MAJOR OF INVESTIGATION: Marine Science

RESEARCH THESIS:

 How does the marine science major differ between the University of Washington, Cal Poly, and the University of San Diego?

1. GENERAL OVERVIEW OF THE MAJOR

* “A major in oceanography focuses—obviously—on oceans. Not just the deep, dark, mysterious waters, but also what they’re made of, what lives in them, how they create and use resources, and how the sea moves and changes” (“Oceanography”)
* “Many oceanography programs give students the opportunity to work directly with the ocean through on-site laboratories, internships, and research projects” (“Oceanography”)
* Biological oceanographers, also known as marine biologists, study the living organisms in the ocean, plants and animals (“What does an oceanographer do?”)
* 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?”)
* Geological oceanographers study the ocean floor, such as how mountains, rifts, and valleys are created, as well as the plate tectonics and climate involved with these processes (“Careers in Oceanography”)
* Lastly, 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 (“Careers in Oceanography”)
* 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 sea.

2. COMPARISON OF MAJOR PROGRAMS

 **SCHOOL 1: University of Washington at Seattle (Oceanography)**

* The School of Oceanography was ranked number one in the world (Holtz)
* UW Oceanography can offer a lot of tuition support for students (Kobayashi).
* 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 (“Courses”)
* There are 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” (“Courses”)
* On the other hand, there are 26 upperclassman courses in the 300-400 range for Oceanography students. These classes range from “Exploring Opportunities in Marine Science” to “Pelagic Ecosystem Function Research Apprenticeship” (“Courses”)
* Undergraduate students 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 (Hickey).
* The RV Rachel Carson will be used to utilize a hands-on learning approach with undergraduate Oceanography students (Hickey).
* The RV Carson 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).
* Undergraduates go on many research cruises and work in jobs or internship in their respective areas (Kobayashi)
* 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).
* Professors in the Oceanography program encourage their students to reach out, for research experience, jobs, and even just advice (Kobayashi).
* 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. (“Courses”)
* Students must complete a senior thesis before graduation (“Oceanography Senior Thesis”)
* Students come up with their own idea for their senior thesis, conduct research, with little help from professors, and write their findings to be presented (“Oceanography Senior Thesis”)
* 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” (“Courses”)
* Results from the students’ thesis “are presented at a two-day long public research symposium and on the students individual web sites” (“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 (“Senior Thesis Symposium 2016”)
* These senior theses all are new research that add to the scientific community, and undergraduate students are making valuable discoveries (“Senior Thesis Symposium 2016”)
* The UW Oceanography program 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 (“Services”).
* UW Oceanography also has the “Marine Chem Lab” which processes “hundreds of seawater samples a day for nutrient concentrations, dissolved organic carbon, oxygen, and many more” (“Services”)
* “There are two water-filled facilities for testing your gear either in salt-water or at high-pressure before sending it to the real ocean. “The [Test Tank”](https://www.ocean.washington.edu/story/Test%2BTank) and “[Pressure Test Vessel”](https://www.ocean.washington.edu/story/Pressure%2BTest%2BVessel) are both located on the ground floor of OSB, and in fact the building was constructed around the *PTV*. It’s capable of taking instruments up to 10,000 psi (~7000m depth) and is used quite regularly by outside customers such as Teledyne BlueView who put all their sonars through it before delivery to customers” (“Services”)

**SCHOOL 2: Cal Poly (Marine Sciences)**

* The marine sciences program was created very recently, in 2016 (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: (“Prospective Students”)
	+ “Biology – Study of marine organisms, populations, communities, ecosystem function.”
	+ “Chemistry – Cycling of inorganic salts, transformation of dissolved organic material.”
	+ “Computer Science – writing code to command/control autonomous underwater vehicles.”
	+ “Engineering – design/building of instrumentation resistant to pressure and salts.”
	+ “Mathematics – modeling the 3D current flows along the California coast.”
	+ “Physics – instrument design, applications of lasers to detect particle fields.”
	+ “Soil Science – coastal erosion, sediment transport in Morro Bay Estuary.”
	+ “Statistics – validation of model output, determining significance in population changes.”
* In general, the Marine Science Degree consists of 72 units general education units, along with 60 upper division coursework units (“Prospective Students”)
* Students must take a Math placement exam as well as an English placement exam to qualify for the program (“Prospective Students”)
* 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”)
* “at Cal Poly you get hands on experience like as soon as you start classes which is pretty amazing!” (Contreras)
* “Overall, the classes are TOUGH here at Cal Poly so you do have to put in the work! However, the professors are pretty amazing here and I have had no troubles with any of them. Actually I did with one, but I think he got fired” (Contreras)
* “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 ! You just have to get the professors to like you and visit them a lot during their office hours” (Contreras)
* Undergraduate students are required to conduct research and and finish a senior project before graduation (“Student Research Opportunities”)
* 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”)
* They have a private pier that they use for Marine research called Cal Poly Pier in Avila Beach (“Field Study Sites and Specimen Collection”)
* 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 (“Field Study Sites and Specimen Collection”)
* Ragged Point, an area closed to the public, is an area of land 22 acres large, that students have access to perform studies and do research (“Field Study Sites and Specimen Collection”)
* 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”)
* “Cal Poly's Center for Coastal Marine Sciences promotes basic and applied studies of coastal marine systems” (“Research Institutes”)
* The Center for Coastal Marine Sciences is the only marine laboratory facility between Santa Barbara and Monterey (“Research Institutes”)

**SCHOOL 3: University of San Diego (Marine Ecology)**

* The environmental and ocean sciences major includes three different avenues that target marine ecology, environmental studies, and environmental sciences. (“Environmental and Ocean Sciences Overview”)
* Marine ecology requires a biology minor (“Environmental and Ocean Sciences Overview”)
* The major is mainly preparing 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 4 classes out of a possible 17 classes, with additional courses for the required Biology minor (“Curriculum”)
* 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 (“Curriculum”).
* 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” (“Curriculum”)
* The biology minor consists of 18 units of classes, such as “Genetics” and “Ecology” (“Curriculum”)
* The biology minor is only 5 classes, “Bioenergetics and Systems with Lab,” “Genomes and Evolution with Lab,” “Genetics,” an upper-division elective in Biology with Lab, and one without Lab (“Curriculum”)
* There are 11 upper-division biology electives to choose from (“Curriculum”)
* Approved study abroad courses can also count towards one’s Marine Ecology major, but must be discussed with a counselor beforehand (“Curriculum”)
* “in EOSC (environmental and ocean science) classes, there are so many field trips that we take to do research, to look at things first hand, etc. So we go to the beach a lot - which is like 10 mins away from the school. This semester we 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 we got a grant for!” (Ghebremichaels)
* “It is a science heavy and therefore challenging major, but enjoyable if your are interested in learning about science and the natural world” (Greenstein).
* Every student in the major must “work at an internship site for a minimum of 45 hours per unit of credit.” (“Research and Internship”)
* Internship opportunities include private companies, education, nonprofit organizations, museums, and even parks. (“Research and Internship”)
* 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 (“Research and 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”)
* The professors all “have their PhD's and you can tell how passionate they are about what they teach and study. These professors are all doing their own outside research along with teaching. They typically take students out into the field (outside of class, like during the summers) to do research with them. You 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” (Ghebremichaels)
* “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” (Greenstein).
* 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 (“Labs and Equipment”)
* USD also has an ICP 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 (“Labs and Equipment”)
* USD has a Spectrometer, capable of analysis for ions in a solution, especially in seawater (“Labs and Equipment”)

3. CAREER OPPORTUNITIES

* “Research scientist jobs and data technician positions exist within the federal government, higher education, private research laboratories, engineering companies, petroleum industries and fisheries” (Dowd)
* Average annual salary for oceanographers is $105,830, according to the U.S. Bureau of Labor Statistics (Dowd)
* The four main pathways for oceanographers is Biological Oceanographers, Geographic Oceanographers, Physical Oceanographers, and Chemical Oceanographers (Dowd)
* “Opportunities for scientists at all levels may be found in governmental laboratories and in the academic or industrial communities“ (“Careers in Oceanography”)
* 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 (“Careers in Oceanography”)
* The average salary for an oceanographer working for the government in 2009 was $105,671 (“Careers in Oceanography”)

CONCLUSION:

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