# MARINE SCIENCE (MSCI)

**MSCI 501A Fundamentals-Phys Oceanog (2 Credits)**
This course provides an introduction to the various types and scales of motion in the ocean, the global heat budget, major water masses, and processes controlling distributions of temperature and salinity. Discussions on phenomena associated with water motion will include global circulation, wind-driven circulation in ocean basins, tides, coastal upwelling, storm surge, waves, turbulence, and circulation in estuaries. Underlying dynamics governing water motion will be presented, elucidating the role of the rotation of the earth. The El Nino/La Nina oscillation will be examined as a key example of large-scale ocean-atmosphere interactions.

**MSCI 501B Fundamentals-Chem Oceanog (2 Credits)**
This course presents an overview of the chemistry of estuaries and the ocean including chemical processes that occur in marine sediments and at the air/sea interface. Discussion topics will include the chemical properties of seawater, chemical equilibrium and kinetics, the seawater carbonate system and ocean acidification, the global and oceanic carbon and nitrogen cycles, ion speciation, trace metals, and nutrients, sediment diagenesis, and fundamentals of radioisotope and stable isotope biogeochemistry. Interdisciplinary applications are emphasized.

**MSCI 501C Fundamentals-Marine Geology (2 Credits)**
This course provides an introduction to the major topics of marine geology without expecting the student to have a background in geology. The course addresses the age and internal structure of the earth, the processes of plate tectonics including the formation of oceanic crust, seamounts, hydrothermal vents, the characteristics and classification of sediments and the distribution of sediments in the deep sea. Also addressed is the interrelationships among and importance of paleoceanography, climate change, and sea-level change, and the processes and characteristics of various marine, estuarine, and coastal sedimentary environments. The course includes discussion of various types of field equipment and logistics and of some economic and societal implications.

**MSCI 501D Fundamentals Biological Ocean (2 Credits)**
This course examines the biology and ecology of marine organisms and how they interact with their environment. Topics include the organisms and their behavior, distribution, and underlying physiology; effects of biology on elemental and nutrient cycles and visa versa; and ecosystem structure and ecological interactions. An interdisciplinary approach will be taken, as biology both depends on and influences ocean chemistry, physics, geology, and climate. The course will emphasize open ocean, pelagic systems, but will include many examples from coastal and estuarine systems, as well as shallow and deep-sea benthic systems.

**MSCI 501E Fundamentals of Aquatic Health (2 Credits)**
This course emphasizes ongoing and emerging concerns in aquatic health. Lectures will address basic concepts and mechanisms of contaminant chemistry, toxicology, and infectious diseases in aquatic organisms. Case studies will be used to illustrate sources, fate, effects and mitigation of anthropogenic chemical contaminants, as well as the role of environmental change on the ecology and evolution of infectious diseases, in aquatic ecosystems.

**MSCI 501F Fundamentals-Mar Fisheries Sci (2 Credits)**
This lecture course will introduce the principles and techniques of fishery science. Lecture topics will include the theory and impacts of fishing, description and status of international, North American and regional fisheries, fisheries oceanography, recruitment processes, single-species and ecosystem-based approaches to stock assessment, and fisheries management, and the goals and problems of sustaining an open-access common pool resource.

**MSCI 503 Interdis Res Estua/Coastal Sys (2 Credits)**
This course provides an interdisciplinary overview of estuarine and coastal systems and exposes students to these systems through student-directed, interdisciplinary group research projects in Virginia coastal waters. The course covers the key geological, physical, chemical, and biological processes that structure these systems, highlights spatiotemporal variability in these processes, and emphasizes examples from Chesapeake Bay and the Virginia Eastern Shore. Concepts are reinforced through group field projects that cover all aspects of the scientific process from project conception to presentation, provide hands-on experience in assessing naturally-occurring, integrative processes in coastal settings, and expose students to the collaborative, interdisciplinary research process that characterizes modern marine science. Emphasis will be placed on integrating diverse results and products into an interdisciplinary "story" that addresses the overall group objective, which is communicated through group poster presentations at the end of the semester.

**MSCI 504 Stats Methods/Data Analysis (3 Credits)**
An introduction to statistics or data science for coastal scientists. Focus is on training the student to become a basically proficient "user" and "consumer" of simple statistical analysis tools as well as familiar with types of advanced statistical analysis tools commonly encountered in modern environmental science research.

**MSCI 505 Fundamentals of Science Comm (1 Credit)**
This foundational course aims to provide first-semester M.A., M.S., and Ph.D. students with essential skills for effective communication across disciplines. The course introduces students to key concepts in scientific communication and public speaking, providing resources for developing oral communication skills and fostering a supportive environment for practice and peer feedback. Additionally, it introduces students to the interdisciplinary nature of marine science, sets expectations for responsible research conduct, encourages engagement with professional development offerings from the Batten School, and strengthens community building among incoming students.

**MSCI 506 Scientific Communication Skill (2 Credits)**
The important elements of oral and written presentation skills for communicating scientific research to diverse audiences will be reviewed in this course. The course addresses topics such as best practices for writing, submitting, and revising scientific papers, proposals, and reports, and developing effective figures and other illustrations. Oral and written presentation skills are emphasized through written exercises and class presentations, with peer review. Other topics include development of effective poster presentations and application materials, such as CVs, cover letters, and research and teaching statements.

**MSCI 508 College Science Teaching (1 Credit)**
Course includes discussion of issues in science teaching and learning, course design, lesson design, teaching and assessment strategies, and teaching statements. Focusing on a course of their own, students develop an assignment, lesson outline, and syllabus. Course is valuable for students who are interested in an academic career and/or other positions that involve teaching and/or outreach.

**MSCI 509 Comm Sci to Diverse Aud (2 Credits)**
The objectives of this course are to provide (1) a foundation of skills for communicating scientific topics and research results to a variety of audiences, (2) an introduction to different mediums of science communication, and (3) an introduction to difference audiences and how they engage with science. Tools/skills for science communication will include the COMPASS message box, eliminating jargon, humanizing your science, and connecting with what your audience cares about. Students will create a portfolio of their science communication products.

**MSCI 522 Coastal Evolution (3 Credits)**
This course will review the drivers of, and geomorphic responses to, change along open-ocean coastal sedimentary environments across a range of climatic zones and from the event scale to thousands of years.

**MSCI 523 Human Dimensions of Marine Sci (3 Credits)**
This course is designed to provide students with an introduction and overview of the human dimensions of coastal and marine science, with the additional intent to inspire students to consider the human dimensions of their own research and areas of interest. The course is separated into a combination of seminars and workshops. Seminars feature guest speakers from a range of sub-disciplines and career types whose work focuses on or integrates human dimensions into coastal and marine science. As part of seminars, students will also read a selection of human dimensions-centered papers to further introduce the consideration of human dimensions across a variety of coastal and marine science topics. Some speakers and authors will be social scientists, others will be non-social coastal and marine scientists who have built human dimensions into their research or other work. Workshops will complement seminars by providing opportunities to "dig in" to some of the research methods featured in seminar readings and discussions. Workshops will involve a series of methods-centered activities in which students will have the opportunity to develop skills in a range of social science research methods and better understand some of the related benefits and challenges. Throughout the semester, students will also build and workshop components for a research proposal on an aspect of human dimensions related to their own interests.

**MSCI 525 Ethics in Marine Science (3 Credits)**
This seminar-style course explores ethical issues in marine science from diverse perspectives and interprets them through the framework of major ethical theories. Topics include marine resource and land management, research methods, and the societal impacts of climate change. Students will examine how knowledge is produced, who bears responsibility for conducting marine science, and how societal factors shape both. Active participation in discussions is expected, as students learn to critically evaluate, construct, and defend arguments on key ethical topics.

**MSCI 529 Fish Physiology (3 Credits)**
This course is intended for students interested in incorporating physiological principles and techniques into projects addressing questions in ecology, fishery biology and environmental assessment. The basic concepts of physiological adaptations and plasticity will be explored, and then applied in the context of environmental and anthropogenic stressors. Students will learn to interpret, synthesize, and communicate main findings of physiological literature.

**MSCI 531 Water System Processes (3 Credits)**
The course introduces students to processes and models of the earth's water systems (oceans, coasts/estuaries, and rivers/streams) and their interactions. It provides the students with the foundation for a higher-level course on numerical modeling. Knowledge of calculus is a pre-requisite.

**MSCI 534 Disease in Marine Systems (3 Credits)**
Exploration of the diversity of pathogens responsible for major marine diseases, the approaches to disease surveillance and study, the epidemiological and evolutionary aspects of disease dynamics, and approaches to disease management, with an emphasis on key resources species.

**MSCI 548 Spec Topics in Marine Science (1-3 Credits)**
This is the avenue through which subjects not covered in other formal courses are offered. These introductory courses are offered on an occasional basis as demand warrants. Subjects will be announced prior to registration and after approval by the Batten School & VIMS Graduate Policy & Curriculum Committee.

**MSCI 550 Rivers:Processes/Management (3 Credits)**
Rivers form the main link between land and the ocean, discharging more than 35 thousand km3 of water and more than 20 billion tons of suspended and dissolved solids annually to the global ocean. Three central themes are stressed: 1) How do rivers work: the hydrologic cycle and water budget, basin character, physical and chemical erosion; 2) Temporal and spatial variations, ranging from seasonal to millennial, with particular emphasis on catastrophic events; 3) Human interactions: land degradation, river management, future impact of climatic change and anthropogenic activities. Includes a one-week field trip.

**MSCI 551 Directed Readings Shellfish Aq (1 Credit)**
This course is a discussion-based course focused on directed readings in the scientific literature about current topics in shellfish aquaculture. Topics will be selected by the instructors prior to the start of the semester. This course is also designed to assist students with problem solving, critical thinking and communication skills, while providing a critical basis for understanding a current topic in shellfish aquaculture.

**MSCI 552A Shellfish Aqua Practice: Ches (2 Credits)**
This short, intensive course provides a hands-on experiential learning opportunity, immersed in shellfish aquaculture in Maryland and Virginia. Students will be actively engaged at each operation (e.g., helping sort oysters, harvesting clams, assisting with hatchery larval care, etc.); students should expect to get wet and dirty and be tired at the end of each day. This course will provide students with an overview of the various types of shellfish aquaculture practiced in the Chesapeake Bay region, and an understanding of the implications for both public stock enhancement and private production.

**MSCI 552B Shellfish Aqua Prac: New Persp (2 Credits)**
This short, intensive course provides a hands-on experiential learning opportunity, immersed in shellfish aquaculture in a region outside Chesapeake Bay (e.g., New England, the Pacific Northwest, the Gulf Coast). Students will be actively engaged at each operation (e.g., helping sort oysters, harvesting clams, assisting with hatchery larval care, etc.); students should expect to get wet and dirty and be tired at the end of each day. This course will provide students with an overview of the various types of shellfish aquaculture practiced in the visited region, and an understanding of the implications for both public stock enhancement and private production. A student may repeat the course up to three times, provided the instructor determines there is no duplication of subject matter.

**MSCI 553 Bound Layer/Sediment Transport (3 Credits)**
This course addresses the physical and geological aspects of coastal and estuarine benthic boundary layers, their dynamic forcing and the associated suspension and transport of sediments. Principles of waves, tides and currents are introduced with emphasis on shall-water processes. Boundary layer structure and shear stress on the seabed, wave boundary layers and turbulence are considered in relation to the coastal environment. Forces on sediment particles, initiation of sediment movement and principles of sediment transport are treated at an intermediate level.

**MSCI 554 Principles Numerical Computing (3 Credits)**
This course provides students in the marine sciences with the tools needed to pursue study and research using numerical methods. It will enable them to write programs to solve fairly complex problems, to explore and understand the current literature in which numerical methods are used. Topics include principles of floating-point computation, interpolation, linear and non-linear systems of equations, numerical integration, ordinary and partial differential equations, and optimization. Emphasis is placed on finite difference solutions to conservation of mass and momentum equations. The course consists of three lecture hours per week, assigned problems using MATLAB, and a final exam.

**MSCI 556 Foundations of Stats & Data Sc (3 Credits)**
Focus is on training the student to become both a "consumer" and a "producer" of the most common statistical and data analyses in modern environmental science research. This course is for students with previous post-secondary course(s) in statistics or data science.
Prerequisite(s): MSCI 504 or MSCI 561

**MSCI 557 Economies of the Coast (3 Credits)**
This course explores key economic sectors of coastal communities around the world—seafood production, tourism and recreation, real estate, and energy—illustrating economic concepts, ideas, and tools through a variety of case studies and real-world applications. Topics covered are expected to include rational choice theory, trade and market formation, externalities, ecosystem goods and services, and tools of policy evaluation.

**MSCI 560A Shellfish Aquaculture:Bio&Prod (1 Credit)**
Bivalve Shellfish Aquaculture is a sequential series of modules offered over one semester designed to introduce students to all aspects of bivalve shellfish aquaculture, including 1) shellfish biology and production methods (MSCI 560A), 2) environmental interactions (MSCI 560B), and 3) socioeconomic considerations (MSCI 560C). Taken individually or collectively, the intent is to provide students a strong background in bivalve shellfish aquaculture to qualify them as competent to work with issues related to commercial shellfish aquaculture. This is not a course intended to teach someone how to become a shellfish farmer. Lectures will be set in a global context and be inclusive of a wide variety of bivalve species, with a focus in field labs on species of importance in Virginia and Chesapeake Bay. Biology & Production (MSCI 560A) is a short course designed to introduce students to bivalve shellfish aquaculture biology & production methods from spawning through nursery and field grow-out. Topics will include an overview of typical shellfish life cycles and life history characteristics, as well as broodstock conditioning practices, selective breeding principles and application, micro-algal culture, hatchery and nursery management, and an overview of extensive and intensive grow-out methods. This course is also designed to assist students with problem solving and communication skills. Assessment of learning outcomes will be conducted through the end of the semester.

**MSCI 560B Shellfish Aquaculture: Env Int (1 Credit)**
Bivalve Shellfish Aquaculture is a sequential series of modules offered over one semester designed to introduce students to all aspects of bivalve shellfish aquaculture, including 1) shellfish biology and production methods (MSCI 560A), 2) environmental interactions (MSCI 560B), and 3) socioeconomic considerations (MSCI 560C). Taken individually or collectively, the intent is to provide students a strong background in bivalve shellfish aquaculture to qualify them as competent to work with issues related to commercial shellfish aquaculture. This is not a course intended to teach someone how to become a shellfish farmer. Lectures will be set in a global context and be inclusive of a wide variety of bivalve species, with a focus in field labs on species of importance in Virginia and Chesapeake Bay. Environmental Interactions (MSCI 560B) is a short course designed to introduce students to interactions between bivalve shellfish aquaculture and the environment. In the first half of the course, lectures will focus on the effects of the surrounding environment on shellfish aquaculture including global climate change impacts, supply of phytoplankton to support bivalve growth, and impacts of fouling organisms. In the second half of the course, lectures will focus on the effects of bivalve shellfish aquaculture on the surrounding environment impacts on local water quality and benthic habitats, impacts on adjacent natural habitats, the potential for aquaculture to introduce or facilitate the spread of non-native species and disease. The role of farm practices in limiting the impacts of aquaculture on the surrounding environment will also be discussed. The lab portion of the course will provide students with the opportunity to lead and participate in class discussions of relevant scientific literature.

**MSCI 560C Shellfish Aqua:Socioecon & Pol (1 Credit)**
Bivalve Shellfish Aquaculture is a sequential series of modules offered over one semester designed to introduce students to all aspects of bivalve shellfish aquaculture, including 1) shellfish biology and production methods (MSCI 560A), 2) environmental interactions (MSCI 560B), and 3) socioeconomic considerations (MSCI 560C).Taken individually or collectively, the intent is to provide students a strong background in bivalve shellfish aquaculture to qualify them as competent to work with issues related to commercial shellfish aquaculture. This is not a course intended to teach someone how to become a shellfish farmer. Lectures will be set in a global context and be inclusive of a wide variety of bivalve species, with a focus in field labs on species of importance in Virginia and Chesapeake Bay. Socioeconomics & Policy (MSCI 560C) is a short course designed to introduce students to bivalve shellfish aquaculture economics, policy, and broader social dimensions. Topics will cover shellfish markets, production costs and business planning, consumer preferences, supply chains and economic impacts, regulatory and management considerations, and the broader social context of bivalve shellfish culture. In addition to bi-weekly lectures, students will hear perspectives on class topics from growers and other industry members.

**MSCI 561 Intro R and Coding with AI (3 Credits)**
This course is aimed at people with no programming experience, to get participants comfortable using R. After taking this course, participants will be able to read data into R, wrangle data in preparation for analysis, conduct analysis and visualization, learn how to write functions and debug code. The course emphasizes workflow and reproducibility. Articulation of questions is first, followed by a plan for analysis, which is then translated to pseudocode, to provide the marching orders for writing computer code. The course also teaches you how to use generative AI tools to convert your pseudocode to computer code, greatly accelerating your work. Writing good pseudocode is not easy, and evaluating AI output requires domain knowledge of programming, sousing AI tools successfully is not easy. This is *not*a statistics course, but rather a methods course to teach you how to use R. It is a useful precursor to statistics and modeling classes that use R.

**MSCI 562 Environmental Pollution (2-3 Credits)**
This course will introduce students to processes impacting aquatic environments. Emphasis will be on pollution by man-made chemicals and metals. Additional topics include consequences of excessive nutrients, habitat modification and introduction of exotic or elimination of native species. Students have the option to register for 2 credit hours (lecture only) or 3 credit hours (lecture with an in-class student presentation).

**MSCI 567 HABs & Toxins (2-3 Credits)**
Course focused on the ecology and toxicology of harmful algal blooms and their toxins. Global and local perspectives will be presented in the context of human and ecosystem health, under the stressors of climate change, eutrophication, and societal needs.

**MSCI 571 Marine Ecology (3 Credits)**
The course covers the fundamental processes underlying structure and functioning of marine ecosystems, both pelagic and benthic, and application of those principles to understanding responses of marine ecosystems to anthropogenic and natural global change. Lectures, readings and discussion will emphasize physical processes supporting primary production, planktonic and benthic dynamics, distribution and functional importance of marine biodiversity, biotic interactions structuring communities, and food web structure. The course concludes with a survey of the major marine ecosystem types. A central part of the course involves design, writing, reviewing, and panel discussion of student research proposals.

**MSCI 574 Phytoplankton Ecology (2 Credits)**
This course will provide a fundamental understanding of modern phytoplankton ecology – the relationship of phototrophic plankton to one another and their environment. Topics covered in this course will include, phytoplankton blooms, toxin production, phytoplankton mortality, and how to conduct experiments with and sample for phytoplankton.
Prerequisite(s): MSCI 501D

**MSCI 597 Internship in Marine Science (4 Credits)**
Students will complete an internship with an organization that is engaged in clearly defined marine or environmental science#oriented programs or activities relevant to the student's preparation, capstone project, and individual development plan.

**MSCI 598 Capstone Research Mar Sci (2-6 Credits)**
Students will conduct independent research that translates, integrates and applies marine science knowledge to an issue in management, policy, law, business, or education. Projects are co#advised by a VIMS faculty member and an individual from the relevant professional field.

**MSCI 599 Thesis (1-12 Credits)**
This is the avenue for original research in biological, chemical, geological and physical oceanography, environmental science, marine fisheries science and marine resource management. The master's project is chosen in consultation with the student's major professor and the Associate Dean for Academic Affairs.

**MSCI 602 SCHISM Modeling (3 Credits)**
The focus of this course is on learning SCHISM, an inter-disciplinary simulation package for rivers, estuaries and oceans. Students will develop understanding of key components of the model and learn how to build the model for real systems from raw DEMs, and conduct simple skill assessment.
Prerequisite(s): MSCI 531 or MSCI 554

**MSCI 611 Estuarine Hydrodynamics I (3 Credits)**
The class is a coordinated treatment of the physical oceanography of estuaries. The course will start with introduction of fundamental principles of fluid dynamics including conservation of mass, momentum, vorticity and the resulting irrotational, inviscid, and boundary layer basic flow patterns. It will then be extended to the core of estuarine hydrodynamics. After finishing the definition and classification of estuaries, the focus will be shifted toward an analytic description of the major physical processes in the estuaries that include the governing equation for tidal dynamics, gravitation circulation and wind-driven circulation along with their analytical solutions and the associated physical interpretations. The role of turbulence mixing in the stratified shear flow regime of estuaries will be illustrated. Lastly, the important topic of interaction between estuaries and shelf sea will also get introduced.

**MSCI 626 Global Ocean Change Biol (2 Credits)**
This course will provide (1) a scientific foundation of physical processes that shape climate (e.g. solar variability, greenhouse gases, atmospheric and oceanic circulation, and volcanic aerosols) and (2) a scientific foundation of biological consequences of global environmental change. Evidence for past and present global environmental change will be discussed, including sea level change, variation in freshwater inputs, and shifts in temperature and acidity. Biological and ecological processes that result from changing ocean conditions will include range shifts, phenological shifts, acclimatization, and local adaptation.

**MSCI 627 Marine Organic Geochemistry (3 Credits)**
Marine Organic Geochemistry is an upper-level graduate course in the Batten School of Coastal & Marine Sciences graduate curriculum. Organic geochemistry is the study of the transformations of organic matter from its origins in biological organisms through its preservation in the geosphere. This course will introduce you to the field of organic geochemistry and its applications to understanding the sources and fates of organic matter in the water column of marine systems as well as that deposited to modern and ancient sediments.

**MSCI 631 Wetland Ecogeomorphology (3 Credits)**
This course focuses on the geomorphic and biological processes influencing coastal wetlands. The course examines interactions between sediment transport and plant growth in barrier islands, coastal lagoons, and estuarine headwater and tidal marsh environments. Through a series of lectures, field trips, assigned readings and an independent project, students will examine geological and biological processes and learn how both natural and anthropogenic factors shape these coastal ecosystems. One Saturday field trip to the Eastern Shore Laboratory is required.

**MSCI 644 Aquatic Epidemiology (3 Credits)**
This course will cover graduate level topics in Epidemiology. Students will gain the ability to critically assess epidemiological literature, design epidemiological studies, and analyze epidemiological data. Where possible, content will focus on aquatic environments and organisms, including human aquatic diseases. A preliminary working knowledge of basic statistics is required. Previous competency in R computing language is expected.
Prerequisite(s): MSCI 504 or MSCI 554 or MSCI 556

**MSCI 649 Ecosystem Modeling (3 Credits)**
This course provides an introduction to quantitative ecosystem modeling in marine science, with an emphasis on the process of constructing mechanistic models of biological, ecological, and biogeochemical processes. Topics include the history of these models, the mathematics behind them, the modeling process (i.e., determination of objectives, model formulation, parameter estimation, calibration/validation, skill assessment, and uncertainty analysis), and use of models to address scientific questions through simulation analysis. The course will focus primarily on compartmental ecosystem and biomass-based individual/population models, with additional coverage of 3D water quality models, ecological network analysis (food web models), and recent or novel/alternative approaches. The course will consist of a series of interactive lectures, readings from textbooks and the primary literature, problem sets and hands-on computer labs, and an independent modeling project on a topic of interest to each student. The course assumes no prior modeling or programming experience.

**MSCI 650 Estuarine Ecology (3 Credits)**
This course covers the ecology of estuaries from the ecosystems perspective. Topics will include both the abiotic setting of estuaries, including geological, physical, and chemical processes, and the biotic components and their interactions, including nutrient dynamics, biogeochemistry, primary production, ecosystem metabolism, secondary production, food web dynamics, and structured habitats. The course ends with overviews of current and emerging issues in estuarine science, including eutrophication, freshwater diversion, and climate change. Class meetings will consist of informal lectures and interactive discussions, supplemented with readings from textbooks and the primary literature and "virtual field trips" to specific estuaries. Students will work on a semester-long project to synthesize course content into an estuarine-focused wiki or website, and will develop a final project on a focused topic or estuarine system(s) that synthesizes available literature, data, and/or models.

**MSCI 655 Marine Physiological Ecol (2 Credits)**
To provide an introduction to foundational literature in marine physiological ecology - the study of how the function of marine organisms interacts with and is influenced by the surrounding environment. The course will incorporate comparative and evolutionary themes into physiological topics and will touch on molecular and cellular mechanisms. The course will emphasize the organismal, ecological, and evolutionary significance of physiological function.

**MSCI 658 Larval Ecology (3 Credits)**
The course is based on a broad discussion of the following topics within the marine invertebrates: the concept of the larval form, spawning and developmental patterns, limitations on the fertilization process and embryology, the Reynolds number environment at typical larval size, feeding and nutrition in the larval size range, larval size and parental investment, larval dispersal and supply in maintaining community structure, roles of physical versus biological processes in inducing metamorphosis, early post-metamorphic survival, and larval ecology in extreme environments.

**MSCI 663 Deep-Sea Biology (2,3 Credits)**
Students will receive an introduction to the animals of the deep sea and characteristics of deep-sea and polar ecosystems. Lectures will survey the major metazoan groups found in deep-sea habitats, as well as physical characteristics of the environments and adaptations to life in these cold, dark, hyperbaric regions.

**MSCI 666 Ichthyology (4 Credits)**
Fishes form a large, diverse group of vertebrates that are culturally, economically, and scientifically important, and they offer much for the study of evolutionary biology. This course provides an intensive overview of all aspects of the evolution of fishes, with an emphasis on their morphology and systematic relationships. The lectures cover the diversity and evolutionary history of fossil and living fishes, and discuss the evidence for different hypotheses of their phylogenetic relationships; other topics include the biogeography, functional anatomy, physiology, and behavior of fishes. The mandatory lab section emphasizes dissection-based anatomical study and the global diversity of fishes, and includes some field sampling.

**MSCI 667 Got Data, Now What? (2-3 Credits)**
NOTE: When taken for 3-credit hours, course requires students to complete an accompanying project and report. This course is aimed at students who have data from lab experiments, field surveys, or field experiments, and who are in the process of evaluating their experimental designs and analyzing their data. It is expected that students come with either potential or actual experimental designs for their research, and real data sets from their research to be analyzed during the course. The course will include (i) examination of scientific modes of inference, including classical/frequentist, Bayesian, and Information Theory (IT), with emphasis on IT; (ii) review of basic concepts of experimental design; (iii) evaluation of each student's experimental design; and (iv) conduct of statistical analyses suited to the students' research, such as survey design, ANOVA, linear/nonlinear regression, and GLMs/GAMs. Analyses will be conducted in R.
Prerequisite(s): MSCI 504

**MSCI 668 Malacology (3 Credits)**
The course begins with a discussion of the ancestral mollusc form and the fossil record, proceeds through examination of the structure and function of the molluscan shell. It concludes with reviews of molluscan taxonomy, reproductive biology, physiology, ecology, and feeding mechanisms.

**MSCI 669 Applied Regression Analysis (3 Credits)**
This course emphasizes the design and analysis of data from controlled laboratory experiments and field-based studies, including observational studies, surveys, and experimental manipulations in natural systems. Students develop a working knowledge of regression modeling for ecological data, including methods for non-normal responses, zero-heavy data, nonlinear relationships, and spatial and temporal structure. Topics may include linear, generalized linear, and mixed effects models; delta and hurdle formulations; generalized additive models; and an introduction to spatiotemporal and nonlinear mixed effects models, with emphasis on model selection, performance, interpretation, and application to real-world problems.
Prerequisite(s): MSCI 556

**MSCI 672 Ecology of Fishes (3 Credits)**
This is an ecology course in which we focus on fishes. We will consider key concepts and questions in ecology using both terrestrial and marine literature, with fishes as our focal group. The course is primarily focused on marine fishes and will assume some knowledge of oceanography. Topics fall under the broad concepts of autecology, community ecology, biogeography and global change. The course includes an individual project, which students should use to focus on their own study system or species. The course does not provide detailed treatment of systematics, morphology (MSCI 666: Ichthyology), physiology (MSCI 529: Fish Physiology; MSCI 655: Marine Physiology Ecology), population ecology (MSCI 671: Fisheries Population Dynamics), parasitoid ecology (MSCI 559: Parasitology), genetics (MSCI 583: Molecular Genetic Data Analysis, Bioinformatics), or management.

**MSCI 673A Prin Molecular Biology (2 Credits)**
This is a lecture, laboratory, and computer laboratory course covering the principles and practice of analyzing and interpreting genomic, metagenomic, population genetic and phylogenetic datasets. Overall, the course will cover the evolutionary processes responsible for the intra- and interspecific genetic relationships among marine organisms, with an emphasis on the application of current molecular methodologies. This modular course (MSCI 673A) covers basic molecular genetic principles and molecular biology techniques during the first half of the semester. For the second half of the semester, students will choose one of two modules (MSCI 673B or MSCI 673C) focusing on molecular genetic studies and bioinformatic analyses of either prokaryotic or eukaryotic organisms.

**MSCI 673B Metagenomics & Bioinformatics (2 Credits)**
This modular course delves into the fascinating realms of metagenomics and bioinformatics, exploring the intricate interactions between microbial communities and their environments. Through a blend of theoretical discussions, practical laboratory experiments, and student presentations, participants will gain a comprehensive understanding of the principles, methods, and applications of biodiversity research and monitoring.
*Corequisite(s):* MSCI 673A

**MSCI 673C Prin Mol & Phylo-Genetics (2 Credits)**
This modular course centers on producing various types of molecular data and analyzing this data within the contexts of population genetics and phylogenetics. Students will conduct a variety of laboratory experiments including extraction of DNA from environmental samples, microsatellite and SNP analysis, fluorescent in situ hybridization, and qPCR. Students will understand the principles of population genetic analysis including generation and interpretation of basic metrics and the principles of phylogenetic analysis including parsimony, maximum likelihood, and Bayesian algorithms.
*Corequisite(s):* MSCI 673A

**MSCI 676 Bayesian Modeling (1 Credit)**
This short course introduces the principles of Bayesian modeling through lectures, reading assignments, and labs. Hands-on computational exercises (mostly toy examples) will provide practice of the principles. The workshop also showcases the flexibility of Bayesian modeling (as opposed to traditional likelihood-based methods), but it is not designed to provide the type of advanced training that is required to conduct analyses that are more complex than the simplest generalized linear mixed models.
Prerequisite(s): MSCI 669

**MSCI 679 Temporal & Dependent Data (3 Credits)**
Field data often violate the independence assumption that is required by standard linear and generalized linear/additive regression models. In this course, modeling needs are showcased through research examples from the environmental sciences. Basic modeling frameworks are introduced to equip the student with the ability to (a) recognize dependencies that require special handling, (b) apply the simplest relevant models to assess the need for more advanced modeling, and (c) to locate advanced modeling reference materials. This course continues from MSCI669, covering a wide range of statistical topics, from intermediate to advanced. The time-series component of this course is presented in the context of regression modeling (as opposed to spectral analysis or dynamic models).
Prerequisite(s): MSCI 669 and MSCI 556

**MSCI 687 Environmental Policy (3 Credits)**
This course explores policy making for environmental problems and focuses on issues that are local, national, and international. This course will cover the application of welfare economics to environmental problems. Topics include differences in consumer surplus and other measures of economic welfare and techniques to measure the economic value of enfironmental resources. We examine national environmental policy, and how that policy is implemented at a local and regional level. We examine the U.S. laws and regulations as well as each agency's approach for quantitatively assessing the benefits and costs of environmental policy.

**MSCI 688 Marine Policy & Mgmt Seminar (1-2 Credits)**
Students will explore marine science-policy-management interfaces in a weekly seminar-style course and through field trips to Washington, D.C. (federal-level) and the Virginia state capitol in Richmond, (state-level). Through discussions with scientists and other professionals, students will learn how scientists are involved in policy development and management decisions. They will have an opportunity to increase awareness of the critical professional skills and competencies scientists need for careers at translational marine science-policy-management interfaces and have opportunities to practice professional networking skills. To receive 2 credit hours, students will also be required to investigate a specific coastal or marine policy topic not covered in class and produce a stakeholder aligned product. Example products may include a white paper, policy analysis, persuasive essay, or a presentation to a stakeholder group or the public. Grading is pass/fail.

**MSCI 689 Pub Pol for Sci & Professions (3 Credits)**
This course examines what governments do and do not do. The class employs an engaging seminar format using provocative materials with practical applications. Students study the assumptions of public policy analysis, markets and government, tools for analysis, and political institutions (e.g., the executive, legislative branches and interest groups).This course is specifically designed for an interdisciplinary class of professional or graduate students from the Schools of Business, Education, Law, and Marine Science, as well as those in the School of Arts and Sciences who are not in a public policy degree program. Students will come to understand public policy as an academic discipline and as a systematic method of thinking about the design, development, and evaluation of public sector policies and programs.

**MSCI 690 Spatial Modeling (1 Credit)**
This 1-credit intensive workshop introduces the basic principles of Bayesian modeling of spatial / spatio-temporal processes. Hands-on computational exercises (mostly toy examples) provide practice of the principles. Students are given a roadmap towards future advanced training beyond this course to facilitate the modeling of real-life spatio-temporal data.
Prerequisite(s): (MSCI 676 or MSCI 679)

**MSCI 693 Environmental Law (2-3 Credits)**
A study of the natural environment and the history of laws designed to balance environmental protection with industrial development. The course will consider the basic regulatory framework for water, air, natural resources, and solid and hazardous waste through the lens of state and federal law, with consideration given to the changing legal landscape presented by today's U.S. Supreme Court, politics, and science.

**MSCI 694 Land Use (2-3 Credits)**
An analysis of the legal principles governing the use and management of land and the fundamental values underlying those principles. While focusing primarily on government regulation of land use, the course also will examine common law rules which affect the way that land is used. Topics that might be considered include judicial control of land use, zoning and the rights of landowners, zoning and the rights of neighbors, land use planning, public regulation of land development, aesthetic regulation, and the preservation of natural and historic resources.

**MSCI 695 Administrative Law (3-4 Credits)**
Administrative law establishes the legal controls over the operation of government and hence it relates to almost every legal practice, from security regulation to social programs to criminal justice. This course is an introductory examination of the rules and procedures of government federal agencies. It explores: (1) the Constitutional background and limitations on agency action, (2) the procedural requirements (from various sources) that an agency must follow, and (3) the doctrines of judicial review that apply whenever a court evaluates agency decisions.

**MSCI 696 Distributed Courses in MSCI (1-3 Credits)**
This is an avenue through which students can participate in distributed courses to gain experience and training in topics not covered through regular catalog courses and not amenable to other special topics courses (MSCI 548 or 698). Distributed courses are those that are conducted on-line or through other distance-learning methods, that contain significant content from faculty outside of Batten School & VIMS and William & Mary and for which no other mechanism for awarding credit is available (e.g., transfer of credit from another institution). Batten School faculty are responsible for coordinating the approval of the course and agree to take responsibility for delivery of course content, ensuring student participation, providing a mechanism for addressing questions from students, and assessing the student's learning of the material. Subjects will be announced prior to registration and after approval by the Batten School & VIMS Graduate Policy & Curriculum Committee.

**MSCI 697 Advance Problem Marine Science (1-4 Credits)**
This is the avenue through which supervised projects may be selected to suit the needs of the graduate student. Projects are chosen in consultation with the student's academic advisor and the instructor. Acceptable research outlines and project reports are required, and the amount of credit depends upon difficulty of course. Examples of projects offered in recent years include management issues in shellfish sanitation; groundwater nutrient processes; bacterioplankton methods and techniques; pesticide analysis in environmental samples; marine molecular population genetics; and law and policy relating to the introduction of non-indigenous plants. Subjects will be announced prior to registration and after approval by the Batten School & VIMS Graduate Policy & Curriculum Committee.

**MSCI 698 Topics in Marine Science (1-3 Credits)**
This is the avenue through which subjects not covered in other formal courses are offered. These advanced courses are offered on an occasional basis as demand warrants. Subjects will be announced prior to registration and after approval by the Batten School & VIMS Graduate Policy & Curriculum Committee.

**MSCI 699 Dissertation (1-12 Credits)**
This is the avenue for original research in biological, chemical, geological and physical oceanography, environmental science, marine fisheries science and marine resource management. The doctoral project is chosen in consultation with the student's major professor and the Associate Dean for Academic Affairs.