the alarm-on, and (2) approaches with the alarm-off. Synchronized underwater acoustic buoys and aerial video recorders documented manatee behavior and acoustic conditions prior to, during, and after controlled boat approaches. 95% of the manatees during alarm-on trials elicited overt changes in behavior (avoidance reactions) prior to the boat reaching the focal manatee. In contrast, only 5% of manatees during alarm-off trials elicited any change in behavior prior to the vessel having to veer off. Changes in behavior observed prior to the boat reaching focal manatees was significantly greater ($F = 471.9$, $df = 1$, $p < 0.01$) during alarm-on trials. The mean distance at which manatees reacted to boat approaches during alarm-on trials was also 20 m compared to only 6m for alarm-off trials ($F = 218.4$ $df = 1$, $p < 0.01$). Manatees responded when received acoustic levels exceeded 12 dB of their critical ratios (behavioral threshold). Counter-intuitive to manatee protection laws, slow boats can be very difficult for manatees to detect and locate. Shallow water attenuates the dominant lower frequencies of slower moving propellers. The directional alarm assures manatees will be able to detect and locate boats at levels & distances sufficient to avoid injury. [Funded by DOD Legacy Natural Resource Management Program, USFWS Permit MA063561-4.]

3:30

5pABa8. Time-frequency analysis of bird songs and neurobehavioral study of the "Catbird Dumetella carolinensis". Babak Badiey (Newark Charter School, 20 Mcintire Dr., Newark, DE 19711, babak.badiey@gmail.com)

There is a commonality between the acquisition of spoken language in human infants and the acquisition of bird songs at the behavioral, neural, genetic, and cognitive levels. Similarities between how birds learn their language and how humans learn is believed to be fundamentally related to the way the brain works. Although the effects of the environment on hearing sensations, and hence the behaviors seems intuitive, it is not yet fully understood. In this paper, we use common digital recording systems to study bird songs in their natural habitat. Then by utilizing the principals of signal processing and spectral analysis individual syllabi are identified and studied for various songs. With the knowledge of the environment from direct measurement and the change in background noise level, the behavior of birds can be studied and documented. This technique was applied to recordings of Dumetella carolinensis (Gray Catbird) in the North East United States. It is shown that in spite of the natural instinct, the catbirds do not easily change their behavior at the onset of loud transient industrial sound. This may be related to the fact that the birds have already been exposed and have learned to live in noisy cosmopolitan environments.

3:45

5pABa9. Effects of industrial tones on bowhead whale calling rates. Susanna B. Blackwell (Greeneridge Sci., Inc., 90 Arnold Pl., Ste. D, Santa Barbara, CA 93117, susanna@greeneridge.com), Christopher S. Nations, Mandy E. Kauffman (WEST, Inc., Cheyenne, WY), Aaron M. Thode (Scripps Inst. of Oceanogr., San Diego, CA), Robert G. Norman, and Katherine H. Kim (Greeneridge Sci., Inc., Santa Barbara, CA)

In summer 2012, exploratory drilling was performed by Shell at Sivulliq, a lease holding in the Beaufort Sea, located within the autumn migration corridor of bowhead whales. The drilling operation involved a number of vessels performing various activities, such as towing the drill rig, anchor handling, and drilling. We aimed to assess the effect of sounds from these activities on bowhead whale calling rates. Acoustic data were collected with six arrays of directional recorders (DASARs) deployed on the seafloor over ~7 weeks in Aug-Oct. Industrial sound was quantified with the use of indices, that measured the presence and amplitude of tones from machinery, or the presence of airgun pulses. For each 10-min period of data collected at each of the 40 recorders, the number of whale calls detected was matched with the "dose" of industrial sound received, and the relationship between calling rates and industrial sound was modeled using negative binomial regression. The analysis showed that with increasing tone levels, bowhead whale calling rates initially increased, peaked, and then decreased. This dual behavioral response is similar to that previously described for bowhead whales and airgun pulses. [Work supported by Shell Exploration and Production Company.]

4:00

5pABa10. Opportunistic behavioral-response studies of baleen whales in response to US Navy Sonar Training off Kauai, Hawaii. Stephen W. Martin, Cameron R. Martin, Brian Matsuyama (National Marine Mammal Foundation, 2240 Shelter Island Dr., Ste. 200, San Diego, CA 92106, steve.martin@nmmpfoundation.org), Elizabeth E. Henderson, and Tyler Helble (SPAWAR Systems Ctr. Pacific, San Diego, CA)

Opportunistic behavioral responses of baleen whales to disturbances from US Navy mid-frequency active sonar (MFAS) training at the Pacific Missile Range Facility, Kauai, Hawai'i, are being studied utilizing passive acoustic recordings. Automated passive acoustic detection, classification, localization, and tracking analyses of the data have shown a behavioral response in terms of a reduction, or cessation, of minke whale "boing" calling in response to US Navy training during the month of February 2011, 2012, and 2013 over a study area of 3,780 km2. The reduced calling is expressed as reduced minimum densities in the study area by utilizing acoustically localized individual whale counts. In February 2011, the density before sonar training was 3.64 whales while the density during sonar training was 0.69 whales (95% confidence intervals of 3.31-4.01 and 0.27-1.8 whales, respectively). Individual ship-whale encounters have been observed to show cessation of calling from ship approaches without MFAS activity as well as ship approaches with MFAS. Sound Pressure Levels and Cumulative Sound Exposure Levels animals are exposed to are being estimated for evaluation of dose-response relationships. Tracking individual whales allows investigation of kinematics coupled with acoustic call details to establish baseline behaviors for comparison with observations during US Navy training.

4:15

5pABa11. Mid-frequency active sonar and beaked whale acoustic activity in the Northern Mariana Islands. Anne Simonis, Bruce Thayre (Scripps Inst. of Oceanogr., 9500 Gilman Dr., La Jolla, CA 92037-0205, asimonis@ucsd.edu), Erin Oleson (Pacific Islands Fisheries Sci. Ctr., National Oceanic and Atmospheric Administration, Honolulu, HI), and Simone Baumann-Pickering (Scripps Inst. of Oceanogr., La Jolla, CA)

Mid-frequency active (MFA) sonar has been associated with multiple mass stranding events of beaked whales around the world. A recent increase in military training exercises in the Mariana Archipelago corresponds with the presence of MFA sonar in the surrounding waters. We provide a quantitative report on MFA sonar and beaked whale acoustic activity detected on two autonomous acoustic recording packages deployed near Saipan and Tinian from March 2010 through December 2013. There were no detections of MFA sonar at Saipan during the 5-month deployment in 2010. On August 21, 2011, MFA sonar was detected near Saipan concurrent with a stranding event involving two Cuvier's beaked whales (*Ziphius cavirostris*). After one observed day of MFA sonar activity in Saipan and Tinian in 2011, observations increased to 1 month of ongoing activity at Saipan and nearly 3 months ongoing activity at Tinian in 2012. In 2013, MFA sonar events were observed during one day at Saipan and zero days at Tinian. Received levels, sound exposure levels, and temporal descriptions of the MFA sonar events are reported along with detections of beaked whale acoustic activity. Here, we highlight the importance of ongoing passive acoustic monitoring, especially for species like beaked whales that are difficult to visually detect at sea.

4:30

5pABa12. Marine mammal passive acoustics applied to the monitoring of long-term trends in beaked whale abundance and to the derivation of a behavioral risk function for exposure to mid-frequency active sonar. David Moretti (NUWC, 71 Woodmark Way, Wakefield, RI 02879, morettidj@hotmail.com), Tiago Marques (Univ. of St. Andrews, Lisbon, Portugal), Len Thomas (Univ. of St. Andrews, Saint Andrews, United Kingdom), Stephanie Watwood, Nancy DiMarzio, Karin Dolan, Ronald Morrissey, Jessica Shaffer, Joao F. Monteiro, and Susan Jarvis (NUWC, Newport, RI)

Knowledge of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales' distinct dive and vocal behavior has allowed for the development of multiple methods of passive acoustic abundance and density estimation (Marques *et al.*, 2009, Moretti *et al.*, 2010).

These methods are being applied to multiple years of data to estimate long-term trends in abundance for Blainville's beaked whales at the Atlantic Undersea Test and Evaluation Center (AUTEC) in the Bahamas and at the Pacific Missile Range Facility (PMRF) in Hawaii, and for Cuvier's beaked whales at the Southern California Offshore Range (SCORE). These passive acoustic beaked whale dive data were combined with sonar and Range ship-track data to derive a behavioral risk function for Blainville's beaked whales at AUTEC, and are being extended to Cuvier's beaked whales at SCORE and Blainville's beaked whales at PMRF. The behavioral risk function maps the probability of beaked whale dive disruption as a function of the receive level of mid-frequency active sonar. The risk function and long-term trend analysis will help inform environmental policy going forward.

4:45

5pABa13. The effects of wind turbine noise on male Greater Prairie-Chicken vocal output during the breeding season. Cara Whalen, Mary B. Brown (School of Natural Resources, Univ. of Nebraska, Lincoln, NE), JoAnn McGee (Developmental Auditory Physiol. Lab, Boys Town National Res. Hospital, 555 North 30th St., Omaha, NE 68131), Larkin Powell (School of Natural Resources, Univ. of Nebraska, Lincoln, NE), and Edward J. Walsh (Developmental Auditory Physiol. Lab, Boys Town National Res. Hospital, Omaha, NE, edward.walsh@boystown.org)

At a previous meeting of the ASA, we reported that the Greater Prairie-Chicken (*Tympanuchus cupido pinnatus*) is, in all probability, able to detect noise produced by wind turbine installations, a finding based on turbine noise output and auditory brainstem response threshold measurements (Walsh *et al*., 2015). That investigation was conducted in concert with an effort to determine if noise generated by a wind turbine farm located near Ainsworth, Nebraska affects the vocal output of male prairie chickens occupying breeding grounds (i.e., leks) where they perform elaborate physical and vocal mating displays. Whalen *et al*. (2014) paved the way to address this question by characterizing the acoustic properties of booms, cackles, whoops and whines, the primary call types produced by male birds, at sites remote from the turbine farm. At lek sites located relatively close (<1 km) to the wind farm installation, boom and whoop production levels were higher, boom durations were shorter, whine fundamental frequency was higher, and cackle biphonation occurred less frequently than among birds occupying leks located at remote locations. Although differences in vocal characteristics were statistically significant, vocal adjustments were relatively minor and the significance of wind turbine farm noise on call acoustics will be discussed. [Funded in part by USFWS-WSFR Wildlife Restoration Project W-99-R administered by the NGPC.]

5:00–5:15 Panel Discussion

FRIDAY AFTERNOON, 2 DECEMBER 2016 NAUTILUS, 1:00 P.M. TO 4:30 P.M.

Session 5pABb

Animal Bioacoustics: The Diversity of Bioacoustic Signals

T. Aran Mooney, Chair
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Contributed Papers

1:00

5pABb1. Prusten and the acoustic character of socializing tigers. Adam Smith, JoAnn McGee (Developmental Auditory Physiol. Lab, Boys Town National Res. Hospital, 555 North 30th St., Omaha, NE 68131), Douglas Armstrong (Henry Doorly Zoo and Aquarium, Omaha, NE), and Edward J. Walsh (Developmental Auditory Physiol. Lab, Boys Town National Res. Hospital, Omaha, NE, edward.walsh@boystown.org)

Although tigers are generally solitary animals, acoustic communication among conspecifics plays an important role in their biology and behavior. This investigation was undertaken to extend understanding of prusten, one of the most common vocalizations produced by *Panthera tigris*. Prusten is a low-level, social vocalization uttered in close proximity of conspecifics. Calls were recorded from a group of nine captive adult tigers, representing the Amur (*P. tigris altaica*), Bengal (*P. tigris tigris*) and Malayan subspecies (*P. tigris jacksoni*). As described previously, the acoustic character of prusten consists of three to nine brief rhythmic pulses emitted at a mean rate of 11.5 pulses per second with a total mean duration of 0.5 seconds. Calls were generally low level, with a mean of 71 dB SPL re 20 μPa at 1 meter from the source. Spectral energy was broadband, extending from below 20 Hz to above 22 kHz, although low frequency energy dominated the call with mean peak and centroid frequencies of 130 and 987 Hz, respectively. A small subset of calls contained infrasonic energy. This study affirms and extends findings from previously published descriptions and is the first report of the production of infrasound in this low level, pulsatile vocalization. [Work supported in part by NSF Grant Award #0823417.]

1:15

5pABb2. Using CT to predict vocal tract resonances in mammal vocalizations: Are calls nasalized? David Reby (School of Psych., Univ. of Sussex, University of Sussex, Brighton BN2 9TJ, United Kingdom, reby@sussex.ac.uk), Megan T. Wyman (Dept. of Evolutionary Biology and Environ. Studies, Univ. of Zurich, Zurich, Switzerland), Roland Frey (Leibniz Inst. for Zoo and Wildlife Res. (IZW), Berlin, Germany), and Joel Gilbert (Laboratoire d'Acoustique de l'Université du Maine – UMR CNRS, Université du Maine, Le Mans, France)

Males of several species of deer have a descended larynx, which gives them an unusually long vocal tract (VT). They can extend their VT by further lowering their larynx during the production of their sexual loudcalls. Formant frequencies are lowered as the vocal tract is extended, as predicted when approximating the vocal tract as a uniform quarter wavelength resonator. However, formant frequencies in polygynous deer follow uneven distribution patterns, suggesting that the vocal tract shape is in fact rather complex. We CT-scanned the artificially extended vocal tract of two adult fallow deer, and measured the cross-sectional area of the supralyngeal vocal