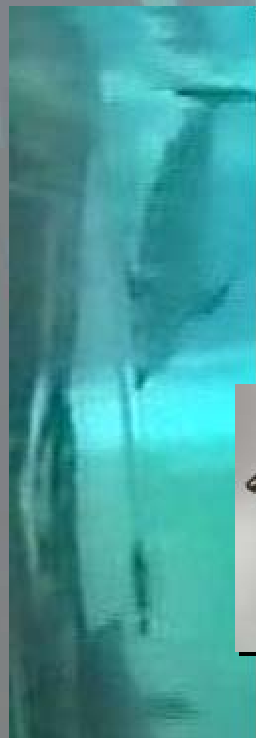
When emitted sound hits a target the majority of the sound waves reflect on the front surface of the object creating an echo highlight. A large part of the sound waves however; passes through the front surface, scatters in the interior structures of the object, and reflects back through other paths with a delay. Circumferential waves travel around the object. Hence, a target object with complex shape and surface structures will reflect back an echo with many highlights. Highlights are more distinct and easier separated if sound emissions are short and sharp. A dolphin can determine distance, location, size, shape and interior properties of an object by scanning across the object or by “illuminating” it with short pulses (clicks) from different angles. They can detect an object over a 100 m distance. Clicks are usually emitted in trains where the inter-click-intervals (I-C-I) are a little longer than the two-way travel time to the target object. The approximate distance from which a dolphin emits sound can be calculated by the I-C-I of recorded sonar sound.

LINKÖPINGS UNIVERSITET in cooperation with Kolmården

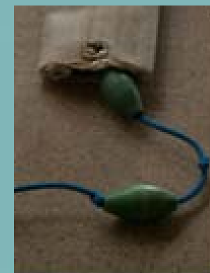
There is a growing demand on the zoo community from visitors, international animal welfare organizations, in some countries legal requirements, but to an increasing extent from the zoo community itself, to have natural exhibits and environmental enrichment implemented to improve animal welfare.

The bottlenose dolphin inhabits coastal waters and estuaries but can travel long distances over the open sea. They are skilled hunters and can dive down to depths of 600 m while foraging. They are known to use bottom structures such as underwater ridges and reefs for navigation when travelling over wide areas. These kinds of orientation references will further be referred to as landmarks.

Four digital Porpoise Detectors (PODs) were deployed in the pool complex monitoring the sonar activity. Two pods were deployed in open spaces to constitute potential visual and acoustic landmarks and two were deployed in smaller spaces to constitute potential obstacles in spaces harder to navigate in. The two pods in open surroundings recorded a higher sonar activity compared to the two pods in smaller spaces. This contradicts the expectation of a greater need of sonar in a space, which is more difficult to navigate in. These results could indicate that objects in open surroundings were used as landmarks. Sonar clicks recorded by PODs in four locations over a 24-hour-period show that the general sonar activity was low and almost none during night hours.



The acoustical target strength in an artificial kelp algae-imitation was increased with air-filled net floats. This device intended to visually simulated a natural like coastal area in which the sight is limited. Improving the acoustical strength of this device added a potential acoustic landmark in the environment. Results show that the presence in the pool increased along with the sonar activity with improved acoustic target strength. This could indicate that objects with good acoustic reflection were used as landmarks.



A hose set in motion by high pressure running water in direct response to sonar sound was introduced in the pool. This device intended to provoke hunting behaviour with which sonar use is highly correlated. This device showed a significant increase in sonar activity. The moving hose triggered hunting correlated displays such as long intensive sonar click trains locked on target and hunting group formations similar to observations made in wild dolphin schools.

Uncompleted part of this study

By looking at the I-C-I of all recorded click data the proportion of the sonar activity within a close range from the device and proportion of sonar activity within a long distance range can be calculated. This will better show if objects with good acoustic target strength are used as landmarks.

Conclusion

The dolphins responded positively to tested acoustic enrichment additions, indicating that this kind of enrichment should be further exploited in order to improve the acoustic aspect of a pool environment. Enrichment methods tested here could beneficially be implemented in existing pools.