

# Hearing threshold measurements using auditory evoked potentials of four stranded short-finned pilot whales (*Globicephala macrorhynchus*) in Key Largo, FL

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## Abstract

Approximately 26 short-finned pilot whales (*Globicephala macrorhynchus*) stranded in Cudjoe Key, FL on May 5, 2011. Four of these animals, two adult females and two juvenile females, were transported to a rehabilitation facility in Tarpon Basin, FL. Auditory evoked potentials (AEP) were recorded in response to amplitude modulated (AM) tone pips modulated at 1000Hz. AEP thresholds were determined at 10, 20, 40, 80 and 120 kHz for all four animals (100 kHz was tested for one animal). Click evoked potentials were also measured. Audiograms were similar to previous findings in pilot whale hearing tests. Short-finned pilot whales have a lower peak sensitivity than other odontocetes such as bottlenose dolphins. Greatest hearing sensitivity was around 40 kHz for all whales, while differences in higher frequency hearing were exhibited between adults and juveniles. Thresholds for the two adult females were 25-61 dB higher at 80 kHz than those for the two juvenile females tested, but were comparable to the previously reported upper limit frequency for an adult pilot whale. Click evoked potentials were similar between the four whales and comparable to previously tested echolocating odontocetes. Five total pilot whales have been tested in this study during two separate stranding events; the previously tested juvenile male was found to have profound hearing loss (Mann et al, 2010 & Schlundt et al, 2011). These findings add to the limited database of pilot whale (short- and long-finned) hearing studies, of which there are only two others (Schlundt et al, 2011 & Pacini et al, 2010).

## Introduction: Previous Pilot Whale Audiograms

### ➤ Curaçao stranding: single juvenile male short-finned pilot whale, Sully

- Tested August 17, 2009: No response to all frequencies tested at highest levels

- Recorded vocalizations including 7 kHz tonal sounds and echolocation

### ➤ Auditory evoked potentials in two short-finned pilot whales (*Globicephala macrorhynchus*). Schlundt, C.E. et al., 2011. JASA 129(2), 1111-1116.

- Second testing of Sully after being transferred to SeaWorld-SD determined a threshold at 10 kHz well above normal levels
- Comparison to 30 yr old adult female (Gm1) housed at SeaWorld San Diego with best hearing at 40 kHz and an upper limit of 80-100 kHz



**Fig. 1 (A)** Sully, male juvenile short-finned pilot whale that stranded in July 2009 in Willemstad, Curaçao. Auditory evoked potential (AEP) hearing test results indicate that this animal has severe hearing loss across all frequencies tested. **(B)** Female adult short-finned pilot whale tested in FL Keys.

## FL Keys Strandings

### ➤ Approx. 25 short-finned pilot whales stranded off Cudjoe Key in the FL Keys on May 5, 2011

- 2 males satellite tagged and released
- 4 females were tested on May 18, 2011

## Conclusions

Five pilot whales have been tested in this study during two separate stranding events. Audiograms for adults and juveniles had comparable thresholds, with cutoff frequencies ranging from 80-100 kHz. These pilot whale upper frequency limits are lower than other odontocetes, such as the bottlenose dolphin which has an upper limit around 120 kHz, but comparable to the killer whale. The juvenile male was found to have profound hearing loss (Mann et al, 2010 & Schlundt et al, 2011). These findings add to the limited database of pilot whale (short- and long-finned) hearing studies (Schlundt et al, 2011 & Pacini et al, 2010).

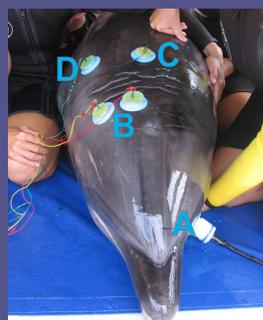
Acknowledgments: Curaçao Sea Aquarium, Paul Hoetjes, and ONR for travel funding to Curacao, as well as volunteers at both strandings.

## Methods: Auditory Evoked Potential (AEP)

### ➤ Sound stimuli delivered through jawphone

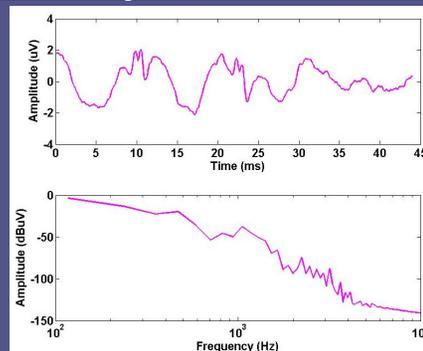
- Amplitude modulated (AM) tone pips modulated at 1000 Hz
- Carrier frequencies ranged from 5-120 kHz
- 0.1ms click with peak frequency of 62 kHz

### ➤ Brain response recorded with 3 electrodes embedded in suction cups using TDT AEP Workstation.



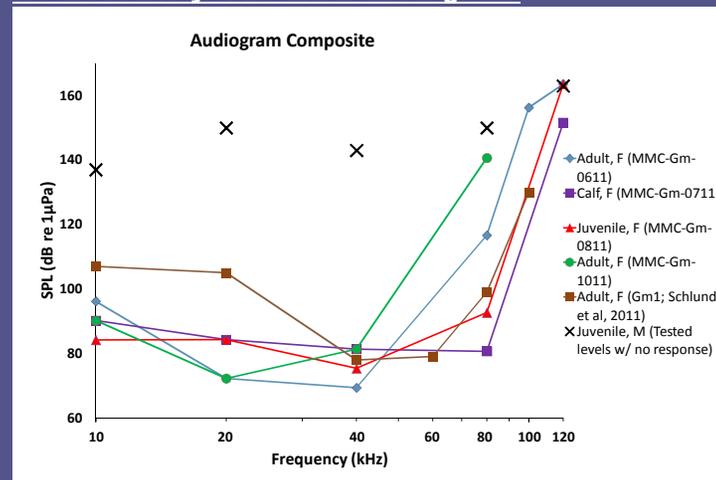
**Fig. 2** Bottlenose dolphin during auditory evoked potential testing showing jawphone (A) and electrode placement: -recording electrode (B, behind the blowhole) -reference electrode (C, posteriorly off the midline) -ground electrode (D, testing in air = on body/testing in water = in water).

## Results: FL Keys Pilot Whale Click AEPs



**Fig. 3** Click evoked potential in response to a double click at 145 dB re 1µPa-peak for adult female pilot whale. **(A)** Single trace in time domain **(B)** Frequency spectrum of click response.

## Results: FL Keys Pilot Whale Audiograms



**Fig. 4** Audiograms of four short-finned pilot whales tested in the FL Keys. Results of adult female (Gm1) audiogram from Schlundt et al, 2011 (brown squares). Highest levels tested on deaf juvenile male from Curaçao (X).

### ➤ Adult females and juvenile female: Comparable results with lower cutoff frequency than other odontocetes

- Best hearing at 40 kHz with cutoff at 80-100 kHz
- Click response down to 94 dB re 1µPa-peak
- Adult female (Gm-1011): possible high frequency hearing loss (upper limit at 80 kHz, and no response to 120 kHz at 176 dB re 1µPa)

### ➤ Female calf (Gm-0711): Better high frequency hearing

- Threshold at 80 kHz is 36-60 dB re 1µPa lower than adults' thresholds and cutoff frequency at 100-120 kHz
- Click response down to 100 dB re 1µPa-peak

### ➤ Juvenile Male (Sully): Severe hearing loss at all frequencies

## Discussion: Possible Causes for hearing loss

- Antibiotic ototoxicity- testing needed before and after drug treatment
- Congenital (suspected cause for Curacao pilot whale)
- Intense, prolonged noise exposure