NATIONAL ACADEMIES Sciences Engineering Medicine

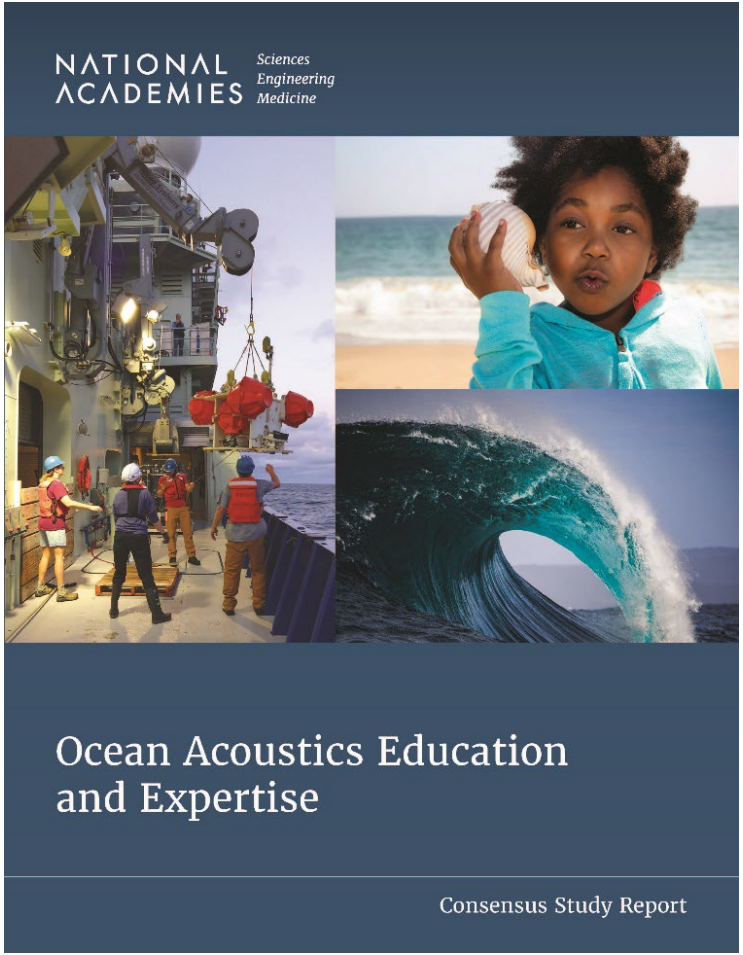
Ocean Acoustics Education and Expertise

Jennifer Miksis-Olds, Committee Chair

OCT 25, 2024

Take-home Messages

- Careers and research related to ocean acoustics are vital for the national security and defense, economic, and environmental sectors.
- Growth within these sectors is requiring increased ocean acoustic skills at all levels, but especially technicians.
- Increased support for training and education is needed to meet the demands of the growing ocean acoustics workforce.



Statement of Task

An ad hoc committee will assess the current and future state of ocean acoustics expertise required to realize the full value of ocean acoustics knowledge and capabilities across a diversity of fields and applications. This will be conducted through (1) an examination of ocean acoustics education in the United States, (2) assessment of the demand for acoustics expertise, as anticipated over the next decade, (3) identification of competencies required for undergraduate, graduate, and professional training programs that will be required to fulfill that demand, and (4) exploration of strategies to raise the profile of careers in ocean acoustics, including education, training, and workforce recruitment and retention. The report will include information on:

- Academic institutions that offer courses in ocean acoustics or include ocean acoustics as a unit within related coursework.
- Public and private sector professional-level organizations that require expertise in ocean acoustics as part of their operations.
- Ocean acoustics workforce needs in key sectors/industries.
- Training programs currently available in these key regions.
- Examples of current ocean acoustic programs.

This information will be gathered by the committee as part of their assessment of the needs for ocean acoustics expertise, anticipated demand in the next decade, and potential needs for additional training opportunities. The committee will recommend resources required to support ocean acoustics research and education, and preparation and recruitment of a diverse workforce.

NATIONAL ACADEMIES Sciences Engineering Medicine

Committee

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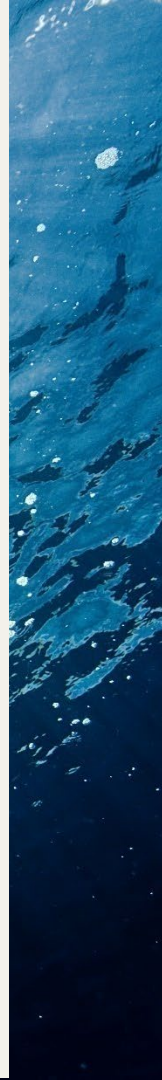
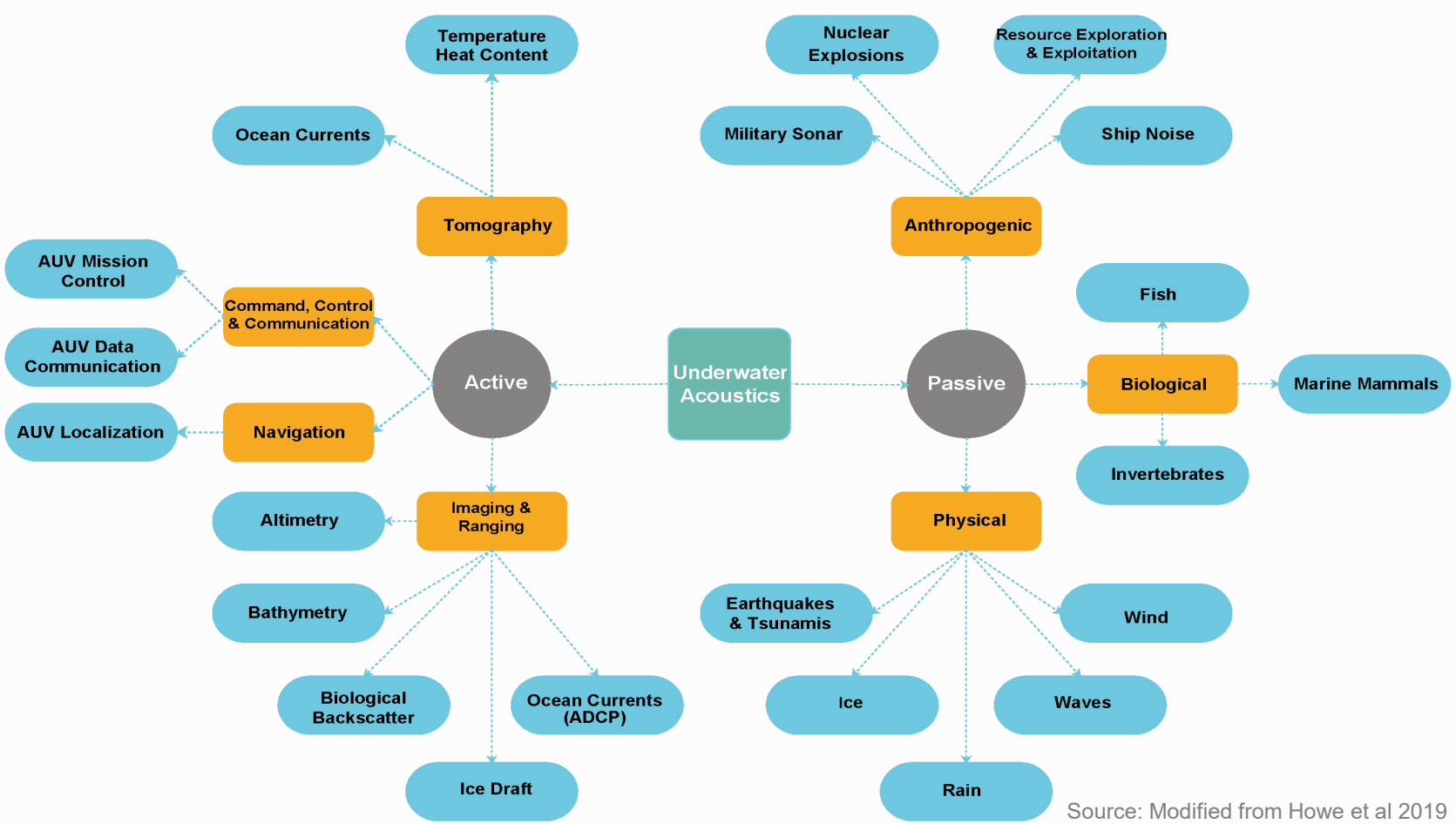


Ocean Acoustics Applications



Source: Modified from Howe et al 2019

State of Ocean Acoustics Education and Training

Formal Education Opportunities: Programs With Ocean Acoustics Courses

Institution	Department or Program	No. of Faculty	No. of Courses	"Acoustics" listed on Diploma
Catholic University of America	Mechanical Engineering	3–5	6–10	
Duke University	Electrical & Computer Engineering, Marine Science & Conservation	6–10	3–5	
Massachusetts Institute of Technology—Woods Hole Oceanographic Institution Joint Program	Applied Ocean Physics & Engineering	6–10	6–10	
Naval Postgraduate School	Physics Department, Maritime Battlespace Environments, Physical Oceanography	3–5	6–10	Ph.D. in Engineering Acoustics, Fundamentals of Engineering Acoustics Certificate, Certificate in Anti-Submarine Warfare
Northwestern Michigan College	Marine Technology	3–5	3–5	Marine Data Processing Certificate**
Oregon State University	Cooperative Institute for Marine Ecosystem & Resources Studies	1–2	1–2	
Pennsylvania State University	Graduate Program in Acoustics	>10	>10	M. Eng., M.S., and Ph.D. in Acoustics
Stony Brook University	School of Marine & Atmospheric Sciences	1–2	1–2	
Syracuse University	Biology (Bioacoustics & Behavioral Ecology Lab)	1–2	1–2	
United States Naval Academy	Physics Department, Ocean & Atmospheric Sciences	1-2	1-2	
University of Delaware	Electrical & Computer Engineering	1-2	1-2	
University of California—San Diego	Scripps Institution of Oceanography	5–10	6–10	
University of Massachusetts—Dartmouth	Electrical Engineering	3–5	6–10	Acoustics Certificate
University of Miami	Department of Ocean Sciences, Electrical Engineering	1–2	3–5	
University of New Hampshire	Center for Acoustics Research & Education, Center for Coastal & Ocean Mapping, Ocean Engineering, Oceanography	3–5	6–10	Graduate Certificate in Acoustics
University of Rhode Island	Department of Ocean Engineering, School of Oceanography	3–5	6–10	
University of Texas—Austin	Electrical Engineering, Mechanical Engineering, Biology, Biomedical Engineering	6–10	>10	

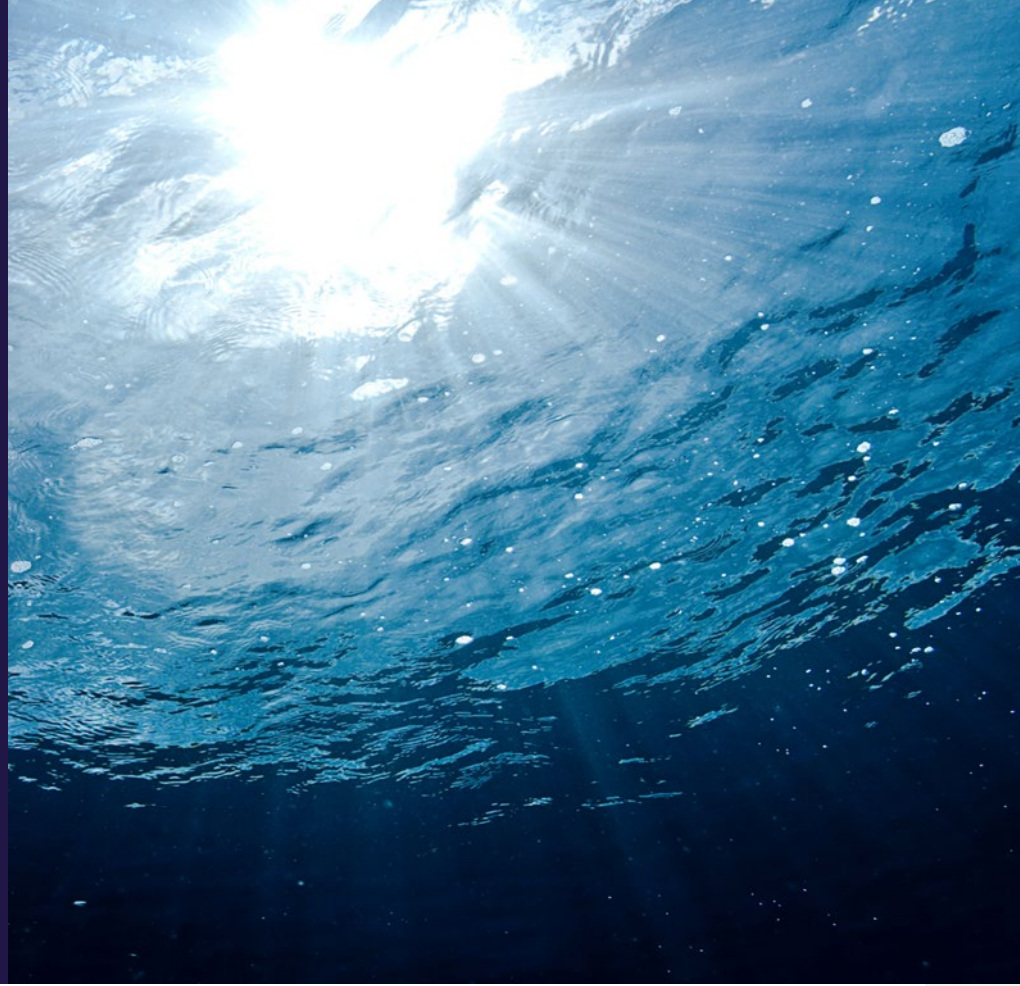
State of Ocean Acoustics Education and Training

- Training programs were identified across higher education, industry, and government
- Professional society mentoring programs are valuable mechanism for delivering professional development
- More ocean acoustics learning opportunities are needed to prepare meet the needs of the future marine technology workforce.

Current and Future Employment Landscape

Current and Future Employment Landscape

- Research faculty with robust and continuous funding are necessary for maintaining U.S. leadership in ocean acoustics.
- Some jobs in ocean acoustics could be filled by those with technical training or on-the-job experience.
- Increasing ocean acoustics expertise at Federal regulatory agencies will enhance credibility and improve trust between regulators and industry.

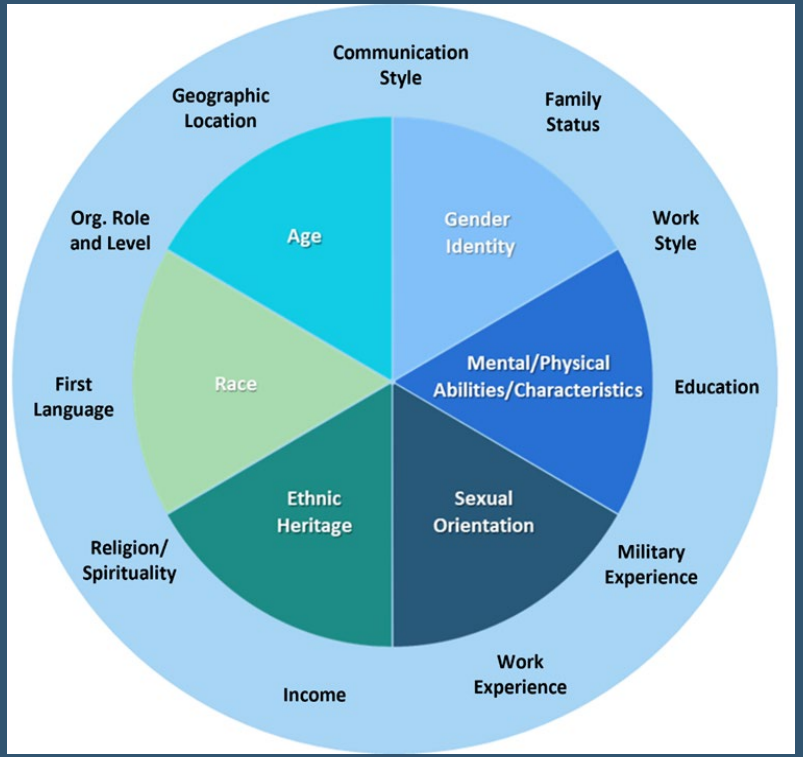


Attracting, Recruiting, Retaining, and Diversifying the Ocean Acoustics Workforce

Diversifying the Ocean Acoustics Workforce

Recommendation 5-1 The ocean acoustics community should increase diversity and retention through the following:

- Institutions of higher education offering degrees in disciplines supporting ocean acoustics should increase academic retention programs to promote a sense of belonging for underrepresented students within STEM disciplines.
- Institutions of learning should provide more exposure to positive STEM role models and mentors for girls, young women, and underrepresented minorities at all education levels to integrate STEM identities, build STEM confidence, and demonstrate the possibilities for turning STEM learning into a career.
- Employers should improve the workplace climate for women and underrepresented minorities by challenging cultural biases, providing leadership training, supporting work-life balance, promoting parity and providing equal pay.



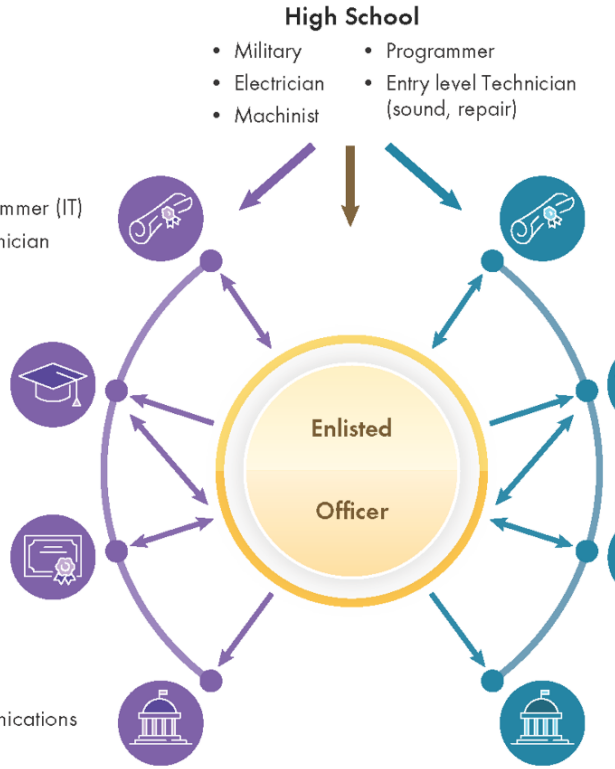
Source: Adapted from Williams (2013) and Yarber (2019)

Increasing Exposure to Ocean Acoustics Content

- Awareness of acoustics as a scientific discipline and related career opportunities is lacking in K–12 education.
- Exposure to acoustics can occur through extracurricular activities, such as the Science for Tomorrow initiative and the National Ocean Sciences Bowl.
- The ocean acoustics community should work with community colleges to include content in existing marine technician programs.

Recommendation 5-2 Federal agencies should collaborate to create programs, including Centers of Excellence in Ocean Acoustics, at regional or national levels to raise the profile of the discipline, coordinate infrastructure and support to build capacity, maximize resources, and prevent redundancy to promote preparation of the next generation of the ocean acoustics workforce.

Increasing Awareness of Ocean Acoustics Research and Careers



Recommendations for Addressing the Gaps Between Education and Expertise and Workforce Needs

Gaps Between Education and Training Opportunities and Workforce Needs

Programmatic Gaps

- Availability of education and training programs
- Applicability of education and training programs

Curriculum Gaps

- Specific ocean acoustics program content
  - For current and future programs

Awareness Gaps

- Ocean acoustics career pathways
- Relevance of ocean acoustics careers to science and society

Without increased investment and regularly offered education, training, and outreach programs, the ocean acoustics community will not grow fast enough to meet workforce demands over the next decade.

Programmatic Gaps

- Alternative Credentialing Programs for Practical Ocean Acoustics Training Recommendation 6-2
- Credentialing Ocean Acoustics-Related Expertise and Skills of Military Service Members Recommendation 6-3
- Coordinated Workforce and Stakeholder-Specific Training in Non-military Applications
- Connection Between Highly Technical Programs and More Conceptual or Applied Programs
- Ocean Acoustics Community-Building Programs to Strengthen Cohesion and Promote the Perception of Ocean Acoustics as a Field with a Broad Range of Opportunities
- Experiential Learning Programs to Foster a Connected and Inclusive Ocean Acoustics Community

Recommendation 6-4

Recommendation 6-4 Relevant federal agencies and industry should engage with senior leadership at institutions of higher education to underscore the continued and critical, importance of acoustics programs within their institutions to support both national security and the growing blue economy and to encourage expansion of academic programs, course content and textbooks, and faculty and technical staff recruitment related to ocean acoustics.

Curriculum Gaps

- Acoustics or Ocean Acoustics Content in K-12 Curricula
- Expanding Higher Education Curriculum, Guidance, and Teaching Materials
  - Ocean Acoustic Content in First- Through Third-Year Undergraduate Programs
  - Expansion of Technical Ocean Acoustics Topics
- Consistent Experiential Learning and Professional Development Opportunities

Recommendation 6-5 Institutions of higher education, in cooperation with the ocean acoustics workforce and professional societies, should develop curriculum guidelines and competencies to meet the demand for workers in both ocean acoustics research and applied ocean acoustics to ensure students receive baseline knowledge and develop the skills required for successful careers. Developing curriculum should include:

- Integration of opportunities targeting first- through third-year undergraduates in science, engineering, and environmental policy to participate in hands-on learning that reinforces ocean acoustics concepts;
- Effects of sound and bioacoustics content;
- Acoustic propagation and soundscape modeling content;
- Artificial intelligence, machine learning, and data science content;
- Numerical modeling and analysis supported by high-capacity computing content;
- Best practices in scientific computing; and
- Data management.

Recommendation 6-6 Organizations with the capacity to develop and offer mission-related professional development opportunities in ocean acoustics should consistently offer short courses, tutorials, and other training opportunities (including online programs) related to ocean acoustics to promote continued professional development. Consistently offering these opportunities overcomes the challenges of sustaining relevant coursework and maintaining suitable instructors.

Awareness Gaps

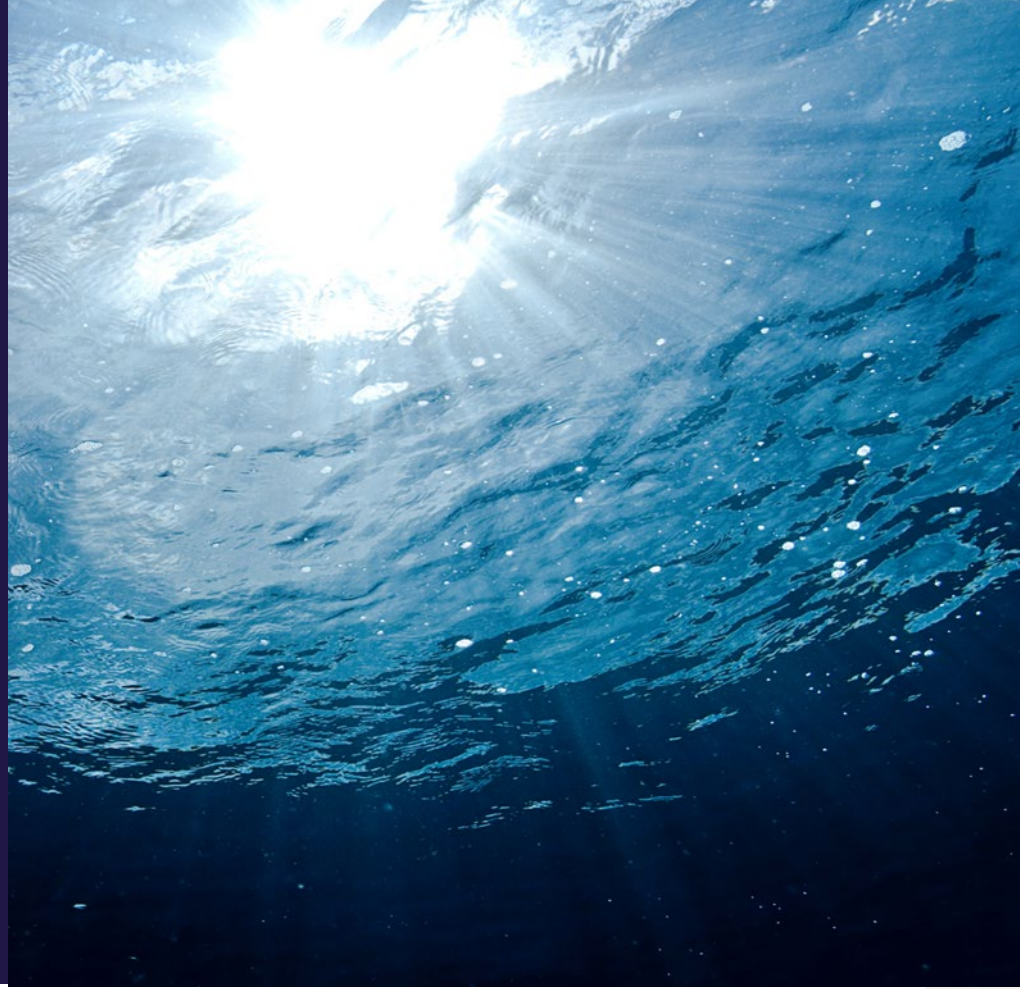
- Limited Awareness of Diverse Career Pathways in Ocean Acoustics
- Mismatched Perception of Ocean Acoustics Career Requirements
- Link Between Climate and Marine Ecosystem Science and Ocean Acoustics
- Public Knowledge of Ocean Acoustics Is Shaped by Negative Media Content

Recommendation 6-7 Federal, industry, and educational organizations should invest in outreach programs to U.S. high schools that focus on marine science or maritime career preparation. In addition, these sectors should provide information about ocean acoustics competencies and potential careers to increase awareness.

Recommendation 6-8 Federal agencies and blue economy industries should dedicate financial support to ocean acoustics education and training both within grant-funded programs (coupled research-education opportunities) and through separate STEM education/training initiatives (education decoupled from specific research grants) that could integrate ocean acoustics into K–12 outreach and teacher professional development programs to increase awareness of ocean acoustics content and career opportunities.

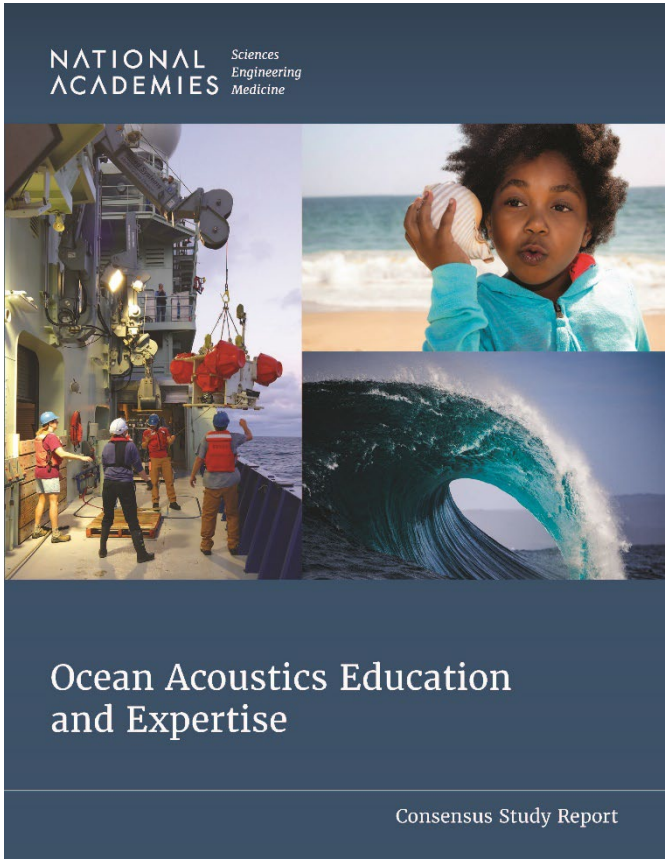
Summary

- The field of ocean acoustics with its deep roots in defense and national security is growing with the expanding blue economy and technology advances.
- It remains critical to continue to support advanced degrees while developing programs at the vocational or associates' level.
- The interdisciplinary nature of the field can be used to help expand education and training programs and increase outreach to meet workforce demands.



Future Disimination Activities

- Acoustical Society of America Meeting – May 2025
  - Proposed component to the Acoustics Education Programs around the World Session
- Workshop
- MTS Journal Special Issue – ~Sept 2025



https://nap.nationalacademies.org/catalog/27337/ocean-acoustics-education-and-expertise