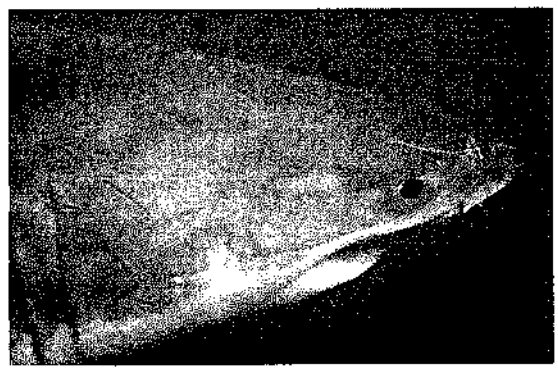
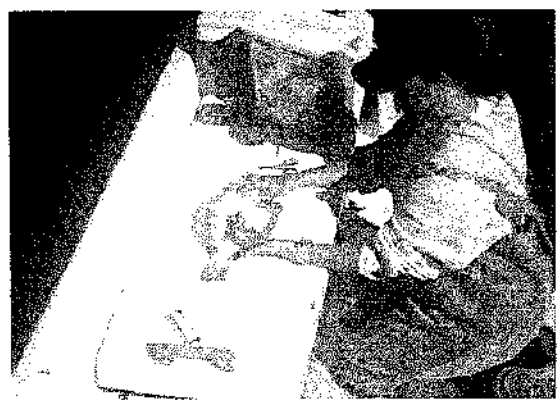
What Does It Take To Become a Marine Scientist?





Sea Grant Marine Advisory Program
Virginia Institute of Marine Science
School of Marine Science
College of William and Mary

Virginia

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Excerpts from Dr. Maurice Lynch, Director, Chesapeake Bay National Estuarine Research Reserve in Virginia.
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Cover photos: Left: Side scan sonar being deployed.
Top right: Great white shark
Bottom right: Flounder stomach content analysis

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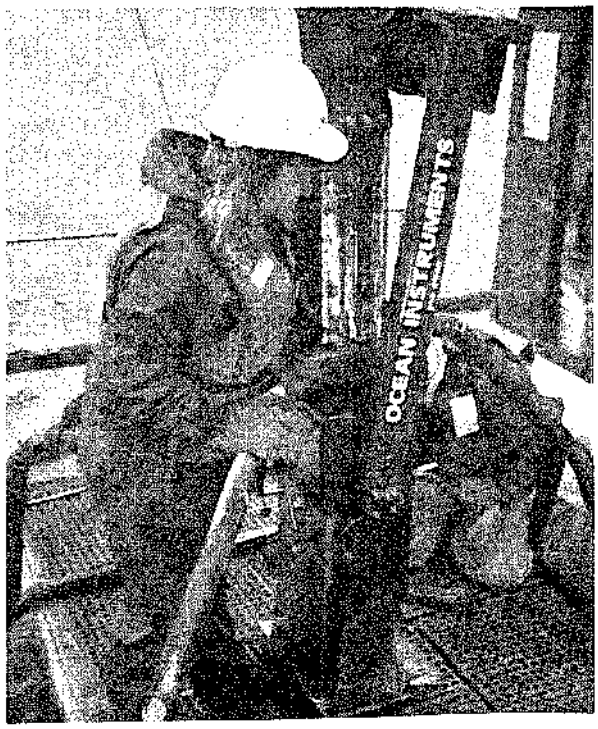
Do You Want To Be a Marine Scientist?

As human impact on the marine environment continues to increase, interest in the health of our world's coastal areas, estuaries and oceans ensures a strong future for studies in the marine sciences. When young students consider careers in marine science, often the first thing that comes to mind is working with marine mammals. However, it is important to understand that few scientists actually specialize in this area and that employment opportunities within the field of marine science are extremely diverse. This packet provides a perspective on the breadth of these opportunities and the education and experience necessary for these careers. Also included is a list of sources for further information.



Defining Marine Science

Marine science is a broad term that can be confusing. There are many disciplines within the science of studying the marine environment and countless professions. A few specific definitions may help to clarify.

Oceanography:
Oceanography is a multidisciplinary environmental science focusing on the oceans. Increasingly, questions posed to scientists require an interdisciplinary approach to research. It is becoming more and more necessary to integrate the biological, chemical, physical and geological disciplines of oceanography as well as ocean engineering to find solutions to research questions. To become a successful marine scientist in the 21st century, a well-rounded understanding of all disciplines with a specialty in one or more areas is strongly recommended.

It is important to remember that Ph.D. scientists don't work alone. Within each field are a number of support positions that require less schooling and can be very rewarding. Research teams often include not only scientists, but technicians, computer specialists, and laboratory and research assistants.

Biological Oceanography (Marine Biology):
Many publications make a distinction between a marine biologist and a biological oceanographer, but both study plants and animals that live in the ocean, their behavior and adaptations, their roles in the food chain, and anthropogenic (human) effects on them. Marine biology can be considered a subset of biological oceanography. A biological oceanographer may focus more on exploring the open ocean environment, while a marine biologist may concentrate on the specific organisms of coastal and estuarine habitats.

Professions in biological oceanography and marine biology include biotechnologist, toxicologist, aquaculturist, microbiologist, ecologist, marine educator, fisheries biologist, mammalogist, algologist, behaviorist, marine pathologist, aquarist, and parasitologist.

Chemical Oceanography:
Chemical oceanographers study the elements of seawater and seafloor sediments and how the chemical make-up of the ocean interacts with biological, geological and physical factors. Additionally, they may study the effects of both natural and man-made chemicals on the ocean environment.

Professions in chemical oceanography include environmental research scientist, aquatic chemist, and biochemist.

Geological Oceanography:
Geological oceanographers study the make-up of the sea floor, its movement and the nature of the minerals found there. Some focus their research on the mountains, basins and trenches of the ocean bottom and the constant changes occurring there while others study sand erosion and deposition on coastal beaches.

Professions in geological oceanography include seismologist, geophysicist, paleontologist, marine archaeologist, and petroleum geologist.

Physical Oceanography:
Physical oceanographers study the physical properties of the ocean as it interacts with boundaries of land, seafloor, and atmosphere. They study the movement of the ocean caused by the forces of winds, waves, currents, and tides and the relationship between the sea, weather and climate.

Professions in physical oceanography include ocean modeler, hurricane forecaster, and meteorologist.

Ocean Engineering:
Oceanographic engineers create the research instruments oceanographers depend on for their research. They design tools such as remotely operated vehicles, depth sounders, submarines, and off-shore drilling rigs. These engineers may also work with satellite systems or create ways to protect the coastline from erosion. As interest in the deep ocean has increased, ocean engineers have become an essential element of ocean exploration and discovery.

Environmental Science:
In recent years, environmental issues have moved to the forefront as a focus of work within the marine scientific community. With increased stresses on our planet from human influences, scientists with a strong understanding of the effects of humans on ecological systems are more in demand than ever before.

As our understanding of the complexity of environmental issues has increased, career opportunities in environmental science have increased, including environmental biology; environmental chemistry; analytical, physical and organic chemistry; biochemistry and toxicology; fisheries science; resource management; and marine policy.

What Does It Really Take To Become a Marine Scientist?

It is wise to seek information early about a career in science. First of all, be aware that the level of opportunity available is usually based on the amount of education achieved. The master's degree, which takes two to four years beyond a bachelor's degree, provides reasonable entry into the more technical aspects of science, such as running experiments for a scientist, doing field work, or acting as an advisor to the state or federal government. A top-level research scientist of any kind or a member of an academic faculty at a university requires a Ph.D. This is four to six years beyond the bachelor's degree.

Understanding that becoming a scientist is a long-term commitment can be an enormous help in preparing an undergraduate background. Students with an aptitude and interest in marine science are strongly discouraged from specializing their coursework on marine science at the undergraduate level. Students should first concentrate on the fundamental courses of math, chemistry, biology, and physics. These provide the framework and background for advanced and specialized courses at the graduate level. With six to nine years of higher education to fill, there is plenty of time to gain a strong knowledge foundation and to take courses, such as English, history, literature and a foreign language, that make for a well-rounded, educated person. When selecting an undergraduate major such as geology, biology, or chemistry, it is important to see an advisor regarding appropriate courses. For example, a major in biology would require physiology, genetics, vertebrate and invertebrate zoology, and botany, among other courses. A major in geology would require such courses as geomorphology, structural geology, mineralogy, petrology, and sedimentation.
Becoming thoroughly grounded in the fundamentals, including skill in writing and working with computers, will make the road ahead much easier.

One of the strengths of this approach is its flexibility. If after a few years of college the selected path does not look as appealing, a diverse educational background, strong in the basic sciences, provides room to change direction without having to start over.

During high school:

- Most importantly, strive for good grades. A strong grade point average will make a difference when it comes time to apply for college.
- If possible, take advantage of opportunities to enroll in college level courses during the junior or senior year.
- Look for a college that will provide a strong background in the fundamentals with some opportunity for experience in any areas of specific interest.

During junior year in college (or earlier):

- Choose a graduate school that emphasizes area(s) of interest, has a record of excellence and is in an affordable price range.
- Seek out opportunities for practical experience in areas of interest. This provides valuable insight for you and indicates motivation on academic applications.

College students seriously interested in a profession in marine science should choose a graduate school and consult with the dean of the school early in their college career to discuss the academic program. The School of Marine Science at the Virginia Institute of Marine Science (VIMS)— a graduate school of The College of William and Mary— suggests the following courses be completed prior to entrance into a master's degree program in marine science.

Before entering a master's program in **Marine Biology (Biological Oceanography)** or **Marine Fisheries Biology**, recommended courses include:

College Algebra	Ecology or Field Biology
Calculus	General Chemistry
Statistics	Organic Chemistry
Introductory Biology	Biochemistry
Genetics	Anatomy of Vertebrates
General Physics	Embryology

Other courses to consider taking at the undergraduate level include:

Invertebrate Zoology	Botany
Microbiology	Physiology
Qualitative Chemistry	Quantitative Chemistry
Foreign Language	

Before entering a master's program in **Chemical Oceanography**, recommended courses include:

General College Mathematics	
College Trigonometry	Calculus
College Algebra	Analytical Geometry
General Chemistry	Statistics
General Physics	Quantitative Analysis
Organic Chemistry	Qualitative Analysis

Other coursework requirements may include:

Physical Chemistry	Fluid Mechanics
Thermodynamics	Differential Equations

Before entering a master's program in **Physical Oceanography**, recommended courses include:

General College Mathematics	
College Trigonometry	Calculus
College Algebra	Analytical Geometry
General Physics	Statistics
Advanced Calculus	Acoustics
Fluid Mechanics	Electricity & Magnetism

Other coursework requirements may include:

Differential Equations	Vectors Analysis
Advanced Physics	Thermodynamics
Optics	

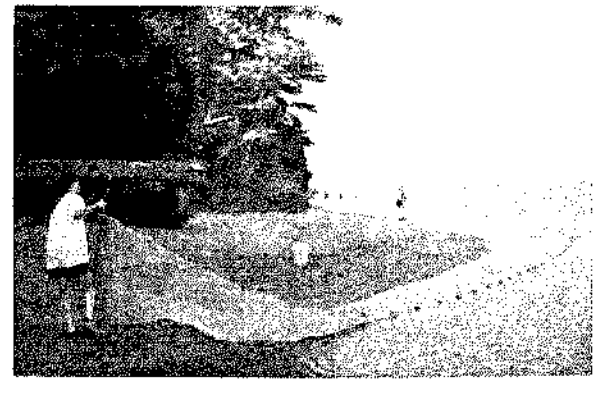
Before entering a master's program in **Geological Oceanography**, recommended courses include:

General College Mathematics	
College Trigonometry	Calculus
College Algebra	Analytical Geometry
General Physics	Statistics
Physical Geology	General Chemistry
Paleontology	Historical Geology
Stratigraphy	Structural Geology

Other coursework requirements may include:

Advanced Calculus	Advanced Physics
Organic Chemistry	One or more biology courses

In all disciplines, an overall grade point average of at least a 3.0 in a 4.0 system is desirable.



Financial aid is, of course, a common concern. The best course of action is to be thoroughly prepared with a strong background and good grades. One of the main criteria used to select the best candidates for financial aid is the breadth of studies in math, chemistry and physics. Like anything that is demanding, be it dancing, music or science, careful preparation is mandatory for professional performance.

Seeking out financial aid can sometimes seem like a struggle, but with the right amount of effort, the payoff can be substantial. To get started, a few websites to explore are:

http://www.finaid.org/
http://info-s.com/aid.html
http://www.grantsnet.org/

The amount and type of financial aid available differs for every institution. It is important to thoroughly investigate what a college has to offer before making a commitment. The following information provides examples of aid available at the College of William and Mary and the VIMS School of Marine Science. These sources may or may not be available at other institutions.

A few financial aid options to consider at the undergraduate level include:

Scholarships: Academic and athletic scholarships are offered at most colleges. High school guidance counselors and college financial aid offices can provide specific information.

Loans and Grants: There are many different types of academic loans and grants available. College financial aid offices can provide specific information regarding qualifications and application procedures.

Work-Study: College work-study allows students to work an average of 10 hours a week while attending school. Students entering college should check with the financial aid office for assistance in locating a work-study job.

A few financial aid options to consider at the graduate level include:

Research and Teaching Assistantships: This funding, usually provided for no less than one year, conveys a commitment on the part of the academic institution that money is available for a guaranteed period of time. Assistantships require a commitment of time (usually no more than 20 hours per week) on the part of the student in support of the teaching or research mission of the institution. Such funding varies depending on the facility and payment of tuition may or may not be associated with an assistantship.

Fellowships: This award is usually based on academic excellence and may convey a funding commitment of a longer duration on the part of the institution. A fellowship award typically includes a stipend and a full waiver of tuition. Traditionally, a fellowship is a financial award to a student for which service to the institution is not a requirement. At the VIMS School of Marine Science, however, fellowship students may be required to commit time in support of the teaching or research mission of the institute.

Workship: Workship students are hired as hourly employees to satisfy operational needs of the institution. At the VIMS School of Marine Science, if a student holds either a fellowship or an assistantship, there is a limit on the number of workship hours he or she can accept.

Research Grants: Research grants provide funding for specific projects or studies a student may wish to conduct. Generally the student, often with faculty assistance, prepares a proposal describing the project and submits it to an organization for consideration. Usually these proposals and requests are competitively evaluated, and most often funds are available only to support the project, not the recipient's educational or living expenses.

In addition to the above, student loans are also not uncommon at the graduate level.

Where To Start

Students often expect a guidance counselor, teacher, or parent to paint the path for them to achieve the job of their dreams. As difficult as it may sound, no one can create that path for you, but many suggestions are out there to help you blaze your trail.

1. **Get real!**
   Contrary to the glamorous, explorer persona depicted of marine scientists by the media, most spend a great deal of time in laboratories and offices, running experiments, gathering data, reading up on current literature, and writing research papers and grant proposals. Time in the field is infrequent and when it does exist, it is often filled with long, strenuous hours in all types of weather conditions. But that is not to sound discouraging. If you enjoy being outdoors in spite of bad weather and insects, and you also enjoy working in a laboratory and using a computer, this may be the ideal profession for you!

2. **Study hard!**
   As an undergraduate, obtain a well-rounded education in one or more of the sciences and in mathematics.

3. **Gain experience!**
   Nothing takes the place of experience. This is one of the best ways to determine if this profession is right for you and to find out what you enjoy doing. Opportunities may be available at a marine facility near you. Explore the options and participate in a few. Seek out volunteer, internship and sea semester opportunities.

4. **Persevere!**
   There are many types of marine oriented jobs available. If one does not work for you, explore and find another. Remember, not all marine professions require a Ph.D.

A common question from students interested in marine oriented fields is "How much money will I make?" The only real answer to this is "It depends." Generally, people seek out jobs in the marine environment because of a love for the water, not because they have a strong desire to get rich. Listed below are a few professions and very general salary ranges one might expect to find. It is important to keep in mind that salaries are dependent upon many factors, including experience, location, and the current economic situation.

Oceanography	
Laboratory Technician	$25,000 – 35,000
Marine Scientist	$25,000 – 50,000
Research Professor	$45,000 – 90,000
Fishing Industry	
Fisherman	based on catch
Fish Culturist	$25,000 – 40,000
Aquariums/Zoos/Museums/Parks	
Director	$45,000 – 90,000
Curator	$30,000 – 50,000
Educator	$25,000 – 50,000
Animal Care Specialist	$20,000 – 30,000
Military Careers Afloat	
Enlisted personnel	$20,000 – 40,000 (additional benefits)
Officers	$35,000 – 70,000 (additional benefits)
Cruise Ship	
Social director, naturalist, photographer, or entertainment staff	$30,000 – 70,000 (includes room & board)
Naval Architect	$40,000 – 75,000
Marine Lawyer	$50,000 – 100,000
Marine Archaeologist	$25,000 – 60,000

Check out these web sites:

Careers in Marine Science

http://www.vims.edu/bridge/
The Bridge - a national warehouse of links to exemplary marine science education information
Virginia Institute of Marine Science

http://www.vims.edu/adv/ed/careers/
General information and links to marine career sites
Virginia Institute of Marine Science

http://scilib.ucsd.edu/sio/guide/career.html
Oceanography On the Net
Scripps Institution of Oceanography Library

http://www.marine.stanford.edu/HMSweb/Career_booklet.html
Marine Science Careers: A Sea Grant Guide to Ocean Opportunities
Stanford University

http://www.aqua.org/education/careers/ricareer.html
Careers - Resources and Information
National Aquarium in Baltimore

http://aza.org/publications/career.htm
http://aza.org/publications/careeraqua.htm
Zoo and aquarium careers, marine science careers
American Zoo and Aquarium Association

http://www.seaworld.org/careers/careerinfo.html
Many examples of marine careers
Sea World

http://www.mcbi.org
Jobs and internships related to marine conservation biology
Marine Conservation Biology Institute

Careers in Marine Mammalogy

http://www.imata.org/careers.htm
Careers in marine mammal training
International Marine Animal Training Association

http://pegasus.cc.ucf.edu/~smm/strat.htm
Strategies for pursuing a career in marine mammal science
The Society for Marine Mammalogy

http://whale.wheelock.edu/
A clearinghouse of marine mammal information
Wheelock College

Careers in Science

http://www.nap.edu/readingroom/books/careers/contents.html
"Careers in Science and Engineering: A Student Planning Guide to Grad School And Beyond"
National Academy of Sciences

Educational Opportunities in Marine Science

http://www.vims.edu/bridge/student_opp.html
Links to sites to find opportunities for experience in marine science
Virginia Institute of Marine Science

Check out these publications:

Marine Science Careers, A Sea Grant Guide to Ocean Opportunities.
University of Maine/University of New Hampshire Sea Grant College Program and the Woods Hole Oceanographic Institution Sea Grant Program, 1996. (booklet, $5.00)

Marine Careers: The Scientist"
University of Delaware, Sea Grant Marine Advisory Services, 1996. (pamphlet, http://www.ocean.udel.edu/geagram/pub.html#order)

The Dolphin and Whale Career Guide.
T. R. Glen, III, Omega/Publishing Division, Chicago, IL, 1997.

The New Complete Guide to Environmental Careers
The Environmental Careers Organization, Island Press, Washington DC, 1993.

Opportunities in Marine and Maritime Careers.
W. R. Heitzmann, National Textbook Company, Chicago, IL, 1988.

Marine Science Reading List.
Marine Biological Laboratory/Woods Hole Oceanographic Institution, Library Publication, 1995.

Education and Training Programs in Oceanography and Related Fields.
C. Fabry, editor, Marine Technology Society, Washington DC, 1995. (booklet, $6.00)

Look into these Mid-Atlantic facilities and organizations:

Virginia

Virginia Institute of Marine Science
School of Marine Science
College of William and Mary
P.O. Box 1346
Gloucester Point, VA 23062
(804) 684-7000
oceaned@vims.edu
http://www.vims.edu

Chesapeake Bay National Estuarine Research Reserve in Virginia
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062
(804) 684-7135
cbnerr@vims.edu
http://www.vims.edu/cbnerr

Mathematics and Science Center
2401 Hartman Street
Richmond, VA 23223
(804) 343-6525 x222
paul@mathscience.k12.va.us
http://mathscience.k12.va.us

Virginia Marine Science Museum
717 General Booth Boulevard
Virginia Beach, Virginia 23451
(757) 425-FISH
VMSM@norfolk.infi.net
http://www.vmsm.org

Mariner's Museum
100 Museum Drive
Newport News VA 23606
(804) 595-0368
education@mariner.org
http://www.mariner.org

Science Museum of Virginia
2500 West Broad Street
Richmond, VA 23220
(804) 367-6552
smvfeedback@smv.mus.va.us
http://world.smv.mus.va.us/

Virginia Living Museum
524 J. Clyde Morris Blvd.
Newport News, VA 23601
(804) 595-1900
webmaster@valivingmuseum.org
http://www.valivingmuseum.org

Old Dominion University
Department of Ocean, Earth & Atmospheric Sciences
Hampton Boulevard
Norfolk, Virginia 23529
(757) 683-4376
anne@ccpo.odu.edu
http://www.odu.edu/webroot/orgs/sci/colsciences.nsf/pages/sciences

Marine Science Consortium
7278 Enterprise Street
Wallops Island, VA 23337
(757) 824-5636
mscv@shore.intercom.net
http://www.msconsortium.org

Center for Marine Conservation
1432 N. Great Neck Road
Suite 103
Virginia Beach, VA 23454
(757) 496-0920
dcmc@ix.netcom.com
http://cmc-ocean.org/

The Oceanography Society
4052 Timber Ridge Drive
Virginia Beach, VA 23455
(757) 464-0131
rhodesj@exis.net
http://wwww.tos.org.tos_general.html

Maryland

National Aquarium in Baltimore
501 East Pratt Street, Pier 3
Baltimore, MD 21202
410-576-3800
e-mail via: http://www.aqua.org/contact/
http://www.aqua.org

Chesapeake Bay Foundation
162 Prince George Street
Annapolis, MD 21401
1-888-SAVEBAY (728-3229)
educationcoordinator@savethebay.cbf/org
http://www.cbf.org/

Maryland Sea Grant
112 Skinner Hall
University of Maryland
College Park, MD 20742
(301) 405-6371
mdsg@mdsg.umd.edu
http://mdsg.umd.edu/MDSG/mdsg.html

Academy of Natural Sciences Estuarine Research Center (ANSERC)
10545 Mackall Road
St. Leonard, MD 20685
(401) 586-9700
strickland@acnatsci.org
http://www.anserc.org/

District of Columbia

Friends of the National Zoo
Research Traineeship Program
National Zoological Park
Washington, DC 20008
(2020 673-4974
susan@fonz.org
http://www/fonz/internships.htm

Consortium for Oceanographic Research and Education
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102
(202) 232-3900
nosb@brook.edu
http://core.cast.msstate.edu/NOSBtop.html

Center for Marine Conservation
National Headquarters
1725 DeSales Street, NW, Suite 600
Washington, DC 20036
(202) 429-5609
dccmc@ix.netcom.com
http://cmc-ocean.org/

Delaware

University of Delaware Sea Grant College Program
111 Robinson Hall
Newark, DE 19716-3501
(302) 831-2841
marine.com@udel.edu
http://www.msdg.u.d.edu/DELSG/

Center for the Inland Bays
PO Box 297
Nassau, DE 19969
(302) 642-SEAL
edlewan@udel.edu
http://www.udel.edu/CIB/

North Carolina

North Carolina Aquarium Society
Roanoke Island, Pine Knoll Shores & Fort Fisher Aquariums
417 North Blount Street
Raleigh, NC 27601
(919) 733-2290
lisa_schell@mail.enr.state.nc.us
http:www//ncaquariums.com

North Carolina Coastal Federation
3609 Highway 24 (Ocean)
Newport, NC 28570
(800) 232-6210
nccf@nccoast.org
http://www.nccoast.org

North Carolina Sea Grant
Box 8605
North Carolina State University
Raleigh, NC 27695-8605
(919) 515-7095
lundi_spence@ncsu.edu
http://www2.ncsu.edu/sea_grant/seagrant/html

Regional Organizations

Mid-Atlantic Marine Education Association (MAMEA)
MAMEA Secretary
National Aquarium in Baltimore
Pier 3, 501 E. Pratt Street
Baltimore MD 21202
(410) 576-3800
gcrapa@aqua.org
http://www.vims.edu/adv/mamea/mamea2.html

For more environmental organizations in the Mid-Atlantic region, visit the web site for the Department of Environmental Quality at http://www.deq.state.va.us/info/direct.html

National Organizations

National Marine Education Association (NMEA)
P.O. Box 1470
Ocean Springs, MS 39566-1470
(228) 374-7557
cseymour@seahorse.ims.usm.edu
http://www.marine-ed.org/

American Zoo and Aquarium Association (AZA)
8403 Colesville Road
Suite 710
Silver Spring, MD 20910
(301) 562-0777 x250
http://www.aza.org/publications/

International Marine Animal Trainers Association (IMATA)
1200 South Lake Shore Dr.
Chicago, IL 60605
info@imata.org
http://www.imata.org/

These resources are just a sampling of what is available. Each of these contacts will lead you to several other contacts. Check with your science teacher, guidance office, or state department of education for information regarding facilities and programs in your region.