Presented at the 47th Annual IAAAM Meeting and Conference, Virginia Beach, Virginia

DIAGNOSTIC PROCEDURES FOR HEARING LOSS IN CETACEANS: AUDITORY EVOKED POTENTIALS AND BEHAVIOR

Megan M. Strobel,[1*+] Michael T. Walsh,[1] Dorian S. Houser,[2] Katie T. Moore,[3] David A. Mann,[4] James J. Finneran,[2] Pat Clough,[5] Lydia A. Staggs,[6] Michelle R. Davis,[7] and Holli C. Eskelinen[8]

[1]*University of Florida, Department of Large Animal Clinical Sciences, College of Veterinary Medicine Gainesville, Florida, 32610, USA*
[2]*National Marine Mammal Foundation, San Diego, California, 92106, USA*
[3]*International Fund for Animal Welfare, Marine Mammal Rescue and Research, Yarmouth Port, Massachusetts, 02675, USA*
[4]*Loggerhead Instruments, Sarasota, Florida, 34238, USA*
[5]*Dolphin Research Center, Grassy Key, Florida, 33050, USA*
[6]*Gulf World Marine Park, Panama City Beach, Florida, 32413, USA*
[7]*Sea World Orlando, Orlando, Florida, 32821, USA*
[8]*Dolphins Plus, Key Largo, Florida, 33037, USA*

Marine mammals are auditory-based predators, with a vast majority of their brain devoted to auditory processing[1] for echolocation. Hearing loss, and especially deafness, in these animals presents a unique and severe impedance to survivability in the wild due to an inability to find food, navigate, socialize and explore the ocean. In 2010 *Mann et al*[2] demonstrated that 57% of stranded bottlenose dolphins (*Tursiops truncatus*) and 36% of stranded rough toothed dolphins (*Steno bradanensis*) studied were deaf, which makes diagnosing deafness an essential component of stranding response and rehabilitation. Hearing loss can also be attributed to aging as the cilia in, especially the higher frequency zone of, the cochlea degrade[3], causing age-related sensorineural hearing loss[4] (presbycusis). Little is published regarding behavioral changes as a result of hearing loss, and the majority of information is anecdotal. The primary objective of this study was to identify whether specific behaviors of cetaceans correlate with a diagnosis of hearing loss as evaluated by the auditory evoked potential (AEP) in both previously stranded and aging animals. The authors also aimed to define and quantify presbycusis in older cetaceans. We hypothesized that individuals with severe hearing impairment or deafness will take longer to adapt to new environments, may be unresponsive to certain recall signals by trainers, and be more introverted than average animals. Presbycusis was hypothesized to exist in all animals over 30 years. Each animal (n=27) studied had either previously received an AEP hearing test or received one as a consequence of this study. Behavior questionnaires for participating animals (n=22) were completed by individuals with extensive knowledge of the animal's history and behavior. Results indicate that stranded individuals with any degree of hearing loss significantly exhibit a behavior change when compared with normal animals; Of 15 variables evaluated, the only significant change included increased vocalizing compared to average. Single stranders were more likely to display hearing losses. Increased vocalizations were seen in individuals with profound hearing loss, both those with no response to AEP stimuli and those with responses at levels over 90dB on the kHz scale.

Individuals with no response to AEP stimuli were more likely to exhibit behavior changes, associated with taking longer times to acclimate to new environments and taking longer periods of time to learn new behaviors. Individuals with profound hearing loss (>90dB losses) also took longer periods of time to learn behaviors and acclimate to new environments compared to normal individuals. Results regarding prebycusis indicated that all individuals tested over 35years had some degree of hearing loss, however degree of loss was not associated with age. Behavior changes were significant in all individuals within this category, with a significant change in responsiveness to trainers. These individuals seem to continue to adapt and learn well, however the extent of change to environment by each facility was not examined in this study. Changes to training methodologies were not significant in this group, likely because of the lack of behavioral

indicators. As a result of these findings, the authors recommend conducting AEP studies in individuals that stranded alone and who are vocal, seem to be adapting poorly to a rehabilitation environment, or learn slowly. All animals over 35 years should be tested via AEP.

ACKNOWLEDGMENTS

The authors wish to thank Ms. Jane Hoppe of the International Fund for Animal Welfare, Ms. Robin Bates and Adrienne Cardwell of Clearwater Marine Aquarium, Dr. Abraham Robinson of Mote Marine Laboratory, Drs. Andy Stamper and Wendi Fellner of Disney's The Living Seas, Dr. Eric Montie of the University of South Carolina, and Ms. Sarah Orfanedes and Dr. Daniel Vanderhart for their support throughout this project. We also wish to thank the incredible staff at the Dolphin Research Center, Sea World Orlando, Gulf World Marine Park, Dolphins Plus, and Clearwater Marine Aquarium for their relentless efforts throughout testing and in submitting surveys. The authors thank the Aquatic Animal Health Program at the University of Florida, College of Veterinary Medicine (CVM) and the IAAAM Medway Award for financial support, and Dr. Jorge Hernandez at the University of Florida CVM for statistical advice and support.

LITERATURE CITED

1. Ketten DR. 2002. Marine Mammal Auditory Systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. Polarforshung 72 (2-3): 79-92.
2. Mann et al. 2010. Hearing Loss in Stranded Cetaceans. PLOSone 5(11): e13824.
3. Seidman MD, Ahmad N, Bai U. 2002. Molecular Mechanisms of Age-Related Hearing Loss. Ageing Research Reviews 1 (3):331-343.
4. Moscicki EK et al. 1985. Hearing Loss in the Elderly: An Epidemiologic Study of the Framingham Heart Study Cohort. Ear and Hearing 6 (4): 184-190.