

The NOSB Fall Tracking Report 2017

Introduction and Method

The Consortium for Ocean Leadership annually implements the National Ocean Sciences Bowl (NOSB) as a regional and national competition-based program for high ability secondary students in the United States. A tracking survey has been implemented to follow students after high school graduation, through college and, for some, graduate school, and into the workplace beginning in 1999 and continuing annually since that year. Drs. Tina Bishop and Howard Walters, of the College of Exploration and Ashland University respectively, have developed the surveys associated to this now longitudinal tracking study, as well as numerous other instruments and data collection procedures. Each year, in addition to the student and past participant tracking surveys, an additional research project has been undertaken focused on one or more of the other constituency or stakeholder groups attached to the program, including scientists and graduate students, judges and volunteers, teachers and parents. For the 2017 research, this second, supplemental research project focused on new NOSB teams, and particularly on developing a case study of a Tennessee team and the private company that provided the financial support for that team. This Tennessee case study is the subject of a different report provided to COL.

For purposes of this current report, the data and summaries following are based on a follow-up survey, which was disseminated in late September, 2017, by the NOSB program office to its most current database of past participants. A total of 96 individuals provided responses to the survey (note: select items were not appropriate for current high school students, or current college students).

Demographics of Respondents

Through voluntary self-report, sixty percent of respondents are female and thirty-six percent report as male, with three percent preferring not to disclose this information. Twenty-five percent of respondents have graduated college and are no longer in formal education. Eight percent of the respondents are currently in graduate school, with approximately sixty percent of respondents currently in college, while nearly fifteen percent are still in high school. As ethnicity was not viewed as a useful demographic variable in this current study, these data were not solicited from the respondents for this study.

Item three identified the categories that most closely described college majors for the respondents. The largest proportions were found in the STEM disciplines, and it should be noted that this item allowed for multiple responses so as to capture students with multiple majors, and so numeric totals of responses exceed the number of individuals who provided data. In rank order, 32% of respondents indicated Engineering, followed by 25% who reported Biological Sciences, 18% reporting Environmental Science, and nearly 15% who reported Ocean or Marine Science as primary majors. Other majors reported included: Physical Science (nearly 7%), Chemistry or Biochemistry (nearly 7%), Geology or Earth Science (nearly 7%), and Mathematics (5%). Other non-STEM majors were numerically insignificant. Of the 95 respondents providing data in item four, nearly 56% reported that they had taken courses in marine, aquatic or ocean sciences, which suggests that far more than the 15% who reported a major in these ocean related areas did, in fact, take courses in this content area. Additionally (item five), nearly 35% of respondents indicated that their career will ultimately include an emphasis on marine, aquatic, or ocean sciences.

Item six asked respondents who were currently college or graduate students to list any courses taken in the last semester or the current semester from the STEM content areas. The purpose of the question is to cross-validate the responses to the majors question in item five. Cresswell (2008) has asserted that the use of such paired questions in surveys creates highly detailed data that enhances the reliability of the observations. In this case, the high proportion of STEM majors reported in item five is followed by very highly specific and detailed lists of courses from those majors in item six. The specificity of courses is far beyond the overarching categories of biology, chemistry, or physical science, and includes such courses as: Shifts and Cycles in Natural Systems, Foundations of diagnostics and Therapeutics in Neurology, Patterns and Processes in Biogeography, to name only a few of hundreds of courses listed. Given the interest in ocean and aquatic related content to COL, however, the following is a list of these courses provided by respondents:

- Fish and Wildlife
- Marine Mammals
- Drones in Marine Ecology
- Natural Hazards
- Urban Oceanography
- Coastal Engineering
- Biological Oceanography
- Marine Pollution
- Oceanography
- Tropical Marine Biology
- Estuarine Dynamics
- Ship Stability
- Groundwater Contamination
- Transport Physical Hydrology
- Introduction to Oceanography

Item seven asked respondents “in which Regional NOSB competition did you compete?” The 92 respondents to this question indicated participation in all the regional bowls, except the Hurricane Bowl and the Southern Stingray Bowl. This represented an excellent distribution of responses from the various regional competitions. The top three ranks of responses were from participants in the Shore Bowl, the Blue Lobster Bowl, and the Blue Crab Bowl.

Item eight asked respondents to provide information regarding their own volunteer work, if any, at one of the regional bowls following three years as a participant. Of the seventy-seven respondents to this question, fifty-eight said they had not volunteered and nineteen said that they *had* volunteered. Those who had volunteered mentioned a variety of regional bowls for which they had volunteered. Of those who responded that they had not volunteered, nine people said they would like to volunteer or were already planning to volunteers.

Item nine asked respondents to describe the primary benefits to themselves of participating in the NOSB. The eighty-five respondents to this question highlighted a number of positive outcomes from their participation in the NOSB. The responses covered a wide range of benefits. These benefits can be grouped into several main themes. First, students perceived a primary benefit was *learning about the ocean and about careers in ocean sciences*. Numerous respondents mentioned increased knowledge and enhanced learning opportunities in content areas, particularly ocean issues and ocean sciences, environmental issues, science and policy, and earth topics. Several respondents mentioned expanding their understanding of content that would not normally be taught. One person stated a greater appreciation for the scientific method. Under this theme, respondents also described Introduction to jobs and career choices in the marine sciences and marine industries, with the NOSB offering insight into jobs and work options. Other respondents described how the competition sparked interest in the ocean, and led to the discovery of passion for the ocean and fields of oceanography, physical sciences, and biology. The NOSB allowed these students to focus on an area that interested them. Finally, this learning supported more advanced course options and was seen as useful in their college choices. A second theme that emerged in the area of benefits to participants was *general study skills and leadership development*. In this area, respondents listed leadership development; enhanced study

processes (including study habits, writing skills, presentation skills, thinking and memory skills); and the development of interdisciplinary study. The third theme to emerge in the area of benefits to participants was *social development as a component of the NOSB*. Numerous respondents mentioned learning how to work in teams, as well as promoting a comradery among team members. The respondents perceived that participating supported their developing friendships, meeting interesting people, establishing bonds with and among themselves, scientists, teachers and professors, and also networking. A fourth theme mentioned by respondents as a benefit was *personal development*. Respondents mentioned increased confidence and personal growth. They talked about the NOSB as a *means to show knowledge and a “place where I could shine.”* The NOSB was seen as a way to apply a competitive spirit to learning and to channel enthusiasm for the ocean sciences, as well as a way to increase their understanding of stewardship and appreciation for the environment. The final theme that emerged in the data was a perception of *fun*, which was mentioned by more than a dozen respondents. The responses to this item were particularly rich, with numerous quotes that illustrate a dynamic range of perception of program benefit. These include:

- *NOSB completely shaped my major/career interests and ocean science in general has made me more altruistic/emotional as a person. Not many people can pinpoint the exact moment they decided what they want to do with life, but I remember exactly—national's trip in North Carolina, walking on an island for my field trip and bringing back more seashells than could fit in my kayak. I'm now pursuing a major in geosciences and a minor in social entrepreneurship at Princeton. Thank you!*
- *The NOSB helped enhance my knowledge of issues concerning the ocean and also helped me form better bonds with the teammates I competed with.*
- *NOSB exposed me to all of the different ocean career choices and helped me shape my future career goals. It also has helped me in terms of being knowledgeable about the ocean for class or to help educate people who don't know as much.*
- *It has inspired an interest in oceans sciences and made me aware of career possibilities in it.*
- *NOSB has granted me an interest and respect for the Ocean Sciences. In addition, NOSB was a great opportunity for me to sharpen the study habits I now use at the University.*

- *The more I learned about the ocean, the more I loved it, and the more I wanted to learn about it. I got to see that you can make a career out of studying the ocean, and got to meet nice people who were doing just that. NOSB was also a place where I could shine (my high school was very competitive, so I was not the top of anything else). As a volunteer, NOSB has been a nice way to stay connected with a diverse group of colleagues each year.*
- *NOSB allowed me to pursue greater knowledge of marine sciences by learning material that wasn't taught in class. I was also able to interact with other women interested in science fields which had a huge impact on my view of women in the science world.*

Item ten asks respondents to indicate the degrees that they have obtained. Of the thirty-three respondents who have already obtained a degree, 30% (7 individuals) have obtained a B.A. degree; 70% (16) have obtained a B.S.; 30% (7) have obtained an M.S.; and 13% (3) have obtained a Ph.D. Item eleven is a follow-up question to ascertain the college or university where respondents obtained their degrees. It is noted that numerous institutions on this list are COL member institutions (note: the list is reproduced using names and spellings as provided by respondents to maintain data credibility):

- MIT
- UC San Diego
- University of Virginia
- Virginia Tech
- United States Coast Guard Academy
- Caltech
- Scripps
- Boston University
- Amherst College
- Duke University
- University of Wisconsin Madison
- University of South Florida
- Penn State
- Scripps Institute of Oceanography
- UC San Diego
- University of Rhode Island School of Oceanography
- UC Santa Barbara
- University of Alaska Anchorage
- Old Dominion University
- University of California—Santa Cruz
- Brown University
- The College of William and Mary
- UC Berkeley
- Mount Holyoke College
- The University of Michigan
- University of Colorado

Item twelve asked, “In what primary content area did you obtain your degree(s)?” The content areas of degrees achieved and listed by 26 respondents included four main areas: 1. The

sciences: including geology, chemistry, physics, earth sciences, ecology, atmospheric sciences, biology, and health sciences. 2. Computer science and engineering of various types. 3. Communication and English and business and marketing. And, 4. Marine and Environmental Science: including oceanography and ocean science. Interestingly, sixty percent (15 individuals) reported in item thirteen that they obtained their degree(s) in the area that they intended at the point they graduated from high school. This response pattern continues to differ from the response patterns of typical entering post-secondary students, who regularly change majors an average of 2-4 times during undergraduate programs (NACADA, 2011). And for these degree completers in this current study, item fourteen indicates that forty percent (10 respondents) obtained their degrees in areas which included an emphasis on marine, ocean, or aquatic science.

Items fifteen and sixteen relate to the development of durable, social or professional relationships as a result of participation in the NOSB. Respondent to item fifteen, one hundred percent (33 individuals) reported that they remained in communication with other NOSB participants. And in item sixteen, eighty-two percent (28 respondents) indicated that they remained in communication with their former NOSB coach/high school teacher. This persistence in relationships after high school graduation, and for some students even beyond college and graduate school, is a strong statement of the impact of the NOSB on its participants.

Item seventeen asked respondents to describe their current employment, and if possible to identify their employer. In some cases, respondents opted to describe the nature of their work to protect the anonymity of the response. These employment settings and/or employers represent a large proportion of STEM related pursuits or settings, and include:

- Software engineer
- Rite-Aid pharmacy
- US Army (commissioned officer)
- Corporation for National and Community Service (federal)
- LTJG in the US Coast Guard

- Professor (oceanography)
- EMT
- Medical student
- Naturalist, Aldo Leopold Nature Center, Wisconsin
- Assistant Director, Wesley Foundation, USA
- Research Assistant (biology) at Penn State
- Postdoc in Paleo-oceanography and marine biology
- Postdoc, Norwegian Polar Institute
- Grad Student, CU at Boulder
- Public relations
- Biology tutor, George Washington University
- Aerospace Engineer, Facebook
- Research assistant, UC Santa Cruz
- Consumer health company
- Library Specialist, Tidewater Community College
- Columbia University/Lamont Doherty Earth Observatory
- Postdoc, University of Michigan
- Administrative Manager, the Schooner Mystic Whaler
- Laboratory for Atmospheric and Space Physics

Item eighteen asked respondents to describe the nature of their work and their anticipated career path and goals. Of the twenty-three respondents, five said they are currently in, or studying for, health-related fields. Four respondents mentioned marine science research. Several mentioned teaching and, in particular, teaching environmental or earth science either in academia or in educational programs for the general public. Other jobs listed included: serving in the Coast Guard, software and product development, applied math, aircraft design, anthropology, and non-profit work.

Item nineteen asked respondents how their participation in the National Ocean Sciences Bowl contributed to their education and career path. The responses to this question reinforced and expanded on the benefits identified earlier (item nine) by the participants. There were twenty-two respondents to this question, as this question applied to those who were further along in their education and career path. Five people indicated explicitly that the NOSB helped them with their career paths and increased their awareness of ocean science careers and the breadth of the oceanography field. Exposure to a university setting as a consequence to the NOSB program

was also seen to be beneficial. Respondents stated that the NOSB provided a good foundation for oceanography, chemistry, biology and earth sciences, as well as highlighting the importance of interdisciplinary study. One person said it helped with applying “ecological principles in the medical field.” The competition was credited with aiding and promoting self-identity. And once again, leadership skills were mentioned. For two respondents, the NOSB help solidify their love of science and the aquatic world and offered a *springboard* for marine science as a “ hobby: enriching life.” Select quotes that illustrate the key observations for this item include:

- *NOSB was essential to developing my self-identity and career path. I cannot be more grateful for the NOSB organization for the knowledge and skills that I developed competing at the Shore Bowl and national competitions.*
- *Increased awareness of ocean science careers. Gave me exposure to a university setting. Impressed me with the multiple sides of oceanography (involves many sciences, not just marine biology of whales and dolphins). I liked that it was hard and challenging.*
- *NOSB showed me working professionals in the scientific community. The program made me feel less alone (nobody in my family is in the sciences) and the representation inspired me to participate in research and study abroad programs in college. Now, my strong backing in marine science is a hobby as is scuba diving. It enriches my life and gives me a very unique perspective in the medical field because I’m able to apply ecological principles in my line of work, which is rare albeit useful.*
- *NOSB helped me discover some of my academic interests (I never would have added Earth Science as a second major without having studied some for NOSB), as well as helped me develop a broad range of knowledge of science that made college courses easier. Studying for NOSB also made me realize how important it is to me to have an interdisciplinary background, which has helped me pursue the double major, as well as seek out useful research experience outside my comfort zone.*

Item twenty was designed to provide a broader understanding of the types of students or individuals who may be drawn to the NOSB through a general love for science. The item asks “Some students particularly loved learning about science while in high school, college or graduate school. If this describes you, what was it about learning science that so interested you?” Twenty-four respondents provided information for this item. The responses clustered around a number of key ideas, including: enjoyment in understanding how things work or go

together, seeing or contextualizing ourselves in the world around us, having a deep and detailed understanding of things, and the process of discovery or learning new things. These responses may be best viewed as dispositions or characteristics of science-interested young adults, and may pre-dispose students toward the STEM disciplines. This would suggest the use of these sorts of characteristics as recruitment variables for new NOSB teams moving forward.

Item twenty-one was focused on science or math learning experiences—teachers and courses of study which respondents might remember as “particularly able to engage students with interesting and exciting class experiences.” Respondents were specifically cautioned not to use teacher names as a means of protecting the identities of these individuals. There were a total of twenty responses to this item, and not surprisingly (based on research in science learning), thirteen of the twenty responses described explicitly constructivist science classrooms that incorporated extensive time for students to construct and test their own understanding of scientific concepts through labs and other hands-on activities, through in-depth experiences in natural settings in the field and authentic data collection activities. One key quote that is indicative of the general tone of the responses was, “Good teachers are the ones who take the time to engage students as individuals, so the ones that work with you as an individual are the best.”

Item twenty-two asked respondents to “describe any ways in which the NOSB may have helped you develop entrepreneurial interests and skills.” Interestingly, the respondents almost uniformly interpreted this item as an opportunity to describe their own growth through NOSB participation and how that linked to later life dispositions or abilities. Several interesting quotes from the nineteen responses emerged in these data, including:

- *I regularly give briefs and presentations to those older and more knowledgeable. The ability to work under pressure during buzzer rounds and then during the policy brief both contributed to my success later in life.*
- *We had a small team and I learned how to find people that were interested in our mission and organize everyone to work hard so we could win our regional competition.*
- *Going to nationals really threw me into a new experience socially. I really had to adapt quickly to meeting new people and handling stress on that sort of stage.*
- *I developed leadership skills through participating in NOSB by helping lead my team through organizing meetings and working with our other team leader to assess our progress, strategize our studying, and build a balanced competition team and train other members for the future.*
- *NOSB gave me a sense of accomplishment and confidence that I look to whenever I delve into a new activity or job.*

Item twenty-three asked respondents to “describe any ways through which you or your team may have incorporated innovative technologies (social media, web applications, software, etc.) in your preparation and study for the competition.” Unfortunately, the larger proportion of respondents are older adults at this point, having participated in the NOSB as early as 1999, well before much of the recent advances in technology and tech applications. There were no important responses of note in this data.

Item twenty-four solicited information from respondents about their stewardship interests and activities which may have been a result of their participation in the NOSB. From the seventeen responses to this item, fourteen were very positive. Select quotes that demonstrate the responses include:

- *NOSB made me more appreciative of the waterways I grew up around. I continue to participate in cleanups in my current state of residence.*
- *It showed me more of the scientific community in my town and state, and gave me opportunities to work with them.*
- *Introduced me to policy and my love for trying to change this world one advocacy pitch at a time.*
- *Through NOSB I learned that I like to teach others about science—so now I volunteer with a marine science center where I teach the public about science and ocean conservation.*

- *I became a part of the Union of Concerned Scientists.*
- *I learned about marine biology in NOSB, and that stimulated my interest and subsequent charitable giving to environmental organizations.*

Item twenty-five, the final item, associated the NOSB with the concept of free-choice learning, defined as self-directed learning, and guided primarily by the learners' own interests. Respondents were asked, "how did the NOSB incorporate free-choice learning for you?" This item elicited twenty-five responses, and it is noted that this was an increase in the number of responses from immediately previous items in the survey. This may suggest strength of agreement with the item's focus area. At the very least, the responses were very rich and extended to this item, with several interesting and positively emotive quotes emerging:

- *NOSB is a perfect example of free choice. There was no study guide, no worksheets, nothing. A single exam at the end of the year, it was up to you to ensure that you were adequately prepared when the regional competition arrived.*
- *I became such a good student in college and I'm sure that reading about a dozen oceanography textbooks in high school definitely played a big part in that! I became an even bigger auto-didact through NOSB.*
- *Many of our practices were student led and we were encouraged to take initiative and guide ourselves. That allowed us as students to be able to work at our own pace as well as absorb the material better.*
- *We studied whatever we felt like really. I memorized every phylum in the ocean, and then read a book about the history of scientific submersibles, and then decided I should read Mutiny on the Bounty, and then The Sea Around Us, and then tried to read Jacques Cousteau in the original French. Perhaps we could or should have been more strategic as a team, but we took the breadth of NOSB questions as an excuse to read basically anything ocean related that struck our fancy and we could get our hands on.*
- *This definitely describes my school's Ocean Bowl team. We had very little faculty support and studied and practiced everything ourselves. I still have Google Docs filled with pages and pages of buzzing questions I wrote about horseshoe crabs. I think students at my high school still use these documents.*
- *At my school there was no oceanography class, and our team was entirely self-run. So we shared resources and worked to make sure somebody studied every subject, but otherwise studied on our own. I got a lot of experience selecting reliable and useful resources, quickly picking out the important information, and finding ways to learn it that worked for me. I also delved more deeply in areas I was interested in, which was useful for competition when we could pool our individual areas of expertise.*

Conclusions and Recommendations

These fall report data were particularly robust with descriptive and rich feedback from the respondents. While one should exercise care in reading *tone* in the typed text of survey response data, the quotes provided above, and those not included in this report, demonstrate the range of emotion-laden vocabulary that characterized these data for this administration of the tracking survey. Respondents, even those who participated more than a decade ago, conveyed that they genuinely felt a bond with the NOSB program. They considered this program to be a highlight of their formative years, to impact career selection, course selection, even hobbies and living sustainably as adults.

It is rare for informal science programs to develop long-term, post-participation assessment in the manner that the NOSB leadership has done over two decades of tracking. Consequently, many informal science program administrators hope for, but never actually compile, the kind of affective impacts of these programs that are evident in the data obtained through this long-term tracking of the NOSB program.

But clearly, as this assessment demonstrates, and has consistently demonstrated twice annually for more than a dozen years, an informal science education program such as the NOSB can indeed change the trajectory of a young adult's life. As one respondent noted: *NOSB was essential to developing my self-identity.* And as another offered: *Not many people can remember the exact moment they decided what to do with their life...but I do...[the NOSB National Trip.]* We too quickly reduce these responses to flat, narrative summaries or bullet points for a presentation or report. In truth: these are the narrative reflections of lives changed, or purpose formed, of vision and identity shaped and directed for a life of positive impact on the

environment, on the ocean. This view of the National Ocean Sciences Bowl suggests that one important characteristic of an impactful and meaningful informal science education program is that it be in place for sufficient time so as to create an authentic and durable social community. These longer time frames foster an understanding of change over time, and this view is rarely possible for shorter-lived programs. This longevity also allows program administrators and researchers the opportunity to gauge longer-term impacts on past participants, whose life history is inseparable from the program itself. This seems to be the nature of the NOSB. Given that we are now seeing this longer-term impact on the students, it may be of importance to attempt to gain this view of the teacher/coaches, scientists, and other related personnel who have been involved over the longer period.

Moving forward, it is recommended that this longevity and impact of the NOSB become part of a strategic and systematic effort to leverage other opportunities, both programming and research. This social network comprising the NOSB is itself a resource for enacting other programs: professional development, training for other informal education leadership, and deep research into the social impacts of creating change through systems analysis and systems awareness. As has been noted in earlier tracking reports and program research on the NOSB, because of its longevity and the evident social cohesion of the NOSB stakeholder community, COL could utilize the NOSB as a platform for developing and enhancing its overarching Education Platform in a way that would be immediately possessed of a large, diverse constituency and credibility. Such a vision is supported by this current report and the earlier, twenty-year history of tracking research.

Dr. Howard D. Walters and Dr. Tina Bishop

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