

The NOSB Spring Tracking Report 2021

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 regularly 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. The data and summaries following are based on a revised, follow-up survey, which was disseminated in late March, 2021, by the NOSB program office to its most current database of past participants. A total of sixty-four individuals provided responses to the survey.

Demographics of Respondents

Through voluntary self-report, fifty-six percent of respondents are female and thirty-eight percent report as male, three percent responding non-binary, and three percent preferring not to disclose this information. Twenty-five percent of respondents have graduated college and are no longer in formal education. Fifty percent of respondents indicated they fell within the age range of 18-24; twenty percent were 25-30 years old; twenty-two percent were 31-35 years old; and nearly eight percent were 36-40 years old. It is noteworthy that, for a high school level program, decades after program inception, a substantial number of past participants continue to remain connected and responsive to program surveys.

With respect to ethnicity or race, sixty-nine percent of respondents indicated they were Caucasian. An additional nineteen percent of respondents indicated they were Asian American, and an additional three percent selected Hispanic American. Approximately two percent indicated Pacific Islander as ethnicity.

Thirty percent of the respondents are currently in graduate school (ten percent MS, three percent MA, and twenty-seven percent in Ph.D. programs), with approximately fifty-seven percent of respondents currently in college (BS and BA) or still in high school.

Item five asked respondents to identify specific colleges or universities which they have attended or are now attending. The list was expansive, as expected, but responses, nevertheless, reflected a strong pattern of COL member institutions represented in the selections. It is a noteworthy observation that there has been a substantial and continuing connection between the COL member institutions and the NOSB regional bowls and these alumni. A comprehensive, unduplicated list of item five responses includes:

Cornell University	Washington State University
The University of Queensland, Australia	University of Colorado, Boulder
University of Michigan	Florida State University
Stony Brook University	Michigan State University
Colorado College	University of California, Santa Cruz
Johns Hopkins University	Massachusetts Institute of Technology
Harvard University	University of Maine
University of California, Berkeley	Western Oregon University
Brown University	Juniata College
University of Washington	Tufts University
University of California	The Ohio State University

North Carolina State University	Rutgers University
University of New Hampshire	University of Alaska, Fairbanks
Naval Postgraduate School	Bellevue College
College of Charleston	Virginia Institute of Marine Science
University of North Florida	Columbia University
Florida International University	University of Miami (Rosenstiel School of Marine and Atmospheric Science)
University of North Carolina, Wilmington	Northeastern University
Christopher Newport University	University of Minnesota
Pennsylvania State University	Pearl River Community College
Binghamton University	University of California, Los Angeles
Oregon State University	Arizona State University
Montana State University	Davidson College
Tulane University	Hawaii Pacific University
Duke University	US Coast Guard Academy
Stanford University	University of Rhode Island
Scripps Institute of Oceanography	University of Massachusetts, Lowell
Clarion University	Haverford College
Purdue University	

Item six asked respondents to summarize post-secondary and graduate degrees which they had obtained. The sixty-two respondents to this item indicated a total of thirteen BA degrees, thirty-six BS degrees, three MA and seventeen MS degrees, six PhDs., and one EdD. Seventeen respondents indicated they had not yet obtained a post-secondary degree.

Items eight and nine identified the categories that most closely described college majors for the respondents. The largest proportions (forty-seven out of fifty-three degrees listed) were found in the STEM disciplines. In rank order:

- Thirty-four percent of respondents indicated Biology or Biological related science,
- Twenty-six percent who reported Ocean or Marine Sciences,
- Twelve percent reporting Physical Sciences,
- Twelve percent reporting Engineering,
- Five percent who reported Mathematics, and
- Three percent reporting Computer Science as primary majors.

Other majors reported included: K-12 Science Education, Business, Rehabilitation Science, Political Science, and International Studies. Of respondents providing information regarding post-secondary or graduate degrees completed and major content emphases, seventy-five percent (n=42) indicated that their degree was obtained in the area they intended at the point of high school graduation. *Interestingly for purposes of the NOSB, fifty-four percent (n=32) indicated that their degree included an emphasis on marine, ocean, or aquatic science.* This response suggests that the broad categories of degree content or discipline described above are likely insufficient to capture an emerging sub-emphasis in marine, ocean, and aquatic sciences as applied disciplinary interests within majors that is not immediately evident in the broader category labels. [As a caveat, the reader is cautioned to consider that there may a selection bias in the survey respondents based on an affinity or professional connection to the ocean which influences their decisions to participate in this survey.]

Item eleven asked respondents to identify the specific regional NOSB competition in which they participated. It is noted that some of these bowl names may no longer be active. The twenty-four regional competitions listed by the respondents suggests that the response pool was widely distributed from across the country, and included:

- | | |
|---------------|------------------|
| • Bay Scallop | • Blue Lobster |
| • Blue Crab | • Chesapeake Bay |
| • Blue Heron | • Dolphin |

- Great Lakes
- Hurricane
- Los Angeles Surf
- Lake Sturgeon
- Loggerhead
- Manatee
- Nor'easter
- Orca
- Otter (now Sea Lion)
- Penguin
- Quahog
- Salmon
- Sea Lion
- Shore
- Spoonbill
- Southern Stingray
- Trout
- Tsunami

Items twelve through fifteen (and also see item nineteen) attempt to document the continuing connection and ongoing community of practice of these NOSB alumni. Questions related to continuing communication with the NOSB and its participants look at the points of contact for these alumni respondents. In item twelve, when asked if they had remained in communication with other NOSB participants, forty-five out of sixty-four respondents (seventy-one percent) indicated *yes*. This illustrates the ongoing community of NOSB participants, which has been documented annually in the tracking surveys from the beginning of the effort.

Item thirteen asked about continuing contact with a former NOSB coach. Though the respondents indicated less continuing contact with their coach than with other former participants, nevertheless over fifty percent said they remained in communication with their former coach/teacher.

Item fourteen indicates that eighteen of sixty-two (thirty percent) of respondents indicated that they were still connected with someone from a regional NOSB competition—either a volunteer (five responses), another former student (four responses), a current student (three responses), through their current work (two responses), a coach, a newsletter, an internship, or a relative employed at that institution (one response each).

Item fifteen asked respondents if they had volunteered at a regional or national NOSB competition, thirty-seven out of sixty-four—more than half of the respondents— affirmed that they had served as a volunteer at a regional competition. This observation attests to the ongoing commitment by this core group of alumni to the NOSB. This further supports the ongoing conclusion that the NOSB competition has fostered the development of an active community of engaged, ocean-concerned citizens and professionals who view the NOSB competition as a meaningful outlet for their efforts.

Items sixteen and seventeen asked respondents to describe their current employment to include their employer (if they were comfortable disclosing this information), and to describe the nature of their work (item seventeen) in the event they were uncomfortable or unwilling to disclose their employer. The fifty-seven responses were distributed across a widely diverse assortment of public and private entities, as would be expected. Given the high proportion of science related academic backgrounds in the response pool, there was a similar focus in the employment data. A select example set of employers includes:

- Researcher
- Software engineer
- Graduate assistantship
- Academic librarian
- Assistant professor of environmental science
- Hydrographic produce manager
- Hydrodynamics researcher (U.S. Navy)
- NOAA contractor/fisheries
- Epidemiologist
- Marine technician
- Engineer
- Science communication intern
- Analytics consultant
- Professor of chemical oceanography
- U.S. Coast Guard
- Marine Science High School Teacher

The responses describing the nature of work that was performed were widely diverse, ranging from laboratory science to a variety of research and analysis contexts. Some respondents were in direct contact with the public in a variety of policy, administrative, non-

governmental organization, or education contexts. Others described a range of management or administrative functions. The predominant description aligned with white collar professional or technical/scientific work contexts. And finally, as expected from the demographics above, many responses described graduate and undergraduate student appointments and functions.

Item eighteen solicited information about the respondents' longer term career goals. Of the fifty-four responses, thirty-seven percent (n=20) indicated that they were already generally in their permanent field but wanted to progress to higher levels of work or position within that field. And additional twenty-four percent (n=13) indicated a desire to move into or become researchers. The next two highest categories of respondents (11% or 6 individuals in each) were to enter public service in some manner or to start their own businesses. Four additional individuals indicated their primary focus was pursuing higher degrees, three individuals were unsure of their next goals, and two individuals indicated they wished to change careers in pursuit of personal life satisfaction in some way. The categories of public service, entrepreneurship, and life satisfaction are issues which have emerged in previous surveys of NOSB participants or past participants and may indicate broader cultural shifts among the population of students/participants involved.

Item nineteen asked respondents if they were employed with any of their former NOSB teammates, or with agencies, scientists, or other personnel they had met through their NOSB participation. Of the sixty-one responses to this item, seven percent (four individuals) indicated affirmatively to the prompt.

Item twenty asked respondents how the NOSB contributed to their education and career path. Fifty-nine respondents answered this question. Several of these respondents explicitly said that the NOSB helped them select their college, e.g. *"I picked my undergrad institution (College*

of Charleston) based on people I met at NOSB.” The wider set of responses to this question fell into several main themes which are discussed as follows: ocean science interest, science interest, and social and life skills with respect to work and study.

Ocean Science: Contributions around ocean science were subdivided into two main foci. One area was how the NOSB influenced and helped increase knowledge and interest in the ocean and offered marine science experiences. The second was how the NOSB led to advanced study and pursuit of oceanography and marine science as a career. More than half of the respondents focused their responses on these two perspectives of the NOSB about the ocean. They listed love of the ocean and oceanography, knowledge about these topics, and the NOSB’s influence on college and career. Certainly, the reader is cautioned that selection bias may influence these responses (those in the field of oceanography and marine science may feel most connected to the NOSB and may be more appreciative of its role in their college and career path and therefore more likely to respond to the survey). To some extent, this response bias is rejected based on the responses to the employer and nature of work questions (items sixteen and seventeen) and the college degree content items (eight and nine) suggest fewer than fifty percent of respondents obtained degrees in marine, ocean, or aquatic sciences, and fewer than fifty percent indicated that their primary employer or work involved marine, ocean, or aquatic activity—even though more than this number obtained some focus in these areas on at least one academic post-secondary program.

For about fifty percent of respondents, the NOSB solidified interest in advanced study in marine science, as well as career pursuit. They mentioned taking oceanography classes in college and appreciating multiple facets of marine science. Comments included:

- *“Pushed me toward going into oceanography”*

- “Sense of belonging in ocean science from an early age”
- “Provided exposure to [National Oceanographic and Atmospheric Administration] NOAA and the federal government science programs, both of which I help serve today.”
- “Took a bunch of oceanography classes”
- “Encouraged the love of ocean sciences”
- “Motivated me to learn more about marine sciences”
- NOSB: “How I learned about oceanography”
- “Outstanding opportunity to learn about a topic I have great interest in”
- “Because of [the] NOSB I decided to pursue oceanography as an academic pursuit in both my undergraduate studies and a PhD.”

Science in General: Respondents also mentioned the contributions that the NOSB made to their education and career in other science areas. Environmental science, animal science, and geosciences/geology were listed. Comments such as “empowered me to be a scientist” and “interest in science was solidified” attested to the NOSB’s influence. Two respondents mentioned that the NOSB made science fun and motivating. The NOSB was also seen as a baseline for college courses or an introduction to academia, as noted in the following quotes: “[the] NOSB was my first exposure to scientific research, a research university and Ph.D. students” and “today I work at a research university...”

Life skills supporting work and study: As observed in previous tracking studies, there were regular notations of soft-skills or life-skills from respondents to the survey. The most frequently mentioned life-skill was teamwork, including trusting those with whom you work. Other life skills included:

- Independent study: Several students mentioned ability to learn independently, being “self-taught and self-guided”;
- Confidence;
- Good study skills;
- Critical thinking and problem-solving skills;

- Time management;
- Ability to communicate;
- Researching topics of interest;
- *“Made me more driven and motivated.”*

Additional, select quotes from this thematic response area further highlight the influence of the NOSB:

- *“I would argue that my participation in the NOSB was the #1 driver in my early career path.”*
- *“I probably wouldn’t have gone to college at all if not for my experiences with the NOSB.”*
- *“Success and the joy of the NOSB convinced me to switch to marine sciences for my studies and now career.”*
- *“100% (of the credit for my career attainment goes) to the NOSB”*

Item twenty-one asked respondents if they had been a Knauss Fellow in the interval since completing post-secondary education, and if so, with which agency. Of the thirty-seven who responded to this question, only two were Knauss Fellows. One was with the Department of Energy and the other was with NOAA National Ocean Service, Office for Coastal Management, Estuarine Reserves Division. One other person works with many Knauss fellows and one person aspires to be a Knauss Fellow in the future.

Item twenty-two requested information about any sources of federal research funding which the respondents had obtained in their professional work. This information has been an informative proxy for gauging the ongoing relationships of past participants in the federal STEM community and pipeline. In response to this question about their sources of research funding, the most frequently indicated sources were the National Science Foundation (NSF) and NOAA, including Sea Grant. Other agencies listed included: Department of Energy, Coast Guard,

National Aeronautics and Space Administration (NASA), National Institutes of Health (NIH), Office of Naval Research (ONR), U.S. Geological Survey (USGS), and the Smithsonian, as well as nonfederal sources, universities, and other foundations.

Item twenty-three expanded the previous item into academic or professional fellowship funding, soliciting sources of any support through this mechanism. Responses highlighted, again, NSF and NOAA, but also included:

- Universities (University of California, San Diego and Virginia Institute of Marine Science)
- South Carolina Education Lottery
- Smithsonian and American Museum of Natural History
- Climate Adaptation Science Center
- Thomas J. Watson Fellowship (ocean acidification)
- Commercial shipyard internship
- Professional Association of Diving Instructors (PADI) Foundation
- Women's Fishing Association
- American Society of Ichthyologists and Herpetologists
- North Pacific Research Board
- NASA
- Private funding through XL Catlin

Item twenty-four solicited responses around ongoing interests in environmental stewardship and/or conservation activities after NOSB participation, and whether this may have been fostered by, in the perception of the respondents, the NOSB. Some general statements indicated respondents' increased interest in environmental activities, in field activities, and environmental topics. There was evidence in the narrative that there was a durable influence in this area, with select statements showing environmental stewardship involvement, such as:

- Piqued my interest
- Joined environmental club
- More awareness of environmental issues
- Paying attention to environmental news or volunteering opportunities
- Increased understanding of the ocean, climate change, STEM and marine science field trips with the national [Finals] competition

- Got scuba certified
- Gained professional contacts
- Used in outreach activities

Specific examples of stewardship activities included:

- Oyster farming
- Board of Directors of Freshwater Future
- NOAA whale count on Oahu
- U.S. Coast Guard Fisheries

Item twenty-five focused on the acquisition of college academic skills and workplace skills through participation in the NOSB. This area of student development has regularly emerged from stakeholder surveys across the NOSB community over the years. The most frequently mentioned response to this question was *teamwork*. More than a dozen respondents listed being part of a team and working as a team member as important skills. One person mentioned the value of becoming a better team member in group projects. A different person stressed the “*importance of connecting with different individuals from different backgrounds and specialties.*” Other frequently mentioned skills were study skills, communication skills (including public speaking), confidence, and leadership. Several mentioned the value of independent learning. Several respondents mentioned preparation for doing research. Problem solving skills, such as analysis, gaining info from text, making intuitive connections, comprehensive reading and listening, and scientific writing were listed as well. Respondents also noted science career portrayals and exposure to maritime careers were also important: “*research scientists are approachable*” and “*saw from NOSB how to progress in a scientific career.*” And finally, other skills which emerged in the narrative from fewer individuals included:

- Time management
- Network building, help getting internship
- Gaining marine knowledge
- Memorization skills

Item twenty-six focused on mentoring and peer support. Of the thirty-two responses to this item, approximately one-third stated *no or not/applicable*. Those who responded affirmatively spoke of their mentoring and peer support activities in several different environments. Most of these respondents were in an academic setting and provided mentoring in the following ways:

- Assisting undergraduates/interns, graduates, and postdocs
- Serving as committee members
- Supervising bachelor thesis projects
- Serving on alumni boards and in an alumni mentoring network
- Serving as resident advisor
- Pairing of pre-tenure librarian with tenured librarian
- Teaching assistant and lab teaching mentor

Several people mentioned outreach with high school and robot summer camp. One person mentioned volunteering at past NOSB regionals. Business mentoring activities included career guidance in the workplace, peer support, and employee resource groups. One person mentioned participating in mentorship program for scientists around the world. One person mentioned the Knauss Fellowship alumni network.

Item twenty-seven addressed the issue of free-choice learning, a concept which emerged from informal science education or museum education which depicts the self-directed aspects of life-long-learning as essential elements to adult development. Although several people responded that there was no impact in this area from the NOSB, nearly forty respondents described how the NOSB incorporated free choice learning for them personally. From these responses it was clear that the NOSB was viewed as highly self-directed, and that free choice

learning was essential to the NOSB. *“Free choice learning was a key concept of NOSB and one of the reasons I loved it.”*

This free choice learning was described repeatedly from two different perspectives. First was the freedom that the preparation for the competition afforded the individual student to explore topics of self-interest and including those content areas which are not usually covered in regular curriculum. They felt free to explore their interests and could choose areas to focus on. This comment was reiterated in many ways *“I had a lot of freedom to explore the different topics and focus on the ones that most interested me.” “[the] NOSB allowed us to explore deeper into passions.”*

The second perspective highlighted the approach that was used in preparing for the competition in which team members selected their topic(s) in which to become “experts” for the competition. Through the team process, topics to study for the competition were assigned based on students’ interests and expertise. In this way all topic areas were covered and studied in depth. There were many responses which illustrated the point that team members were able to select their favorite topic to specialize in as members of their team. *“Ocean science is a huge topic! My team wasn’t strategic at all about covering it—we just all learned everything that caught our interest.”* They described the NOSB as directed by students with freedom to choose based on their interests. One respondent described the NOSB’s influence on looking beyond courses work and finding other sources of information. One person said *“other similar teams at our school like academic decathlon had set books of things to memorize whereas we (NOSB team) learned whatever was most exciting to us.”* Career focus was also mentioned with one person stressing that the *“NOSB exploded my view of possible careers.” “For my NOSB team, I*

was the marine policy expert. This has really spawned a whole interest and passion for policy.”

One person emphasized how the NOSB *“brings to light new connections in my work.”*

The final survey item, item twenty-eight, asked respondents how the NOSB shaped their understanding of science and/or environmental issues. The responses to this item fell into four main themes:

- 1) ***Broader Perspectives about Science and the Environment:*** Respondents acknowledged that the NOSB gave a broader perspective of marine topics and ocean challenges, exposure to many viewpoints, and greater appreciation of science in general. Several people mentioned being more aware and more concerned about environmental issues. One person said, *“NOSB broadened my horizons to wider global perspectives”* and *“exposed me to a wide range of issues.”*
- 2) ***Understanding Systems:*** The NOSB highlighted that studying the ocean is multidisciplinary and requires a systems approach. Their comments such as *“how all the parts fit together,” “how all disciplines fit together,”* and *“how everything is connected”* illustrate this awareness. The NOSB showed how environmental issues are *“all encompassing”* and the NOSB offered opportunity for *“in depth knowledge of ocean systems.”*
- 3) ***Enhanced Science Skills:*** The respondents offered ways that the NOSB improved their science skills, such as identification and use of reliable sources, helping to think critically about issues, and increased ability with research methods.
- 4) ***Foundational Knowledge and Possible Future Study and Careers:*** NOSB was described as offering a good base knowledge and forming the foundation for later study, helping to accrue knowledge and the policy surrounding it. *“I learned more about environmental science through NOSB-related events than I ever did from any official academic curriculum.”* It also was seen as helping students *“to see the strong ocean science community and imagine my place within it.” “It sparked my interest and encouraged further study.” “Every competition I would come away knowing about more fields and possible topics that I could study.” “It was a boost for my knowledge of marine science and helped me narrow down my true interest areas early on.”*

Numerous comments seem summative regarding the overall success of the NOSB for increasing understanding and appreciation of science and the environment for its participants:

- *“My NOSB experience was fundamental to my understanding of the scientific disciplines, their organization and interdisciplinary work.”*
- *“The NOSB made me love science and care about the environment.”*
- *“The NOSB fundamentally changed my understanding of science.”*

- *The NOSB made me very passionate about environmental issues that I now follow.”*

Conclusions

In April, 2020, the NOAA Office of Education, Environmental Literacy Program (ELP), released the report *Community Resilience Education Theory of Change*.¹ The report “outlined how creating a more environmentally literate society can help us face climate and other threats to build a safer, healthier, and more resilient future for people and the planet.”² The report notes that from 2015 and onward, “NOAA ELP grants shifted from focusing on climate change education to community resilience education” in response to a need for “approaches that are more solutions-oriented for educating, engaging, and empowering children, youth, and adults to tackle climate impacts and other environmental challenges.”³ The authors of the report crafted a helpful and refocused definition of resilience, moving away from a “bouncing back” conception—which infers a return to a steady state which might be “unstable or unjust,” to incorporate a “bouncing forward” conception, “that is, transforming to a more equitable and sustainable future state.”⁴ The report further situates such resilience, not only in professional settings where individuals apply science-based information, but also outside of those professional contexts in communities, “While building the capacity of adults to use this information in a professional context is essential, so is equipping community members with the environmental literacy necessary to make informed decisions about the place-based challenges they face outside of a professional context.”⁵ And finally, the extensive report continues by

¹ Bey, G., C. McDougall, & S. Schoedinger. 2020. Report on the NOAA Office of Education Environmental Literacy Program Community Resilience Education Theory of Change. National Oceanic and Atmospheric Administration, Washington, DC. Doi: 10.25923/mh0g-5q69.

² Ibid, p. 5

³ Ibid, p. 7

⁴ Ibid, p. 8

⁵ Ibid, p. 8

describing a series of potential causal pathways through which such resilience education can be architected from grassroots levels up through strategic and complex partnerships.

The authors of this current NOSB evaluation tracking study have not currently, nor explicitly, attempted to apply the mapping approaches recommended in this important NOAA report to the present study. Nevertheless, in view of the twenty years of formal data collection on the impacts of the NOSB program, its significant partnerships and fiscal relationships, its complex community of stakeholders, and its substantive and active community of past participants, nuances are observed in the current data from NOSB which hold relevant attachment points back to NOAA ELP and its conception of resilience education. From this perspective, NOSB in its current longevity, represents a large-scale program with existing, measurable and complex outcomes already well defined and described. This program, and these outcomes, might serve the purpose of helping to validate the Theory of Change planning and assessment model as an *in situ* and *ex post facto* legacy program. This potential may be seen in the following observations from this current NOSB tracking study.

First, the community of STEM-engaged past participants of the NOSB program comprise a remarkably durable community, generally unrecognized in informal education, i.e. an identifiable, accessible, and responsive population of adults which can be tied explicitly to a long-term, programmatic treatment which intended to influence secondary students toward STEM careers certainly, but overtly also toward environmental stewardship and complex understandings of the global system from an ocean and aquatic point of view. It seems evident that it should be possible, as the NOAA report suggests, to work backwards in time from the outputs and outcomes (now realized, not merely planned) of the NOSB to visualize the causal

pathways which have contributed to the formation of this now existing community where one did not exist twenty-some years ago.

Second, the free choice learning dimensions of the NOSB as elucidated by these past participants illustrates that critical focus, not only on professionals as professionals making scientifically informed decisions, but on adults as community members across a wide-ranging professional and geographic range. These adults learned to understand the world in complex, systemic scientific terms and framed from the ocean- and aquatic-systems perspectives. They now live and work in society having benefitted from the NOSB programming that fostered this indepth understanding. As such, they typify the *citizen as scientific thinker* who can increasingly foster cultural awareness and change in society. They are at the leading edge of environmental stewardship, possessed of a globalized scientific world-view, that of the globally interconnected ocean. Moving forward, the question of how these individuals bring their awareness into social, civic, cultural, personal and professional lives seems paramount for those agencies interested in forward leaning resilience.

It may be that next steps for further study of NOSB past participants (or environmental or science education programs more broadly) may include review and inventory of quiz question content, regional bowl extended programming opportunities, or resource materials for coaches and other stakeholders, and in what ways a program's content connects with community resilience issues in particular geographic and social contexts. This may include intentional mapping—as the *Theory of Change* document suggests—of the pathways through which the program has both developed in the past and is leaning in the future. Additional questions may include: how does the NOSB encourage civic engagement around resilience in its program and activities? How does the competition, its format and content, address the interaction of human

and natural systems? How does the program and its programs, as well as current and past participants, contribute to both *stable and just* resilience in the environment, while eliminating disproportional vulnerabilities? This reveals the further possibility of demonstrating the alignment of the NOSB and its outcomes with the *Environmental Literacy Standards (Goals and Outcomes)*. These conceptual ideas will require additional refinement as the authors consider the next phase of this year's evaluation of the NOSB.

And finally, the recurring observation of socially connected network consciousness as a cybernetic construct within and around the NOSB system over the years resonates with the interests of NOAA for scientifically informed community engagement, community of practice, cultural and historical contexts of place and social cohesion as essential to a forward leaning resilience education theory of change. The NOSB community formed around a shared commitment to and deepening knowledge of the interconnected ocean and aquatic earth, and the role of humans impacting that system. The ongoing attachment and commitment of this NOSB past participant community and the NOSB wider stakeholder group is rich with potential to enhance our understanding of the causal pathways outlined in the NOAA ELP resilience education document. The consistent and durable relationships formed through a competition program centered on science seems to model many of the explicit and inferred goals for NOAA Education over time and should be studied in view of this emerging change model.

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