Title: **Multibeam Echosounders (MBES)**

Time: 18 September 2024

Presenters: Michael Smith (KD) & Hilary Kates Varghese (BOEM)

Abstract: Concern regarding the potential for impact of multibeam echosounders (MBES) on marine life has increased in recent years. This set of presentations will go over the fundamentals of why we use MBES, how they operate, and the current framework for impact mitigation. This is followed by a review of empirical studies looking at the potential impact of MBES on the local marine environment.

Duration: a 40-minute presentation followed by a Q & A session

Audience: Those interested in the underwater radiated noise of multibeam echosounders, and those involved in the international decision-making community.

Goal: Inform the public regarding the unique operating characteristics of MBES and demonstrate that the highly directional radiation pattern represents a unique challenge for mitigation. Further, inform the public regarding the potential for impact of the MBES by looking at existing case studies.

Intro to MBES (Mike)

- Tools for mapping the seafloor:
  - Brief review of echosounding.
  - Why do we use MBES.
  - What are other uses of this system
- What is a MBES: The basics
  - Array basics
  - Array sizes
  - Multi Sector / Multiswath functionality
- MBES Pings:
  - What does it look like and sound like?
- Sound in the water: The MBES radiation pattern
  - What does it look like
  - How does it compare to similar frequency systems?
  - Is 240 dB really 240 dB?
- MBES and Acoustical Impact
  - Modeling for mitigation
  - Modeling output examples
  - Weighting and applying thresholds

Effect of MBES on the environment and marine mammals (Hilary)

- General overview: what we know about echosounders and their effect on marine life and the acoustic environment?
  - Very few empirical studies on MBES specifically
  - Risk of auditory injury low
  - Behavioral effects possible

    - Source characteristics and context of exposure are important!
- Case study: 12 kHz deep-water MBES survey in Southern California
    - Effect of 12 kHz MBES survey on the marine acoustic environment
        - Array-wide broadband sound level visualization
        - Array-wide decidecade band sound level visualization
        - Spectral level visualization from a single hydrophone
    - Spatio-temporal assessment of 12 kHz MBES survey on foraging behavior of beaked whales
        - Beaked whale detections during a 12 kHz MBES survey visualization
        - Comparison of beaked whale foraging characteristics before-during-after 12 kHz MBES survey
        - Comparison of beaked whale spatial use of array for foraging before-during-after 12 kHz MBES survey

Relevant DOSITS pages

Single beam echosounders

Multibeam echosounders

How is sound used to map the seafloor?

How is sound used to identify ecological hotspots?

How is sound used to monitor and study seagrass beds?

How is active acoustics used in fisheries research and management?

Tutorial: Echosounders

Tutorial: Find Objects on the Sea Floor

Tutorial: Measure Water Depth

Some Other MBES Resources

Kates Varghese, H., X. Lurton, M. Smith, J. L. Miksis-Olds, and L. Mayer. (2024). **"**Soundscape Assessment of a Deepwater (12 kHz) Multibeam Mapping Survey," A. N. Popper et al. (eds.), *The Effects of Noise on Aquatic Life*, https://doi.org/10.1007/978-3-031-10417-6_76-1

Kates Varghese, H.S.C. 2021. "The Effect of Deep-Water Multibeam Mapping Activity on the Foraging Behavior of Cuvier's Beaked Whales and the Marine Acoustic Environment." *Doctoral Dissertations*. 2648. Retrieved from: https://scholars.unh.edu/dissertation/2648

Kates Varghese, H., Lowell, K., Miksis-Olds, J., DiMarzio, N., Moretti, D., and Mayer, L. (2021). Spatial Analysis of Beaked Whale Foraging During Two 12 kHz Multibeam Echosounder Surveys. *Frontiers in Marine Science* 8:654184. DOI: 10.3389/fmars.2021.654184.

Kates Varghese, H., Miksis-Olds, J., DiMarzio, N., Lowell, K., Linder, E., Mayer, L., and Moretti, D. (2020). The effect of two 12 kHz multibeam mapping surveys on the foraging behavior of Cuvier's beaked whales off of southern California. *The Journal of the Acoustical Society of America* 147(6), 3849-3858. DOI: 10.1121/10.0001385.

Kates Varghese, H., Smith, M.J., Miksis-Olds, J.L., and Mayer, L. (2019). Regulation Consideration of Ocean Mapping Multibeam Echo Sounders: A Square Peg in a Round Hole. *Journal of Ocean Technology* 14(3), 40-46.

Lurton, X. (2016). Modelling of the sound field radiated by multibeam echosounders for acoustical impact assessment. *Applied Acoustics* 101, 201-211.

Lurton, X. and DeRuiter, S. (2011). Sound radiation of seafloor-mapping echosounders in the water column, in relation to the risks posed to marine mammals. *International Hydrographic Review* 7-17.

Mayer, L.A. (2006). Frontiers in seafloor mapping and visualization. *Marine Geophysical Research* 27, 7-17. doi: 10.1007/s11001-05-0267-x

Mayer, L., Jakobsson, M., Allen, G., Dorschel, B., Falconer, R., Ferrini, VS, Lamarche, G., Snaith, H., and Weatherall, P. (2018). The Nippon Foundation-GEBCO Seabed 2030 Project: The Quest to See the World's Oceans Completely Mapped by 2030. *Geosciences* 8(63). Doi: 10/3390/geosciences8020063.

Ruppel, C.D., Weber, T., Staaterman, E., Labak, S. and Hart, P. 2022. Categorizing Active Marine Acoustic Sources Based on Their Potential to Affect Marine Animals. *Journal of Marine Science and Engineering* 10, 1278. doi: 10.3390/ jmse10091278

Smith, M. (2024). Modeling Approaches to multibeam echosounders for sound field characterization. *Journal of the Acoustical Society of America.*156(2), in press.

Smith, M.J. (2019). Analysis of the radiated sound field of a deep-water multibeam echo sounder using a navy hydrophone array. M.S. thesis, University of New Hampshire, https://unh.idm.oclc.org/login?url=https://search.proquest.com/docview/2273838102?accountid=14612.