

Vocalization Behaviors Of Minke Whales In Relation To Sonar In The Planned Undersea Warfare Training Range Off Jacksonville, Florida

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Background

- A new Undersea Warfare Training Range (USWTR) is being developed off the coast of Jacksonville, Florida.
- The U.S. Navy made two deployments (fall & winter) of nine Marine Autonomous Recording Units (MARUs).
- Recordings were made continuously before, during, and after mid-frequency active sonar exercises.
- Cow/calf pair sighting has been reported in the area.
- To date there have been no studies of minke whale vocal behavior in relation to sonar.

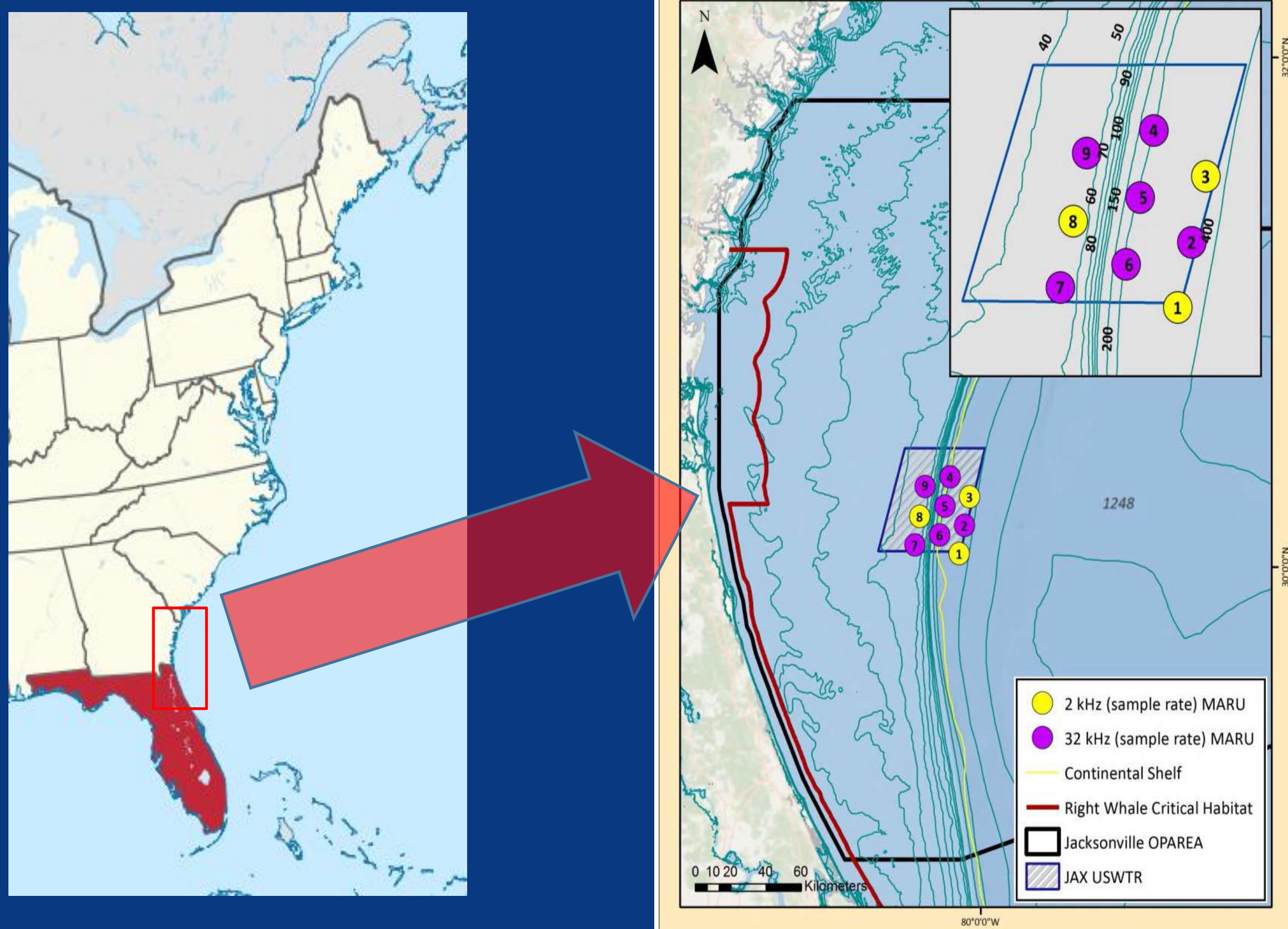


Figure 1. Map with location of USWTR and MARU deployment locations.

Fall (Deployment 1): 26 days (13 September to 8 October 2009).
Winter (Deployment 2): 37 days (3 December to 8 January) 2009-2010.
Sample rates of 2kHz (yellow circles) and 32kHz (red circle) recordings were used.
MARUs deployed at three depths: 'shallow' (45 m), 'mid-depth' (180 m) and 'deep' (305 m).

Methods

- Data were reviewed using the MATLAB program Triton (Wiggins, 2007).
- Minke whale and sonar 'event' logs were created for each day for all sites.
- Minke whale acoustic 'events' were defined as one or more occurrences of minke whale vocalizations separated by an interval of >10 minutes between sounds.
- Custom-written MATLAB scripts (based on Melcón et al. 2012), were used to calculate the probability of vocalization events occurring in the presence and absence of sonar.

Reference:
Hodge, L. E. W. 2011. Monitoring Marine Mammals in Onslow Bay, North Carolina, Using Passive Acoustics. Ph.D. dissertation.
Melcón, M.L., A.J. Cummins, S.M. Kersey, L.K. Roche, S.M. Wiggins, and J.A. Hildebrand. 2012. Blue whales respond to anthropogenic noise. *PLoS ONE* 7(2): e32681.
Mellinger, D.K., C.D. Carlson, and C.W. Clark. 2000. Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico. *Marine Mammal Science* 16(4): 739-756.
Wiggins, S. 2007. Triton (Version 1.80) (Acoustic Processing Software). Scripps Institution of Oceanography, UC San Diego, La Jolla, California. Retrieved August 1, 2011. Available from www.oceans.ucsd.edu.

Objective

Characterize minke whale vocalization events in relation to U.S. Navy sonar activity.

Results

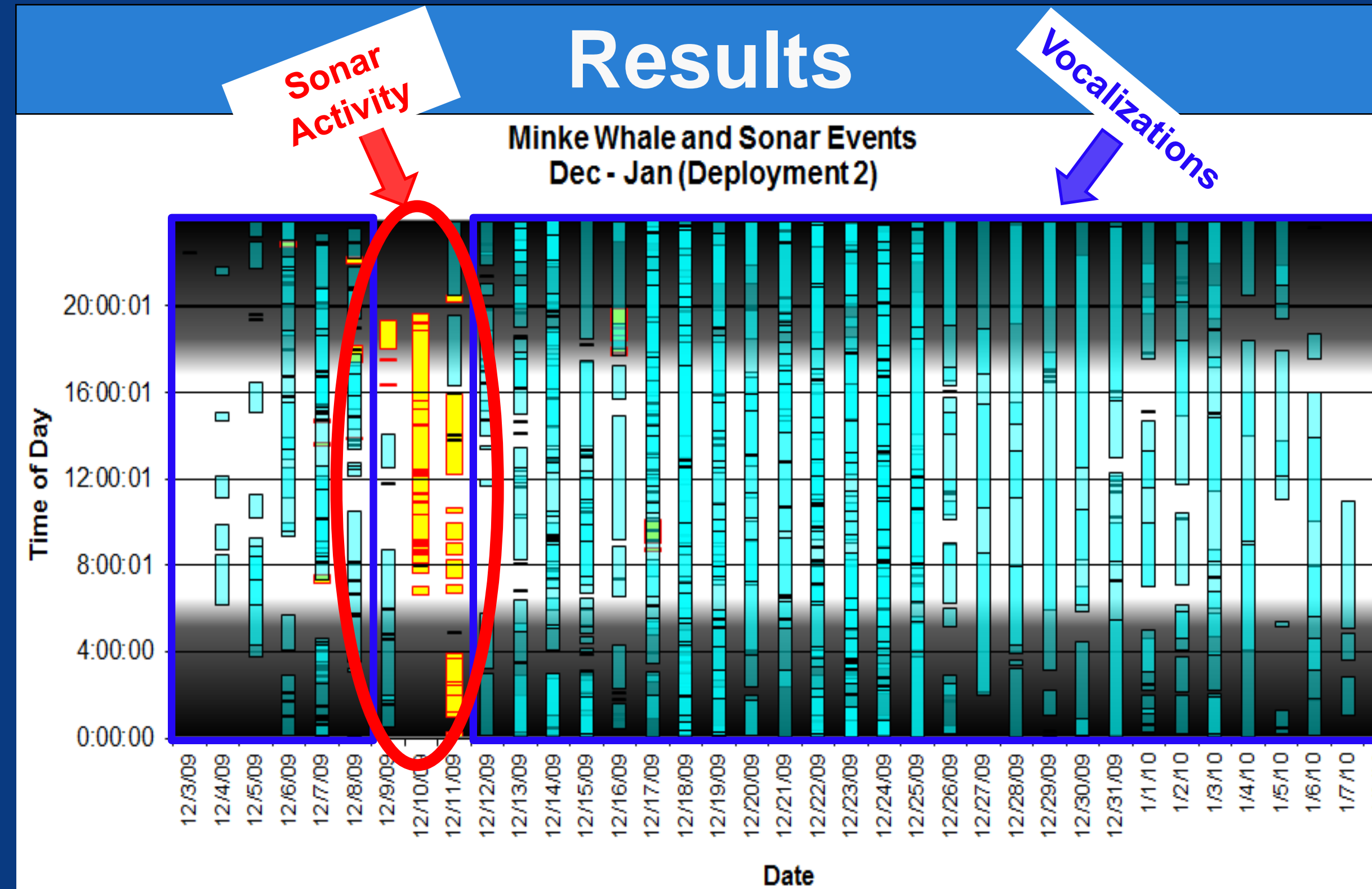


Figure 2. Minke whale vocal events (blue bars) and sonar events (yellow bars) by day and time. Black shading represents night-time. Minke whale vocalization events were detected only during the winter deployment. Vocalizations were greatly reduced or non-existent during most days with concurrent sonar events.

Minke Whale Vocalization Events Winter Deployment

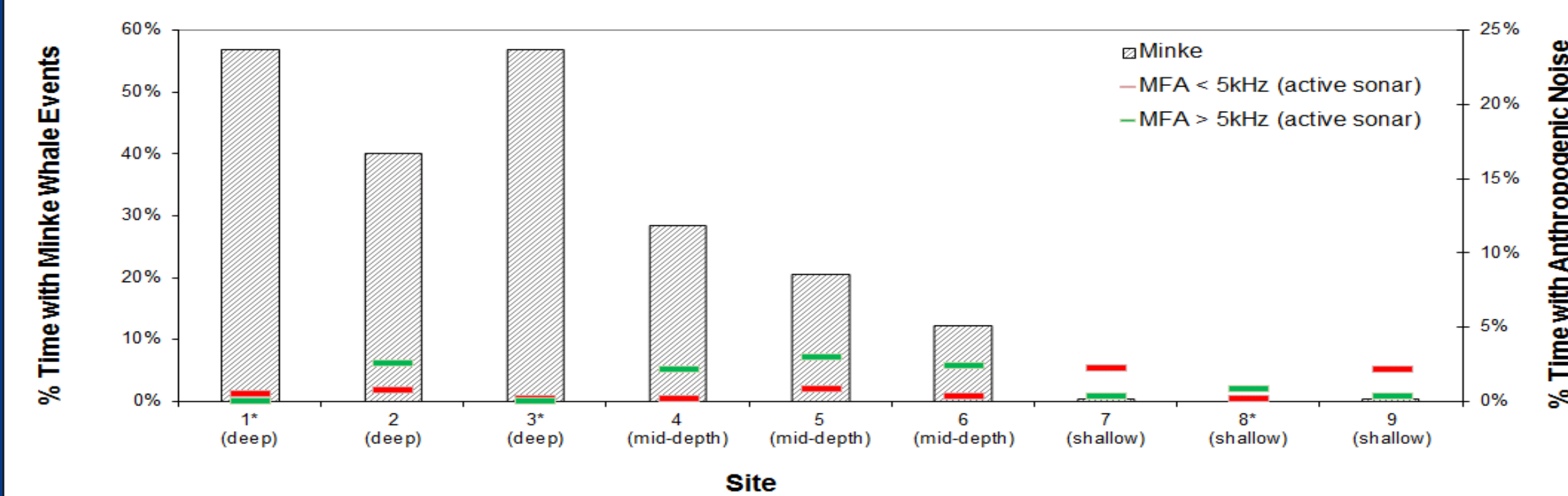


Figure 3. Percent time of minke whale vocalization events by site. Vocalizations were primarily detected at deep water and mid-depth sites. At all shallow-water sites minke whale vocalizations were detected at very low levels (less than 0.3%).

Probability of Minke Whale Vocalization Events Deployment 2

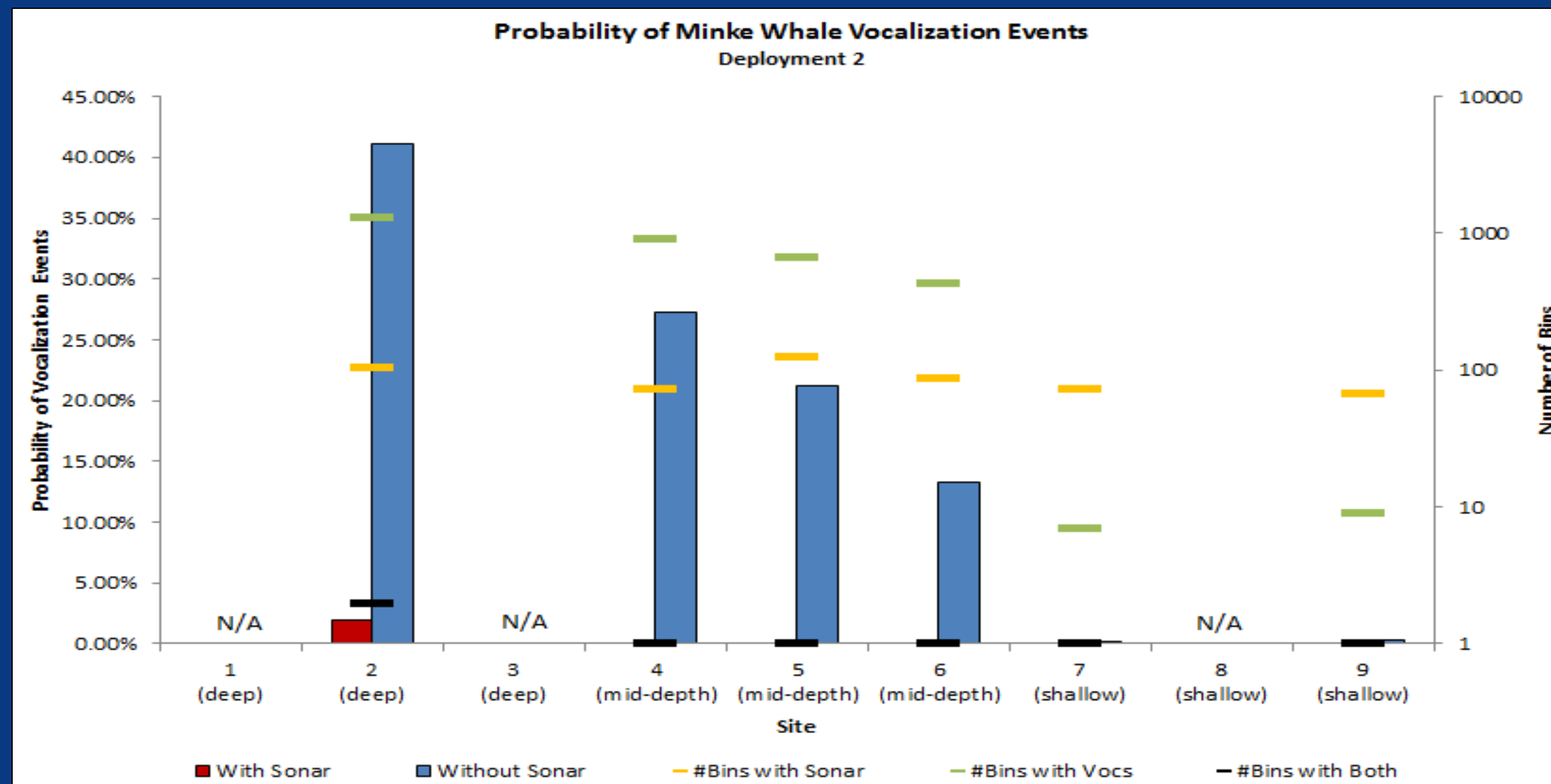


Figure 4. Probability of occurrence of minke whale vocalizations in the presence of sonar (red bars) and in the absence of sonar (blue bars). Probability analysis suggested a very strong negative correlation with sonar. This is indicated by the greatly reduced probabilities of vocalization events occurring when sonar was present compared to when sonar was not present.

Vocalizations

- 'Slow-down' pulse trains were the predominant vocalization type detected (~81%).
- 'Consistent' pulse trains were found (~15%) only occurring 2.5 minutes after a 'slow-down' pulse train (Figure 5).
- 'Short' pulse trains were found less frequently (~3%).
- 'Speed-up' pulse trains were found infrequently (~1%).

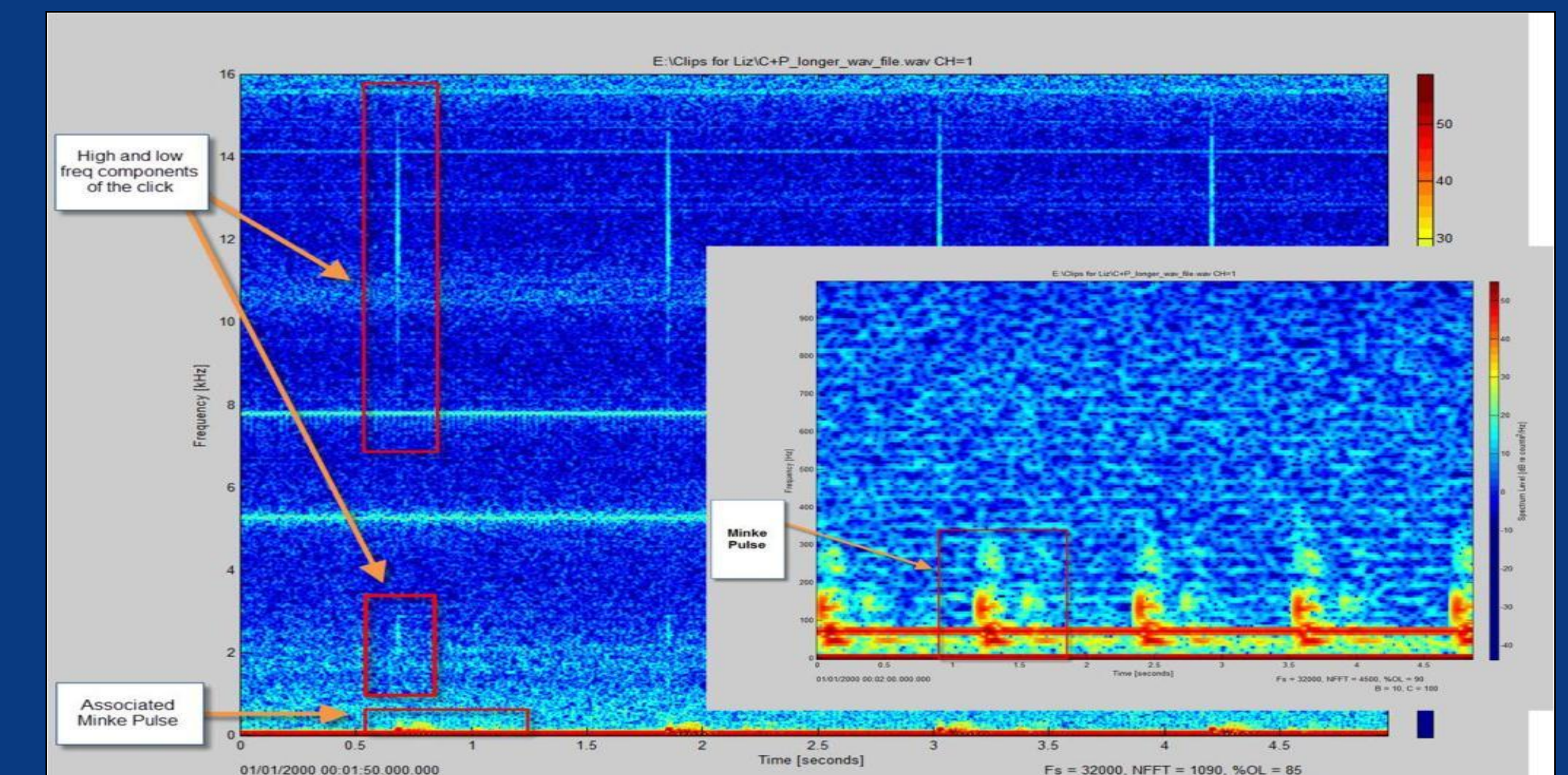


Figure 5. Minke whale 'consistent' pulse train. The low-frequency pulse and the clicks always occur simultaneously. The low-frequency pulse duration was approximately 0.25 seconds. The inter-pulse intervals were approximately 0.95 seconds for the pulses and 1.18 seconds for the clicks (due to their shorter durations).

Conclusions

- This is the first documentation of minke whale vocalizations in this region.
- The high level of vocal activity in winter implies this might be an important area for courtship and breeding.
- Occurrence of vocalization events was greatest at deep sites and mid-depth sites and limited at shallow sites.
- Vocalization types were similar to those detected off Onslow Bay, North Carolina.
- Very low probability or absence of minke whale vocalizations in the presence of sonar.

Ongoing & Future Studies

- Aerial surveys with sonobuoy deployments to monitor changes in behavior in response to anthropogenic noise.
- More robust statistical analyses of vocalizations in relation to sonar are being conducted by St. Andrews, Cornell-BRP and Bio-Waves Inc.