Connor Mowatt-Larssen

Palshaw

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The Final Frontier

While the earth’s oceans cover over seventy percent of our surface, humans have explored less than five percent of the underwater ecosystem (“10 Unbelievable Facts About the Ocean”). Although many have the belief that most of the earth has been explored by humans, and much of it has, the ocean is the last great frontier for humans to explore. We have been to the moon, over 225,000 miles away, but have not even bothered to explore our own planet (Sharp). With climate change currently affecting our ocean by rising the temperature and ocean acidification affecting crustaceans, it would seem that a top priority across the world would be studying our “beloved” ocean. However, that has been the focus of the few, not the many. This is the task of oceanographers across America. They are the explorers and discoverers of our generation, the Christopher Columbus’s and Neil Armstrong’s of the seventy percent of our world. Oceanography is a broad branch of science that studies the biological, physical, chemical, and geological aspects of the ocean. However, these cutting-edge professionals must, obviously, get a very solid foundation of education before they can dive into the deep world of marine science studies. This education all starts with undergraduate studies, and one must research the major they will be studying, as well as the career prospects in their field to truly understand what they are getting themself into. Three major colleges that are known for their solid oceanography programs are the University of Washington, California Polytechnic State University, and the University of San Diego. Prospective oceanographers must look at the undergraduate opportunities presented to them to make the best decision possible about where to receive their education.

Oceanography is a fascinating, broad, and deep world of science that essentially focuses on anything having to do with the ocean. Because the ocean is so incredibly broad, the field of oceanography is equally as broad, and scientists can spend their lives studying millions of different things within the field. The oceanography undergraduate major targets the study of our world’s oceans, but also focuses on how they move, what lives in the deep depths, and what they’re made of. Many of these undergraduate programs offer students the opportunity to work first-hand with the ocean, doing research and taking samples (“Oceanography”). There are four major pathways within the oceanography major, biological oceanography, chemical oceanography, physical oceanography, and geological oceanography. Biological oceanographers, also known as marine biologists, study the living organisms in the ocean, plants and animals. Chemical oceanographers focus on the components of seawater, the interactions between seawater and other chemicals such as the atmosphere, and the different cycles of seawater (“What does an oceanographer do?”). Physical oceanographers look at the physical properties of the ocean, including waves and tides, as well as coastal erosion and deep currents in the ocean. Lastly, geological oceanographers study the ocean floor, such as how mountains, rifts, and valleys are created, as well as the plate tectonics and climates involved with these processes. However, these are only the main divisions of oceanography, as there are countless subdivisions such as geophysicists, atmospheric and climate researchers, and marine physicists (“Careers in Oceanography”). All of these different disciplines are remarkably similar, and different types of oceanographers all work together with a common goal: explore the ocean and understand the gigantic blue body of water.

There are many extremely different schools that offer some sort of oceanography or marine science undergraduate degree program. The main aspects of these degree programs tend to be courses, internships and research, and resources that the program has. To make the best choice about a college, one must compare the strengths and weaknesses of these programs in these selected areas. The University of Washington, boasting the number one oceanography program in the world, seems to be very strong in all areas (Holtz). There are four main options within the Oceanography program: Marine Geology and Geophysics, Chemical Oceanography, Physical Oceanography, and Biological Oceanography (“Research”). There are 43 undergraduate courses just in the oceanography department to choose from, and 16 various courses for underclassmen in the Oceanography discipline, ranging from basic classes like Introduction to Oceanography to more specific ones such as Chemistry of Marine Organic Carbon. On the other hand, there are 26 upperclassman courses in the 300-400 range for third and fourth year students. These classes range from Exploring Opportunities in Marine Science to Pelagic Ecosystem Function Research Apprenticeship (“Courses”). While the program can be extremely expensive, Mariko Kobayashi, a former marine biology minor who spent significant time in the UW Oceanography program, explains that the University of Washington oceanography department can offer a lot of tuition support for students. There are many classes for students to take, and as a result, students can find their oceanography focus at a much younger age, while they are still attaining their undergraduate degree.

The University of Washington is one of the fewundergraduate programs in the country that has their own research vessels, making it much easier for students to go out and take samples or do research, which is an extremely important part of the oceanography field. Undergraduate students at UW have access to research vessels, international programs, and obviously, access to open ocean and coastal waters (“Undergraduate”). The school of Oceanography at the University of Washington has two ships that they use, one of them the R/V Thomas G. Thompson, a 274-foot, 3000 ton ship. (“Vessels”). A new ship, the RV Rachel Carson, will allow UW students to explore Puget Sound and other nearby coasts. It will be used to approach learning with a hands-on focus, and it was built specifically for research, with a laboratory on board, space for 13 people to sleep, and better tools that allow it to more easily lower items into the water (Hickey). Kobayashi explains that undergraduates go on many research cruises and work in jobs or internship in their respective areas. In 2014, twenty-four UW Oceanography students were able to go on a ten day research cruise off the coast of Canada, to take samples and conduct research for their Senior theses (Hickey). Clearly, these students have access to some of the most wonderful research vessels in an undergraduate oceanography program in the world. This is an extremely important aspect, as when these students graduate, they will already have a headstart on their competitors, with research and sampling already under their belt.

To go along with their large research vessels, research and internships are an essential part of the University of Washington School of Oceanography, and it clearly shows. Kobayashi tells that in his experience, professors in the oceanography program encourage their students to reach out, for research experience, jobs, and even just advice. The Pelagic Ecosystem Function Research Apprenticeship offers students one of many ways to conduct independent research as undergraduate students, while getting college credit as it counts as a class. Undergraduate students must propose, research, and write a thesis during their senior year in order to graduate from the UW School of Oceanography. Three courses are offered to write this thesis, Undergraduate Thesis: Proposal, Undergraduate Thesis: Research, and Undergraduate Thesis: Data Analysis and Writing. Results from the students’ theses “are presented at a two-day long public research symposium and on the students individual websites” (“Courses”). An example of senior theses from 2016 include “Behavior Analysis of Oithona in Hypoxic/Anoxic Conditions” by Katrina Radach, and “Subsurface Oxygen Maximum Anomaly Found at Depth in Muchalat Inlet” by Michael Bamonte. These senior theses all add new research and findings to the scientific community, and undergraduate students are making valuable discoveries (“Senior Thesis Symposium 2016”). This allows students to graduate with something important already to their name, and shows possible employers that these students know how to conduct important research, and are highly focused and motivated individuals.

Lastly, another major focus of deciding the strengths of an undergraduate program are the laboratories and resources available to students. The UW School of Oceanography seems very strong in this area as well. UW has an exclusive center called “Pooled Equipment” for students to rent gear for data collection at a lower price, so students don’t have to buy gear for just one experiment. They also have a Marine Chem Lab which processes “hundreds of seawater samples a day for nutrient concentrations, dissolved organic carbon, oxygen, and many more.” There are also two facilities in the department that can be used to test gear either in salt water or at extremely high pressures, before sending it into the ocean unprepared. These facilities are used by outsiders as well, such as *Teledyne BlueView*, who tests their sonar devices before sending them out to customers (“Services”). Obviously, the facilities at UW are world-class, as well as the courses, ships, and research opportunities.

Another university with a relatively new marine science program created just two short years ago is California Polytechnic State University, in San Luis Obispo (Wilson). The Marine Science major includes Major courses, a course on Marine Resources Conservation and Policy, Marine Biodiversity, Communicating Science, and Electives (“BS Marine Sciences”). There are many different pathways within the Marine Science degree, biology, chemistry, computer science, engineering, mathematics, physics, soil science, and statistics, all based around the ocean and marine science. In general, the Marine Science Degree consists of 72 general education units, along with 60 upper division coursework units. Students must take a Math placement exam as well as an English placement exam to qualify for the program. There are many scholarships available for Marine Science students, as well as funding being available to undergraduate students through the Biological Sciences department (“Prospective Students”). A current student at Cal Poly studying marine science, Edwin Contreras, explains that “at Cal Poly you get hands on experience as soon as you start classes which is pretty amazing!” He continues that “overall, the classes are tough… so you do have to put in the work! However, the professors are pretty amazing and [he has] had no troubles with any of them.” Overall, there are slightly less courses at Cal Poly than the University of Washington, and they are less specific, especially as an upperclassman, but the difficulty of the courses seems to be very similar. Both programs prepare their students very well academically.

Cal Poly, like the University of Washington, takes a hands-on based, research approach to the learning. Contreras continues, that at Cal Poly, “you will find a lot of research opportunities within your lab instructors because they’re always looking for motivated people to work on some of their projects!” Undergraduate students are required to conduct research and and finish a senior project before graduation.. Undergraduate biology students participate in faculty-directed research as well as projects funded by private or federal agencies (“Student Research Opportunities”). Students can participate in “faculty-led research projects dealing with sustaining local fisheries, mapping ocean currents along the shore, the effects of ultraviolet light on marine organisms, the Morro Bay ecosystem, the dangers and control of invasive species, and monitoring a wide variety of intertidal life forms” (“Field Study Sites and Specimen Collection”). While there are tons of research opportunities for students, Cal Poly simply doesn’t have the resources or ships that the University of Washington has, so research is more based around the local ecosystem in San Luis Obispo.

Cal Poly’s marine science program, while it doesn’t have research vessels like the UW Oceanography program, does have their own resources and ways to conduct research privately. They have a private pier that they use for Marine research called Cal Poly Pier in Avila Beach (“Field Study Sites and Specimen Collection”). The Undergraduate Biotechnology Laboratory is used all year for undergraduate students to conduct research and is used in many undergraduate classes (“Laboratories”). Cal Poly students also have access to El Chorro Biological Reserve for research and wildlife studies, as well as Ragged Point, an 22-acre area closed to the public, which provides students access to perform studies and do research. Morro Bay is just 17 miles from campus, and students can conduct research and experiments in the biodiverse estuary (“Field Study Sites and Specimen Collection”). The Center for Coastal Marine Sciences is the only marine laboratory facility between Santa Barbara and Monterey, and is open to undergraduate students to perform research and study marine sciences (“Research Institutes”). So, while Cal Poly does not have the research vessels of the University of Washington, they do have their own private laboratories and areas to perform research, which is a clear bonus to students and their education.

The last school, the University of San Diego, has an equally prestigious marine ecology program, which is benefitted by committed professors and a terrific location. The environmental and ocean sciences major includes three different avenues that target marine ecology, environmental studies, and environmental sciences. The marine ecology major requires the student also complete a biology minor, and mainly prepares students for graduate studies (“Environmental and Ocean Sciences Overview”). The Prep for the Major courses (first two years) consists of 9 classes, while the upper division core is 2 classes, senior seminar, and at least two credits from research, internship, or independent study. The upper division electives consists of four classes, one is geo/physical based, while the other three are biology based; one must be an ecology course and two of them must have labs. The introductory courses for the marine ecology major are very basic, consisting of courses such as Organisms and Ecosystems, and General Chemistry. However, as the student progresses through the program, the electives get more specific, consisting of courses such as Plankton Ecology, and Invertebrate Zoology. The biology minor is only five classes, Bioenergetics and Systems with Lab, Genomes and Evolution with Lab, Genetics, an upper-division elective in Biology with Lab, and one without Lab. There are eleven upper-division biology electives to choose from. Approved study abroad courses can also count towards one’s marine ecology major, but must be discussed with a counselor beforehand (“Curriculum”). One current student in the Environmental and Ocean Sciences curriculum, Sara Ghebremicael, explains that “in EOSC (environmental and ocean science) classes, there are so many field trips that [the classes] take to do research, to look at things first hand, etc.” She continues that “this semester [they] are even going on a big research ship for 24 hour data collection, which is a really huge deal because the ships are actual research vessels and cost thousands of dollars to rent out—which [they] got a grant for!” This is an obvious contrast from the University of Washington Oceanography program, where they can go on data collection whenever they need to, as they own their own research vessels, eliminating the need for a grant. Another student in the program, Jason Greenstein, describes the marine ecology major as being “a science heavy and therefore challenging major, but enjoyable if [one is] interested in learning about science and the natural world.” Clearly, the University of San Diego has a very strong academic program, that prepares students well for future studies or jobs. This seems to be a similarity between the three schools, the strength of the academics, while the amount of research and resources seems to be the area that sets the three schools apart.

Like UW and Cal Poly, USD also focuses on hands-on learning and getting students actively engaged through internships and research. Just to graduate, each student must complete 45 hours of work at an internship per unit of credit. An internship capstone must be completed to graduate, which includes maintaining a journal throughout your internship, writing two biographies about mentors at the internship, getting an evaluation done from the internship mentor, and completing a poster on the results of your work during the internship. Places near USD with internship opportunities include private companies and scientific research, nonprofit and political organizations, museums and parks, educational institutes, and many others (“Research and Internship”). Ghebremicael explains that the “professors are all doing their own outside research along with teaching. They typically take students out into the field to do research with them… [one] can look into the different things that these professors are studying, and email them asking to do research with them and they typically accept most students.” Greenstein, with a similar opinion, says that “essentially, you can choose either a internship or do research with a professor to present at the Senior Research Seminar where you present your poster… If you do research and put effort into it, it will pay off; especially if you are friendly with the professors, then they will connect you with a bunch of great opportunities like attending professional conferences.” Overall, the consensus from both students seems to be that the professors at USD are very helpful and love to do research with students and help set them up for future opportunities. This seems to be a major point that sets USD apart from UW and Cal Poly, as the professors are extremely involved with their students, and do research directly alongside them.

While it seems that no other school has the vast amount of resources as the University of Washington, USD does have some very helpful labs and equipment available to students. The USD Marine Science department has a Laser Diffraction Particle Size Analyzer, which allows students to have their sediment samples analyzed extremely quickly, compared to traditional methods. They also has an inductively coupled plasma mass spectrometry (ICP-MS) capable of analyzing metals, and major elements in samples, which can be extremely helpful to marine science majors after they have taken a water sample, if they are testing for a specific element in the ocean. USD has a Spectrometer, capable of analysis for ions in a solution, especially in seawater (“Labs and Equipment”). All of this equipment is directed towards making research for undergraduates more efficient, which comes back to the point that USD, like UW and Cal Poly, take a very hands-on, research based approach to their marine science program.

After looking at all of this necessary education for future oceanographers, one would wonder what the career opportunities and job prospects look like for these explorers and scientists. Many oceanographers either choose to work at a university, where they can teach and do research, at a government or state level job, or at a private institution. The average annual salary for oceanographers is $105,830, according to the U.S. Bureau of Labor Statistics (Dowd). However, there are many different paths for oceanographers, and some are not paid as much. The average yearly salary someone with a bachelor’s degree in oceanography, in 2009, was $33,254, while those with a post doctorate ranged from $37,400 to $49,452. On the other hand, the average salary for an oceanographer working for the government in 2009 was $105,671 (“Careers in Oceanography”). The job outlook for Environmental Scientists in general, from 2016 to 2026, is 11%, which is faster than average (“Environmental Scientists and Specialists”). Job satisfaction for environmental scientists was rated at 70%, and 65% of respondents believed their job was meaningful (“What Do Environmental Scientists Do”). Overall, it is a job with relatively high satisfaction, and decent pay, depending on whom one works for.

Changing the world can be tough. However, it is essential for the progression of humans that we keep pushing the boundaries, exploring, discovering, and solving problems. These are all tasks that oceanographers face on a daily basis. While it can be a long road, with lots of education, research, and hard work, becoming an oceanographer is an essential and important job for our future generations. Choosing a fitting and proper college can be a hard task, but it is necessary to one’s career development. When it comes to the marine science major, the education, research, and resources that the college has seem to be the most important, recurring factors. One must weigh the importance of each of the factors, and look at the strengths and weaknesses of a prospective college to make the best possible decision. An undergraduate degree is the first step, of many, that can lead to changing the world.

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