internationally in recent years. With encouragement and supports from Whitlow Au, biosonar research, auditory sensitivity measurement, and long term acoustic monitoring have been extensively conducted on Chinese white dolphins and oceanic finless porpoises, which are the key species in coastal environmental assessment, especially for the windmill farm construction area in Asia. In the meantime, Whitlow dispatched students to help our researches and also accommodated Asian students in Hawaii. So far, there are more than five Ph.D. students from Asia in underwater bioacoustics field supervised or partially supervised by Whitlow Au. Some of them have already grown up as leading researchers in marine mammal bioacoustics in Asia.

**8:55**

**3aAB4. Biosonar detection range of mesopelagic patches by spinner dolphins in Hawaii.** Whitlow Au (Univ. of Hawaii, P.O. Box 1106, Kailua, HI 96734, wau@hawaii.edu), Marc O. Lammers (Univ. of Hawaii, Kaneohe, HI), and Jakob Jung (Bremen Univ. of Appl. Sci., Kaneohe, Hawaii)

Spinner dolphins (*Stenella longirostris*) in the near-shore waters of the Hawaiian islands forage on the mesopelagic boundary community (mbc) of organisms consisting of myctophids, mid-water shrimp, and small squids. They forage at night in a coordinated fashion swimming parallel to shore hunting for patches of prey that they can encircle and herd into a tight three-dimensional patch. A profiler housing a broadband echo-ranger that projected dolphin-like biosonar signals was used to measure the target strength of the mbc. Echoes consisted of a number of highlights bunched together with target strength between -45 and -55 dB based on a dolphin's integration window of 264 ms. Noise values collected by an autonomous acoustic recorder at midnight in the location where the profiler data were obtained were used to estimate the biosonar detection range of spinner dolphins for mesopelagic patches. The receiving directivity index and the width of the auditory filter for *Tursiops truncatus*were used to estimate the biosonar detection ranges of *Stenella longirostris* searching for mbc patches. Using the sonar equation, the biosonar threshold detection range of spinner dolphins was estimated to be approximately 100 plus m, more than sufficient range for the animals to formulate their prey herding behavior.

## *Contributed Papers*

**9:15**

**3aAB5. Using acoustics to examine odontocete foraging ecology: Predator-prey dynamics in the mesopelagic.** Kelly J. Benoit-Bird (Monterey Bay Aquarium Res. Inst., 104 COEAS Admin Bldg., Corvallis, OR 97331, kbenoit@coas.oregonstate.edu), Brandon Southall (Southall Environ. Assoc., Inc., Aptos, CA), and Mark A. Moline (Univ. of Delaware, Lewes, DE)

From his expertise in biosonar, Whitlow Au brought a wealth of ideas on sonar use, design, and context to the study of wild cetaceans, resulting in great contributions to our understanding of odontocete foraging ecology. This contribution follows that foundation, using an integrated approach comprising echosounders deployed in a deep-diving autonomous underwater vehicle, ship based acoustics, visual observations, direct prey sampling, and animal-borne tags to explore the behavior of Risso's dolphins foraging in scattering layers off California. Active acoustic measurements demonstrated that Risso's dolphins dove to discrete prey layers throughout the day and night. Using acoustic data collected from the AUV, we found layers made up of distinct, small patches of animals of similar size and taxonomy adjacent to contrasting patches. Prey formed particularly tight aggregations when Risso's dolphins were present. Squid made up over 70% of the patches in which dolphins were found and more than 95% of those at the deepest depths. Squid targeted by dolphins in deep water were also larger, indicating significant benefit from these rare, physically demanding dives. Careful integration of a suite of traditional and novel tools is providing insight into the ecology and dynamics of predator and prey in the mesopelagic.

**9:30**

**3aAB6. Echolocation behavior of the Icelandic white-beaked (*Lagenorhyncus albirostris*) dolphins: Now and then.** Marianne H. Rasmussen (Husavik Res. Ctr., Univ. of Iceland, Hafnarstett 3, Husavik, Iceland 640, Iceland, mhr@hi.is), Jens Koblitz (BioAcoust. Network, BioAcoust. Network, Neuss, Germany), and Peter Stilz (BioAcoust. Network, BioAcoust. Network, Hechingen, Germany)

First studies of the echolocation behaviour of free-ranging white-beaked dolphins (*Lagenorhyncus albirostris*) were conducted in Faxafloi Bay in the Southwestern part of Iceland in the years 1997 to 1999. However, the sighting rate of white-beaked dolphins has decreased in that area since then and the current studies were conducted in the Northeastern part of Iceland. The aim of this study was to investigate the difference between normal clicks compared to clicks from buzz sequences. The recordings of the Icelandic white-beaked dolphins were conducted using a vertical linear 16-hydrophone array in Skjalfandi Bay, Northeastern Iceland during August 2015 and June 2016. The hydrophones were connected to NI-Boards and to a laptop computer on board using a sample rate of 1 MHz per channel. The group size of the dolphins varied from three individuals up to 30 animals in the area during the recordings. The dolphin echolocation clicks were recorded and it was possible to track individuals and to estimate beam-pattern from their clicks. Estimated beam pattern from 45 regular clicks gave -3dB BW of 9.6 degrees and maximum source level was 208 dB re. 1mPa. In addition buzzes with short inter-click-intervals down to 2.5 ms were recorded on all 16 channels.

**9:45–10:00 Break**

**10:00**

**3aAB7. Echolocation behavior of endangered fish-eating killer whales (*Orcinus orca*) recorded from digital acoustic recording tags (DTAGs): Insight into subsurface foraging activity.** Marla M. Holt, M. Bradley Hanson, Candice K. Emmons (NOAA NMFS NWFSC, 2725 Montlake Blvd East, Seattle, WA 98112, Marla.Holt@noaa.gov), Deborah A. Giles (Wildlife, Fish, & Conservation Biology, Univ. of California, Davis, Davis, CA), Jeffrey T. Hogan (Cascadia Res. Collective, Olympia, WA), and David Haas (Marine Sci. and Conservation, Duke Univ., Durham, NC)

Killer whales are apex predators with diet specializations that vary among ecotypes. Resident killer whales use broadband echolocation clicks to detect and capture fish prey in their underwater environment. Here, we describe the echolocation behavior of endangered Southern Resident killer whales using DTAGs to determine subsurface foraging activity and to assess the effects of vessel and noise on foraging behavior. We deployed 29 DTAGs on individually-identified killer whales and collected complimentary field data over four seasons in summer habitat. DTAGs had two hydrophones that each recorded sound at sampling rates of 192 or 240 kHz, and other sensors to reconstruct whale movement. Prey remains were opportunistically collected during tag deployments to validate feeding. Echolocation signals of the tagged whale were inferred from spectral content and the angle of arrival that corresponded to tag placement. Preliminary results reveal that individuals produced steady click trains during shallow dives then dove to deeper depths while clicking at higher repetition rates that graded into bottom-associated low-level buzzes before ascent occurred. These results, together with movement data, are reliable subsurface foraging cues in this endangered population that can be used to assess vessel effects on foraging behavior.