

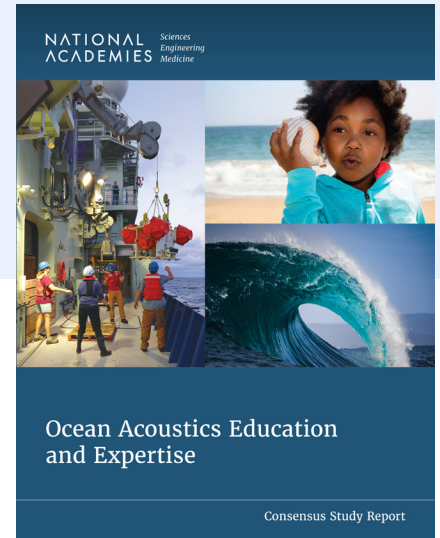
Ocean Acoustics Education and Expertise

Ocean acoustics¹ – the study of sound in the ocean, how it travels, interacts with, and is affected by its underwater surroundings – is a growing and critical field. Sound from both natural and human-generated sources is an effective tool for exploring the ocean environment. Sound travels efficiently over large distances and can convey information through interactions with ocean boundaries, physical properties, and objects within the ocean. While the first applications of ocean acoustics began in the military for defense purposes, applications today encompass offshore energy production, national security, environmental monitoring, climate science, exploration and mapping, as well as fundamental ocean science.

Ocean acoustics is multidisciplinary, requiring knowledge of mathematics, natural sciences (e.g., physics, chemistry, biology) and engineering. As a result, it may be housed in a diversity of departments within higher education institutions. Content in or related to ocean acoustics or acoustics can be found in mechanical engineering, electrical engineering, computer engineering, civil engineering, computer science, biology, physics, aerospace engineering, oceanography, ocean engineering, geophysics, and marine science departments. In addition, career paths also vary widely. Career paths and trajectory of formal education can range from the vocational/associates' level through the doctoral level.

While the demand for ocean acoustics is growing, both the multidisciplinary nature of ocean acoustic education and the different types of career paths have proved challenging for workforce development. This report, conducted at the request of The Office of Naval Research (ONR), explores the existing educational challenges and opportunities, and presents recommendations to achieve future training and education needs for an expanding workforce.

¹ Many concepts of education, workforce needs, and gaps presented in this report are not specific to ocean acoustic and can be expanded to other areas of underwater acoustics, including freshwater.



The report examines the state of ocean acoustics education; assesses the anticipated demand for acoustics expertise over the next decade; identifies competencies required across higher education and professional training programs to fulfill that demand; and presents strategies to raise the profile of careers in ocean acoustics to increase awareness, recruitment, and retention of a diverse workforce.

STATE OF EDUCATION AND EXPERTISE

The current ocean acoustics workforce has come from various education pathways, including a combination of formal education and on the job training programs. Growth within marine industries over the next decade will increase the need for skilled workers, including many with technical or applicable ocean acoustics competences that may not require advanced degrees. Coupled with this need in maritime industries is the continued need for ocean acousticians with advanced degrees to maintain expertise critical to national security and expand oceanographic research.

Ocean acoustics content is a small part of various larger departments or programs in education institutions. The size and lack of a consistent home department impedes recruitment, growth, and recognition of the field. To meet the growing demand for ocean acoustics education, programs such as workshops, short courses, and tutorials can be offered to the existing workforce to broaden expertise and augment formal education program for students, although increasing the extent and coverage of formal education programs is still necessary. Microcredentials, which are short, competency-based training opportunities, are another approach the ocean acoustics community can utilize to help meet the future needs of the marine workforce.

ATTRACTING, RECRUITING, RETAINING, AND DIVERSIFYING THE OCEAN ACOUSTICS WORKFORCE

Ocean acoustics faces challenges in the attraction, recruitment, and retention of a diverse workforce because of its interdisciplinary nature, in addition to challenges common to the broader STEM domain. However, opportunities are available to overcome these barriers, beginning with an understanding of current demographics and representation within the field to raise awareness and build capacity throughout the entire

educational pipeline from K-12 through the doctoral level. Increasing exposure to acoustics in curricula and educational programming, as well as increasing community awareness and outreach opportunities can improve recruitment into higher education programs. Community-wide, coordinated efforts to address recruitment at the undergraduate level and retention of students in formal education programs are critical for building a robust and diverse workforce that meets the needs of the nation. Career recruitment can be increased by raising awareness of the variety of career paths and jobs related to ocean acoustics and how many are connected to topics related to areas of growing interest (e.g., climate science, data science).

FILLING GAPS BETWEEN EDUCATION AND EXPERTISE AND WORKFORCE NEEDS

Challenges facing the ocean acoustics community today stem from its historical development, multidisciplinary nature, and diverse uses requiring various levels of technical expertise. Gaps identified between existing ocean acoustics education and training opportunities and expertise to meet current and future workforce needs were sorted into three categories by the committee: 1) Programmatic Gaps, related to the availability of education and training programs; 2) Curriculum Gaps, pertaining to content in current and future programs; and 3) Awareness Gaps, associated with the lack of educational awareness of career pathways related to ocean acoustics.

Filling the programmatic, curriculum, and awareness gaps between existing ocean acoustics education and training opportunities and the expertise needed to meet current and future workforce demands will require several actions from relevant federal agencies, industry, and academia as summarized below.

Building programs for ocean acoustics:

- Federal agencies and institutions of higher education should collaborate to create programs that support the next generation of the ocean acoustics workforce; fund opportunities to accelerate mentorship and scholarly work; and invest in programs that support ocean acoustic skills at non-advanced degree levels to meet the future demands of the field.

Improving ocean acoustics curriculum:

- Organizations should offer short courses and other training opportunities related to ocean acoustics to promote continued professional development.

Building awareness of ocean acoustics:

- Agencies and organizations should invest in high school outreach programs, through grant-funding and other STEM initiatives, that inform about marine science, maritime, and ocean acoustics careers.

Meeting anticipated workforce demands:

- The ocean acoustics community should focus on increasing diversity and retention by reaching out to institutions about programs for underrepresented students and providing more exposure to STEM role models at all education levels.
- Employers should provide leadership trainings, support work-life balance, and provide equal pay for women and underrepresented minorities while also expanding their recruitment efforts beyond professional society conferences.

- The Department of Defense and other agencies should better translate military experience and knowledge to allow an easier transition into civilian employment in the ocean acoustics workforce.
- Education institutions should develop curriculum guidelines and competencies to meet the demand for a skilled, successful ocean acoustics workforce. A curriculum should include opportunities targeting first through third year undergraduates, sound and bioacoustics content, acoustic propagation and soundscape modeling, and data management, among other topics.

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