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Costa, Daniel P.

Gedamke, Jason

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of California, Santa Cruz
1156 High St.
Santa Cruz, CA 95064

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14. ABSTRACT
A song playback experiment to singing minke whales on the Great Barrier Reef was carried out. Songs were played to singers at ranges of 0.5-2.0km. A remotely monitored sonobuoy array was used to monitor whale movements and singing behavior. Upon initiation of playbacks, whales either moved away from the playback vessel, or stopped singing, indicating song is likely used to maintain spacing between singing individuals.

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Final Report

Grant #: N000140210848

PRINCIPAL INVESTIGATORS: Daniel P. Costa & Jason Gedamke

INSTITUTION: University of California, Santa Cruz

GRANT TITLE: Minke Whale *(Balaenoptera acutorostrata)* Response to a Sound Playback Experiment

AWARD PERIOD: 7/1/02-6/30/03

OBJECTIVE: To investigate the effect of song playback on the spatial patterns and song behavior of dwarf minke whales; to determine the functional value of song in the life-history of the dwarf minke whale (*Balaenoptera acutostrata*).

APPROACH: All fieldwork and analyses will be carried out by the P.I. and co-P.I listed above at the Lizard Island Research Station and the University of California at Santa Cruz. The general approach of the playback was to simulate the addition of a single singing animal into the environment, close to a singing whale. To conduct the playback, the 8m Lizard Island Research Station vessel NQEA was equipped with an underwater sound projector (Oceanears--DRS-12, loaned by Cornell University) and amplifier. One assistant monitored the VHF receiving station on Lizard Island and localized singing whales within the array. Singer locations were relayed to the research vessel, which approached to approximately 500m-2.5km.

A standard ABA playback protocol was initiated where a 15-30 minute control period was followed by 15-30 minutes of song playback. This was then followed by another 15-30 minute control. Playback stimuli consisted of a variety of natural recordings from 1997-2000 to avoid the potential effects of pseudo-replication. Separate trials were run with the 30s and 200s song repetition rates to assess differential responses to the two stimuli.

ACCOMPLISHMENTS: A successful field season as described above took place in June-August, 2002. Real-time localization of singing whales worked flawlessly, and singer locations were relayed directly to playback vessel within moments of the animals singing. Ten playback trials to 11 singing whales were completed at ranges of 400-2500m. All singing whales surrounding the playback vessel were localized before, during, and after the acoustic playback. Distances between the playback vessel and surrounding singers were measured to determine if distances increase or decrease after the initiation of playback. The whales' movements during the pre- and post-control periods were compared to movements during the playback session. Responses to the 30s song repetition stimulus and the slower 200s song repetition stimulus are currently being compared. Finally, all of the playback trials are being compared with the control trials to verify that any

observed reactions were in response to the introduction of song, and not the presence of the playback vessel.

CONCLUSIONS: The reactions of singing whales to the introduction of song were startling. The distinct changes in behavior were immediately apparent in most cases. Out of 11 singers that were monitored during the song playbacks:

- 3 animals stopped singing entirely.
- 4 whales dramatically changed (>90 degrees) their movement path (Figure 1).
- 2 previously stationary singers had moderate movement away during playbacks.
- 2 others did not have immediately discernable reactions, however, these singers were at ranges where they may have been unable to hear song playbacks.

Initial analyses indicate that there was a significant change in behavior in the whales during the playback period compared to the pre-control period (Fisher's Exact, $p=<0.05$). In addition, analysis of movement patterns indicates the whales significantly changed their direction of movement to increase the distance between themselves and the playback vessel during playback experiments (Mann Whitney U, $p=<0.05$).

The results of the playback experiments appear to confirm our analysis of spacing behavior from the passive monitoring of the population. These animals clearly maintain spacing with their song and in some instances appear to establish ''dominance'' as one singing whale may ''drive'' other singers from their previous locations. Acoustic characteristics that may establish these relationships are being investigated.

SIGNIFICANCE: Considering the state of knowledge of minke whale acoustics just a few short years ago, this project has made great strides in understanding the acoustic system of communication of this animal. We have been able to take an animal where very little was known about its acoustic behavior and 1) describe the entire repertoire of sounds produced during its breeding season, 2) demonstrate that it produces a unusually complex and regularly repeated song, 3) determine at least one of the song's functions is to maintain spacing between singing individuals through passive monitoring, and 4) experimentally test this function of song through playback experiments. We have come a long way towards understanding the minke whale system of communication on the Great Barrier Reef. With further analysis we hope to continue to shed light on the role of sound in the life history of baleen whales.

In addition, we described the possibility that the minke whale produces the ''boing,'' (Gedamke *et al.*, 2001) an unusual N. Pacific sound whose source has remained a mystery for over 50 years. We based our discussion on the similarities between the boing and the ''star-wars'' song sequence we recorded on the Great Barrier Reef. Recently, Jay Barlow and Shannon Rankin, on a NOAA cruise north of the Hawaiian

Islands, verified that the source is indeed a minke whale, confirming our theory and solving one of the oldest mysteries in ocean sounds.

PUBLICATIONS:

Gedamke, J. D.P. Costa, C.W. Clark, D.K. Mellinger, F.L. O'Neill. 2003. ''The Role of Song in the Spacing of Singing Dwarf Minke Whales(Balaenoptera acutorostrata): Preliminary Results from Playback Experiments'', *1st International Conference on Acoustic Communication by Animals*. pp. 95-96.

Gedamke, J. D.P. Costa, C.W. Clark, D.K. Mellinger, F.L. O'Neill. 2003. ''The Role of Song in the Spacing of Singing Dwarf Minke Whales(Balaenoptera acutorostrata): Preliminary Results from Playback Experiments'', *Conference on the Environmental Consequences of Underwater Sound*. p.41.

Gedamke, J. D.P. Costa (in prep). ''Minke Whale Acoustic Communication on the Great Barrier Reef: A Discretely Graded Song.''

Gedamke, J. D.P. Costa, C.W. Clark, D.K. Mellinger, F.L. O'Neill. (in prep) ''The Role of Song in the Spacing of Singing Dwarf Minke Whales(Balaenoptera acutorostrata): Results from Playback Experiments''