

## **NOSB Spring 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 remains in a planning phase, but is likely to include a focused study of one or more of the newest NOSB team sites.

For purposes of this current report, the data and summaries following are based on a follow-up survey, which was disseminated in late January, 2017, by the NOSB program office to its most current database of past participants. A total of 100 individuals provided full to nearly full sets of responses to the 34 items in the survey. This response number is large enough for meaningful analyses and is typical of response rates over the years of the study.

### **Summary of Demographic Items**

Items one through three reflect that nearly half of the respondents are out of college or in graduate school, while twenty-six percent are still in high school. Through voluntary self-report, sixty

percent of respondents are female and forty percent report as male, with no reporting in other categories. Nearly three-quarters of respondents are white, with Asian or Hispanic respondents comprising nearly ten percent in each category.

In item four, respondents were queried about the regional bowl at which they originally participated. The respondents listed twenty-two regional bowls. The Chesapeake Bay, Manatee, and Dolphin Bowls were not listed. The three bowls listed most predominantly by the respondents were: Penguin Bowl (18), Lake Sturgeon (14), and Sea Lion bowls (8).

Item five asked respondents to indicate their majors or prospective majors in college. For their majors, *biological sciences* and *marine sciences* were the leading two majors listed. Thirty-one individuals listed “other,” but used this response to primarily, further differentiate sub-branches of the categories listed previously. A set of twenty-two responses indicated “none” as these students were not yet in college. Other majors included finance and business, elementary education, history, animation, forensic psychology, and global environmental science. This observation suggests, as has been observed in other years of study of the NOSB, that the program not only influences students who are tracking towards science careers, but also, importantly, is influencing student-participants who will ultimately be employed in a wide range of careers, thereby bringing an understanding of the oceans to those professional areas.

Item six responses reflect that two-thirds of past participants have taken a marine science course and only one-third had not. Item seven responses suggest that forty-six percent of respondents anticipate a career with emphasis on marine, aquatic or ocean science.

The previous questions about anticipation of a future academic or vocational career related to ocean sciences are clearly limited in their predictive value, as the intent of students in high school or early college is not always indicative of actual choices. For that purpose, item eight asked students at

the college level to delineate actual courses they have taken during the immediately previous semester.

Forty-seven past participants responded to the question. Twelve respondents listed marine and ocean related courses. These included:

- Marine conservation biology
- Marine climate change
- Marine pollution
- Ocean technology management
- Climate extremes-ocean
- Integrative oceans
- Marine ecology
- Oceanography
- Marine biology
- Salmon behavior and life history
- Climate change ecology
- Science of sea

Science courses listed most frequently were those in biology, chemistry and physics. However many of the courses were interdisciplinary within the science domains. In Chemistry, ten respondents mentioned general chemistry courses, and also organic and inorganic chemistry. Other chemistry courses included geochemistry, biochemistry, physical chemistry and atmospheric chemistry.

Twelve people mentioned Physics (I and II level courses), while other physics course were more specific including: optics, thermal physics and geophysics.

Introductory biology courses were mentioned frequently but other more targeted biology courses included conservation biology, environmental microbiology, computational biology and molecular biology to name a few. This specialization has been observed to be a long-term curricular trend in the sciences.

Other science courses in the STEM listing fell into categories of geology, environmental science and astronomy. Three respondents were in medical school, with course areas including human anatomy and infectious diseases, as well as psychology, neurophysiology and forensics.

Technology and computer sciences courses included general programming and also computing for specific disciplines, such as for biology and for geoscience. CAD and cyber-security emerged as in other years of this study, reflecting the growth of these disciplines within the academy as high-employment vocations.

A variety of engineering courses were also reported, and these ranged from introductory level to engineering dynamics, engineering ethics and engineering mechanics.

In math the courses mentioned most often were calculus at various levels, statistics and differential equations.

Item nine asked respondents to discuss any sources of research funding they had obtained. Thirty individuals responded to this item. Two-thirds mentioned federal level agencies, with the top two sources being the National Science Foundation and the National Institutes of Health. Also listed were Department of Energy, NOAA, Department of Defense, NASA and NERC in the UK. Six respondents listed university sources of funding, with a mix of other sources rounding out the list.

### ***Continued Commitments To and Benefits From NOSB***

Item ten asked, "Have you returned to an NOSB Regional Competition to serve as a volunteer, and if so, which one? Fifty-seven responses were submitted to this item. Of those responding twenty-seven stated that they did **not** volunteer. Of the thirty who mentioned they volunteered, the largest group (eight individuals) indicated that they volunteered for the Blue Lobster Bowl. The next highest commitments were to the Orca Bowl, then La Jolla Surf, Aloha and Sea Lion Bowl with three volunteers each. This ongoing commitment demonstrates, as has been observed over the years of research, that the NOSB seems to create enduring, social commitments among past participants that carry forward into and through higher education and into their eventual careers.

Item eleven asked, “Did you find your NOSB preparation activities and competition in high school benefitted you in college in some way?” Of the fifty-seven individuals who provided specific written responses, a large number listed studying skills. Other frequently mentioned benefits included:

- Team work
- Leadership
- Problem solving and critical thinking
- Motivation to do well and learn new things
- Confidence
- Test taking skills

A number of respondents articulated that the NOSB helped them identify the field of study they wanted to pursue. It helped lead them into internships and supported their later research. Others mentioned that the information they obtained through the NOSB prepared them for college courses and helped them every day in their major, classes, and extracurricular activities. It helped them have an advantage over classmates when it came to science content understanding. Select narrative quotations that illustrated this included: “It was the first exposure to marine science I ever had;” “Participating in NOSB was invaluable for my scientific career;” “[It helped] me understand my passions;” “It helped steer my academic and professional interests.”

Item twelve asked, “Please describe the types of activities in which you engaged to prepare for your regional ocean bowl.” The eighty-three respondents provided recollections of the types of preparatory activities in which they engaged to prepare for their regional bowl. The activities reported were diverse and numerous. Many respondents reported that they did team practice sessions, where the team assembled and studied weekly or more often. These sessions often occurred after school, and were either self-directed or through an after school or ocean science club. During these group sessions, many reported that they reviewed practice questions and team challenge questions, and practiced with the buzzer equipment (the most common answer). They conducted simulated bowl competitions. Another large group described the use of independent study in the content areas.

Methods for preparation most often mentioned were textbooks, reading and online research. They also listed field trips, watching nature documentaries, webinars, quizzes, and other interactive learning activities, such as use of flash cards, maps, outlines and charts of information, work sheets and power point (several mentioned giving presentations). Several alumni said they took ocean and marine courses to better prepare. Only one respondent said that the school curriculum was the preparation, with little studying required outside of school.

Item thirteen asked, “Were you involved in a science club in high school?” This item has emerged from the years of tracking research as a frequent characteristic of team cohesion and management in the high school sites. That was observed again in this data set, as seventy-five percent of the respondents said that they had been in a science club in high school. These clubs have been observed to frequently be overarching content organizations, where numerous content-specific science teams coexist and socialize.

Item fourteen asked, “How were high school students other than your ocean bowl team-mates involved in learning the ocean content—if there were other students involved?” This prompt received responses from two-thirds of the total respondents (n=66). Only a dozen of these said that no others were involved in learning ocean science. Most often mentioned as a mechanism for other students to learn about the ocean were other courses or classes or electives in the school that offered some ocean science content. This course exposure to ocean topics ranged from “minor mention” in a biology class to extensive involvement of all students attending the Ocean Research College Academy or the Governor’s School. Courses listed included:

- Marine ecology
- Marine science
- Oceanography
- Oceanology
- Water quality/ecology
- Biology course with marine focus

- Earth science course with oceans

Students other than team members also gained knowledge from the Science Olympiad, the marine biology club, and team presentations. Some students practiced with the team but were not in the competition. Some outside students offered resources or advice. Item fifteen responses (a specific question about marine biology or other ocean related courses in their schools) demonstrate that 77% of respondents had a specific, ocean-related or marine biology course offered in their high schools. This is a significant shift upward for this observation than in the very earliest years of the program. [This observation should be only carefully considered, as this may be explained either through the growth in the number of these courses, or by a shift in the participation of high schools over the years to groups of schools that already had these types of courses. Further, this may also reflect a selection bias in the respondents, as these individuals may be most attached to or involved in marine sciences and thus more willing to respond.]

### ***College Related Items***

Item sixteen asked, “Did you receive specific information while a high school student, regarding careers in science, technology, engineering, or mathematics, and if so, what do you remember of this information?” Of the sixty-three responses that were obtained for this item, thirty-eight were affirmative. While this was a majority response, i.e. more than half, it nevertheless seems limited given the fairly long-term (at this point) commitment to STEM career recruitment across the curricula, and the reality that these respondents had demonstrated a proclivity toward science already at the high school level. Some research suggests that much of the traditional counseling role of high school guidance offices has been overshadowed by the purposing of these counselors toward managing the increasing complexity of secondary school testing, course advising, and compliance issues. It may be that this

somewhat explains the unusual pattern of positive to negative responses in this item. But continuing forward, the students who responded affirmatively most frequently described the nature of the information they received as particular resources they could appropriate to study career issues on their own. Less frequently, schools hosted guest speakers on career topics from the STEM discipline areas, and convened specific career-focused events (fairs, lectures, speakers, resource packets for distribution) that addressed career issues. Only two respondents intimated that they had been placed in specific relationship with a potential career mentor, and in both cases these were associated with an NOSB competition.

Item seventeen asked respondents to categorize the college degrees that they had already been awarded. Forty-one of the respondents reported data for this item, which corresponds to the remainder of the respondent pool when high school students and current post-secondary students are removed. The item allowed for multiple responses, and collectively the forty-one respondents had received forty-eight degrees. These included: ten, BA degrees; twenty-eight, BS degrees; two, MA degrees; thirteen, MS degrees; three, Ph.D. degrees; and two, JD degrees. In the “other” response field that was provided, additional reporting included: three, M.ED degrees; one, MD degree; one, DO (Doctor of Optometry) degree; and one, MAT degree (Master of Art in Teaching). Item eighteen asked the specific college or university from which these degrees were obtained. No discernable pattern emerged, although many of the Nation’s finest STEM institutions were recorded across the list, including many of the notable ocean science institutions, i.e. MIT, Scripps, UNC Wilmington, URI—School of Oceanography, UC San Diego, University of Washington, and the University of Miami—all member institutions of the Consortium for Ocean Leadership.

Item nineteen asked, “In what primary content area did you obtain your degree(s)?” There were forty-three responses to this item, of which thirteen were in ocean or marine science fields. Only seven of these respondents indicated a content area other than a STEM discipline, and two of these

indicated education (and thus potentially included as science education). As has been noted in previous cycles of this tracking research, this observation does not suggest that NOSB is causal with respect to funneling students into a STEM career, though there are anecdotal data over the years that it has done so for some students. It is evidence, nevertheless, that at the least, students with a desire and proclivity to move towards STEM careers find in the NOSB a support system, and a create for themselves durable social relationships and mentoring systems, that are part of their journey toward the STEM career pipeline. The import of this support system cannot be under estimated. And interestingly, in item twenty, sixty-eight percent of these respondents indicated that they had obtained their college degrees in the area they intended at the point of high school graduation. This further indicates that these high school students participating in the NOSB program are indeed at highly impressionable stages of their career decision-making, and likely would benefit from the type of educational supports that the NOSB offers. And finally, as noted in years past, this match between intent (at the secondary school exit) and persistence in STEM (by completing degrees in STEM areas) seems to exceed that of students in the general population, who are observed making multiple changes to career and degree plans during the first two years of post-secondary school. It may be that the NOSB helps to solidify, at an earlier stage, career choices (either for or away from STEM disciplines) for these students. As such, it would thus be of great benefit financially to these young people in making their college experience more efficient.

Items twenty-one through twenty-three addressed areas of the majors and minors for those respondents who had completed academic degrees. Forty-nine percent of forty-five respondents completed degrees that included an emphasis on marine, ocean, or aquatic sciences. And for the twenty-one respondents whose degree did not have an ocean content connection, only three did not perceive that their degree had a connection to another STEM content area. Again, this confirms the relative commitment to STEM areas among the types of students who have participated in the NOSB (without asserting a causal relationship). There were no obvious themes or patterns of response in the

minors that were listed, although there were some interesting areas relative to expectations when considering the majors were in STEM disciplines, i.e. students listed as minors history, philosophy, religious studies, English, film, and political science among other areas.

### ***Workforce Issues***

Item twenty-four asked, “Now that you are in the workforce, do you or your employer receive funding from any federal agency (NSF, NOAA, other)? Please identify the agency or agencies.” The intent of this item was to assist the NOSB leadership in identifying the network of relationships that exist which may connect COL/NOSB through the past participants, to workforce and other agency connections for purposes of communication and potential leveraging efforts. The primary vehicles for federal STEM funding were listed, i.e. NSF, NOAA, NIH. Additionally, other agencies that were included in the twenty-seven responses included: NASA, NEH, Department of Defense, NERC (UK), and the USGS.

Items twenty-five through twenty-seven were related to the durability of the social relationships established in the NOSB program for the past participants. As with previous years’ survey responses, these data were consistently positive. Approximately seventy-three percent of respondents indicated that they remained in communication with other members of their NOSB team. Approximately seventy-seven percent of respondents indicated that they remained in communication with their former NOSB teachers/coaches. And interestingly, twelve respondents (36% for this item) indicated that they had established a durable connection with the university or institution at which they competed in a regional or national NOSB competition. Each of these individuals described that relationship as one of matriculation at a university. This is important evidence of the role that the NOSB plays as a vehicle for linking high ability secondary students with institutions of higher learning, which can become, and for these respondents did become, the place they continued their education.

### ***Career Related Items***

Item twenty-eight asked, “Please describe your current employment to include employer (company or organization). If you would like to limit your response to the type of company or organization, please do so.” This item elicited thirty-nine responses (note: the decreased pool of responses at this point in the survey reflects the inapplicability of these later questions to respondents who remain in either secondary, post-secondary, or graduate schools). Responses to this item included a variety of STEM related, public and private organizations:

- The Earth Observatory of Singapore;
- High school teacher;
- NH Americorp;
- Ambri Company (battery technology);
- Environmental Consultants, Inc. (forestry);
- Catalina Island Marine Institute;
- Science Teacher (Albany High School);
- Bellevue College (instructor in Oceanography);
- Mystic Seaport (interpreter);
- IDEXX Laboratories;
- Healthcare Consultant, Putnam Associates;
- Bloomberg LP;
- Columbia University, Lamont Doherty Earth Observatory;
- Attack Pattern (software engineer);
- Dauphin Island Sea Lab (lab technician);
- Mathnasium (math tutor);
- Barr Engineering and Environmental Science Canada;
- Math/Science teacher (Cashmere Middle School); and
- Luntz Global Partners.

These respondents were further asked to describe the nature of their work and anticipated career path and goals moving forward. The responses reflected consistent goals to advance professionally within a variety of STEM and STEM-education related pursuits. While no clear patterns emerged with respect to ocean sciences, nor would that be anticipated given the wide variety of specific STEM areas reflected in this group of respondents, there was an evident commitment to STEM content, reflecting appropriate career patterns in these areas. The responses also reflected a desire for

movement into leadership, whether in research, management, or academic endeavors. This is also not a great surprise as evidence over the years of tracking these past participants reflects that they have learned, and have enjoyed, specific leadership opportunities and have developed skills associated to leadership.

Item thirty asked, “How might your participation in the National Ocean Sciences Bowl have contributed to your education and career path?” The respondents to this item were comprised of thirty-eight individuals who have each obtained at least one academic degree. Across a wide variety of ideas expressed in the narrative responses, it was clear that the NOSB was perceived to have been consequential to these individuals, in a variety of very specific ways. Respondents noted increased content knowledge in science, which served to both attract them to further study and enhance their ability to succeed there. Others noted increased confidence as a result of the competition—whether they won, or “learned to lose gracefully,” as one respondent phrased it. One respondent noted that, “it gave me direction, beefed up my resume, and allowed me to participate in the COAST Internship in 2006.” Other typical and illustrative quotes from this response set include:

- *Participating in the NOSB was the first exposure to ocean sciences I had ever had. I really didn't know anything about the oceans prior to this point. My team worked together to learn a lot. Since our school had never participated in NOSB before, we competed in the junior varsity division, and ended up winning, much to our surprise. After this experience, my scholarship and internship applications and choices continued to focus on marine science. I have participated in Earthwatch expeditions, internships at the Woods Hole Oceanographic Institution, Summer school at Shoals Marine Laboratory, Sea Semester, and even more. These opportunities stemmed from my first experience learning about the ocean, and having the opportunity as the winners to meet researchers and see aquatic research first hand.*
- *It helped to prompt me to take more science courses as electives in college, despite not having a science-based major. Which greatly broadened my understanding of the mechanics underlying our world.*
- *It is the sole reason I discovered a passion for the ocean.*
- *Exposed me to oceanography as a field of study, exposed me to the campus of my graduate school, inspired additional interest in ocean science. Helped me identify as someone who “likes studying the ocean.” Helped me transform my thinking about the oceans as something that little kids like (dolphins, the beach, seashells) into something more similar to what I loved learning in my AP Chemistry and AP Physics class. Before NOSB, I didn't know that ocean science had that*

*same level of rich, challenging content to learn. I learned ocean science was about much more than dolphins and whales and marine biology.*

Item thirty-one focuses more tightly, asking, “Do you think the NOSB has contributed to or helped shape your understanding of science and environmental issues? If yes, how?” Thirty-five of the thirty-seven responses to this item were affirmative, with numerous respondents providing narrative to support their answer. Among the examples of the NOSB shaping broader environmental understanding were: formal study of pollution; field trips to see exotic and invasive species in habitats; the development of a strong foundation of scientific knowledge; learning about policy issues in a variety of areas; and being introduced to global issues. The tenor of the responses suggests that while the quiz-type questions associated to part of the NOSB competition may indeed be highly technical and in-depth related to ocean science, much of the broader preparation for participants is encompassing and expansive in its treatment of the oceans within broader, general science frameworks.

Item thirty-two asked, “have you been involved as a career professional in some type of career mentoring or presenting to high school students?” The forty-six responses included twenty-one (46%) affirmatives and twenty-five (54%) negatives.

Item thirty-three sought to further understanding the specific post-secondary education and professional experiences of the respondents. This item asked, “Identify other content areas where you have had formal study or professional experiences.” The item allowed for multiple, overlapping responses by the thirty-three respondents providing feedback here. Of these respondents, 42% identified Climate Science; 48%, Climate Change; 24%, Atmospheric Science; 33%, Technology; 60%, Mathematics; 24%, Engineering; and 63%, Geosciences.

The final survey item, item thirty-four, asked respondents to consider providing email and telephone contact information directly to the researchers. The intent was to identify potential, follow-

up on subjects for additional career-related and STEM pipeline research, should those opportunities emerge, or for additional feedback for COL or NOSB leadership should that become necessary. Those contact data will not be disclosed here in the written report, as anonymity was provided to the respondents for their responses generally. Nevertheless, it is observed that thirty-nine individuals agreed to provide this information, which should be viewed as a strong statement of continued interest in the NOSB program by individuals many years beyond their participation.

### ***Conclusions***

This year's response data in the tracking study emerges after a semester (Fall 2016) in which the past participants were not queried. In any effort to track a group of individuals longitudinally, it is not desirable to have such a break. Nevertheless, in research, funding availability frequently necessitates that which is not essentially desirable. In this case, there was a gap in funding availability that precipitated the gap in fall 2016. That said, no evident loss of momentum was observed in the spring 2017 response patterns. The number of overall respondents, their distribution across academic level, and the robust narrative they provided were consistent with earlier years of study.

Additionally, the patterns of the content of responses were highly consistent with earlier years. Respondents describe the durable nature of the social system—their continued connections to NOSB team members, to high school teachers, and to the disciplines of STEM to which they have attached themselves both academically, professionally, and culturally (through hobbies, civic engagement, and community service). The data continue to reveal that—whether causally or co-relationally—the NOSB program draws and supports students with a passion for science, who are highly likely to matriculate in college in STEM disciplines, and who are reasonably likely to engage in STEM as a career. In many cases, the post-secondary study includes additional, formal study of the oceans. In numerous cases, this study leads to academic degrees in ocean, marine, or aquatic related areas, or significant coursework in

related majors. And as in earlier years, the NOSB has directly impacted high ability secondary students who have persisted through the pipeline and into ocean-related STEM careers. The NOSB program remains energetic and attractive for high ability secondary students, and demonstrates (as assessed by its past participants) characteristics that push beyond the boundaries of “one off programs.” As such, it should be considered a dynamic social system, which continues to impact a wide variety of ocean related stakeholders.