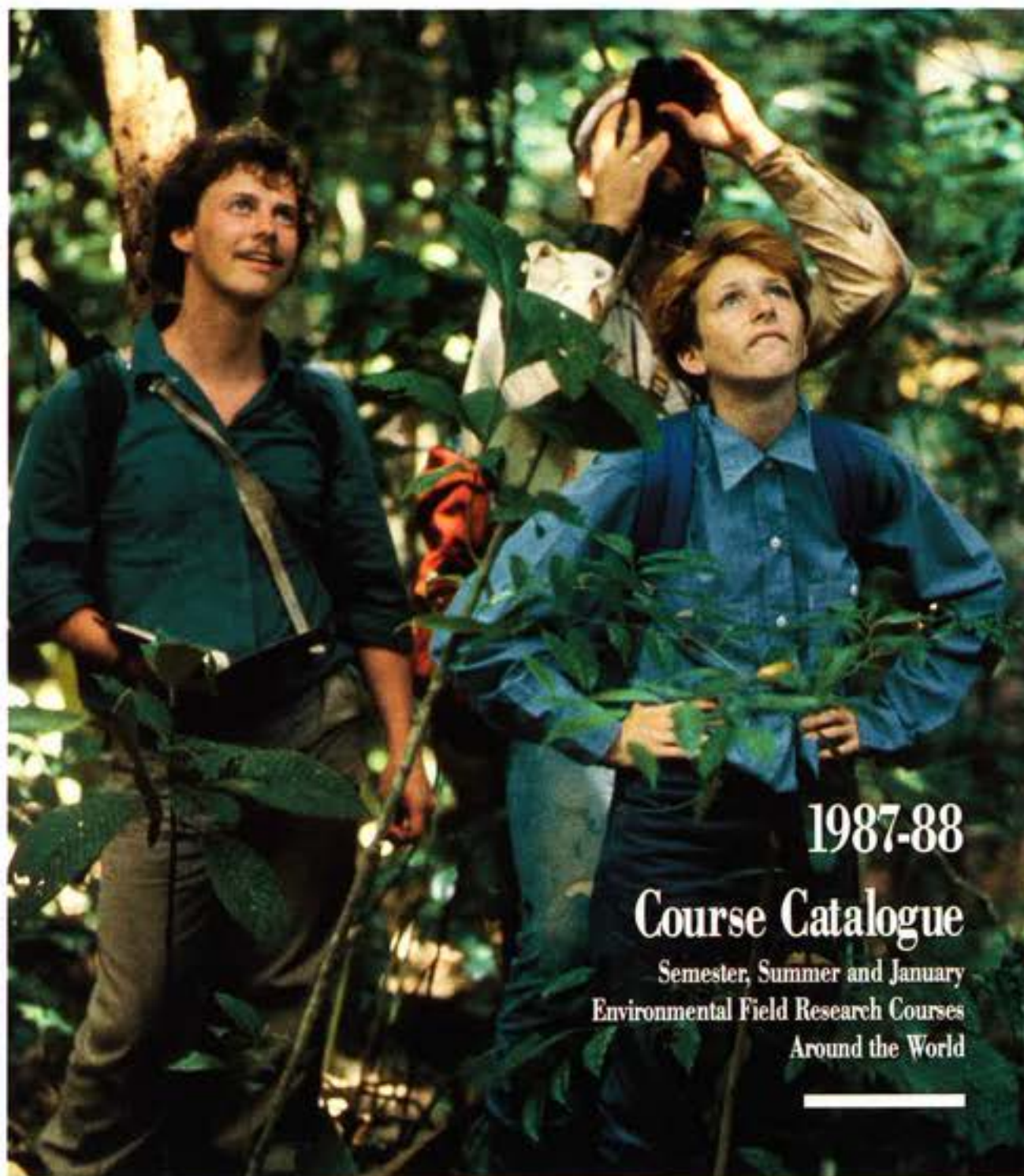


THE SCHOOL FOR FIELD STUDIES



1987-88

Course Catalogue

Semester, Summer and January
Environmental Field Research Courses
Around the World

THE WORLD IS YOUR CLASSROOM

I refuse to let school stand in the way of my education."



Mark Twain came right to the point. Do you know what your education is?

The "school" in The School for Field Studies is probably different from what you have experienced. It is active—you participate, you apply concepts to real situations, you wrestle with real problems. Trite as it may sound, there is no reason on earth why learning can't be fun...new places, new friends, new concepts, new challenges.

But don't make the mistake of thinking "fun" means easy. You will still have homework, exams, papers—in fact, our expectations may be higher than you are used to. But if you become as involved and interested as most of our participants do, it will be hard work that is deeply rewarding. An educational adventure different from any other you have known.

Try it. You might just get an education.

Sincerely,

James L. Elder

James L. Elder, Jr.
President

P.S. No previous scientific experience is necessary to join us. Call us at (617) 927-7777, our Admissions staff will be happy to answer your questions about admissions, financial aid or academic credit.



THE SCHOOL FOR FIELD STUDIES

CONTENTS

	Page
WHAT IS SFS?	2-4
Team Profile	3
Academic Credit	4
Selected Research Papers	4
CURRICULUM	5-7
Semester	5
Month-long	7
FACULTY	8-9
SFS-AFRICA	10-13
SFS-AUSTRALIA	14-17
SFS-VIRGIN ISLANDS	18-23
SFS-CENTRAL/SOUTH AMERICA	24-29
SFS-EUROPE	30-33
SFS-NORTH AMERICA	34-47
PROCESSES AND REQUIREMENTS	48-50
Admission	48
Financial Aid	48
Academic Credit	48
Open Houses	48
Deposits, Tuition & Fees	49
Travel & Equipment	49
Refunds	49
Student Conduct	50
Changes	50
APPLICATION FOR ADMISSION	51
SFS ORGANIZATION	53

1987-88 CURRICULUM

	SEMESTERS		JAN. TERM	JUNE 16 to JULY 15	JULY 22 to AUG. 20	PAGE
	FALL	SPRING				
SFS-AFRICA						10-13
Wildlife Ecology and Management Semester Program	■	■				12
Wildlife Management				[B]	[A]	13
SFS-AUSTRALIA						14-17
Biogeography: Patterns of Ecological Diversity Semester Program	■	■				16
Tropical Species Diversity				[A]	[B]	17
SFS-VIRGIN ISLANDS						18-23
Marine Biology and Management Semester Program	■	■				20
Coral Reef Ecology				[A]	[A]	21
Marine Parks Management				[B]		22
Sources of Reef Fish Toxins					[B]	23
SFS-CENTRAL/SOUTH AMERICA						24-29
Deforestation: Tropical Rainforests					[A]	24
Medicinal Botany: Discovering New Plant Medicines				[B]	[B]	26
Endangered Monkeys: Experimental Social Ecology			■	[A]	[B]	28
SFS-EUROPE						30-33
Recovery of Endangered Species				[A]	[B]	30
"Acid Rain": Changing Forest Ecosystems?				[A]		32
SFS-NORTH AMERICA						34-47
"Acid Rain": Changing Aquatic Ecosystems					[A]	34
Dolphin Biology and Behavior			■	[A]	[B]	36
Social Ecology of Spinner Dolphins				[B]	[A]	38
Parks for Preservation: Large Mammal Ecology				[B]	[A]	40
Ecology of Bald Eagles				[A]	[A]	42
Population Dynamics of Harbor Seals				[A]	[B]	44
Humpback Whale Ecology						46

Level B: June 8-July 7
Level A: July 2-31
Level A: July 27-Aug. 25

SFS is a private, non-profit, educational institution.

Front cover photo: William F. McComas
SFS students and faculty searching for tiny tamarin monkeys in the Panamanian jungle canopy.

Inside cover photos: Paul Valiulis, Joe Madison
Back cover photo: Jack Shea
SFS research team observing dall sheep behavior in Alaska.

WHAT IS SFS?

Since 1980 The School for Field Studies has launched more than 100 student **research teams** in unique **field-based courses** throughout the world, immersing students directly in the ecosystem they are studying and teaching them the **skills** they will need to address critical environmental issues.

SFS operations span five continents. SFS bases in Kenya, the Virgin Islands and Australia operate on a year-round basis and are the sites of ongoing long-term research by semester and summer course participants. SFS month-long courses operate out of more than a dozen mobile bases, affording an unparalleled opportunity to locate our studies in an ecosystem offering the most dramatic illustration of the environmental issue under consideration.

The decision to take an SFS course in the middle of the summer was a difficult one. Instead of saving money, I'd be spending it. Since my return, I have not regretted my decision once, this was the greatest learning experience I've ever had."

Susan Nemo
Groton, NY
SUNY - Binghamton

Courses

We have built our educational model on the examination of a particular environmental problem or issue—such as acid rain, wildlife management or deforestation—while structuring our courses around traditional academic disciplines including wildlife biology, tropical ecology, animal behavior, and marine biology. Each problem we investigate exceeds the limits of a clear, text-book case, as we consider a complex network of interrelated social, biological and technological processes in our assessment. All SFS courses offer participants the opportunity to observe and participate in local issues while our semester programs expand that opportunity as we situate these issues within their global context.

SFS courses are structured, intense academic endeavors accredited for college-level science. (For information on academic credit see page 4.) Each course incorporates lectures, assigned readings, critical reviews of current research papers, independent projects and presentation and exams. Training in field research methodology leads to long, often arduous hours of data collection using SCUBA diving, tracking, censusing, capturing or any of a dozen other methods. The pursuit of our research goals is enhanced by a sense of discovery, the knowledge that we are contributing to a valuable effort, and the joy of sharing a remarkable experience.

Research

Our research component provides a unique opportunity to make a personal contribution to science and humanity. Addressing issues such as how to feed an expanding world population, how to control loss of species diversity and how to balance the growing conflicts between development and conservation, we directly engage in critical, real world problem-solving.

'Doing' science is harder than reading about science. We think of science as a verb—an **action** word—not a noun. Each course concludes with a final report, many of which have been published in scientific literature (bibliography available upon request). Examples of research projects include: the effects of human generated activity on whales and seals, the impacts of hazardous waste on shellfish populations, the behavioral changes evidenced by giraffes on a Kenyan game ranch and the pharmaceutical value of plants growing in the Ecuadorian Andes.

Based on my daughter's experience in Prince William Sound, I recommend SFS with unqualified enthusiasm. Here is an intellectual challenge, even a spiritual opportunity, to care about threatened environments and to learn how to make a difference."

Donald Abbott
Headmaster, Millbrook School
Millbrook, NY

Field Based Curriculum

The world is your classroom—and it's the best of all possible laboratories. By situating our courses in the midst of carefully chosen ecosystems, we have an unequalled opportunity to immerse ourselves in real-life illustrations of what we only imagined in classroom lectures. Facts and theories come to life in a way that textbooks can't match. Much of our work—our wildlife management research in Kenya, our work with dolphins and whales, our behavioral studies of primates in Panama—requires special permits, affording us access to sites and experiences not available to tourists. Camping in tents or working out of our permanent base sites provides us a mobile base of operations and an opportunity to experience firsthand the delicate balances and interactions of the ecosystem we are studying.

Skills

SFS courses are designed to teach you the skills you need—in research methodology, teamwork, a scientific discipline, and outdoor living. No other program offers growth and development in all these areas. **You do not need field training, a science background or previous experience to participate in an SFS introductory course.** We have designed courses on two levels to accommodate introductory and advanced students. We will teach you how to approach a problem, how to form a hypothesis, how to work as a team utilizing each member's strengths and weaknesses to the benefit of the entire group. You will learn how to engage in problem solving under real-life circumstances. These are valuable, life-long skills applicable to any career or direction you choose to pursue.

This is how learning should be. You don't have to be a biology major to love it!"

Frank Lorch
Pataskalus, OH
University of Notre Dame

Teams

As an SFS participant, you become an active member of the team, involved in all aspects of our research and day-to-day living. This team approach to learning and problem solving is the heart of the SFS educational philosophy and is one of our greatest strengths. Working with new people from many different backgrounds under demanding conditions teaches us something about ourselves, how we relate as members of a team, how we adapt to new people and different environments. Living and traveling together, whether for 30 days or for 12 weeks, presents many challenges. As we have a great deal of important work to accomplish in a limited amount of time, there is little opportunity for extended ventures on your own. You will have time to yourself for personal reflection.

A sense of comradery builds daily as we share tasks—setting up camp, cooking, tackling a challenging aspect of the research or sharing thoughts at the end of a long day. Learning how to work with each other, how to communicate effectively within a diverse group are skills we will utilize far into our futures. Not the least of the benefits of an SFS course is the strong network of friendships that grow from sharing special experiences and working toward a common goal.

Team sizes range from 15 students and two faculty on month-long courses to 22 students and four faculty on semester programs. **Students** from public and private high schools and colleges and graduate programs, from science as well as liberal arts majors, and from across North America and many foreign countries have contributed to the success of SFS research

teams. Approximately 35% of these students are recipients of SFS financial aid awards. (For financial aid information see pg. 48.) Ranging in age from 16 to 26, all share a desire to learn more about the natural world.

SFS faculty are special people. Selected for their extensive teaching and field experience, knowledge of the research topic and strong interpersonal skills, they are carefully chosen from hundreds of applicants worldwide. Complementing their strong backgrounds in the sciences (the majority hold Ph.D.s) are a broad range of skills and experiences that uniquely qualify them to lead SFS courses. The success of SFS programs—in effectively challenging your intellectual, physical and social capacity and in building your self-confidence and self-reliance—can in large measure be attributed to our outstanding faculty.

TEAM PROFILE — PRIMATE BIOLOGY AND BEHAVIOR/ PANAMA - JULY, 1986

Photo: William McComas



Faculty:

Dennis Rasmussen, Ph.D.

Carol Skinner, Ph.D.

Students:

Boris Dolgonos
Oceanside, NY

Elizabeth Fleming
Lighthouse Park, FL

David Jolly
E. Aylmer, Ontario, CANADA

Gwen Lighter
Rye Brook, NY

Aimee Mark
Randallstown, MD

Lois Morrison
Lake Forest, IL

Siegfried Musser
Chicago, IL

Michael Palopoli
Union Lake, MI

Dustin Penn
Oklahoma City, OK

Brian Roley
Los Angeles, CA

School/Major:

University of California-Riverside
(Comparative Psychology)

Kent State University
(Ecology/Animal Behavior)

Jr./Oceanside H.S.

Jr./Tufts University
Major: Political Science
Sr./Arthur Voaden Secondary School

Jr./Blind Brook H.S.

Jr./Barnard College
Major: Biochemistry
So./University of Pennsylvania
Major: Biological Basis of Behavior
Fr./Univ. California-Berkeley

Sr./Univ. of Michigan
Majors: Biology/Psychology

Jr./Central State University
Major: Biology

Jr./Wesleyan University

Interests:

Recipient of N.I.H. Senior National Research Award to study Macaque biology and behavior - Wisconsin Regional Primate Research Center

Instructor in Biology, Kent State University

Ham radio operator; Model U.N. Clubmember; Columbia University Science Honors Program

Career interest: Environmental Law; participant in Sea Turtle rescue project

Hopes to become a primatologist; participant Junior Conservationist Award program

Nature Center volunteer; varsity soccer, softball and cross-country

Conducting herpes drug research at NYU Medical School; wants to promote environmental change through awareness

Seeking hands-on experience to complement classroom learning; currently on SFS Biogeography Semester program in Australia

Alum of SFS Humpback Whale Ecology course, 1985; sails; regional award winner NASA Space Shuttle Student Involvement Program

Career goal is to work in animal behavior; scuba diver; research project on growth of goldfish retina

Interests include backpacking and photography; investigating a career in Behavioral Ecology

Seeking "active learning"; participated in Outward Bound/Sierras

Academic Credit

All SFS participants are registered at Northeastern University in Boston, which accredits all SFS courses. Twelve week semester programs that incorporate five courses carry 22-23 quarter credits, month-long summer courses carry eight quarter credits, and twenty-one day January term courses carry four quarter credits. Many students have arranged to receive credit, in most cases in the sciences, directly through their home school or college. A few of the over 80 colleges and universities that have awarded/accepted credit include:

Amherst College
Augsburg College
Barnard College
Bates College
Berca College
Boston University
Brown University
California Lutheran University
Carnegie-Mellon University
Clark University
Colby College
Colgate University
College of the Atlantic
Connecticut College
Dartmouth College
Dennison University
Duke University
The Evergreen State College
Framingham State College
Guilford College
Hamilton College
Harvard University
Haverford College
Indiana State University
Kansas State University
Kenyon College
Macalester College
Marlboro College
Merrimack College
Mount Holyoke College
Ohio State University
Oregon State University
Pennsylvania State University
Prescott College
St. Lawrence University
Salem College
Simon's Rock College
Smith College
Swarthmore College
Trenton State College
Tufts University
University of California
University of Cincinnati
University of Connecticut
University of Iowa
University of Maine
University of Massachusetts
University of New Hampshire
University of North Carolina
University of Pennsylvania
University of Southern Maine
University of Vermont
University of Wisconsin
Virginia Polytechnic Institute
Washington University
Wellesley College
Williams College
Xavier College

Please contact the Admissions Office for further details.



The world is your classroom, and the best of all possible laboratories.

Photo: Jack Shea

SELECTED RESEARCH PAPERS RESULTING FROM SFS FIELD COURSES

1982 to present (partial listing)

Coral Reef Ecology, St. John, U.S. Virgin Islands 1982, 1983, 1984, 1985, 1986

BRODY*, M., S.J. MILLER*, M.T. BALBACH**, J.M. EAGLES**, M.L. FINLEY**, H.C. FOWLER**, R.D. ING**, R.A. MADON**, W.S. MALDONADO**, D.P. REMSEN**, N.A. ROSE**, P. SIMPSON**, T.R. WHITE**, 1984

Man and the Biosphere: Ground Truthing Coral Reefs for the St. John Island Biosphere Reserve. Report to the Virgin Islands National Park Service.

Deforestation and Tropical Rain Forest Ecology, Ecuador and Costa Rica 1984, 1985, 1986

PALLANT*, E.V. KAPOS*. *In preparation.*
Occurrence of tree-fall gaps in two sites in the Napo River Basin of Ecuador.

Ecology and National Park Planning, Atacama Desert, Chile 1983

RAEDEKE*, K.J., J.A. SIMONETTI*. *In review.*
Food habits of *Lama guanicoe* in coastal desert of northern Chile. *Journal of Mammalogy*.

Hazardous Waste and Coastal Ecology, Chesapeake Bay 1985.

KRISHNAN**, K., W.D. MARSHALL, J.S. BLAIS, W.I. HATCH*. 1985
Littorina irrorata, a bioindicator of alkyllead pollution in Chesapeake Bay. Presented at the Eastern Region Conference of the Canadian Association on Water Pollution Research and Control, McGill University, Montreal.

*SFS Faculty
**SFS Student

Limnology, Adirondacks, New York 1983, 1984, 1985, 1986

SINGER*, R., D.A. ROBERTS*, C.W. BOYLEN*, 1983.
Biological effects of acidification on small oligotrophic Adirondack lakes. Proceedings of the Second New York State Symposium on Acid Deposition, Ithaca, New York.

Marine Mammal Biology and Conservation, Glacier Bay and Kenai Peninsula, Alaska 1982, 1983, 1984, 1985, 1986

CALAMBOKIDIS*, J., B.L. TAYLOR*, S.D. CARTER*, G.H. STEIGER**, K. DAWSON*, L.D. ANTRIM*. *In review.*
Distribution and behavior of harbor seals in Glacier Bay, Alaska. *Canadian Journal of Zoology*.

Population Dynamics of Endangered Species, Greek Islands 1983, 1984

HUSBAND*, T.P., DAVIS*, P.B., J.H. BROWN*, JR. 1986.
"The population measurements of *Cretin Agrimi*". *J. Mammal.*

Primate Social Behavior, Costa Rica, Panama 1984, 1985, 1986.

RASSMUSSEN*, D. *In preparation.*
Responses of wild groups of Panamanian Tamarins to experimentally introduced strangers.

Wildlife Conservation, Kenya 1982, 1983, 1984, 1985

STELFOX*, B. 1985. *In review.*
Effects of fire and topography on the Athi Plains ecosystem, Kenya. *African Journal of Ecology*.

SFS CURRICULUM

SFS courses are designed to help you learn as much as possible in a short period of time. Our programs allow you firsthand study of an international environmental issue through the mastery of essential field techniques. Learning is intensified as we work closely with faculty members while we are directly involved in the ecosystem we are studying. Semester participants have the unique opportunity to actively integrate semester coursework in a global context, placing the environmental issue under study within a larger framework of social, economic and political concerns. Month-long participants examine these critical issues in a local context, focusing on a specific research problem relevant to the ecosystem we are studying.

Each SFS course presents the equivalent academic content and rigor of a course taught on a college campus. A detailed syllabus, prepared for each program, describes academic and research objectives, and includes reading lists and information on the site, necessary personal equipment as well as medical visa and travel information. At the end of your course, we expect you to have the skills—and the questions—to continue your own search for answers.

We carefully design SFS courses to develop your ability to implement methods of observation, measurement, recording, interpretation and analysis in the biological sciences. SFS courses offer exposure to some or all of the following field techniques:

- plant/animal identification
- map making
- quadrat and transect analysis
- computer modeling
- hypothesis formulation
- research design
- resource sampling and assessment
- scientific report writing
- behavioral observation techniques
- statistical analysis
- population modeling
- survey and census
- using photographs as a recording device
- standing crop measurements

Concurrent with academic and field training, there will be instruction in outdoor skills; planning field expeditions; safety, health and risk assessment; and emergency procedures.



Photo: David Jolly

"I was nervous before I gave my final independent project oral report, but as I got into the subject I found I actually enjoyed sharing the information I had collected."

Lisa Steiner
University of Miami

SEMESTER PROGRAMS

Each SFS semester program enrolls 18–24 students in a series of five rigorous, carefully designed courses, fully equivalent to any college-level course on the same subject. Courses are linked by a common focus on the flora, fauna, and human populations comprising the critical ecosystem under study. These must be considered together in any plan to evaluate or preserve natural habitats and wildlife populations. This link is explicit in **Directed Research**. Within this capstone course, students integrate all coursework with independent (or small team) investigations focused within key environments.

You will complete the equivalent of 22–23 quarter hours (16 semester hours) of college studies through this series of five courses, involving lectures, discussions, assigned readings, papers, literature critiques, training in field techniques, and extensive first-hand experience. There also will be ample exposure to the people and culture of the area, as well as training in field anthropology.

Prerequisites: A minimum age of 18 is required; one college-level biology/ecology course is highly recommended/required depending upon the program.

Courses

Each SFS semester program incorporates five of the following six courses:

- 1) **Introduction to Exotic Ecosystems**
- 2) **Population and Community Ecology**
- 3) **Cultural Ecology**
- 4) **Environment and Society**
- 5) **Principles of Resource Management**
- 6) **Directed Research**

Although course titles, content and itineraries vary by program, the general structure of the courses is similar. Each course includes approximately 48 hours of formal lecture/discussion sessions. All courses have reading assignments, written and oral evaluations of the students, laboratory and field projects, and many periods of informal discussion. The structured part of the laboratory/field projects totals about 16 hours per week, but the nature of the program is such that learning often takes place in impromptu settings; thus the figures listed above are minimum contact hours.

Schedule

The semester programs are twelve weeks of intensive study. A series of lectures and group discussions will sup-

plement training in field research and laboratory analysis. Field trips to wildlife parks or reserves, visits to local villages, and occasional sightseeing in the major towns and cities of the area are scheduled as an integral part of the semester program.

Courses are taught six days a week, excluding Sundays, which are usually free for recreation and travel. We will also have a break of four days between weeks 6 and 7. In each session, two courses usually run concurrently on a M-W-F/T-Th-S rotating basis, except when overnight field trips require changes. Each day will have a 2-3 hour classroom component in which lecture material is presented and assigned reading discussed and the field exercise for the afternoon is planned. Three hours or more in the afternoon will be occupied with field work and training, which complement the morning's lectures and reading material. Evenings will include films, guest speakers, and cultural events. The field library will be available for research and assigned reading. You may participate in planning evening programs in your own areas of interest.

Much of the program will be allocated for supervised field research on a topic of your choice. Your project will incorporate material from most of your previous and concurrent course work to answer a specific question about the ecosystem you have been studying. The last two days will be used to present the results of your directed research to the group and outside guests, as well as to complete evaluations and prepare final versions of papers.

Evaluations

The faculty will conduct periodic oral and written evaluations on the basis of class work, field work, examinations, papers, presentations, and group participation at the midpoint and conclusion of each course. Each student will receive a grade card and may request an official transcript from Northeastern University. (see pages 4, 48 for additional information on academic credit). Evaluations and academic work will be forwarded to your home institution as requested.

Faculty

Semester programs are usually taught by a Field Director, two senior faculty, and one teaching assistant (depending on actual enrollment). Faculty members and the Field Director will hold a Ph.D. or its equivalent and have substantial teaching and research experience at the program location. (See pages 8, 9 for additional faculty information).

“Unlike at school where my peers can be uncooperative because of competition in a high pressure, intense environment, I found myself in a situation where mutual support and dependability were essential to our success.”

Jean Fang
Burr Ridge, IL
Cornell University



Photo: Kathy Gow

“I discovered how much I enjoy the outdoors; the interaction with nature taught me an appreciation for the environment which never would have been fostered by more conventional teaching methods.”

Jean Fang
Cornell University



Photo: Sandra Taylor

Our faculty student ratio of 1:7 encourages close interaction. Here, Dr. Toni Milewski shares his insights with a Wildlife Management team member.

JANUARY TERM AND MONTH-LONG SUMMER COURSES

SFS January term courses (4 quarter credits) depart in late December. Month-long summer courses (8 quarter credits) depart in June, July and August. Teams are usually comprised of 14 students and two faculty. You can expect a complete, intense learning experience, exposing you to issues that will engender thought and reflection long after your course has ended.

Course Levels

Level A courses are taught at an introductory (college freshman) level. They assume little background in the academic discipline and no field work experience. They are open to students who have finished at least their junior year in high school. Level A courses are designed for people who want initial exposure to field experience in environmental disciplines.

Level B courses assume completion of one or more of the following:

1. college-level course in an appropriate discipline (biology, ecology, geology, etc.), preferably a laboratory course;
2. an SFS Level A course or other scientific field experience;
3. special permission from SFS.

Level B courses are taught at a more advanced academic level and usually involve mastering more sophisticated data collection and analysis techniques. They are directed toward people who are committed to environmental studies and are seeking experience which will help them make or further career plans.

Schedule

Activities are planned seven days a week and usually ten to twelve hours every day with a one to two day break in the middle of the course.

Phase One: Introduction and Preliminary Evaluation

- general discussion of expectations and individual introductions
- safety and first aid procedures
- outdoor skills training
- explanation of the research project; history of the problem

- description for means for academic evaluation
- pre-test in skills and readings
- review of data-keeping procedures
- initial exploration of site

Phase Two: Lectures and Field Work

- faculty presentations on general comparative ecology, ecosystem organization, environmental issues, local natural history and peoples
- topical lectures on course material
- overview of research problem and research design
- student critique of scientific papers
- description of scientific method, research methodology, field tools and techniques, successful hypothesis testing
- introduction to laboratory methods
- field data collection
- field trips as appropriate

Phase Three: Mid-term Evaluation

- faculty evaluation of student progress
- student evaluation of course progress
- mid-term break

Phase Four: Implementation of Independent Projects

- continuation of data collection; lectures/discussions
- lab work, data processing and analysis
- independent projects

Phase Five: Conclusion

- presentation of group findings and independent projects
- integration of research results to date; practical applications
- written examinations, group discussion
- faculty evaluation of students
- student evaluation of faculty and course

All participants will receive an academic grade for their coursework. An official transcript will be issued upon request by Northeastern University. (See pages 4, 48 for additional credit information).

Students with field experience such as this not only have an edge in landing that interesting job, once hired, they are more capable of carrying out their research responsibilities."

Dr. Harry O. Haakonsen
Coordinator, Environmental Studies
Southern Connecticut State University

Guest lecturers in our Kenyan classroom contribute valuable perspectives on game ranching issues.



Photo: Elsen Karsrud

1986-87 SFS

FACULTY (partial listing)

Our faculty are chosen for their leadership skills as well as the depth and breadth of their experience. They are a diverse, extremely competent group. Research conducted by members of our faculty has resulted in hundreds of published scientific articles, documenting research funded by *National Geographic*, NATO, the National Science Foundation, U.N.E.S.C.O., the EPA and Sea Grant among other sponsoring organizations. Individual faculty members have lived underwater for weeks at a time, crewed sailboats across the oceans, lived in African villages for years, shared the neighborhood with yellow-tailed baboons in Tanzania, kayaked down the Yukon River and explored burial mounds of the ancient Maya.

George Allen, Ph.D. (North Dakota) Zoology.
Ecology of Bald Eagles.

William Allison, MBA, Ph.D. candidate (University of Toronto) Marketing/Environmental Studies. Faculty of Administrative Studies, York University. *Coral Reef Ecology.*

Eric Angress, M.A. (San Francisco State) Biology. Instructor at Sierra Institute, University of California. *Population Dynamics of Harbor Seals.*

Lisa Ballance, M.Sc. (California State) Ph.D. candidate (University of Arizona) Marine Science. *Dolphin Biology and Behavior.*

Dusty Becker, MFS (Yale), Ph.D. candidate (Cambridge University) Wildlife Biology. *Wildlife Biology and Management.*

Brian Bock, Ph.D. (University of Tennessee) Biology. Post doctorate research at Smithsonian Tropical Research Institute, Panama. *Deforestation: Tropical Rainforests.*

Frank Bowles, Ph.D. (Harvard) Biological Anthropology. Coordinator of field research, Marine Biological Laboratory, Woods Hole, MA. *Marine Ecosystem Under Stress.*

Charles Cable, Ph.D. (Cambridge University) Archaeology. Lecturer in Archaeology, University of Nairobi. *Wildlife Ecology and Management.*

Frank Cipriano, M.S. (California State) Ph.D. candidate (University of Arizona) Marine Science. *Dolphin Biology and Behavior.*

Gordon Duff, Ph.D. candidate (James Cook University) Botany, biochemistry. *Biogeography: Patterns of Ecological Diversity.*

Peggy Edds, M.S. (University of Maryland) Biology. Zoology Instructor, University of Maryland. *Humpback Whale Ecology.*

Peter Edmunds, Ph.D. (University of Glasgow) Marine Biology. Resident SFS faculty. *Marine Biology and Management.*

Paul Garber, Ph.D. (Washington University) Assistant Professor of Anthropology, University of Illinois. *Primate Biology and Behavior.*
SFS course



Photo: Tim Stout

In addition to being excellent teachers and researchers, SFS faculty are people with whom you'd like to spend a month or a semester in the field, and we know that's a special quality.



Photo: Percy Lowmy

"Brad (Dr. Brad Stelfox) is so enthusiastic about everything, he seems to enjoy teaching as much as we enjoy learning from him."

Scott Moore
Swarthmore College

The fact that the faculty lived with us allowed spontaneous questions to be answered. That really added to my learning because I wouldn't just "give up" if I was stuck, and I felt comfortable enough to ask lots of questions."

Darren Aronofsky
Brooklyn, NY
Edward R. Murrow H.S.

Nicky Goudberg, Ph.D. candidate (James Cook University) Zoology. *Biogeography: Patterns of Ecological Diversity.*

Jim Heimlich-Boran, M.S., Ph.D. candidate (California State) Marine Science. *Dolphin Biology and Behavior.*

Sara Heimlich-Boran, M.A. (California State) English, Graphic Arts. Freelance scientific illustrator. *Dolphin Biology and Behavior.*

Paul Joyce, M.S., Ph.D. candidate (University of Rhode Island) Biological Oceanography. *Marine Biology and Management.*

Stephanie Kane, Ph.D. (University of Texas) Anthropology. *Marine Biology and Management.*

Stephen Koester, Ph.D. (University of Colorado) Cultural Anthropology. Instructor of Anthropology, University of Colorado. *Marine Biology and Management.*

Chris Kohler, Ph.D. (Virginia Polytechnic Institute) Fisheries Management. Assistant Professor, Department of Zoology, University of Southern Illinois. *Sources of Reef Fish Toxins.*

Don Levitan, M.S., Ph.D. candidate (University of Delaware) Biology. *Coral Reef Ecology.*

Marc Liverman, M.S. (Oregon State) Ph.D. candidate (University of California). *Wildland Resource Science. Ecology of Bald Eagles.*

Cynthia Lott, B.A. (University of Southern Florida) Interdisciplinary Natural Sciences. *Marine Ecosystem Under Stress.*

Suzanne Macy Marcy, Ph.D. (University of Washington) Animal Behavior. *Behavioral Dynamics of Harbor Seals.*

Julia Miles, M.S. candidate (Northeastern University) Marine Science. *Coral Reef Ecology.*

A.V. Milewski, Ph.D. (Murdoch University) Ecology. Resident SFS faculty. *Wildlife Ecology and Management, Wildlife Management.*

Gary Miller, Ph.D. (University of New Mexico) Biology. National Science Foundation Postdoctoral Fellow, Antarctica. *Reintroduction of Endangered Species.*

Jim Miller, Ph.D. (St. Louis University) Biology. Adjunct Assistant Professor of Biology, University of Missouri. *Medicinal Botany.*

Chris Neefus, Ph.D. (University of New Hampshire) Marine Botany. Research Associate, Computer Usage Consultant, University of New Hampshire. *Marine Biology and Management.*

Richard Osborne, M.A. (Western Washington University) Anthropology. Research Director, The Whale Museum, Friday Harbor, WA. *Dolphin Biology and Behavior.*

Chris Petersen, Ph.D. (University of Arizona) Ecology and Evolutionary Biology. Postdoctoral visiting scientist, University of Washington. *Marine Biology and Management.*

Erv Peterson, Ph.D. (University of Michigan) Natural Resource Management. Field Director, SFS-Australia. *Biogeography: Patterns of Ecological Diversity, Tropical Species Diversity.*

Peter Phillips, M.S. (University of Massachusetts) Ph.D. candidate (Southern Illinois University) Zoology. *Sources of Reef Fish Toxins.*

Michael Poole, M.A. (Sonoma State) Ph.D. candidate (University of California) Biology. *Dolphin Biology and Behavior.*

Tony Povilis, Ph.D. (Colorado State University) Wildlife Biology. Lecturer, University of Colorado. *Reintroduction of Endangered Species: Alpine Ibex, Parks for Preservation: Large Mammal Ecology.*

Dennis Rasmussen, Ph.D. (University of California) Comparative Psychology. Senior Fellow, Wisconsin Regional Primate Research Center. *Endangered Monkeys: Experimental Social Ecology.*

Shelly Raven, M.A. (California State) Ph.D. candidate (University of California) Anthropology. *Marine Biology and Management.*

Deborah Roberts, Ph.D. (Rensselaer Polytechnic Institute) Biology. *Acid Rain: Changing Aquatic Ecosystems, Acid Rain: Changing Forest Ecosystems?, Marine Biology and Management.*

Joanne Sharpe, M.S. (University of Massachusetts) Ph.D. candidate (University of Georgia) Botany. *Deforestation: Tropical Rainforests, Primate Biology and Behavior.*

Jack Shea, M.S. (University of Alaska) Wildlife Ecology. Director, Outdoor Program Advisory, Berkshire Community College. *Natural Resource Conservation.*

Nancy Shea, M.S. (Southern Connecticut State) Ph.D. candidate (University of Massachusetts) Philosophy. *Natural Resource Conservation.*

SFS Course

Bob Singer, Ph.D. (University of Illinois) Limnology. Field Director, SFS-Virgin Islands. *Marine Biology and Management, Acid Rain: Changing Aquatic Ecosystems.*

Carol Skinner, Ph.D. (Kent State University) Ecology, Animal Behavior. Instructor of Biology, Kent State University. *Primate Biology and Behavior.*

Brad Stelfox, Ph.D. (University of Alberta) Zoology. Resident SFS faculty. *Wildlife Ecology and Management, Wildlife Management.*

Peter Stevick, B.S. (College of the Atlantic) Human Ecology. Marine Observer, Manomet Bird Observatory. *Humpback Whale Ecology.*

Reed Stewart, Ph.D. (Clark University) Geography. Assistant Professor of Geography and Anthropology, Bridgewater State College. *Wildlife Biology and Management.*

Claudia Swain, B.S. (Hartwick College) Environmental Studies. Coordinator of Environmental Education, Frost Valley Environmental Center. *Acid Rain: Changing Aquatic Ecosystems.*

Josef Treggor, B.S. (Central Connecticut State University) Biology. Marine Science and Music Instructor, Newington High School. *Humpback Whale Ecology.*

Chris Waythomas, M.S. (Southern Illinois University) Ph.D. candidate (University of Colorado) Geology. *Natural Resource Conservation.*

Werner Wilbert, Ph.D. (University of California) Anthropology. Research Professor, LaSalle Foundation of Natural Sciences, Venezuela. *Medicinal Botany.*

John Winter, Ph.D. (University of Queensland) Zoology. Zoologist and Ecological consultant. *Biogeography: Patterns of Ecological Diversity.*



Photo: David Jolly

Dr. Dennis Rasmussen typifies SFS faculty, chosen for their unique abilities to inspire, motivate, challenge and teach.

Faculty Profile

Dennis Rasmussen:

Education: A.B. (Psychology) with high honors, Humboldt State University
M.A. (Comparative Psychology) University of California—Riverside
Ph.D. (Comparative Psychology) University of California—Riverside
Post-Doctoral Fellow at Darwin College, Cambridge University, England.

Background: Teaching & Research Assistant—Departments of Psychology, Humboldt State University and University of California. (4 years)
Lecturer—University of California—Davis.
Taught Comparative Psychology, Comparative Sociobiology. Internship Leader. (1 year)
Assistant Professor—California State University. Taught Wildlife Management. (1 semester)
Field Director—Olive and yellow baboon study, Tanzania, East Africa, with Dr. Jane Goodall. (2 years)

Principal Investigator—Social/sexual behavior of Bonnet Macaques, California Primate Research Center. (2 years)

Affiliate Scientist—Smithsonian Tropical Research Institute, Balboa, Republic of Panama. (1 year)

Group Leader—Field research expeditions studying Panamanian Tamarin. (1981 to present)

Published: Over a dozen scientific papers on Primate Behavior & Ecology in journals such as: *Animal Behavior, Folia Primatologica, International Journal of Primatology*

Personal: Age 37, married; 2 sons.
Dr. Rasmussen initiated the SFS Primate Behavior and Ecology program in Panama during the Summer of 1985. He was recently selected for a three year N.I.H. Senior National Research Service Award to study Macaque behavior and biology at the Wisconsin Regional Primate Research Center, which he expects will allow him to continue teaching with SFS for at least the next three summers.

CURRICULUM • Wildlife Ecology and Management Semester Program
• Wildlife Management Summer Course

Background

It is a time of high drama on the plains of Kenya. This land of enormous physical beauty—from the rugged scar of the Great Rift Valley, its soda lakes teeming with pink flamingos, to the vast savannas and escarpments approaching Mount Kenya—is becoming a vulnerable and worried land. With one of the highest population growth rates in the world and a rapidly developing economy, Kenya provides a dramatic illustration of conflicting priorities of preserving land, protecting wildlife, and feeding people, that are being played out around the world.

Population and economic growth have placed severe pressures on the rapidly diminishing natural habitats needed to sustain Kenya's majestic and irreplaceable wildlife herds. The increasing need for meat in particular has led to extensive ranching of beef cattle. These cattle strains, however, were originally developed in countries with abundant grasslands and water, commodities in short supply in Kenya. Some biologists have proposed what at first seemed a radical solution: the practice of game ranching, in which populations of various native species of ungulates (cloven hoofed mammals) are strictly managed in a protected environment and periodically cropped to be used as food.

Substituting native wildlife species for domestic cattle offers an ecological alternative that lowers water and energy demands, potentially leading to increased food production. Yet game ranching itself may pose ecological threats. How do harvested populations differ from natural herds? Only carefully coordinated research including population and habitat studies will provide the answers.

Mankind must find a way to satisfy the needs of both wildlife and humans on shared land, rather than assuming that the presence of one excludes the

other. SFS students will have the unique opportunity to become directly involved in this dilemma, conducting research to examine first-hand impacts of game-ranching in Kenya in a 30 day Wildlife Management course, or expanding this research, placing it within a larger, global framework of social, political and economic considerations in the 12 week semester program.

Site

The enormous variety of wildlife in Kenya occupies an equally remarkable variety of terrain. Herds of antelope, buffalo, giraffe, and zebra graze in the expansive savannas of eastern Kenya as lions, cheetahs, leopards and other large carnivores prowl in the bush. The lush mountain forests of western Kenya are home to duikers, bushbucks, forest hogs and colobus monkeys as well as a large number of impressive birds. In the Great Rift Valley, believed to be the ancestral home of modern man, hipopotami cool off in lakes shared with white pelicans and pink flamingos.

Significant areas of the country have been set aside as national parks and game reserves where native flora and fauna thrive with little human interference. These settings provide the rare opportunity to witness the complex interrelationships of vegetation, climate, physiography, and animal life.

Our base of operation will be "Wildlife Ranching and Research, Ltd.," established by Dr. David Hopcraft, a Cornell University graduate, as an experimental game ranch. Here a variety of large mammal populations are protected, carefully monitored and ranched. Situated approximately 40 kilometers southeast of Nairobi in the Athi Kapiti Plains, the ranch consists of laboratory facilities, a slaughterhouse, a small library, and 81 square kilometers of protected savanna where wildebeest, giraffe and gazelle roam freely.

Research Focus

The success of wildlife ranching depends on whether wild ungulates can be maintained on limited areas under a regular cropping regime. In our sixth consecutive year of research in Kenya, we will assist in analyzing criteria that

are crucial to game ranch management. We will investigate questions such as: How much time do different species spend watering and how much time shading? What is the moisture content of forage and faeces? When do different species forage? What is the ratio of males to females in harvested and unharvested populations? How many offspring per female are there in harvested and unharvested populations? What percent of cropped females are pregnant as compared to previous years?



Photo: John Gemery

"The first time we saw one it took me minutes to pick it out of the landscape, even though I was staring directly at it with Brad saying 'look RIGHT there'."

Living and Working Conditions

Although located near the equator, Nairobi enjoys a year round climate similar to that of a New England September. Nights are cool to chilly, days are warm to hot. While rain is scarce and water supplies restricted, there will be sufficient water for showers. Adapting our working hours to match the schedules of the animals we observe, we will rise in the cool dawn and take a break during the midday heat when the animals are less active.

Located in its own isolated setting on the ranch, our SFS basecamp includes a permanent dining/lecture hall, open air showers and outhouses. Our lab, located two kilometers away, houses a specimen collection and small library. When in camp, our accommodations will be thatched huts called "bandas", while we will sleep in tents when we are on off-ranch field expeditions.



Photo: Reed Stewart

Thatched "bandas" house us at our ranch basecamp while tents will be used on our safaris.

I learned more valuable knowledge in this one month course than in a year at college. I feel so privileged to have experienced Kenya this way....This course took my way of looking and thinking about things and improved it to the point that I feel I've gained just from learning how to learn."

Kimberly Barron
Rockville, OH
Virginia Polytechnic Institute



Photo: Sandra Taylor

"One of my most vivid memories is of our visit to a secondary school...questions such as 'can you see the sky in New York City?' and 'what tribe are you from?' emphasized the differences between our cultures."

Katy Heinzl
University of Pennsylvania



Photo: Sandra Taylor

After having the unique opportunity to dissect a giraffe, students reconstructed its skeleton which now stands outside our classroom facility.

SEMESTER PROGRAM

WILDLIFE ECOLOGY AND MANAGEMENT

AREA

Kenya

COURSES

Wildlife Biology, Population and Community Ecology, Cultural Ecology, Environment and Society, and Directed Research

DATES

September 4-December 2, 1987;
January 1-March 31, 1988

Program Structure

This 12 week semester program is designed to allow students to compare aspects of game ranching with the management of preserved herds as a promising experiment in wildlife management while studying the theory of wildlife ecology. Through a series of four interrelated academic courses, complemented by a capstone course, Directed Research, we will seek to learn about the organisms, habitats, peoples and cultures of East Africa; to understand the ecology of East Africa; and to increase our awareness of the philosophical, social and economic justifications for various conservation strategies.

Wildlife Biology will orient us to the major vertebrate groups of the East African savannas through a discussion of their evolution and ecological requirements. Ungulate population biology will be emphasized and the physiological and behavioral ecology of individuals and natural social groupings will be explored thoroughly. The field and laboratory portion of this course will take place at the Ranch and in various National Parks including Masai Mara Game Reserve and Nairobi National Park. This portion will cover field identification of common birds and mammals, classification of social groupings and behaviors, demonstrations of ungulate anatomy and parasitology, techniques for capturing organisms and standard techniques for population sampling. We will also spend a week on 14,000-foot high Mt. Kenya where daily lectures will focus on geomorphology, glaciology, and the various plant and animal species living at different altitudes along the mountains.

In Population and Community

Ecology, we will begin with mathematical models of population dynamics forming the basis for investigating interactions between populations of different species, including competition, predation, parasitism and mutualism. Coevolutionary aspects of these relationships will be discussed with emphasis on plant-herbivore and parasite-host interactions. We will apply many of these theoretical concepts to field situations, making use of a wide variety of plants and animals as subjects for study. We will spend a week studying the coastal ecology the Indian Ocean near Mombasa, where fishing and shelling threaten Kenya's fragile coral reef communities.

Cultural Ecology will introduce us to the varied cultural heritage of Kenya. The first week includes an introduction to basic Swahili, which will help us communicate with local Kenyans. We will then review the East African evidence for human evolution and concentrate on the traditional cultures of the major indigenous tribes of the area. The social, political and economic impact of the colonial and post colonial era will be examined during the last week of the course. The course will consist of classroom lectures and field trips to areas or events of particular cultural interest including local Akamba and Masai villages.

Environment and Society will allow us to synthesize information on wildlife biology, ecological and evolutionary principles and human cultural, political and economic forces into a general understanding of the role of people in the environment and their options for conserving the unique species and environments of East Africa. Our safaris will allow us to examine a number of approaches to land utilization and their impact on the natural communities of organisms. We will discuss the goals of

various conservation programs both globally (such as the World Conservation Strategy) and locally, and justifications for these goals. The course will present options for preservation, from the level of the individual organism to entire ecosystems. Management required at each level will be emphasized.

The capstone course, building heavily on the other four, will be **Directed Research**. We will investigate research questions on ecology and conservation biology that are of particular interest in Kenya. In the first three weeks of this course, we will sharpen our hypothesis formulation skills, learn specific research techniques, and gather preliminary data on potential research topics. Coinciding lectures will be presented on approaches to biological research, sampling design, experimental design, and basic statistical analysis.

Our field research, commencing in the fourth week, will involve two large scale student independent projects conducted throughout the semester and a series of smaller, week-long projects. Potential topics may include examining different aspects of ungulate ecology and behavior; examining the impact of the tourist industry on the coral reef community at Mombasa; and determining methods for assessing habitat and ecosystem stability.

Our field work will be conducted within the Ranch and in various National Parks enabling us to perform comparative studies of species in controlled and uncontrolled conditions. The laboratory and slaughterhouse on the Ranch will facilitate our investigation of the taxonomy and biology of various species.

Tuition: \$6,840 + \$100 Registration Fee

Departure Point: Nairobi, Kenya

Prerequisite: One college level biology/ecology course.



Photo: Sandra Taylor

Reconstructing a skeleton provides an unusual opportunity to study structure and function.

I have no doubt that as a future teacher, I will be recalling my experience as an SFS student in Kenya and arousing students in my classroom until my teaching days are over."

Derek Madden
Fresno, CA
California State University

SUMMER COURSE

WILDLIFE MANAGEMENT

AREA

Kenya

PURPOSE

To compare the population dynamics and water conservation strategies of large mammals (gazelle, giraffe, wildebeest, and zebra) in hunted populations on a game cropping ranch with those of protected populations in national parks; to assess the long term implications of game ranching as a wildlife management technique.

COURSE

Level B: June 16-July 17

LEVELS,

Level A: July 22-August 21

DATES

Academic Content: Introduction to East African ecosystems, general principles of ecology, ungulate taxonomy and identification, and the principles of game ranching will be provided by faculty and guest lecturers. Faculty will also present advanced lectures on ungulate parasitology, ungulate social systems, the role of parks in wildlife conservation and the economics of game and cattle ranching.

Field Work: After meeting in Nairobi, we will head 40 kilometers southeast through the rolling savanna to our research site, Wildlife Ranching and Research, Ltd., an experimental game ranch. The ranch spans 81 square kilometers of open savanna, offering habitats to an enormous range of African wildlife, several species of which we are likely to see on our initial approach to our camp.

Arriving at the ranch, we will stow our gear in bandas, the thatched huts that will serve as our homes when we are not conducting off-ranch research. Introductory lectures will include a brief orientation to the local language, Swahili. A tour of the facilities will allow us to meet with local specialists to discuss the major wildlife management objectives of the ranch and learn about the cropping method used here.

SFS - KENYA

Research conducted by previous SFS teams determined that species have different abilities to withstand drought and may be affected differently by cropping in wetter and dryer years. Our new concerns are: whether cropping alters reproductive ability of different species; do species differ in their ability to withstand regular cropping?

Rising early each morning, we will travel either by foot or in landrovers to specific sites in the ranch to begin our field survey. By careful observation with spotting scopes, we will collect detailed population records for wildebeest, gazelle, zebra and giraffe. We will also monitor food preference, the ratio of males to females and pregnant females. Though not subjects of our research, we may see cheetahs, spotted hyenas, aardvarks and warthogs during our days in the field, and the shade of intermittent acacia trees is always a welcome sight.

Each Thursday night, ranch personnel ride out to conduct their cropping regime. Their return with fresh carcasses provides us with a superb opportunity to study anatomy and morphology firsthand. From stomach content analyses compared to our assessment of local forage availability, we can determine food preferences. With these data, we will conduct a survey of forage plant distribution and the water content of these plants. Level B teams will also study evolutionary relationships of the Athi Plain biota from a systematic approach.

In addition to participating in the team research efforts, each student will have the opportunity to conduct an independent project. Giraffes will be the focus of much of our research attention this summer and topics of interest may include a comparison of sex ratios on and off the ranch or observations of foraging strategies in water stressed ungulates.

Several field trips outside the ranch will take us to some of the more spectacular Kenyan parks including: Amboseli to examine the effects of intense tourist pressure on wildlife; Masai Mara Game Reserve to observe the annual migration of over one million wildebeest; Nairobi National Park to compare our data on species populations with park data; or we may climb Mount Kenya's Teleki Valley to examine key elevational gradients established by extremely unusual highland plant

I actually can now say that I have partially dissected a giraffe, and I did it with my Girl Scout knife. I bet they never thought their knife would be used for that!"

Cathy Coleman
Westwood, MA
University of Vermont



Photo: Geoff Levner

Our experiences in Kenya will go far beyond those of an ordinary tourist.

species. Our travels will take us along dusty red dirt roads where our stops at small villages allow us an opportunity to practice our Swahili talking with the local peoples.

Our research is part of a continuing analysis of the game ranch as an economically and ecologically viable concept. Our results from both team and independent projects will be integrated with ranch management analyses, assisting the government of Kenya and outside conservation agencies to monitor the effectiveness of the ranch. Among the most important results of our work is the ongoing demonstration to Kenyans and other people considering game ranching as a preservation option that the ranch can provide a major source of food while making money.

Tuition: \$2,140 + \$100 Registration Fee
Departure Point: Nairobi, Kenya

SFS—AUSTRALIA

CURRICULUM • Biogeography: Patterns of Ecological Diversity Semester Program

• **Tropical Species Diversity Summer Course**

Background

Less than 10% of the Earth's surface is covered by rainforest habitat, yet more than half the world's species, the majority of them to date unidentified, make their home here. Tropical rainforests are complex ecological arenas within which intricate evolutionary scenarios have been unfolding for over 100 million years. They are the source of lifesaving medicines, food, minerals, energy resources and germplasm stocks for the world's agricultural crops. Each year scientists are identifying a plethora of new bird, plant, insect and animal species here.

Man is a relatively new arrival to this venerable ecosystem, yet he is rapidly making his presence felt. Rainforests are currently being degraded worldwide—through burning, logging, mining and development—at the rate of approximately one percent per year, or an area approximately the size of Switzerland. Although portions of these forests may someday regenerate, it is only in the original irreplaceable primary forest, that some of the earth's rarest and most unique plant and animal species are able to survive.

The tropical forests that span northern Queensland are the most diverse in all Australia and are inhabited by the greatest diversity of wildlife found anywhere on the continent. The greatest concentration in the world of primitive flowering plants—thirteen of the known original nineteen families—are found here in an area botanists claim to be “a priceless world heritage.”

When Australia was cut off from the rest of the world by its separation from Asia over 60 million years ago, it became isolated from the mainstream of mammalian evolution. A unique evolutionary pattern arose. Instead of the dominance of placental mammals found elsewhere in the world, marsupial

(pouch-bearing) mammals—kangaroo, possum and bandicoots—evolved. Australia's isolation coupled with the lack of a major human presence and the absence of other predatory animals, allowed the survival of bizarre evolutionary phenomena—the egg-laying, milk-producing, furred duck-billed platypus, the even stranger spiny anteater, and the air-breathing lungfish which crawls about mud flats on its fins.

As a consequence of the exceptionally high incidence of endemism—the evolution of species found nowhere else on Earth—the botanical and faunal riches of this area are irreplaceable. The degradation of this resource is one of Australia's most critical environmental issues. This is truly a unique area just now being recognized for its significance. SFS students have a rare opportunity to be at the forefront of the research being initiated here. Semester participants will be among the first researchers to explore the extent to which endemic species—such as possums—can serve as indicators of biological disturbance. Month-long participants will continue this work which may eventually lend support to the creation of new protected areas for threatened species.

Research Focus

Initial data indicate that key marsupial species vanish from forests with increased disturbance due to clear-cutting and other logging procedures. How are species diversities and compositions affected by size and age of logging clear-cuts? Of particular concern are the arboreal folivores, vertebrates such as the tree kangaroo that consume and range through tree foliage. Our investigations will focus on the extent to which sequences of possum occurrence are indicators of ecosystem stress.

Site

The Cape York Peninsula of far northern Queensland, has the greatest biological, climactic, and societal diversity in all of Australia. Jutting some 400 miles towards New Guinea from the

rest of the continent, it separates the Coral Sea from the Gulf of Carpentaria. A narrow strip of Australia's largest remaining tropical rainforest runs down to the water along the shoreline fringed by the magnificent 2,000 kilometer-long Great Barrier Reef.

The town of Millaa Millaa sits on the Atherton Tablelands approximately two hours southwest of the resort city of Cairns. Situated at an elevation of 800 meters, Millaa Millaa abuts the western edge of Palmerston National Park. To the north, east and south, rainforest abounds, while to the west, the land has been cleared for dairy farming. Millaa was once a bustling dairy town, but with closing of the cheese processing plant, the community is now quite small. On the edge of this true Australian farm town, SFS will make our base in two rented houses complete with vistas of nearby ridges, rainforests and a stream where platypuses drink daily at sunset.

Access to the rainforests is outstanding from our site, with a good diversity of forest types nearby. On our forays into the rainforest we may encounter over 500 species of canopy trees, and an equal number of animal species including the cuscus, pandemelon wallaby, tree kangaroo, giant lorikeets, Birds of Paradise, 2-foot long forest dragon lizards, and frogs and toads in more colors and shapes than you can imagine. For example, the entire worldwide populations of the five species of possum we will study can be found within our study site. Flights of up to 2,000,000 flying foxes (which are actually bats) cloud the evening skies. Crystal-clear streams wind their way through dense, lush vegetation and occasional waterfalls fill the air with the persistent hum of crashing water.

Living and Working Conditions

Be prepared for wet weather. The summer rainy season is November through April, and an average of one meter per month or more of rain can be expected to fall in this period. Frequent thunderstorms will be punctuated by intense

sunshine. Ocean breezes usually keep the air temperature in the 80's, although higher temperatures are normal just prior to the rains. Access to the rain-forest will be via four-wheel drive vehicles when the water is down. While the rains are very heavy we may not be able to get into the forests so our field work may be temporarily postponed in favor of data crunching or field trips to drier areas.

Our two farmhouse base in Millaa Millaa will also serve as our library and classrooms. Affectionately called "Platypus Heaven", after the marsupials who visit our backyard each evening, our base will have modern showers, cooking facilities, and appliances to dry our clothes. Millaa is a very small town with four stores and a gas station so our presence will hardly go unnoticed. Fresh fruits, vegetables, fish and meat should be available in abundance to embellish our culinary endeavors.

One of the many methods we will use to compile our catalog of species in the Australian rainforest will be the mistnetting of birds.



Photo: Chip Isenhart



Photo: Chip Isenhart

Kangaroos are among the better known marsupial species; our studies will involve us with several other, less studied, endemic marsupials.

The greatest change has been in my being able to survive, flourish and begin to love an ecosystem unknown to me prior to this course. I was constantly admiring either a fungus and its brilliant color, a bird-song, or an eagle soaring over a grassy hilltop."

Aurora Andreescu
Woodside, NY
Barnard College



Photo: Nicky Goodberg

Our study site is home to five endemic possum species found nowhere else on Earth.

SEMESTER PROGRAM

BIOGEOGRAPHY: PATTERNS OF ECOLOGICAL DIVERSITY

AREA

Queensland,
Australia

COURSES

Introduction to Exotic Ecosystems, Population and Community Ecology, Environment and Society, Principles of Resource Management, Directed Research

DATES

September 8-December 4, 1987;
February 3-May 1, 1988

Program Structure

Through five distinct but interrelated courses, we will investigate the biological, behavioral, economic, political and historical issues that must be considered in determining strategies to preserve the endemic wildlife of Australia. **Introduction to Exotic Ecosystems** provides the ecological background to understand the tremendous diversity of Australian ecosystems. We will focus to a large degree on the rainforest, but field trips to the savanna "outback" as well as eucalyptus and acacia woodlands will enrich our studies. A field trip to the Great Barrier Reef, perhaps the world's largest and most spectacular reef, will also introduce us to the incredibly diverse marine life off the Australian coast including over 1,500 species of fish and 400 species of coral. Lecture topics will include plant and animal diversity, energy flux, nutrient cycling, soil structure and life cycle variability. Field work will take place daily, as we explore habitats, measure life form abundances, and study the evolutionary convergence as well as the uniqueness of Australia's biota.

Building on these foundations, **Population and Community Ecology** will enable us to sharpen our natural history skills while providing a theoretical overview. Emphasis will be placed upon population growth and the processes by which it is

limited, including predation, parasitism, disease and competition as they arise in rain-forest habitats and within our study sites in particular. Genetic load, drift, adaptation via natural selection and principles of population genetics will also be presented. Processes of dispersal and colonization will be explored as they relate to Australian biogeographic patterns of both genetic and species diversities. Laboratory sessions and field demonstrations focus upon sampling techniques for this ecological diversity, demographic computer models, plant/herbivore co-evolution and the quantification of both plant and animal distribution and abundance.

In **Directed Research**, we will investigate how to address key biogeographic questions using scientific method. Effective hypothesis formulation, experimental procedures for testing such hypotheses, data analyses, presentation skills and the use and misuse of data will be discussed. Using this training in consultation with the faculty, we will each develop independent research projects pertaining to the maintenance of biological diversity. Likely topics include tests of competitive hierarchies among plants competing for sunlight or for soil nutrients, successional predictions from forest seedling distributions, possum territoriality in response to resource availability, tree kangaroo foraging behavior within disturbed and intact habitats, and elevational gradients in bird species composition (via mist netting). We will make oral presentations of our findings to parks and wildlife service professionals. Written reports will be sent to the Australian government research organization, C.S.I.R.O.

Man's impact upon local, regional and global geographies will be examined in **Environment and Society**. Terrestrial,

aquatic and aerial modes of pollutant dispersal (from both point and diffuse emission sources) will be investigated, with particular emphasis on Australian examples. North American environmental risk perception, policy and pollution control technology will be considered. We will devote particular attention to issues such as deforestation and hazardous waste storage, which span global and local scales and discuss attitudinal variation among citizens of undeveloped and developed nations with respect to land use and the consequences of these perspectives upon landscape ecology. Political, social and economic implications will be presented in order to develop a predictive overview of the societal impacts upon environmental quality.

Concepts of population growth, resource depletion and steady-state dynamics developed in the preceding courses will be applied in **Principles of Resource Management**. Case studies emphasize yield optimization in tropical forestry, fisheries and farming practices and include field trips to Queensland logging sites, the Great Barrier Reef and agro-ecosystems of the Cape York Peninsula. Although coursework develops problem solving tools with respect to Australian rainforest issues, newly acquired techniques—such as environmental impact assessment—will be applicable throughout the world. International resource management policies will be presented, with particular emphasis upon strategies of multiple land use, inter-cropping and the design of biotic reserves.

Tuition: \$6,050 + \$100 Registration Fee
Departure Point: Cairns, Australia

Prerequisite: One college level biology/ecology course.



Photo: Chip Lechare

Surrounding us daily are living illustrations of concepts most students only read about in books or hear about in lectures.

TROPICAL SPECIES DIVERSITY

AREA

Queensland,
Australia

PURPOSE

To gain insight into the diversity of plant/herbivore interactions with biogeographically unique ecosystems involving rare host plants and endemic marsupials by identifying patterns of herbivorous marsupial (green and bushy-tailed possum, laughing kookaburra, tree kangaroo and fluffy glider) occurrence within habitats disturbed by logging, to help begin testing predictions of species recovery from forest disruption.

COURSE LEVELS, DATES

Level A: June 18-July 18
Level B: July 23-August 22

Academic Content: Lectures will address biogeographic patterns and the processes by which these diversities are maintained; plant/herbivore interactions and the responses of both to disturbance (natural and man-induced) will be explored. The concept of critical centers of endemism will be developed for the Australian flora and fauna. Field demonstrations will include the use of elevational transects, vegetational mapping, timber cruising, censusing techniques, behavioral observation and analyses of species diversity and similarity measures for comparing patterns within and between disrupted habitats. Guest lecturers will address key issues in tropical biogeography.

Research Focus: How resilient is the tropical rainforest ecosystem with respect to recovery from increasing logging demand? Our approach will make use of clear-cuts varying in age since original establishment. Here, our

SFS - AUSTRALIA

purpose is to determine a "chronosequence"—successional comparisons of species compositional change through time. Techniques for assessing species richness, diversity and uniqueness will be replicated among study sites with respect to host tree and marsupial occurrences. We seek to develop a predictive basis for equating biodiversity to level of disturbance, data which should offer substantive backing for efforts to create new species refugia in Queensland.

Field Work: "Commuting" to work will initially involve a 5 km hike or drive from our farmhouse base into the lush tropical rainforests of Palmerston National Park. Our first few days will pass quickly as we orient ourselves to the intricacies of this 100 million year old rainforest. At first glance, we can't help but notice the canopy of tree crowns towering 60 meters above us and the vines and epiphytes (rootless, attached "air plants") streaming about us. At this point, our faculty become our guides, teaching us how to see beyond the obvious into the web of life that makes up the rainforest ecosystem. We will learn to look for feeding damage, feces, or even eyes peering from the foliage that indicate the presence of arboreal folivores: the lumholtz tree kangaroo, the speckled flying fox, the spotted cuscus, the spiny bandicoot and five species of possum.

Going beyond learning how to identify and measure the extraordinary plant and animal diversity found here, we seek to understand how it develops. What disperses seeds that eventually become towering trees? How many seedlings must be initiated before one actually survives to produce "offspring"? How linked is any one species—whether marsupials or herbivorous insects such as bizarrely sculpted tree-hoppers—to the occurrence of a particular vegetation type? How do trees physically and chemically defend themselves against naturally occurring disturbance? Building component by component, we begin to assemble a working perception of plant/herbivore interaction.

Using newly introduced field techniques including quadrat analyses of vegetational occurrence, timber cruising, mist-netting of birds, and home range mapping, we find there is an order to the complex diversity of life-forms surrounding us. As we census various

naturally stressed sites—insect defoliation, fungal attack, treefalls—we should find that we can predict patterns based on the occurrence of key species within each habitat.

Armed with our questions and predictions, we will travel to several of the 5 national parks that lie within 40 km of our base. New animal species—laughing kookaburra and fluffy gliders—appear with changes in height of land, soil type or tree composition. Here we also see evidence of the large scale disturbance caused by the newcomer to the rainforest: Man. What is the relation between clearcut area and the diversity of associated plant and animal species? As we conduct replicated transects, we begin to establish whether the presences or absences of key species serve as indicators of the magnitude of disturbance.

The last few days of the course will find us finishing our independent projects possibly assessing possum foraging distances as responses to food availability, or regeneration patterns within clearcuts. We will compile a report from our team and independent findings to be submitted to Australia's Central Scientific and Industrial Research Organization for potential use in developing logging policies that will prevent further endangerment of this rare, fragile and irreplaceable ecosystem.

Tuition: \$2,090 + \$100 Registration Fee
Departure Point: Cairns, Australia



Field trips will allow us to visit several of Australia's varied ecosystems and take a break from our research tasks in the rainforest.

Photo: Chip Isenhardt

SFS—VIRGIN ISLANDS

CURRICULUM • Marine Biology and Management Semester Program

Summer Courses:

- Coral Reef Ecology
- Marine Parks Management
- Sources of Reef Fish Toxins

Background

Because the majority of the earth's surface—over 70%—is covered by oceans, many people have the mistaken notion that we have an almost limitless resource at our disposal. In reality, less than 0.2% of the earth's oceans are productive (in terms of released oxygen and generated carbon). The narrow coastal region on which coral reefs and algal beds lie is an important exception.

The entire reef complex is a hub of productivity amid relatively unproductive tropical ocean. Coral reefs protect shores and harbors from erosion and wave action and provide a spectacle for tourists that has tremendous economic importance in many tropical communities. Reefs play a role in the critical regulation of the ocean's salt content by creating evaporation lagoons between themselves and the shore. In addition, coral reefs provide a habitat for over one-third of all fish species, ensuring an important source of protein for human populations.

Not only are reef ecosystems limited in size and number, they are extremely fragile. Disturbing one component can disrupt the entire system. Worldwide, the ecosystems are being seriously impacted by oil, sediment, sewage, toxic wastes, dredging, land development and overfishing. White skeletons of reefs are often all that remain of once productive communities.

The Virgin Islands and their surrounding waters offer us an unparalleled classroom/laboratory in which to study marine biology. Historically, the inhabitants of the Virgin Islands have grown lucrative crops—sugar cane, bananas, and coconut; raised cattle and goats, and supplemented their diets with food from the surrounding waters. Over-



Photo: Brenda Bernstein

After diving for samples, we will have the opportunity to analyze our findings at our on-site laboratory.

grazing and overplanting, however, have now rendered much of the land unsuitable for agriculture. Currently, the Virgin Islands' rapid population growth is placing severe demands on its fishery. Yields from the fishing industry have dropped substantially, giving rise to a major concern that local fisheries are rapidly being depleted. Additionally, several species of normally edible fish are being eliminated from consideration as a food source as it is currently impossible to determine which individual fish carry ciguatera, (unusually high levels of toxins which can have lethal effects on humans who eat these "poisoned fish").

While the hundreds of thousands of tourists that flock to this area each year provide a much needed economic boost, they add further pressure to an already stressed ecosystem. It is also possible that increased levels of boating and diving are impacting on delicate coral reefs that are home to fish, conch, lobster and numerous other species.

It is essential that management plans dedicated to sustaining what is left of this valuable resource be updated and improved by new research. SFS semester students can make a significant contribution toward addressing this

problem as they census commercially harvestable fish populations, analyze existing policies, and explore local attitudes toward fishery management in order to assist in developing suitable guidelines for future uses of this valuable resource. Students in SFS summer courses will assist in this effort as they investigate specific aspects of this resource use issue.

Research Focus

Focusing directly on the fisheries resources of the Virgin Islands, we will utilize SCUBA to quantitatively sample conch, lobster, sportfish and commercially harvestable fish populations in nearshore Caribbean waters. Impacts of current levels of biotic and abiotic stress on these resources will be assessed in order to recommend appropriate guidelines for future management.

Site

The Virgin Islands lie at the eastward edge of the Greater Antilles chain of Caribbean Islands, just east of Puerto Rico. The environments of these tropical paradises vary from lush green forests to dry, desert-like terrain. Some islands are pristine and undeveloped; others have

oil refineries and industry and are plagued with pollution problems. All are characterized by sandy beaches, mangrove swamps and quiet lagoons created by the extensive coral reefs that usually fringe each island.

The majority of our research will be done on and around the island of St. John. The most beautiful and least disturbed of the U.S. Virgin Islands, St. John rises from the sea, her volcanic topography clothed in a mantle of subtropical vegetation. Our home base will be the Virgin Islands Ecological Research Station (VIERS), a small, isolated field laboratory several hundred yards from the shore of Lameshur Bay. Owned by the University of the Virgin Islands, VIERS is located deep within the Virgin Islands National Park, which encompasses much of St. John, and has been the site of six years of SFS research.

From the VIERS dock at the waters edge we will head out daily into our natural laboratory. The clear waters of Lameshur Bay teem with activity. More than 300 species of brightly colored fish have been identified among these reefs. Each species—from the algae eating parrotfish and iridescent blue tang surgeonfish to the nocturnal, crab-eating squirrelfish and yellowtail snapper—plays a vital role in the functioning of the sensitive coral reef ecosystem.

"Thank you, SFS, for introducing me to special people I never would have met on my own."

Amy Kandel
Mount Union College

Living and Working Conditions

One could not ask for a more ideal setting for a tropical research station. Arriving on St. John we are confronted with a kaleidoscope of color—turquoise waters, white beaches, lush tropical vegetation—and that's just the view from shore! Set among palm trees only a few hundred yards from the ocean, VIERS provides us with basic living and research facilities including small screened bunkhouses, a dining hall and classroom (none of which are impervious to heat, humidity or small insects), as well as a laboratory and

library with computers for our use.

Although quite rustic, the site has electricity and solar heated outdoor showers. The mean annual temperature is 79° F, ranging from extremes of 63° to 95° F. Water shortages are frequent so our showers and general water use may be restricted.

Meals are prepared by the VIERS staff, but students assist in clean up duties. From time to time we will sample island cuisine, which is spicy and flavorful. Stewed fish, curry fried plantain, breadfruit and manioc are local delicacies.

Note: Students are responsible for providing/renting their own SCUBA equipment.

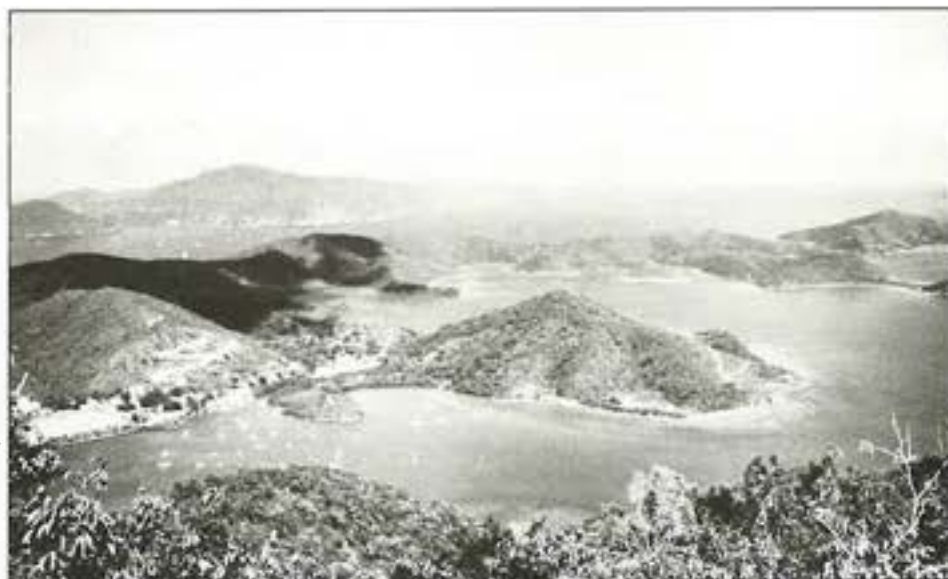


Photo: Beth Gaudwin

The island of St. John is one of three permanent SFS sites where we are conducting long-term, ongoing research on a year-round basis.



Photo: Shawn Cummings



Photo: Chris Neefus

Data collection under water requires a carefully coordinated team effort.

SEMESTER PROGRAM

MARINE
BIOLOGY AND
MANAGEMENTAREA **Virgin Islands**COURSES **Population and Community Ecology, Introduction to Exotic Ecosystems, Principles of Resource Management, Cultural Ecology and Directed Research.**DATES September 9-December 5, 1987;
February 3-May 1, 1988

Program Structure

Through a five course sequence, SFS semester students will investigate first-hand the scientific, economic, political and historical issues involved in managing marine resources in the Virgin Islands. **Introduction to Exotic Ecosystems** will orient us to the marine environment and its functional groups of organisms. Study topics will include photosynthesis and respiration, food webs, basic ecological principles of energy flow and nutrient cycling. We will focus upon the stability of marine and coastal ecosystems and their ability to recover from disturbance. The field and lab component of the course will include supervised SCUBA exercises, demonstrating techniques for underwater observation, data analyses, and report presentation in preparation for individual projects.

Population and Community Ecology explores the physiological and behavioral responses of marine organisms to their environment and examines evolutionary responses to long term environmental change. Included in this focus are the identification, phylogeny and evolution of major marine groups and the reproductive biology of these species. Mutualism, competition and predation will also be studied with respect to how these symbioses structure marine communities. Using SCUBA, we will utilize non-destructive techniques of collecting including experimental manipulations and in-situ behavioral observations. Our emphasis upon comparative ecosystem ecology necessitates replicated data collection at contrasting sites in the U.S. and British Virgin Islands. For these transects, we will

travel by sailboat on inter-island field trips.

In **Cultural Ecology**, we will study the economics, politics and human cultures of the Caribbean and relate these factors to the management and preservation of the marine environment. We will investigate societal development and structure, documenting how the ocean and its fisheries have been incorporated by those insular cultures. Lectures by faculty and guests will illuminate factors underlying recent political and cultural developments, alien-immigration issues and the effects of major industries, such as tourism and oil shipping, on the region's economy and culture. We may conduct limited field surveys within the local communities exploring attitudes regarding fisheries, the National Park and conservation issues.

In **Principles of Resource Management** we will develop an international focus on harvesting dynamics, environmental risk assessment and conservation practice. Critical case studies will introduce effective and ineffective management practices within a variety of arenas including fisheries, forests and other agro-ecosystems. Special attention will be focused on the management of the Caribbean fishery resource and problems faced by the National Park Service in establishing and enforcing environmental protection policies under various types of park use. We will also consider environmental problem solving on both local and global scales. Economic and biological models for yield optimization, steady state dynamics, diversification/multiple use strategies will be presented. Additional topics for discussion include environmental policy and regulation, cost/benefit analysis, pollution control and biotic reserve design.

The **Directed Research** component of our program will complement our overall objective of quantifying the impact of

fisheries on the National Park ecosystems.

The opportunity to integrate perspectives developed in the preceding courses becomes evident here as students design independent projects from well coordinated parts of the overall research effort. Research topics may include the role of herbivory in structuring reef communities, diurnal changes in fish distribution, patterns of benthic diversity, fish species compositions within disturbed versus protected habitats. Results will be presented orally to the group and to guest speakers at a seminar and will also be submitted to the National Park Service.

Tuition: \$6,030 + \$100 Registration Fee (+ \$100 SCUBA Fee for students requiring SCUBA certification)

Departure Point: VIERS, St. John, Virgin Islands

I expected a bunch of science geeks with whom I could not relate, but the location and subject matter were just too tempting so I signed up anyway. Boy was I lucky, in addition to completing fulfilling my academic expectations, there was a sort of magical chemistry within the group, the likes of which I've never experienced before."

Frederick Reiken
South Orange, NJ
Princeton University



Photo: Beth Goodwin

Understanding local attitudes about fisheries and their impacts on potential solutions is one goal of the Cultural Ecology component of the semester program.

SUMMER COURSE

CORAL REEF
ECOLOGY

AREA

St. John,
Virgin Islands

PURPOSE To investigate the effects of man-made and natural disturbances upon coral reef structure and function to prevent loss of diversity in these fragile ecosystems.

COURSE LEVELS, DATES Level A: June 16-July 15;
July 22-August 20

Academic Content: Introductory lectures will expose us to species identification, evolutionary ecology and reef function and structure. Subsequently, adaptive physiology, behavioral ecology, nutrient cycling through reef food webs will be discussed.

Research Focus: Questions addressed by our research include: What happens when an anchor drags over coral? How do coral species differ in their vulnerability to such disturbance? Is the damage caused by anchors so severe that a new community develops? What is the succession of species which invade a new scar from anchor damage? For instance, are algae and sponges supplanted by urchins and sea cucumbers, which finally give way to dominant corals, or does another "climax" community, like a seagrass bed, develop? How long do these (or other) patterns of succession take? Are there positive impacts of anchor damage? Do they provide a refuge for conch, lobster, and other species?

Field Work: Much of our time during our first few days on St. John will be spent near the white dock that juts into the blue waters of Lameshur Bay. Upon our arrival at VIERS, on the isolated southeastern side of the island, we will spend our first week taking a full SCUBA certification course. Diving into the warm, turquoise waters gives one entry to another world where a



Photo: Dr. Richard Wick

"Yes, there were adversities and dealing with them was a major part of our learning experience. It's unbelievable to me how the group—leaders and students—pulled together and dealt with everything."

Mary Clare Furman
Huntington College

spectacular array of fluorescent fish dart between living corals and sponges.

Our data collection will begin with a visit to a relatively undisturbed site in Lameshur Bay. With our snorkeling gear, we will dive on the reef to quantify its architecture, noting the diversity of hard and soft corals, size of coral heads, and the diversity of colonists such as crustaceans, mollusk, starfish, urchins and sponges. Working in pairs, we will lay transects on the reef to determine the concentration of different species of marine life.

We will then travel by boat to several other relatively undisturbed sites on the southeastern side of St. John to document the variations in species composition and the condition of the reef at different locations. At VIERS, careful analysis of our data from each site will help us differentiate between variations in species composition that are due to natural causes and to human disturbances.

After collecting sufficient data from these sites, we will travel to three areas where boat traffic is heavy. Here, using SCUBA, we will conduct comparative studies of coral conditions and species diversity. Accompanied by brightly-colored fish of varying shapes and sizes, we will explore the reef for large anchor scars, noting their size and abundance. Detailed observations of the species inhabiting these scars and adjacent areas will help us assess how the reef has been altered and whether a new community has developed.

As our analysis of disturbed and undisturbed sites progresses, we will begin work on independent projects. Topics may include: the colonization of disturbed reefs and its predators, community succession within these impacted areas, effect of depth on the size, shape, and recovery time of anchor scars.

At the end of the course, we will analyze our results and determine the long-term effects of damage to the reef ecosystem such as scars caused by boat anchors on the concentration and distribution of inhabitants. Our data will provide the Park Service with vital information on the potential impact of heavy tourist use on this valuable ecosystem.

Tuition: \$1,810 + \$100 SCUBA Fee
+ \$100 Registration Fee

Departure Point: VIERS, St. John, Virgin Islands

Note: Scuba certification will be offered in this course.

I am building on my SFS independent project in Honors Biology at school. I've established a salt-water aquarium and am studying territorial behaviors of damselfish in captivity compared to those I observed in the Virgin Islands."

Jesse Griggs
Portland, ME
Catlin Gabel School

SUMMER COURSE

MARINE PARKS
MANAGEMENT

AREA

St. John,
Virgin Islands

PURPOSE

To quantify the effects of local fisheries and development impacts on edible fish species (red snapper, grouper and barracuda) in the St. John National Park; to assist in formulating sustainable management plans to prevent overfishing.

COURSE
LEVEL, DATE

Level B: June 16–July 15

Academic Content: Lecture material will cover principles of population growth and control, reef ecosystem dynamics, resource planning and management theory. Between dives, faculty will present lectures on food chain dynamics, statistical interpretation, and the ideals and actualities of fisheries management. Guest lecturers—including U.S. Park Service managers—will speak on marine resource management. When possible, we will visit the island's fishing operations to learn about the fishing traditions, the evolution of various fishing techniques and the areas where fishing is most heavily concentrated.

Research Focus: Previous SFS research indicates that current catch limits for conch and lobster would rapidly deplete these populations, even if the fishery resources were allowed to recover. Although aware of this fact, Resource Managers for the U.S. Park Service do not have data to allow them to set different limits, create special seasons, designate protected zones, or employ other management strategies. How abundant are populations of conch, lobster and reef fish? To what extent does the population size of these species vary with location, intensity of fishing pressure, habitat type or physical variables? How do behavioral and distributional biologies affect the vulnerability of a species to overfishing?

Field Work: Our first days will pass quickly—dives from the VIERS dock will enable us to check our scuba equipment, sharpen our skills and explore the turquoise waters of Lameshur Bay. We will begin our field research by taking a complete census of several commercially harvestable fish—snapper, grouper and barracuda. Our initial dives will enable us to identify these distinctive species with ease. Divided into pairs and utilizing hand slates, we will survey adjacent sections of the reef, comparing species compositions, diversities and similarities in detail as we go. Although it is difficult at first, within days we will become adept at communicating with our dive partners underwater.

Aboard our boats we will amass total population counts of each area of the reef. This procedure will be repeated until we have censused a major portion of Lameshur Bay. Next, we will turn our attention to the conch, which because of its patchy distribution may prove challenging to locate, and to the spiny lobster, best seen at night. Our night dives will add further intrigue to the course as the reefs that are so familiar to us in the daylight take on new dimensions at night.



Photo: Brenda Bernstein

"Actually doing research in the field gives you a good idea if this is for you or if you should start to look for another career direction."

Bennett Sandler
University of Michigan

In documenting the habitats and behavior of these species, we will focus on feeding habits, social interactions (between individuals of the same and different species) and territory size as it is affected by antagonistic behavior. Once sufficient data have been collected, we will construct detailed ethograms (behavior catalogs) providing us with a structured outline for behavioral data analyses.

We will then use maps of St. John and adjacent waters to select several sites exposed to varying levels of fishing. At each of these sites, we will again take population counts of species, record their behavior, and document the characteristics of their habitats. Comparison of our data between undisturbed and heavily utilized areas will enable us to determine the types of ecosystems and fish species that are most susceptible to overfishing.

As our research progresses, we will design independent projects, either individually or in small groups. Topics may include: differential behavior of fished and unfished populations, effects of continuous trap fishing on the diversity of fish populations, and age structure of conch.

At the end of our course, we will analyze our findings and determine the habitats that are most preferred by different fish species and the species that are most susceptible to overfishing. We will then compile our data in a report for the National Park Service. Our data on the abundance, distribution, and population structure of shellfish will aid the Park Service in developing protective measures to preserve stocks and sustain high yields.

Tuition: \$1,810 + \$100 Registration Fee
Departure Point: St. John, Virgin Islands
Note: SCUBA certification is a prerequisite for this course.

By the end of the second week I could say "Did you see that *Stenorhynchus seticolnis* under that *Montastrea Annulans*?", and actually know what I was talking about."

Kate Sullivan
Abington, MA
Colorado College

SOURCES OF REEF FISH TOXINS

AREA

St. John,
Virgin Islands

PURPOSE

To study the distribution and origin of toxin (ciguatera) in ordinarily edible fish, such as grouper, snapper and barracuda, and to determine ways of detecting the poison in individual specimens so that they can be consumed by humans without fear of injury.

COURSE

LEVEL, DATE

Level B: July 22-August 20

Academic Content: Faculty will lecture on predator/prey cycles, algal taxonomy and diversity, coral reef ecology, population growth and food web dynamics. We will also spend time in the VIERS laboratory observing toxic dinoflagellates microscopically in preparation to learning their ecosystem role.

Research Focus: Little is known about Ciguatera, caused by toxic, single-celled algae which are eaten by fish and then biomagnified within the food web. Ciguatera toxins occur sporadically and unpredictably, which likens eating some species of fish—especially grouper, snapper and barracuda—to a form of Russian roulette. We will focus the majority of our research on the tiny single-celled algae, called dinoflagellates, probing the origins of these toxins. To what extent is the distribution of dinoflagellates affected by physical and chemical characteristics of the water column? How does dinoflagellate distribution vary within and between bays? We will also study the human aspect of the problem. How can fish with accumulations of toxin be recognized? Is the local perception of areas in which toxic fish occur realistic?

SFS-VIRGIN ISLANDS

Field Work: Our first task will be to sharpen our SCUBA skills while orienting ourselves to the colorful and abundant marine life in the clear waters of Lameshur Bay. We will then begin our field research with several boat trips to different regions of the nearby reefs to locate sites where high concentrations of toxic dinoflagellates may be found. Using SCUBA, we will dive between spectacular coral heads accompanied by bright blue-green wrasse, butterfly fish, sergeant majors and majestic angelfish to record data defining the physical environments of these species. We will focus specifically on water turbulence, light penetration, temperature, dissolved oxygen and pH, to assess which variables promote dinoflagellate growth. We will also scrape surfaces of attached seaweed and tow plankton nets from our boats through the water column to collect samples of dinoflagellates for detailed analysis back at VIERS.

Once we have delineated those habitats which are most favorable to toxic dinoflagellates, we will document associated algae-feeding fish species. Diving to the bottom and stationing ourselves to avoid disturbing the fish, we will census the abundance of prey species and their larger predators. Outside of park borders, we will catch several fish for later dissection at our lab for stomach content analyses and to determine toxin levels within tissue. By understanding the predator-prey relationships on the reef, we can assess the stages at which toxins enter the food web.

After conducting a study of Lameshur Bay, we will travel to several other sites along the reefs of St. John to

explore the difference in concentration of toxic dinoflagellates between bays. We also plan to collect data that will expand our knowledge of the particular species of macro-algae most commonly harboring dinoflagellates. Returning to VIERS in the late afternoon, we will begin the preliminary analysis of our findings and test for correlations between dinoflagellate population densities and site-dependent population density.

To complement our field research, students will have the opportunity to pursue specific topics of interest through independent projects. Possible topics include dinoflagellate settling rates on different types of bottom-dwelling macro-algae, algal biomass within toxic fish, or variability of fish species response to blooms of toxic algae. Breaking up our long days of underwater research will be visits to several towns on St. John and St. Thomas interviewing local inhabitants and marine scientists to determine the frequency and severity of illnesses caused by poisoning when humans ingest affected fish.

We will spend the final days of the course analyzing our data and writing a report illuminating the sites of toxic dinoflagellate occurrence. This report will be submitted to the National Marine Fisheries Service and the U.S. Park Service to assist in designing regulatory policies for the fishing industry that will help reduce the potential threat of Ciguatera to local people.

Tuition: \$1,810+\$100 Registration Fee

Departure Point: VIERS, St. John, Virgin Islands

Note: SCUBA certification is a prerequisite for this course.



Photo: Tim Scout

Few sights can match the daily technicolor parade of fish that inhabit our coral reef laboratory.

DEFORESTATION: TROPICAL RAINFORESTS

AREA

Costa Rica

PURPOSE

To determine how forest regeneration is influenced by the distance of the regenerating forest from mature forest habitat; to assess how rate of regeneration affects the genetic diversity of disturbed species in a tropical rainforest.

COURSE
LEVELS,
DATES

Level A: July 22–August 20

Background

Rainforests are, in the words of the World Conservation Strategy, the “most exuberant celebration of genetic diversity on Earth”. Of the estimated 4 to 5 million species of plants on Earth, 3 million exist only in rainforests and only a sixth have even been identified.

Today just as scientists are beginning to unveil the hidden secrets of this ecosystem, rainforests are being destroyed at a rate of 25–50 acres a minute. If current rates of clearcutting continue for crops, cattle, timber and firewood, over half the world’s rainforest will be eliminated within 25 years. In 1900 over 90% of Costa Rica was covered by forest; today that area has been reduced to less than 35%. Each day several plant and animal species that have yet to be identified are lost forever. Without tropical rainforests to turn carbon dioxide into oxygen, some scientists have suggested that the Earth’s climate may gradually become warmer causing the polar ice caps to melt and massive flooding to occur.

Global conservation efforts have recently begun to focus on designing reserves in deforested regions so these regions may one day return to primary forest. Little is known, however, about



Photo: Chip Leebhart

“It became very evident that saving the forest we came to love was just as much a social issue as a biological one.”

Karla Greenleaf-MacEwan
Cambridge Rindge and Latin H.S.

the environmental factors that must be present to allow deforested areas to regenerate. One of the major factors may be the proximity of primary forest on the deforested areas. In our research, we will investigate the role neighboring primary forest plays in the process of regeneration.

Course Design

Academic Content: Faculty will lecture on ecosystem stability, nutrient cycles and energy flow, soil development, succession and the techniques for using plant identification keys. Additional discussions will focus on the economics of deforestation, erosion and habitat destruction, interdependence of organisms and the principles of natural resource management.

Research Focus: We will investigate the interrelatedness of plants, animals, and humans by addressing questions such as: Does the species composition of specific plant and animal groups vary between primary rainforest and mature second growth rainforest? What is the

impact of primary forest on this composition? Does the population density of mammals vary with age of a deforested area and distance from the primary forest?

Field Activities: The central region of Costa Rica is mysterious and enticing. Steep mountain ranges, tall trees dripping with epiphytes, sparkling waterfalls and a huge array of animal life—tapirs, jaguars, pumas, ocelot, toucans and capuchins—create an unforgettable tropical world. Costa Rica’s lack of an army and its neutrality have earned it a reputation as “the Switzerland of Latin America,” and have provided a stability conducive to long-term scientific research. Deep in the jungle 8 miles from the nearest town, we will set up our camp at Rara Avis, a 1700 acre wildlife refuge owned and designed by Amos Bien, leader of two previous SFS teams studying tropical rainforest ecology in Ecuador.

Our journey to Rara Avis will take us on barely passable dirt roads that weave like snakes through overhanging jungle and along steep mountains. Arriving at our camp, we will stow our gear in screened cabins within sight of a cascading waterfall. Several brief hikes into the adjacent lush green forest will allow us to begin to become familiar with our surroundings. As we make our way through stands of huge mahogany and cyclopia trees, past colorful miniature orchids, the cacophony of birds and monkeys in the branches overhead will constantly accompany us.

Following several days of orientation to the rainforest ecosystem, we will head out on expeditions into the mountainous terrain to explore and map with compasses regions that have been deforested at different times in the last twenty years. Government records and conversations with local residents will enable us to determine when these areas were first deforested.

With our map complete, we will conduct a survey of the animal and plant species in the vicinity of our site. Using tape measures and surveying instruments, we will lay out transects in deforested areas at increasing distances from the primary forest. In pairs, we will then walk along the transects recording all species of animals we see as well as tracks from larger mammals like jaguar and puma. We will also bait and set small traps and most likely continue previous mist-netting of birds along the transects to

help determine the range of smaller birds and animals inhabiting these areas. Compiling and analyzing our data from each transect will help us determine the variation in composition as one moves further from the primary forest.

After we have sampled several sites, we will move into the adjacent primary forest to conduct similar studies on animal composition in undisturbed areas. By comparing our data on the distribution of animals in forested and deforested regions, we will be able to determine how the primary forest affects the recolonization of deforested areas by animals. Because the study areas are of different ages, we will be able to determine how the distribution changes over time.

While we are conducting our research on animals, we will take a survey of plants at each site and then compare our findings to the distribution of plants in the primary forest. Again, we hope to assess the importance of the proximity of primary forest on the recolonization by plants of deforested areas. Is the distribution of plants in primary forest and deforested areas the same? Does primary forest have a direct effect on the types of plants growing in deforested areas? In designing preserves for the re-establishment of rainforests, is it important to have primary forests in close proximity?

Along with our overall field study, we will have the opportunity to work on independent projects that might focus on a description of soil characteristics in deforested and primary forests, the effect of age of a deforested area on the complexity of tropical communities, or bird diversity in deforested regions.

Toward the end of our third week in the field, we will take an extended hike to La Selva, a large, progressive research station owned by the Organization for Tropical Studies. Here, we can talk with scientists about their research, our data and plans for future preserves.

The last three days of our course will be devoted to compiling all our findings in a final report which we will present to the Organization for Tropical Studies. Our data on the impact of the proximity of rainforest on the recolonization by animals and plants of deforested areas will provide valuable information for the design of management plans for reserves in deforested regions.



SFS gratefully acknowledges the Archer Daniels Midland Company, Decatur, Illinois, processors of agricultural products, for their support of this course.



Photo: William McComas

The need for teamwork goes beyond our research tasks as everyone pitches in to help with cooking, supplies, and maintaining the camp.

I felt that being placed in a totally new environment with new expectations and standards, I was given a wonderful opportunity to establish myself as an individual, independent of my friends, family and culture."

Karla Greenleaf-MacEwan
Cambridge, MA
Cambridge Rindge and Latin H.S.

Living and Working Conditions

Our research at Rara Avis will take us to a remote virgin tropical rainforest, a cloud forest with an elevation of 2,000 meters, and a steamy lowland rainforest near sea level. The temperature at these locations varies from cool at higher elevations, to hot and muggy at lower elevations. Rain showers at all the study sites are short, but frequent.

Our campsite consists of bunk beds in screened rooms covered by a thatched roof. A dining and meeting room, with a kitchen is nearby. We will carry in our food, purchased at local markets in Las Horquetas. As a team, we will share all cooking and cleaning duties. Plenty of fresh water will be available from tanks that collect the rain runoff from roofs.

Tuition: \$1,690 + \$100 Registration Fee
Departure Point: San Jose, Costa Rica



Photo: William McComas

"You learn from keeping your eyes and ears open and take part in everything. This is how learning should be."
Frank Lorch
University of Notre Dame

MEDICINAL BOTANY: DISCOVERING NEW PLANT MEDICINES

AREA

Ecuador

PURPOSE

To identify and collect plant specimens from the tropical rainforest that contain active ingredients with pharmaceutical properties unknown to modern medicine; to help document the traditional medicinal knowledge of the Yumbo Indians now endangered by cultural changes.

COURSE
LEVELS,
DATES

Level B: June 16-July 15;
July 22-August 20

Background

Tomorrow's cure for cancer may come from a plant that grows in a tropical rainforest. Today, more than 25 percent of all pharmaceuticals come from this rapidly disappearing resource. Treatments for Hodgkin's disease, hypertension, and rheumatoid arthritis have been derived from tropical flora. The essential ingredients for birth control pills and Curare, a muscle relaxant now used in heart surgery, grow only in rainforests.

The western world has tapped only a tiny fraction of the medicinal potential of the tropical rainforest ecosystem. Only one sixth of the forests' 3 million species have even been identified, much less investigated in any detail. The greatest storehouse of information about the pharmaceutical properties of tropical plants resides not in university libraries, but in the oral traditions of indigenous peoples who have used these plants for centuries.

This storehouse is being threatened in three ways. First, modern medicine has reduced the dependence on folk remedies, and the traditions are not being passed on. Second, socioeconomic upheavals are altering tribal structure, relocating people and destroying traditional folk ways. Finally, deforestation is eliminating vast numbers of species at an alarming rate.

Course Design

Academic Content: Initial lectures will introduce students to the cultural history of the indigenous people of Ecuador, the botanical explorations of the early European explorers, the use of medicinal plants by indigenous tribes, and the taxonomy and physical adaptations of major plant groups. Advanced lectures will cover the biochemistry of plant alkaloids, the isolation and concentration of active plant products, introduction of ethnobotanical and anthropological methods, and descriptions of impacts of deforestation on people and plants.



Photo: Julie Schwantes

Many of the plant species in the rainforest have never been previously identified. Who knows what we'll find!

Research Focus: With the assistance of a Yumbo "informant", we will identify and collect samples of diverse and little-known species from the tropical rainforest. We will investigate the importance of these plants to the shamans, or tribal doctors. What plants are of medicinal importance, and what are the active pharmaceutical ingredients? What is the distribution and abundance of these plants? How do the tribal cultures use and prepare these plants? What are the ancient customs and controls in the use of medicinal remedies?

Field Activities. Upon arriving in Quito, we will board a bus and head through the lush green highlands of the Andes. As we rise to higher elevations along narrow winding roads, we will pass Otavalo Indian villages with thatched cottages surrounded by crops of corn, wheat and potatoes. We will then descend into lowland tropical rain forest abundant with brightly-colored hummingbirds, to the small river port of Misahualli. Loading our gear into motorized dug-out canoes, we will head for our base camp at the Reserva Biología Jatun Sacha, about 8 km east of Misahualli along the Rio Napo, only 1 degree south of the equator.

Our field research will incorporate investigative techniques of botany and medicinal anthropology. Our focus during the first half of the course will be on the primary forest. One can expect almost daily encounters with mud as we hike through low-lying areas to our study site where we will collect herb-arium specimens from undergrowth overshadowed by a lofty canopy. Huge emergent trees over 60 meters tall dangle long, woody vines from their heavy cloaks of epiphytic orchids, ferns, bromeliads and lianas. Often specimens from the upper reaches of the forest must be obtained with the aid of a clipper pole, or a tree-climbing bicycle. We will conduct transects to document the diversity and density of endemic and often previously undescribed species of plant life found in this region. Using plant presses constructed with aluminum corrugates, we will prepare and process our specimens for later identification and analysis.

During the second half of the course we will travel by canoe along the Rio Napo to reach the home of our Yumbo Indian informant, a *Yachaj runa*, or shaman, with more than 50 years expe-



We will spend as much time as possible with an "informant" from a local Yumbo village.

rience in the recognition, preparation, and administration of plant remedies. Our informant will lead us into the forest on collecting expeditions, and will describe the Yumbo conceptions of health, disease, anatomy, physiology, and supernatural influences. We can then contrast Yumbo knowledge and systematics with the systematics and taxonomy of classical botany. Yumbo methods of collection and preparation will also be demonstrated. Brightly colored toucans, parrots, huge frogs, grasshoppers and magnificent Morpho butterflies with iridescent blue wings will be common sights on our expeditions.

Each student will carry out an independent project, drawing on the issues raised by the botanical studies and interactions with the informant. Questions to be considered include what are the major differences in biota at various levels of the primary forest? How do individual shamans develop their unique repertoire of remedies? What are some of the important determinants of speciation across the divergent areas of Ecuador? How do Yumbo perceptions of major life processes, such as reproduction, conception, illness, differ from ours?

Each evening at our base camp we will compile our findings and carefully label, press and dry all plant samples collected during the day. The final days of our course will be devoted to analyzing our findings from the two segments of our study, and describing the specimens used for medicinal purposes by the Yumbo Indians. We will present our final report to the U.S. Agricultural

Research Service and the Ecuadorian Government to provide important information on the broad range of medicinal substances that may be extracted from plants in tropical rainforests. Our data, in conjunction with findings from other similar studies conducted in rainforests around the world, will contribute information about the vast potential of tropical plants to aid in future development in medicine.

Living and Working Conditions

The verdant greens of the rainforest are fostered by drenching rains—in this area up to 6 meters annually. Days are often clear and warm while nights, when most of the rain falls, can be cool requiring a warm sleeping bag. Our base camp at Jatun Sacha will provide simple but adequate accommodations accompanied by a spectacular view of the snow-capped Andes rising in the distance. Our tents will be pitched on platforms to keep out rain and the ever present mud.

Our close proximity to the river makes bathing each day easy. Because of the ease of infection from even minor bites and cuts in a hot, moist climate, personal hygiene will be stressed. We will purchase food in Missahuali and prepare our daily meals in a covered outside kitchen utilizing recipes we have brought from home and learning to prepare local dishes.

Tuition: \$1,690 + \$100 Registration Fee
Departure Point: Quito, Ecuador

I felt exhilarated when I could bravely walk through the jungle and be aware of the fact that I knew exactly where I was, where I was going and coming from."

Aurora Andreescu
Woodside, NY
Barnard College



Photo: Chip Isenhart

"The more we learned about the forests, the more exciting and unlimited the information became. With every discovery we were more aware of how much lay ahead undiscovered."

James Geanacou
Community College of Rhode Island

ENDANGERED MONKEYS: EXPERIMENTAL SOCIAL ECOLOGY*

AREA

Panama

PURPOSE To determine changes in the population density of the Panamanian tamarin monkey in an area we are helping to become the first reserve for this endangered species; to study their social organization through experimental trapping, tagging and introduction studies; to study tamarins introduced and provisioned on an island in order to propagate the species.

COURSE LEVELS, DATES Level A: June 16-July 15
Level B: July 22-August 20

Background

The lush jungles that once blanketed most of Panama were home to the rufous-naped or Panamanian tamarin. Groups of four to more than a dozen of these tiny, ten inch monkeys dwelled in the branches of cecropia trees, swinging rapidly through the treetops. Panama's growing human population has depleted the jungles leaving only pockets of what was once continuous forest. Unless measures are undertaken to protect or relocate them, this ongoing loss of habitat may drive the gremlin-like tamarin and many of its neighbors to extinction. SFS students are playing a major role in developing management strategies to protect the tiny, threatened monkey.

Students will have the rare opportunity to study at close range a population of Panamanian tamarins previously

undescribed in the scientific literature, and to contribute to an effort to preserve an endangered primate. Dr. Dennis Rasmussen, our senior faculty member, has conducted research at our study site since 1981. The discovery by Dr. Rasmussen and SFS students that our study site has one of the highest population densities of any known area suggests that secondary neotropical jungle is a particularly favorable habitat for the tamarin. On the basis of this information, SFS, the University of Panama, and several conservation organizations are lobbying to make our study area a refuge where this species can continue to survive. At this time an executive decree declaring our study site to be the first refuge of its kind for tamarins is being considered by the President of the Republic of Panama.

Course Design

Academic Content: Following an introduction to the natural history of tamarins and a review of the scientific study of social behavior, faculty will discuss foundations of evolutionary theory, primate taxonomy and principles of animal behavior. Methods of scientific interpretation of tamarin social ecology and behavior will include reproductive and parental strategies, and territorial defense. Level B students will also examine theoretical distinctions in levels of behavioral explanation while covering the lecture material in greater depth.

Research Focus: Students will focus on three major areas of research this summer. To continue our studies of social organization and social ecology we will trap and mark individuals to collect data on leadership, range use, social interactions and population size. From these data we hope to determine what changes in population have occurred over the last year? How many infants were born? Is the group composition stable?

Additionally, we will continue our investigation of how resident groups react to strangers introduced in cages. Placing caged strangers of different ages and sex high in the trees within the territories of various groups will provide us with clues to the social organization of this fascinating species. Our results may help us to learn how to reintroduce tamarins to areas where their numbers have been depleted.

Our third study will entail observing behavior and range use of a group of

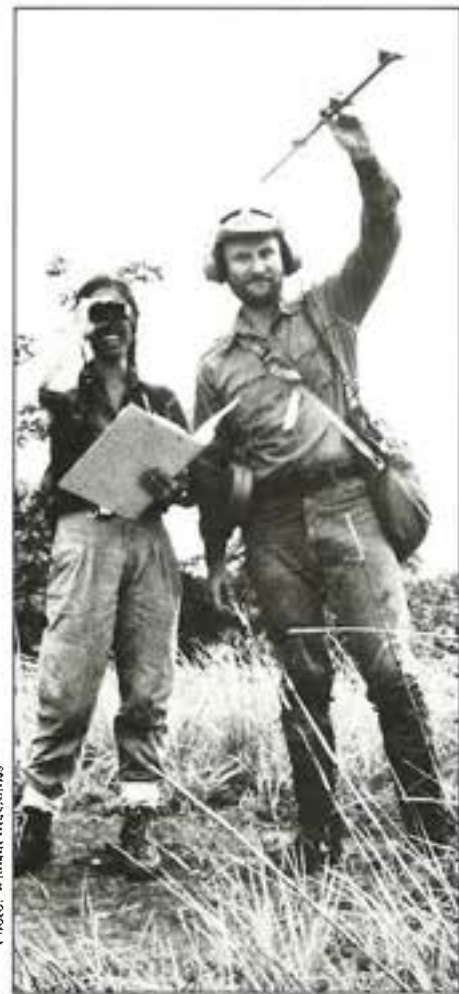


Photo: William McComas

With the aid of radio-tracking, we can follow the tamarins through the dense jungle of our study area from dawn until dusk.

"Knowing the results of my study may be used for constructing and designing "tamarin farms" and a tamarin reserve at our study site made me proud to have participated in the study."

David Jolly
Aylmer, Ontario CANADA
Arthur Voaden Secondary School

tamarins introduced and provisioned on a nearby island in a collaborative effort between SFS and The World Wildlife Fund. Is this a means of rapidly producing tamarins who can then be re-introduced into areas where populations are declining?

Field Activities: Our research will take place in lush, uninhabited neotropical jungle. After arriving at Panama's international airport, we will board a bus for the quick trip from the Pacific Coast to the Atlantic Coast. Our first night will be spent camping on the shores of Gatun Lake after a late dinner of local fare.

At first light we will load our gear into our boats for the five mile crossing to our base on a tranquil cove. After tying up our boats at the small pier, we will set-up camp in a jungle clearing complete with a 20x30 foot covered patio (Bohio), to the accompanying cacophony of a colorful array of tropical birds. Our first days will focus on learning the skills essential for working safely in the jungle. We will familiarize ourselves with several miles of cleared paths while learning how to observe Panamanian tamarins and other creatures, such as capuchins, howler monkeys and the coati mundi, a close relative of the raccoon.

Chopping through the overgrowth with machetes, we will improve and expand on the network of trails made during previous SFS courses. Further details will be added to maps of the area by use of hand transits and thirty meter tapes. Patience on everyone's part will be required as we wait for curious tamarins to investigate our specially designed cages placed high in the treetops of our study area. Each monkey that we capture will be weighed, censused, measured and then marked with a color coded collar, offering students an unusual opportunity to gain direct hands-on experience with the monkeys.

Capturing, measuring, and marking tamarins from as many groups as possible, we will add to the over thirty individuals we have identified during previous courses. With the aid of radio tracking, we will observe and follow our main study group through dense jungle from dawn to dusk. The data we collect on spatial leadership and on social organization will be the first ever assembled on this endangered species.

After long days in the jungle, we will relax with a refreshing swim in the clear, warm water of Gatun Lake. Once a week 3-4 students and a faculty member will travel to the island site of our tamarin introduction project for a day of data collection.

Shortly after the start of the course, faculty will assist students in choosing and designing independent projects. Potential topics include studies of range use, assessment of the likelihood of trapping different aged and sexed individuals, relationships between leadership and the age and sex of groupmembers, mother-infant interactions, and territorial interactions between groups.

Oral and written reports of our independent projects and our group research results will be presented to students and faculty members of the University of Panama interested in our research efforts who will visit our site. Written summaries of the results of our research will be provided to the Smithsonian Tropical Research Institute, the Ministry of National Resources of the Republic of Panama, and the University of Panama to aid in the development of conservation and protection measures.



Photo: William McComas

Few undergraduates have the opportunity to do hands-on research with primates in the wild.

Living and Working Conditions

The watchword here is wet: rainfall averages 11 inches a month and is often accompanied by magnificent lightning and thunder. This is truly a "steaming jungle" where we will often be sun-burned, and soaked with sweat and rain all in one day. The temperature ranges from a maximum of 85° F during the day to a minimum 70° F at night. Tents erected in a jungle clearing overlooking Gatun Lake will be our home for the month. We will buy food at western-style supermarkets in Colon (about 90 minutes away by boat and train). In addition, we can catch an abundant supply of fresh fish from the small pier right at our campsite.

Tuition: \$1,690+\$100 Registration Fee.

Departure Point: Panama City, Panama

***This course will be offered in the January Term, 1988. Please contact the Admissions Office for details.**



Photo: David Jolly

The dock at our research site is an ideal place for informal discussions with faculty, a relaxing swim and to fish for dinner.

RECOVERY OF ENDANGERED SPECIES: ALPINE IBEX

AREA

Switzerland

PURPOSE To investigate the recovery rate and environmental impact of reintroduced alpine ibex (*Capra ibex*) in their original habitat; to develop a model for assessing the effectiveness of reintroduction programs in altered ecosystems; to assist in the development of wildlife management strategies.

COURSE LEVELS, DATES Level A: June 16-July 15
Level B: July 22-August 20

Background

Awe-inspiring and fortress-like in appearance, the Swiss Alps are among the world's most fragile alpine ecosystems. Easily damaged through human activity, it takes many years, even centuries, for plant and animal species to adapt to major disturbances. Ungulates (hoofed mammals) have been a significant part of the natural history of Switzerland throughout recorded history. During the last century, however, the alpine ibex was completely eliminated from its native alpine habitat. In the early 1900's, with only a handful of ibex remaining on a king's estate in Italy, a small number were secretly taken to Switzerland, where they were bred and subsequently reintroduced into some of their original locations in 1921.

Today, more than 10,000 ibex roam spectacular but unforgiving mountain terrain. This remarkable success story is not without cost. Signs of overgrazing are evident due to increased competition with other recovering alpine species. The potential now exists



Photo: Katharine Browne

Sharing discoveries with the people who have worked so hard alongside of you is one of the rewards of team research.

for a variety of critical environmental problems including erosion, avalanches, and food shortages for many wild and domestic animals. Alpine ibex herds are now being culled in areas where their numbers are judged too high, and detrimental to the Alpine environment.

The remarkable recovery of the ibex population raises two important issues which have been the subject of SFS research for the past two summers. One is of general biological importance, the other related to management concerns. First, how does the reproductive success of the ibex compare with that of other native species such as roe deer, or chamois? Second, what are the lessons to be learned from 80 years of efforts to conserve the ibex? Can a definitive "operating manual" be developed for the preservation of other endangered species? Is the recovery of one species necessarily at the expense of others?

Course Design

Academic Content: Lecture material will introduce the biogeography of alpine ecosystems, animal behavior and social organization, theories of population dynamics, methods for scientific field studies, and the ecology and management of endangered species. Methods for studying plant habitats (eg., monitoring and transecting), and animal distribution and behavior (eg., censusing techniques, focal sampling, and time sampling) will be demonstrated. When possible, guest lectures and site visits will supplement discussions of cultural and economic realities of natural resource management.

Research Focus: Our primary goal will be to determine the factors influencing the abundance and distribution of ibex at two different habitat sites. How does adaptive capability under varying environmental conditions differ? Are these differences age or sex specific? How do ibex range-use patterns differ from those of other ungulates? We will also examine socioeconomic factors that influence current management policies. Does the preferred habitat for ibex overlap that of domestic livestock? How does one determine when a species has recovered? What considerations influence the decision to cull populations of ibex?

We faced many of the problems forest, fish and wildlife managers and field biologists face every day. I now realize wildlife research is a far cry from the glamorous work "Wild Kingdom" presents it to be. I know how much work is involved and how often a year's worth of research can have to be altered and repeated. I now realize the work I want to do will not be easy but I'm going into it with my eyes open."

Amanda Williams
Hebron, ME
Kenyon College

Field Activities: We will catch glimpses of spectacular mountainous countryside as we travel south by train from Zurich through narrow mountain passes and quaint Swiss villages toward our study site. Here where small cottages are scattered across even the steepest terrain, we will set up camp at Dom Mountain, the highest peak in Switzerland, not far from the Italian border. We will hike daily from our campsite among intermittent stands of spruce and sun-splashed meadows dotted with wildflowers into the high rocky alpine zone that is home to the ibex. After locating and classifying ibex groups by age and sex composition, we will collect behavioral data on both individuals and small groups of these animals whose agility as they move among the rugged peaks will continually amaze us. Focusing our observations primarily on food preferences, social structure, and foraging behavior, we will also note the presence of other large mammals seen in our study area, such as red deer, chamois, and roe deer.

We will describe the ibex habitat in detail. Using tapes, compasses and transects we will measure the frequency and distribution of different species of vegetation. Habitat microclimate, including humidity and sunlight levels will also be recorded. These data will be recorded on topographical maps to help identify important characteristics of the preferred habitat.

Several days observing ibex foraging behavior will give us data for comparison with similar information to be collected at our second site.

The imposing, deep valley created by the snow-capped peaks of the Jungfrau, Monch and the Eiger in the heart of Switzerland will be the second of our spectacular natural classrooms. Hiking up steep, grassy and forested slopes, we will continue collecting data on foraging behavior. Later comparison with observations from Dom Mountain will help us determine variations in levels of adaptability to different environments. By recording occurrences of foraging by other species, we can also determine the effect of excess grazing on habitat quality.

Independent student projects will provide the opportunity to explore many questions associated with our major study. What is the effect of altitude on local floristic distribution, and how does this relate to ibex population density? What are the differences in energy budgets among species of alpine ungulates? How are these related to foraging success? What segments of the population are most susceptible to culling measures, and how will this affect population growth?

The last days of our study will be spent analyzing our behavioral and environmental data to understand the utilization of the alpine habitat by the ibex and to assess the impact of the ibex on the environment. Our findings

will be incorporated in a final report to be presented to the Swiss Federal Forestry Agency to aid in the design of future wildlife management strategies, and will provide a basis for designing reintroduction programs in other parts of the world.



Photo: Susan Beckett

It's one thing to read about it in a textbook, but it's another to see it with your own eyes!

Living and Working Conditions

Switzerland is raw physical beauty taken to a high art. Weather conditions, even in summer, can be as surprising and rugged as the mountains. Our base camps will be in alpine meadows while our field work will often require challenging hikes to the playgrounds of the ibex on the sides of rugged, glaciated peaks.

Temperatures within these different environments vary considerably. Eighty degree days of blazing sunshine may be common while temperatures may dip below freezing at night. We will be camping in sensitive alpine areas, and therefore will carry only essential equipment and will purchase our food in local villages.

Tuition: \$1,710+\$100 Registration Fee
Departure Point: Zurich, Switzerland



Photo: Katharine Browne

"After sharing thoughts about life, college and the future with my teammates, I don't feel I'm alone in this sea of life. They have the same fears and uncertainties about their futures as I do."

Lisa Steiner
University of Miami

"ACID RAIN": CHANGING FOREST ECOSYSTEMS?

AREA

**Bavarian Alps,
Germany**

PURPOSE

To understand the relationship between long-term effects of air pollution transport and deposition patterns on alpine forest dieback in Central Europe; to compare severely impacted and mildly impacted forest areas to further clarify the factors responsible for dieback.

COURSE
LEVELS,
DATES

Level A: June 16-July 15

Background

The earth's forests can be thought of as the lungs of an intricate web of life support systems which humans depend upon for survival. The World Conservation Strategy reminds us that if the world is to support its growing human population, we must ensure certain ecological processes vital to food production, health, and economic development. Cycling of oxygen and carbon throughout the biosphere, moderation of climates, sheltering of plant and animal life, recycling of chemical nutrients, cleansing of air and water, and the prevention of floods and soil erosion are the by-products of healthy, functional forest ecosystems.

The forests of Central Europe have been a battleground on which essential ecological processes have been confronted by the effects of hundreds of years of human activities. Some scientists have predicted that within the next quarter century, over 30% of the forests

Photo: Dieter Deemling



Is acid deposition contributing to "dieback" in Germany's once luxuriant forests?

now blanketing Europe will be lost prematurely. This unprecedented phenomenon, known as "dieback", is marked by accelerated aging, followed by death.

The alpine forests of West Germany display some of the most vivid consequences of human impact. In many areas, alpine forests cling tenuously to a relatively thin topsoil above unstable lower layers deposited on mountainous terrain during periods of glacial development. Beginning centuries ago, alpine agriculture, primarily in the form of grazing cattle, caused the eroding of the thin layer of topsoil. In addition to threats of avalanche, rock slides, and river flooding following the deposition of eroded material, forest growth began suffering as moisture and nutrient availability decreased.

During the last hundred years, laws directed at reducing agricultural damage have led to an increase in wildlife.

Photo: Karen Josephson



Alpine meadows carpeted with wildflowers and towering snowcapped peaks will take our minds off the rigors of daily hikes to our study sites.

Today, deer and mountain goats forage on the new growth of young trees, killing them outright or reducing their growth, making them more susceptible to disease or competition from other types of weedlike vegetation. The development of alpine areas for recreational use, including ski resorts and hiking trails, has created an additional threat as these fragile ecosystems become more accessible.

Industrial expansion beginning in the early 1900's has placed forests under attack from atmospheric changes. Today, more than 3 million tons of sulfur dioxide are pumped annually into the air over West Germany alone. Air borne pollutants come from West Germany's industrial heartland in the Ruhr Valley, from France, Czechoslovakia, East Germany, and as far away as the United Kingdom. As these pollutants settle on the forest canopy, they interfere with air circulation within the trees and nutrient transport from the soil. Pollutants which reach below the canopy increase soil acidity, leading to critical leaching of necessary nutrients into water runoff, depriving trees even further. The importance of air borne pollutants relative to other forms of impact on the forests (disease, insects, moisture stress) continues to be a matter of some controversy and is one of the major issues SFS students will address.

Course Design

Academic Content: Lecture material will include an introduction to alpine biogeography, plant pathology, atmospheric conditions influencing acid deposition patterns, emission inventory and

sources, and the chemistry of soil processes. Soil and atmospheric analysis techniques will be demonstrated, examples of normal and abnormal tree growth patterns will be reviewed, and students will be shown a variety of methods for discerning degrees and sources of forest damage.

Research Focus: Our goal is to document how the effects of air pollution, together with other stresses such as recreational development and excess wildlife density, contribute to the forest dieback problem. How are needle count and weight, and color distinction indicative of the various conditions of stress associated with different regions of the alpine forest? How is susceptibility to dieback influenced by altitude, age, atmospheric moisture conditions? How well do levels of sulfur dioxide, nitrogen oxide and ozone correlate with type and extent of damage?

Field Activities: After a brief orientation in Munich, we will ride south by train to our campsite near Bad Tolz. Here spectacular promontories of the Bavarian Alps, will form the walls of our month-long classroom. On a typical day, after a morning lecture, we will hike to our densely forested study area. Our hikes will sometimes take us across gently sloping meadows carpeted in brilliant wildflowers, while at other times we will embark on somewhat more arduous treks into higher, more mountainous elevations.

Using simple tools such as needle counts, color shifts, degree of root proliferation at different depths, identification of soil difference, and a characterization of surrounding vegetation, we will document critical factors associated with differences in degree of forest damage. We will measure atmospheric loadings of air borne pollutants above, at, and below the canopy level, as well as levels of acidity in water and soil in a variety of settings, differences in seedling survival, growth rates, and type and frequency of abnormal growth patterns within these settings.

We will begin to develop a conceptual model of the complex interactions influencing forest dieback in Central Europe. Occasional field trips to museums and areas of controlled logging, complemented by guest lectures by foresters and other scientists will help us understand the political and economic forces that have shaped these problems and are influencing solutions.

SFS gratefully acknowledges The Boston Globe Foundation for their support of this course.

Student independent projects may investigate the threshold levels at which trees at different stages of development become susceptible to damage from pollutants. How do pH levels vary with soil depth under different degrees of damage? How does root structure damage proceed as affected trees begin to show symptoms of deterioration?

Group discussions will emphasize the controversial nature and the complexity of these issues. The results of our study will be made available to state forestry officials for consideration in developing policies to reduce future forest damage, and to interested scientists in Europe and the United States.

"Our lectures, discussions and debates brought to my attention environmental concerns, challenging me to acknowledge and evaluate my individual actions upon society and nature. This heightened awareness forced me to accept greater moral responsibility for my conduct."

Jean Fang
Burr Ridge, IL
Cornell University

Living and Working Conditions

A rustic cabin serving as our classroom/kitchen will be the focal point of our base campsite. The towering peaks of the Bavarian Alps frame our forested setting. Weather can be unpredictable, we will hope for warm, sunny days and will **expect** chilly nights.

If we move **quietly**, we can spot small roe deer, elk-like red deer, rabbit, fox, and pheasant on hikes to our study site. As we climb to rocky higher elevations, nimble-footed chamois will scramble across the alpine peaks above us. As over 60 million people inhabit this area, which is approximately the size of Pennsylvania, we will not be totally isolated from the "distractions of civilization". We will, however, carry out our study in relatively remote areas of alpine splendor.

Tuition: \$1,650 + \$100 Registration Fee
Departure Point: Munich

Note: Participants are encouraged to take advantage of a unique opportunity to obtain a comparative and global perspective on this critical issue by also enrolling in *Acid Rain: Changing Aquatic Ecosystems in the Adirondacks*. Students may design independent projects spanning both projects.



Faculty will lecture in an alpine classroom defined by snowcapped peaks and a huge sky.

"ACID RAIN": CHANGING AQUATIC ECOSYSTEMS

AREA

Adirondack
Mountains,
New York

PURPOSE

To study biological effects of atmospheric pollutants (acid rain) on sensitive Adirondack lakes and streams; to determine how the communities of these altered systems function, so future effects of acidification or neutralization can be predicted.

COURSE
LEVELS,
DATES

Level A: July 22-August 20

Background

Nestled between mountains and surrounded by rocks left untouched since the retreat of glaciers 12,000 years ago, the lakes that dot the Adirondack Range of New York state appear far removed from the effects of people, pollution, and other external pressures. Recently, many species of fish have disappeared from lakes and streams here. Much of the blame for this environmental catastrophe has been placed on the well-publicized phenomenon called acid rain, caused by acidic airborne pollutants from the industrial heartlands of North America.

There is evidence that acid rain raises the level of acidity in certain inherently sensitive lakes and streams, particularly those without limestone bedrock to buffer acid impact. The effects of acid deposition are complex, but a major concern is that freshwater fish are extremely sensitive while insects, algae,

plankton and higher organisms survive and even flourish.

Our study site lies within Adirondack State Park, one of the world's most striking illustrations of the impacts of acid deposition. This 6-million-acre park is characterized by beautiful, rolling mountains, huge expanses of deciduous and coniferous forests and some 4,000 secluded lakes. Aquatic biologists have found these ecosystems to be altered by acid rain, giving rise to the popular but deceptive notion of "dead" lakes. In fact, these waters contain abundant plant and animal life and are very much alive, despite high levels of acidity.

This is the fifth year of SFS's major effort to assess the impact of acid rain on the freshwater ecosystems of the Adirondacks. SFS faculty, Dr. Robert Singer and Dr. Deborah Roberts, have co-ordinated the activities of more than 50 SFS students describing the range and impact of acid deposition on the complex food chain of selected lakes and streams. Their results indicate that not only is acid deposition exceptionally toxic to fish, but in lakes devoid of fish, insects become the top predator. We are just beginning to understand changes in food chain interactions resulting from removal of fish species and plan to continue to develop our extensive database describing both stream and lake ecosystems.

Course Design

Academic Content: Course topics will include an introduction to theories of limnology, water chemistry, and basic principles of ecology, with more detailed coverage of physiological adaptations to acid-stress, impacts on forest ecosystems, mineral weathering of igneous rock, and management implications of liming and other forms of control technology. Basic laboratory and field techniques such as stream-flow measurement, titrations, determination of acid-neutralizing capacity, and collection and identification of major plankton, plant, and macro-invertebrate species will be demonstrated.

Research Focus: What is the role of predatory insects in food chains as they take over the niche left vacant by the demise of fish populations? How do populations of zooplankton respond to acidity and to predation? What is the importance of naturally occurring acids relative to the deposition of acidic pollutants? Are the changing patterns previously identified continuing?

Field Activities: Our base of operation will be The Fresh Water Institute, a turn of the century lodge on Lake George that serves as a field station for Rensselaer Polytechnic Institute. Our first expedition will take us through dense birch, beech and maple forests to Beaver Brook, a small stream west of



Photo: Robert Singer

"This course, for me, was not only important but necessary. The experience in the field, the collecting of data, the DOING science, was great!"

Laurie Wetherbee
Rensselaer Polytechnic Institute

Lake George. Here, in a classroom defined only by mountains and a huge sky, amidst some of the most beautiful and remote backcountry in the eastern United States, we will study how water reacts with the rocks and soils over which it flows and how these reactions affect the acid level of the water and the organisms it contains. After familiarizing ourselves with the site, we will collect water samples from pre-determined locations, as well as a variety of representative invertebrate species. These samples and specimens will eventually allow us to better understand watershed dynamics and hydrology.

After four days we will return to the laboratories at The Fresh Water Institute to analyze our samples and summarize data on the daily changes in physical, chemical and biological parameters in Beaver Brook. We will discuss how to improve our collecting and analyzing techniques to better understand the subtleties of aquatic ecology.

On our second extended expedition, we will canoe through a system of sparkling lakes and streams north of Stillwater Reservoir. After establishing our base camp on the shores of remote Salmon Lake, we will hike through pine-scented woods to different lakes each day. Using small inflatable boats or snorkeling gear, and specialized nets, we will collect large predatory insects, zooplankton, and plant and water samples, in addition to measuring water clarity, depth and temperature. Later, back at the laboratory, we will analyze our samples to determine levels of nutrients, pollutants and chlorophyll.

We will complement our team research with student projects, important opportunities to develop individual research capabilities. Topics may range from the characterization of the zooplankton communities, to the determination of feeding preferences of invertebrate predators, or the description of daily migration of insects in the water column.

Our data will allow us to determine how variations in aquatic chemistry affect distribution and adaptations of fresh-water organisms, and how new food chains develop in acidic lakes. As we learn more about the science of acid deposition, social, political and economic implications will invariably lead to much lively debate and discussion each evening over a dinner prepared on portable stoves. After long

SFS gratefully acknowledges The Boston Globe Foundation for their support of this course.



Photo: Edward Rice

Using canoes and small boats we will continue our data collection which has led to one of the largest databases in the world on non-fish species in acid lakes.

hours of research, it will be a welcome relief to snuggle into warm sleeping bags under star-studded skies.

With our field research complete, we return again to The Fresh Water Institute to perform laboratory analyses, summarize our data, and form our conclusions about the biological and chemical variations in our study area. We will prepare a final report, to be submitted to state and federal agencies responsible for environmental protection. Our work may well influence future policies on the restoration of aquatic ecosystems altered by acidic deposition.

Living and Working Conditions

This is a wilderness experience. Extensive hiking and canoeing necessary to reach our study sites will undoubtedly challenge us. We will need to be constantly aware of the potential impact our presence may have on the otherwise pristine wilderness and peaceful quiet of this country's oldest mountains.

Weather in the Adirondacks is notoriously variable; while most days will be pleasantly warm, the evenings and nights will be chilly and the rain unpredictable. The rigor of our somewhat primitive campsites, however, will be offset by quite comfortable conditions at The Fresh Water Institute, where we will find rooms, beds, plumbing, and a large, inviting fireplace.

Tuition: \$1,410 + \$100 Registration Fee
Departure Point: Bolton Landing, New York



Photo: Barth Anderson

"I know this experience will help me get a job because I'll be able to offer employers experience most others won't have."

Maria Markow
University of New Hampshire

Note: Participants are encouraged to take advantage of a unique opportunity to obtain a comparative and global perspective on this critical issue by also enrolling in "Acid Rain: Changing Forest Ecosystems?" in the Bavarian Alps. Students may design independent projects spanning both courses.

BIOLOGY AND BEHAVIOR OF BOTTLENOSE DOLPHINS*

AREA

Gulf of Mexico

PURPOSE To document the social ecology and life history of bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Mexico through behavioral observation and photo-identification; to investigate the impact of commercial fishing, natural gas exploration, and recreational boating on the distribution, foraging strategies, and reproductive success of resident dolphin populations.

COURSE LEVELS, DATES Level A: June 16-July 15
Level B: July 22-August 20

Background

The power of humans over nature is epitomized in Mobile Bay, Alabama. Here, engineers recently completed a massive project merging two rivers well inland of their former junction. A dramatic increase in port activity and a drastic change in the environment of Mobile Bay now pose a serious threat to resident populations of bottlenose dolphins, while outside the Bay, in the Gulf of Mexico, commercial shrimping, gill-netting, and sport-fishing compete with the dolphin for a variety of limited food sources. Oil and natural gas exploration, tanker and freighter traffic all increase the habitat degradation with which dolphins must cope. In the face of the significant and rapid changes in this area, little research has been aimed at identifying the impact on the local dolphin populations.

Access to coastal breeding and feeding areas is critical for the continued presence of the bottlenose

dolphin in many areas of the Gulf of Mexico. Yet unchecked growth in commercial and industrial disturbances continues to reduce the amount and quality of available habitat while a huge fishing industry competes for ever-dwindling prey species which also suffer from habitat degradation.

Now, yet another source of disturbance threatens the social stability of dolphin groups. Incredibly curious and highly intelligent, this species of dolphin has become the most captured for use in marine parks and research laboratories around the world. While many facilities have begun to breed

terms, and learning abilities. Material on methodology and statistics, cetacean research techniques, and general principles of sociobiology will also be presented.

Research Focus: Previous research conducted by SFS last summer and in January began photo-identification that will allow us to develop case histories based on later re-sightings. We will continue to photo-document movement, behaviors and group membership of identified dolphins, as well as collect data on habitat parameters—water depth, temperature, visibility, and distance from shore. Reactions to the



Photo: Eric Taniuchi

It is often difficult to assign vocalizations to individual dolphins because they do not move their lips while vocalizing.

dolphins in captivity, large numbers are still removed from the wild each year, through special permission of the United States Marine Mammal Commission. Recently, dolphins in Mobile Bay have become a major source of animals to be maintained in captivity. Dolphins are known to form highly social groups built on kinship and dominance hierarchies. The impact of removal on social cohesion and ultimate reproductive success of affected groups has yet to be studied and documented.

Course Design

Academic Content: Lectures will cover marine mammal taxonomy and evolution, cetacean anatomy and physiology, sensory and communication sys-

different types of human-generated activity will be noted, and amount of time spent in various activities such as foraging, reproductive activity, and resting will be recorded.

Identifying individuals will allow us to follow changes in membership and social dynamics of dolphin groups following removal of individuals for marine facilities. Documentation of dolphin social ecology and natural history will answer questions about habitat use and impact of disturbance. How do dolphins use different areas in and around Mobile Bay? How does commercial and recreational boat traffic influence distribution and movement patterns? What is the overall effect of human/dolphin competition for fish?

Field Activities: Our study will be based in Mobile Bay and the adjacent Gulf of Mexico waters. Long white sand beaches and windswept dunes frame the warm azure waters of the bay. This extremely rich estuarine habitat is buzzing with human activity including commercial shrimping, gill netting of fish, sport fishing, oil and natural gas exploration and tanker and large ship traffic. Since it is also an area with high concentrations of bottlenose dolphins, it is not unusual to see them surfing in the wake of a huge ship or patrolling for food in the vicinity of fishing boats.

Weather conditions permitting, much of our data collection will be made from SFS's 30-foot twin-engine boat and outboard inflatables. Heading out to sea daily, we will search for pods of dolphins. Once we locate them, team members will begin pre-assigned tasks of photographing individual dorsal fins for later identification, recording location and habitat characteristics, and documenting group composition and social activity. In addition, B-level students will use hydrophones (underwater microphones) to record changes in echolocation clicks, and variations in the whistles associated with social interaction.

Each team member will carry out an individual project that may address age/sex differences in foraging strategies, variations in acoustic patterns at different times of the day, or in different areas of the study site, or identification of behaviors associated with social status. As time and opportunity permit, site-visits to near-by oceanaria, commercial fish processors and government agencies may occur. Dolphins that die from natural or human causes occasionally wash up along the beaches. If this occurs during the course, we will examine the specimen to determine probable cause of death.

Late nights can be expected toward the end of the course as we compile our research results and prepare to present our independent projects. Data we collect on the impact of activity in Mobile Bay on dolphin behavior and distribution will be submitted to the National Marine Fisheries Service to aid in the development of policies to minimize disturbance of human activities on dolphin populations in the area, as well as to the Alabama Department of Conservation and Natural Resources.

Photo: Beth Grundwin



"Because we were all in the same situation working for the same goals, we were able to put aside our differences and see each other as individuals. It was a great experience in abandoning stereotypes."

Shelley Holstrom
Kansas University

Photo: Eric Tamiuch



We will have the unusual opportunity to reconstruct the skeleton of a dolphin that came ashore during our January course.

Living and Working Conditions:

A beach cottage on the tip of a narrow, 30 mile peninsula near the old civil war edifice, Fort Morgan, will serve as our home and research base. Looking out from the porch one sees large expanses of white beaches and sculpted sand dunes covered with sea oats. Brown pelicans, royal terns and black skimmers squawk overhead and the lush vegetation supports numerous species of land birds. On the bay side of the peninsula, extensive wetlands support many great blue herons, snowy

I had begun to feel maybe I had chosen the wrong field. I wasn't sure how I could survive all the courses necessary to get a Marine Science degree. The SFS Dolphin Biology and Behavior course has given me new reinforcement to go forward. Now when I get down in the dumps from too much school work, I think back on my SFS course and get a new perspective on everything."

Lisa Steiner
Two Rivers, WI
University of Miami

egrets and even an occasional alligator.

The weather is warm and humid, while calm periods alternate with sea breezes. We will prepare our own meals, dining on many of the specialties of the area such as shrimp, king mackerel and red snapper.

Tuition: \$1,710+\$100 Registration Fee
Departure Point: Mobile, Alabama

***This course will be offered in the January Term, 1988. Please contact the Admissions Office for details.**

SOCIAL ECOLOGY OF SPINNER DOLPHINS

AREA

Kauai, Hawaii

PURPOSE

To document the inshore use, by spinner dolphins, of an area in Hawaii that is becoming subject to greater recreational and commercial utilization by humans; to assess the potential for displacement from critical resting sites; to photo-identify individual animals and describe long-term social patterns and school stability.

COURSE
LEVELS,
DATES

Level B: June 16-July 15
Level A: July 22-August 20

Background

For reasons as yet unknown to marine biologists, the Hawaiian population of spinner dolphins (*Stenella longirostris*) appears to be unique among this species which is one of the most beautiful and acrobatic of marine mammals. The common name derives from the spectacular spinning leaps frequently executed while milling about in groups of anywhere from 30 or 40 to literally hundreds and sometimes thousands of animals. Elsewhere in the Pacific, spinners are a deep water species, rarely being seen close to shore. The Hawaiian groups, however, after feeding at night in deep oceanic waters offshore, return each morning to protected small bays in certain areas of the Hawaiian islands, where they rest during most of the mid-day. As late afternoon approaches, they substantially increase their activity level, engaging in a variety of behaviors apparently aimed at communicating within the group readiness to leave the resting area for a night of foraging.



Photo: Randall Wells

Spinner dolphins derive their name from their acrobatic antics and behaviors.

The resting areas selected during daylight hours seem to be characterized by proximity to off-shore feeding areas, protection from shark predation and inclement weather, and avoidance of humans. Favored locations are used almost daily during the year, although it is not yet clear how much interchange exists between groups utilizing various locations throughout the Hawaiian island chain.

The island of Kauai, the northernmost of the seven inhabited Hawaiian Islands, is every dreamer's real life paradise. Here, lush tropical forests line high, rugged volcanic cliffs. Fresh water streams plunge down precipitous gorges and gush from green valleys seeking outlet to the surging seas. For centuries, much of Kauai's northly, or windward, shore has been relatively inaccessible. Today, helicopters and inflatable boats bring even the most isolated areas within a moment's reach of a constant flow of visitors. Resort development and increased recreational use of inshore waters is a constant threat to coastal species. Our study of the spinner dolphin will allow us to learn more about the habitat requirements and social behavior of this graceful and little-known species, and evaluate the potential for disturbance posed by human activities.

Course Design

Academic Content: Faculty will lecture on evolutionary theory, marine ecology, marine mammal taxonomy, cetacean anatomy, the physiology of sensory and communication systems, and the social ecology of toothed whales and dolphins. Basic principles of research methodology and biometric analysis will be reviewed. Students will be instructed on the use of visual and acoustic monitoring, such as theodolites, hydrophones, and spotting scopes. Cetacean research techniques will be described and demonstrated. Guest lecturers will provide additional material on the flora and fauna of the Hawaiian islands.

Research Focus: The SFS research team will document spinner dolphin temporal and geographic use of the Kalihikai Bay area of Kauai. Shore-based sighting teams will record the frequency and duration of periods during which the dolphins are present in the study area. From small boats we will photograph individual dolphins, collect acoustic data, record habitat characteristics such as temperature, depth, and turbidity, and note behaviors. Our data will further clarify the social behaviors and habitat requirements of the Hawaiian spinner dolphin. How is activity level associated with time of day? To what extent do these dolphins form a "closed society"? What is the degree of human disturbance on spinner dolphin distribution and behavior?

Field Activities: We will erect our tent camp on the outskirts of Kilauea, an old sugar plantation town, near the inshore waters of the Kilauea Point National Wildlife Refuge, our primary study site. Here, on a high cliff overlooking white-sand beaches, faculty will instruct us in the use of a theodolite (surveyor's transit), which we will use to track groups of spinner dolphins as they move inshore during daylight hours. We will record changes in the "spread" of the group, and note changes in general behavioral state. Differences in specific behaviors such as leaps, body slaps, and diving patterns will be documented, as well as occurrences of boats and helicopters in the area. We expect to see other cetacean species, including pilot whales, false killer whales, beaked whales, spotted dolphins, and rough-toothed dolphins in our study area as well.

As the shore-based group searches for spinner dolphins with binoculars and spotting scopes, a boat team will launch

from approximately 3 miles west of Kilauea Point. Using CB radios, the boat and shore teams will coordinate data collection, and verify each others' observations. Spinner dolphins are difficult to approach under most circumstances, so much care will be given to developing subtle techniques to photo-identify individual dolphins using dorsal fin shape and body markings. Differences in depth, turbidity and temperature of water, as well as changes in bottom topography, will be noted throughout the study area. The boat team will also periodically record dolphin vocalizations in order to document relative amount of acoustic activity associated with changes in group behavior. It is seldom possible to associate vocalizations with individual animals but there are marked changes in the type, intensity, and overall amount of sounds made in different behavioral states.

Our work will provide a basis for comparison with previous studies carried out in the most southerly of the Hawaiian Islands, in an area subject to considerable levels of habitat disturbance from agricultural run-off and boat traffic. Our study on Kauai will provide many new questions about spinner dolphins, which may form the basis for the individual project each team member will conduct. How are weather and inshore occurrence related? With what other species of cetaceans are spinners found? What age and sex classes of the population determine the general

Photo: Don Moses



We will use spotting scopes and theodolites for many of our land based observations from high atop these cliffs at Kilauea Point.

behavioral state of the group? How are the different age and sex classes distributed within the group?

During the last days of the course, we will compile the data we have collected and prepare to present our independent projects. The results of our research will be submitted to the National Marine Fisheries Service, State of Hawaii biologists, and the U.S. Fish and Wildlife Service, for their consideration in designing future management policies.

Living and Working Conditions

The many faces of the Hawaiian ecosystem will surround us as we conduct our research. The fauna of the Hawaiian Islands, much of it introduced, adds incredible color and aroma to this idyllic setting. Fragrant plumeria, graceful hibiscus, and vibrant bougainvillea will be common sights at our base camp from which we can also see frigate birds and sooty terns soaring on the crest of trade winds just offshore. We will live in tents, but will prepare our own meals and attend lectures in facilities at the Wildlife Refuge.

In Hawaii, over-exposure to the sun is the major concern—be certain to bring an effective sun-blocking agent and light but protective clothing. Our study site is exposed to gusty trade winds, and early morning hours can be on the cool side. Occasional rain or high winds may cause us to curtail our water work at times. Expect to get wet on the boat from which we will often see the protected green sea turtle, and we may even encounter the rare and endangered Hawaiian monk seal.

Tuition: \$1,750 + \$100 Registration Fee
Departure Point: Princeville, Kauai

I remember thinking, 'Why am I doing this? I don't know anyone, I've never been there, I don't know the first thing about dolphins or field research!' I was scared to death, but I'm so glad that I went through with it and thinking back on all my fears now, I just laugh."

Amy Kandel
Shaker Heights, OH
Mount Union College

Photo: Earl Larson



Small boats will afford us an opportunity to record vocalizations and photograph individual spinner dolphins.

PARKS FOR PRESERVATION: LARGE MAMMAL ECOLOGY

AREA **Colorado Rockies**

PURPOSE To determine the quality and size of ecological land units needed to preserve species diversity and conserve populations of bighorn sheep, American elk, mule deer, black bear, and other large mammals in the Rocky Mountains; to aid in the development of a biological preserve system for Colorado able to support and protect the state's wildlife in perpetuity.

COURSE LEVELS, DATES **Level B:** June 16-July 15
Level A: July 22-August 20

Background

Amid the startling grandeur of snow-capped mountain peaks that jut skyward from green-forested valleys, elk, mule-deer and the solitary black bear roam at will. Bighorn sheep clamber effortlessly across mountainous terrain that challenges the most experienced human climber. The remote San Juan basin of southwestern Colorado is one of America's most outstanding remaining wilderness areas. Here, diverse wildlife still roam free, as yet untouched by the demands of expanding human populations.

However, major land-use changes are being planned throughout the Rocky Mountain region, raising concern that the ensuing development will result in a rapid loss of wildlife habitat in the San Juans, similar to that occurring else-

where in the southwest. Before management plans can be created to protect the diversity of species which naturally occur in these potentially threatened primary wildlife areas, these areas must be described in terms of overall faunal abundance and landscape characteristics. With such data, biologists and resource management officials may better determine where, how large, and how "natural" key areas need to be to sustain the diversity and abundance of wildlife that forms such an important part of our heritage.

A number of previous SFS courses have investigated now depleted habitats which once served as preserves for luxuriant growth of natural vegetation, extensive wildlife, and natural areas. In many cases, by the time damaging impacts from development were evidenced in a habitat, restoration was impossible. Ecologists concerned with protecting large mammal habitats must be able to predict future land-use consequences. They must evaluate how much economic development is compatible with a region's natural resources, so that the regional economy remains vital while protecting the habitat. This new SFS course provides an ideal laboratory for exploring these issues.

Course Design

Academic Content: Lectures will address vegetation and habitat types of southwestern Colorado, the natural history and ecology of focal species such as black bear, bighorn sheep, elk, bald eagle, greater sandhill crane, and Colorado squawfish; conservation biology, and theories of biogeography. Training in the use of landscape mapping systems and aerial photo interpretation will be provided. Interactions with faculty and guest lecturers from agencies such as the Colorado Division of Wildlife and the U.S. Forest Service will expose students to discussions of the impact of land use on wildlife, the San Juan and Rio Grande National Forest plans, and human attitudes toward the land and its future.

Research Focus: In this first year of our study, we will document summering areas for bighorn sheep, elk, mule deer, and black bear over two distinct landscapes in the San Juan Mountains. These data will be later integrated with findings on fall-winter concentrations of these species. Special efforts will be made to identify unique or critical habitats (old growth forests, undisturbed riparian habitats, areas of high berry productivity).



Photo: Tony Povilis

Our studies in the Colorado Rockies will give us the unusual opportunity to anticipate an environmental problem and formulate preventative measures rather than react to an issue that has already become a problem.

We will cross-check our findings with the use of aerial photographs and the most recent data available from public and private resource organizations. Our findings will be of use in answering a number of critical questions: How much human land use can be interspersed with the natural systems of a region? What is the carrying capacity of the current system? How seriously will it be impacted by proposed land-use changes?

Field Activities: The San Juan Mountains, featuring some of the wildest and most beautiful country in Colorado, lie to the north of Mesa Verde National Park and the Southern Ute Indian Reservation, along the Colorado-New Mexico border. Their range extends from sagebrush habitat below 7,000 ft. to high peaks towering over 14,000 ft. Following our arrival in Durango, we will familiarize ourselves with the San Juan area using maps and slides. We will then establish our first base camp amid the rocky terrain of the spectacular Animas River Canyon-Needle Mountain area.

Our initial efforts will include a survey of the area as we count pellets and follow animal tracks and use binoculars and spotting scopes to determine types and distribution patterns of key large mammals. This will allow us to characterize primary summer habitats for each of the species studied. Our daily observations will be field-verified using Landsat satellite images and aerial photographs. We will note the features of greatest importance in those areas associated with particular distributions of large mammal species. Our backpacking journey through this vast, untouched area will take us far from any evidence of civilization, giving us ample opportunity to develop and utilize wilderness survival skills.

Daily wildlife sightings will continue during the second phase of our study as we will travel east to the Piedra River, resuming our study in the grasslands and forests of the Weminuche Valley. Comparing the two study areas will add to our knowledge of the critical features of large mammal habitats, as well as the relationship between the area of a particular ecosystem and type and diversity of species it will support.

We will usually engage in field work until early afternoon, devoting the remainder of the day to lectures and discussions. Designing and executing an

independent project will allow students to expand their own areas of interest. There are many important questions to be addressed, such as how well do aerial photographs allow us to detail important elements of various habitats? How do various species differ in their habitat area requirements? Do public land-use values threaten the pristine qualities of this region?

As our month in this unforgettable wilderness draws to an end, we will compile our findings and present the results of our independent projects. Less formal presentations will undoubtedly occur at the end of each day, as we relax around a glowing campfire, and consider topics that may range from cultural differences in land ethics, to our own personal views about conservation and wildland protection.



Mule deer are one of the primary species we will census and track amid the pristine splendor of one of America's last wilderness areas.



"From the very start we were lectured on the safety hazards of anyplace we were to go and how to deal with any situation that might come up."

Cathy Coleman
University of Vermont

I returned with a newfound image of myself and a sense of satisfaction for doing something I never thought I could— I set up and slept in a tent (I never had before)—and now I've taken up hiking as a new sport. I came home knowing I tried harder than I ever had before."

Cathy Coleman
Westwood, MA
University of Vermont

Living and Working Conditions

Backpacking to isolated sub-alpine campsites where we will pitch our tents at the edge of flower-speckled meadows or beneath the shadows of trees and mountain peaks, we will indeed feel far removed from the "distractions" of civilization. Stepping out of our tents each morning, we will find ourselves gazing at breathtaking panoramas reminiscent of calendar photographs.

Weather conditions will range dramatically from mid-day heat to night-time cold. While it will be generally warm and dry at lower elevations, we can expect afternoon thundershowers, particularly along the higher mountain slopes. Nearby mountain streams will provide water for cooking and washing.

Tuition: \$1,560+\$100 Registration Fee
Departure Point: Durango, Colorado

ECOLOGY OF BALD EAGLES

AREA

Alaska

PURPOSE To study the ecology and behavior of nesting and newly-fledged bald eagles in Southeast Alaska, to identify habitat requirements and effects of disturbance on behavior; to locate new nesting sites; to provide information on habitat requirements that may help in reintroduction programs underway in other areas of the United States.

COURSE LEVELS, DATES **Level A:** June 16–July 15;
July 22–August 20

Background

The American bald eagle surrounds us in daily life—on currency, flagpoles, even on cans of beer. Yet few Americans have had the opportunity to watch the living embodiment of this proud raptor as it soars overhead or plunges earthward in search of food. Populations of bald eagles have been nearly eliminated throughout most of the lower 48 United States, as their habitats, once constituting some of the most spectacular wilderness areas in the world, have been decimated.

A significant population of bald eagles still nests in the towering conifers that line the coastal inlets of southeast Alaska. Eagle reintroduction programs in other areas of North America depend on an awareness of critical environmental factors which allow eagles to maximize food intake, and minimize injury and energy expenditure. SFS research teams will return to Alaska for a second year to collect data that may contribute to the success of these reintroduction efforts.

For eagles, finding and protecting food is a vital endeavor. Periods of plenty associated with runs of spawning salmon in late summer and early fall are



Photo: Paul Valiulis

"Someday I'm going back to that place on the top of the world and be a wildlife biologist. I'm going back where the eagle soars and the whale swims—Alaska."

Barbara Barton
Michigan State University

followed by lean winters, forcing eagles to fly south. When they do, they are threatened by human activity—hunting, widespread use of chemical toxins, and reduction of suitable habitat through land development.

Variability in food availability exerts a major impact on predation strategies and energy budgets. Feeding on live prey and dead, they migrate widely in search of food, and pirate food from other smaller or nearly-satiated eagles. They reduce energy expenditure by increased idleness and sheltered nesting during harsh weather. Only certain tree species (conifers in some cases, cottonwoods in others) provide protection against low temperature and high wind speeds. Habitat changes that threaten the food supply or availability of protection from the rigors of a hostile climate have a quick and disastrous effect on population size.

Course Design

Academic Content: Faculty and guest lectures will discuss Alaskan ecosystems, bird taxonomy, and the natural history of the bald eagle. Additional lectures on principles of ecology, evolution and natural selection, physiology, statistical methods and resource management will occur throughout the course. Techniques of observation and data collection will be demonstrated prior to initiation of field research.

Research Focus: Our methods will be descriptive studies of population dynamics, habitat use and food availability, and correlational studies that identify environmental factors affecting population size and distribution. Observations of nesting adults and newly-hatched fledglings will help identify variables influencing locations of nests and the relative success of nests exposed to different levels of disturbance. We will observe adult-young interactions, focusing on feeding behavior, and assess the effect of food availability on reproductive success, growth of fledglings, and number of occupied nests. How much food do nesting eagles need for themselves and their young? Are there types of disturbance to which eagles habituate?

Visits to previously-identified nests document the extent to which old nests are re-used. In 1986, the first year of our eagle study, we identified a number of previously undocumented nests. The trees in which these nests were found were marked with U.S. Fish and Wildlife Service plaques to prevent damage or destruction by humans. We will continue this work as well during the current course.

Field Activities: Heading north from Juneau into the Tongass National Forest, we will set up our base camp amid towering Sitka spruce. Only a few miles away huge glaciers crawl from the per-

manent ice fields of Southeast Alaska's higher elevations. As we look across Lynn Canal the spectacular Chilkoot Mountain Range rises in the distance beyond a marked landscape of dissected mountains, alpine glaciers, and high-gradient streams.

We will first familiarize ourselves with our study area, review safety measures, and practice using topographic maps and compasses. Our research activities will begin with shore trips orienting us to the difficult art of spotting eagle nests. We will gather information about species and condition of nest tree, status of the nest, surrounding vegetation, distance from the water, and whether the nest has been previously identified. Moving through dense coniferous forest and flowering alpine meadows we may see moose, deer, bears and porcupines. Near-shore waters are home for killer whales, feeding humpbacks and stellar sea lions.

Our group will next divide into daily teams; some setting out in kayaks to look for nests on offshore islands and along the mainland coast, while others continue to locate nesting sites along the shore, and document surrounding vegetation. Once a nest is located, an attempt will be made to go ashore and record data on the nest tree, and its location from the water. These data will be important for determining distribution patterns and effects of varying levels of disturbance on nest utilization.

Once our surveys are completed, we will document the behavior of eagles inhabiting the nest we have identified. Positioning ourselves behind natural blinds to minimize disturbance, we will use telescopes and binoculars to observe nests with newly-hatched fledglings. How often do parent eagles visit the nest? What kind of food do they bring their young? We will observe young eagles as they test their wings and become independent. Students may choose to document the behavioral development of the juvenile eagles for an independent project. Other project topics include variations in nest size and reproductive success of eagles, interactions between adjacent nesting pairs of eagles, or spacing of nests in relation to food resources.

Our results will be presented to Forest Service, National Park Service and Alaska wildlife management personnel. In addition to assisting in management and impact plans for the



Photo: James Fraser

"What's for dinner, Mom?" Understanding the food requirements of fledgling bald eagles will be one goal of our research.



Photo: George Allen

We will assist the U.S. Fish and Wildlife Service by marking previously undocumented nest trees.

area, our study may also aid recovery plans underway in other areas of the United States.

I was very lucky one day and saw one of the nestlings fly for the first time. That sure made up for all the long hours of observation."

Amanda Williams
Hebron, ME
Kenyon College

Living and Working Conditions:

Our site has been described as an aquamarine jewel in a forest setting. The sight of snow-peaked mountains reflected in rippling fjords is truly unforgettable. The scenery will help make days of damp, cool weather more bearable and there are no words to describe the perfection of a sunny day in Alaska.

Our campsite, located in the National Forest wilderness area, requires us to practice minimum-impact camping. We will leave little behind but our footprints. We will prepare our meals under rustic camp conditions, encouraging great leaps of creativity in the preparation of culinary delights from a kitchen larder carried to the site in backpacks.
Tuition: \$1,610+\$100 Registration Fee
Departure Point: Juneau, Alaska

BEHAVIORAL DYNAMICS OF HARBOR SEALS

AREA

Prince William
Sound, Alaska

PURPOSE To identify critical aspects of human disturbance that affect the distribution and behavior of harbor seals (*Phoca vitulina*); to assist conservation and regulatory agencies in developing sound management policies to protect seals from increasing commercial and recreational boat traffic.

COURSE LEVELS, DATES **Level A:** June 16–July 15
Level B: July 22–August 20

Background

During the summer breeding season, female harbor seals haul out on the glistening icebergs of Alaska's Prince William Sound to rest, give birth, and suckle their young. Here, where snow-covered peaks rise above crinkled fjords, they make their homes with humpback whales, sea otters and stellar sea lions as their neighbors. Currently, human activities such as tourism, energy exploration, and the fishing industry are expanding into these once secluded waters. In what ways are harbor seals affected by this? Is their future security jeopardized? Are they destined to join the endangered species list with other marine mammals with whom they share their home? SFS is finding out.

Following our research of marine animals in Glacier Bay from 1982 through 1984, we began a study of harbor seals in west Prince William Sound. SFS students kayaked along 150 miles of jagged coastline, collecting data on the distribution of harbor seals, stellar sea lions, and sea otters. Breeding populations of seals are particularly susceptible

to human disturbance. They must find protected areas to give birth, and they require access to clean water to maintain their good health. Our results suggest that harbor seals are more plentiful in areas distant from daily human disturbance by commercial and recreational boating. The exact impact of increased disturbance is complex and unclear. Our efforts to identify specific sources of interference will help management authorities set effective policies for the protection of seals and other marine animals within the study area.

Course Design

Academic Content: Formal lecture material will include topics such as the principles of evolution and ecology, physiological adaptations of marine mammals, systematics and natural history of pinnipeds (walruses, seals, fur seals, whales, otters and sea lions), the natural history of Kenai Peninsula, and field identification of the area's bird and mammal species. Important aspects of design, implementation and analysis of scientific investigation will be described, and guest lecturers will review issues of conservation and management of marine mammal populations.

Research Focus: We will document the distribution and behavior of harbor seals and investigate the impact of other marine mammals and human disturbances on the use of haul-out sites. What specific behavioral changes can be used to determine the nature and intensity of disturbance? Are harbor seals being disturbed enough in certain areas to warrant new management efforts?

Field Activities: Our journey will begin in the small town of Whittier on the northeast side of Kenai Peninsula. After loading our research equipment and supplies into two-person ocean kayaks, we will paddle through narrow, tree-lined fjords to reach our base-camp below Blackstone Glacier (A level only) or in Nassau Fjord (B level only) on the western side of Prince William Sound. We will have entered the most spectacular natural classrooms imaginable. Majestic, snow-capped mountains and massive glaciers tower above us as we glide through the marine habitat of killer whales, sea otters, and seals. Marmot, mink, eagles and bears will watch our progress from shore.

Once we have established base camps at the edge of virgin forests of spruce, alder and hemlock, we will explore the upper recesses of the study sites to determine several locations where seal populations appear to be the most dense. From land stations overlooking the more densely inhabited sites, we will census seals using spotting aids such as binoculars, scopes and a surveyor's transit to record the number and the behavior of target animals on ice floes and on shoals. As commercial and recreational boats move into our study area, we will observe changes in harbor seal behavior as well as the size, type and movement pattern of the target vessel. In addition, members of the B team will observe both opportunistic and experimentally controlled approaches by various sized vessels to haul out sites to assess effects on the seals' "rate of scanning".



Photo: Barb Taylor

Harbor seals, the principal subjects of our research, aren't the only marine mammals we may encounter; harbor porpoise, killer whales and sea otters are common visitors to our study area.

Extended field expeditions in the Chugach National Forest will provide an opportunity to observe the diverse ecosystems of Kenai Peninsula. We will also work on independent projects that may focus on such challenging issues as: What is the nature of the interactions between mothers and their pups? Do some of these animals have specific territories and if so, how are they defended? Or, students might choose to focus on other animal species and their relationships to seal populations.

In the last few days of the course, we will analyze our data, seeking answers to our primary research questions. What are the best means of detecting differences in long-range and short-term effects of disturbance? What segments of the population are more subject to disturbance than others? How do this year's findings compare with those from the two previous years? We will submit a report of our findings and conclusions to the U.S. Forest Service, which manages the National Forest and Wilderness Area. Our findings will also be available for the development of use-intensity regulations and marine mammal approach guidelines for campers in the National Forest.

Photo: Donald Brewster



Kayaking is the best means of covering the distance between our research sites, and good physical conditioning is a must for all participants.



Photo: Claire Saks

"Everyone ought to be required to take a course like this . . . there's a whole world out there they never dreamed existed."

F.J. Maloney
Boston College

Living and Working Conditions

Some say there is no beauty that compares with that of Alaska on a sunny day. Traveling by ocean kayak will allow us to traverse the great distances between haul-out sites and observe the marine mammals that surround us while causing only minimal disturbance. Several long days of paddling will bring us to sites so isolated we may go days without encountering other humans. The physical demands of paddling require all participants to be in good shape. The breathtaking panorama that surrounds us on all sides provides ample compensation for our efforts.

We will make camp on small, secluded rocky beaches where our huddled dome tents will contrast with the angular landscape. These sites are strictly regulated, requiring us to practice low impact camping techniques to minimize our disruptive effects on these locations.

The weather will vary dramatically, from warm, sunny stretches to cold, overcast days with thick fog or pounding rain. Meals will be quite simple as our food is limited by what can

be carried by kayaks and prepared easily in the field.

Tuition: \$1,610 + \$100 Registration Fee

Departure Point: Anchorage, Alaska

(Students will be met in Anchorage but must purchase train ticket to Whittier).

Iwould like to thank SFS for providing me with scholarship aid to attend this program. I feel what was spent was not wasted. It was probably a very inexpensive way to get some of my priorities in order. It is difficult to choose a career when you have not been out in the world enough to know exactly what you like."

Lisa Steiner
Two Rivers, WI
University of Miami

HUMPBACK WHALE ECOLOGY

AREA

Gulf of Maine

PURPOSE

To understand how distribution and density patterns of endangered humpback whales in the Gulf of Maine are related to the occurrence of fish stocks, to study the extent to which recovery of the humpback whale may affect availability of commercially-important species of seafood; to further document the life history, reproductive success and association patterns of identified whales.

COURSE
LEVELS,
DATES

Level B: June 8-July 7

Level A: July 2-July 31;

July 27-August 25

Background

With a mouth that can hold nearly as much water as an olympic-sized swimming pool, and an appetite to match, humpback whales consume large quantities of fish. Each summer, hundreds of humpbacks return to the food-rich banks of the Gulf of Maine. They pass long summer days searching for large schools of fish on which to feed in the highly productive waters of the North Atlantic. Humpback whales are seasonally anorexic. This means that in a brief three to four month period, they must build up a thick coat of blubber to carry them through a period of fasting during their long migration to the winter breeding and calving grounds in the Caribbean. The apparent increase in the number of humpback whales roaming the North Atlantic raises new questions about protection and management.

The factors that determine the distribution and movement patterns of humpback whales on the summer feeding grounds have never been clearly

understood. As their numbers increase, there have been concerns about disturbances associated with whalewatching vessels, the potential impact of increased commercial fishing, and the effects of oil exploration. Last year, humpback whales failed to return to Stellwagen Bank, one of the most popular areas for whalewatching during the last decade. While this may well have been the result of a change in distribution of prey species, a variety of other factors may play an important role.

Despite the great deal of worldwide attention directed toward the humpback whale during the last decade, much remains to be learned about their natural history and behavior. SFS's studies of humpback whales over the last four years have tracked changes in distribution throughout the Gulf of Maine, added to an ongoing catalogue of individually-identified whales, and documented behaviors associated with feeding episodes. Further effort is needed to determine the habitat requirements and use patterns of humpbacks throughout the Gulf of Maine, to assist in clarifying the degree of recovery of this species, and to understand the implications of recovery for future management policies.

Course Design

Academic Content: Faculty will lecture on the anatomy and physiology of whales and dolphins, the natural history of the humpback whale, marine food webs and humpback feeding patterns, physics of light and sound transmission in water and techniques for studying and identifying cetaceans. Safety precau-

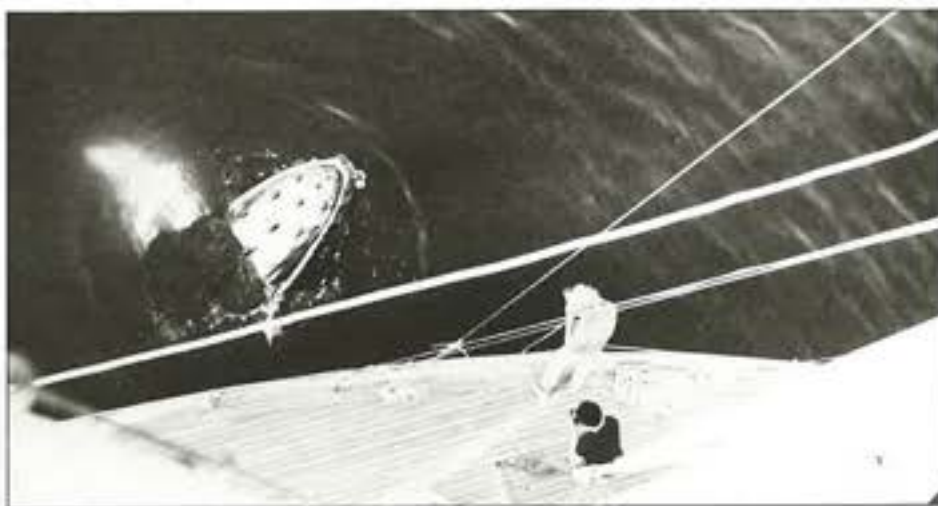
tions and sailing skills associated with ocean-voyages will be demonstrated.

Research Focus: Our research activities will include censusing of humpbacks and other species of great whales along pre-determined ship transects, measuring ocean characteristics in areas differing in whale density, and photo-identification of individual humpback whales. We will attempt to document behaviors, particularly with respect to social interactions among co-ordinated groups of feeding whales.

Although identification of age and sex class is extremely difficult in the field, we will be interested in observing differences in the distribution and behaviors of calves, sub-adults and adults throughout the study area. When possible, we will use underwater recording equipment to document sounds made during feeding. We will also note the type and occurrence of boat activity during our observation periods.

Field Activities: One of several small islands guarding the entrance to Boston Harbor will be our first destination after meeting in Boston. Here, camping in sight of saltmarshes teeming with wildlife and the Boston skyline rising in the distance, we will spend an intense week preparing for our next three weeks at sea. Having much to learn about boat safety, data collection, and team-work, we will cover as much of the preliminary material as possible so that we can spend every minute that we are at sea watching the whales.

After provisioning our research vessel, a large sailing ship chartered just for our study, we will set out for three challenging and rewarding weeks. We



One of our most difficult tasks will be to calmly record behavioral data while these magnificent 40 ton creatures spyhop and breach alongside of our boat.

Photo: Ben Baxter



We will break up into three rotating watches while at sea. One responsibility of the science watch will be to scan the seas for the telltale blow of a whale.

will divide our team into three 8-hour watches, that will rotate throughout the day and night. As one watch rests, the science watch will conduct the team research activities, while the sailing watch will assist the regular ship's crew in the operation of our floating home and classroom.

Research will begin at first light. Sailing through the chilly waters of the Atlantic off Cape Cod and on toward Nova Scotia, we will search the seas for the tell-tale blow of the whale. Once we sight whales, we will record their location, number, general activity, direction of movement, while also documenting general sea and weather conditions.

Whenever possible, we will photograph the exposed underneath surface of the whale's tail, or flukes, permitting individual identification on the basis of unique markings found there. We will occasionally stop to deploy our hydrophone (underwater microphone) to record any sounds the whales make.

During our ship surveys, we will undoubtedly see other cetaceans. Perhaps we will encounter the rare right whale, or the 60-ft. fin whale, or the smaller minke whale and sei whale.

Students in both levels will conduct individual projects related to the overall

study. Possible topics include discovering long-term associations among individually identified whales, documenting differences in behavior among calves, sub-adults and adults, or among adults of different size and sex.

Field trips may take us to the Center for Coastal Research in Provincetown, where we will examine an extensive computerized photo record of individual whales, or other scientific institutions interested in the biology and behavior of marine mammals. When possible, guest lecturers, such as National Marine Fisheries Service personnel, will augment staff lectures.

As the course draws to a conclusion, we will present our projects and summarize our data on distribution, habitat quality and use, frequency of whale-boat encounters, and number of whales of different species that were observed. Our results will be sent to the National Marine Fisheries Service, where they may be used in future management decisions. Our fluke photographs will be made available to other researchers, and to the central repository of identified whales in the North Atlantic, providing important additional data on the movement, social behavior, and reproductive success of identified individuals.



Photo: Beth Goodwin

"Field work never goes exactly 'by the book'. By taking students into the field, SFS allows them to build confidence and poise, not only in their knowledge, but in their abilities to handle the unexpected."

Susan Neno
SUNY-Binghamton

Living and Working Conditions

In search of whales, we will maneuver our boat through blue Atlantic waters as salty sea breezes bite our faces and fill our sails. It may take a few days to get our "sea legs", but the excitement of seeing whales serves as a great antidote for even the queasiest of landlubbers. Patience is a virtue and may be especially necessary on those days when the whales aren't where they are supposed to be or, if we're unlucky, when fog or storms confine us to port.

Shipboard life can be close at times, requiring consideration for shipmates and diligence in areas of personal responsibility. A willingness to be a co-operative team member is especially important on a sailing ship; things go smoothly only if everyone does his or her share including watch rotations, cooking and clean-up chores.

Tuition: \$1,780 + \$100 Registration Fee

Departure Point: Boston, Massachusetts

PROCESSES AND REQUIREMENTS

Requirements for Admission

We are seeking a body of curious students with a thirst for learning and the maturity and personal initiative to make use of our unique educational opportunities. Individuals should exhibit enthusiasm, character, compassion, flexibility and social concern. Also evident should be a demonstrated promise to benefit academically and socially from this experience. The essay in which the student defines his or her motivation for participation is a strong determining factor in the admissions process.

Admission to all SFS courses is open to eager, motivated students. A background in science is **not** required to be part of an SFS experience. (See page 7 for course levels). Participants are screened by the Admissions Committee to insure that you are choosing the right course for the right reasons. If you are willing to commit your emotional, intellectual and physical energies to working toward a better understanding of these crucial environmental issues, join us. We promise you a learning experience to last a lifetime.

Applicants for admission are required to submit an SFS application form, a 300 word essay describing their reasons for participating, a \$30 application fee and an SFS reference form. Applicants for month-long courses should have completed at least their junior year in high school. Semester applicants should be 18 years of age, have completed at least one college-level biology or ecology course and must submit an up-to-date transcript.

For further information regarding Admission, please call the SFS Admissions Office at (617) 927-7777.

Acceptance

The Admissions Committee will review completed applications for summer courses on February 1 and 15, March 1 and 15, April 1 and 15, May 1 and May 15, 1987. **Applications received after May 15 will be reviewed on a rolling admissions basis for any remaining openings.** Applications for January 1988 courses will be reviewed beginning September 15, 1987. Fall and spring semester applications will be reviewed on a rolling admission basis.

Teams fill quickly. We strongly urge you to apply early to join the course of your choice. Waiting lists are maintained for courses that fill early.

Students will be notified of the Committee's decision within two weeks of the above review dates. Course syllabi for month-long courses will be available in early March and will be sent to all accepted applicants. Course faculty will contact all accepted students during this period to discuss their participation in the program.

Open House

A series of open houses for those students interested in learning more about the SFS experience and financial aid opportunities will be held in New York, Boston, Washington and Chicago in March and April. Contact the SFS Admissions Office for details.

Each year, admissions representatives visit high schools and colleges across the country to talk with students about SFS. Watch for a presentation at your school.

Academic Credit

All students receive academic credit for their SFS course from Northeastern University in Boston, Massachusetts. A \$100 registration fee is due 10 days after acceptance into the program. Upon completion of your course you may request an official transcript from Northeastern University at any time. Over 80 colleges and universities accept or award credit for SFS courses. Please consult your Registrar or the SFS Admissions Office for further details.

Financial Aid

We are committed to making the SFS experience accessible to everyone who wishes to participate. **Financial aid, in the form of scholarships and/or interest-free loans is available to qualified students based on need.** The School receives generous contributions from foundations, corporations and individuals to make this possible. In 1986, over 160 of our participants received financial aid totaling more than \$165,000. If you will need financial aid to participate, we encourage you to request, complete and return a SFS financial aid application as soon as possible. Aid is available by need until funds are exhausted. **Semester applicants may arrange to apply federal financial aid monies toward their tuition in addition to applying for SFS funding.** For more information on how you may qualify for assistance, please call the Admissions Office at (617) 927-7777.

Deposits, Tuition and Fees

Like other non-profit, tax-exempt educational institutions, SFS meets its expenses with a combination of tuition charges and income from grants and donations. Tuition pays for instruction, room and board, and ground transportation during the expedition. It also includes group equipment, medical supplies, scientific instruments and material.

It does not include transportation to and from the departure point.

A non-refundable deposit of \$350 (\$250 for financial aid candidates) for January and month long courses or \$500 for semester programs is due no later than 10 days following acceptance to reserve your place. All students will be registered for academic credit with Northeastern University. The non-refundable registration fee of \$100 is due with your deposit. (Deposits and registration fees for financial aid candidates are non-refundable 10 days following financial aid offer.)

Full tuition is due sixty days prior to course departure. No student with an outstanding tuition balance will be allowed to participate in the program.

Personal gear such as packs and sleeping bags and personal equipment such as SCUBA gear are the responsibility of each student, as are medical insurance, inoculations, passports and visas. The tuition fees listed in this catalogue are based on estimates made a year in advance of departure and involve many variables—currency rate, outside project support, enrollment projections, etc.—all of which may change. The tuition for each expedition is tentative until confirmed in writing by SFS.

Tax Deductions

Fees and directly related out of pocket expenses such as airfare may be treated as a tax-deductible contribution to a scientific research effort. Since tax circumstances vary with the individual, you should consult your own tax advisor.

How To Figure the Total Cost of Your SFS Course

In addition to tuition charges you should also consider the following to determine the total cost of your participation.

Transportation and Travel Arrangements

To ensure the best possible group fares as well as orderly arrivals to the departure site, we work with one travel agency which handles all SFS travel. We strongly recommend that you utilize this travel agent who will make arrangements for you from your area to our site. Specific details will be forwarded to you upon your acceptance. To help with your planning, the following are representative round-trip fares from New York City.

Anchorage, Alaska	\$695	Panama City, Panama	\$549
San Jose, Costa Rica	\$550	Zurich, Switzerland	\$699
St. Thomas, Virgin Islands	\$330*	Honolulu, Hawaii	\$588
Munich, Germany	\$700	Nairobi, Kenya	\$1300*
Quito, Ecuador	\$599	Cairns, Australia	\$1075*

*Transportation for semester programs may be higher due to length of stay.

Clothing and Equipment

SFS will provide food, cooking equipment, tents and all scientific and research equipment you will require. You will be responsible for personal gear including sleeping bags, backpacks, clothing and SCUBA gear (if applicable). Chances are you already have most of what you need, much of the rest you can probably borrow from friends.

Physical Examination and Medical Insurance

All participants must have an SFS Medical Release Form completed and signed by a doctor. No one will be allowed to join an SFS course without proof of up-to-date medical insurance coverage.

The above elements should all be considered in estimating the cost of your course.

Refunds

January and Month-long courses:

Deposits and registration fees are non-refundable. If a student withdraws prior to 15 days before the start of the course, his/her deposit may be transferred within 12 months to another SFS course. Tuition due will be refunded to a student withdrawing 15 or more days prior to the start of a course. 50% of tuition due will be refunded to a student withdrawing less than 15 days before the course. No refunds are made once the course has begun.

Semester Programs: Deposits and registration fees are non-refundable. If a student withdraws prior to 30 days before the start of the course, his/her deposit may be transferred to another

SFS course within a 12 month period. 50% of tuition due including deposit will be refunded to a student withdrawing more than 30 days prior to the start of the program. Any student withdrawing 30 days prior to course commencement to 14 days after the course departure date will receive a refund of 25% of tuition due. No refunds are made after the second week of the program.

The SFS Admissions Staff will be happy to answer your questions. Please call (617) 927-7777

Changes

SFS programs are obviously different from travel or adventure programs. Each project is unique and often cannot be implemented exactly as planned for a variety of reasons. There are factors which, although monitored closely, are beyond our control. For example:

- over half of our projects take place in highly regulated and sensitive environments, usually requiring special permits, such as in St. John, Kenya, Panama and Switzerland.
- some projects depend on the goodwill and generosity of individuals and institutions which lend support.
- tenuous weather situations or natural disasters or changes in political conditions in another country may require last-minute changes in sites or plans.

Applicants are advised that these or other variables may require changes before or during a course. Indeed, part of the challenge is in adapting to changing conditions and overcoming the obstacles they may present. In other words, the whales are not always where we want them to be, so be flexible.

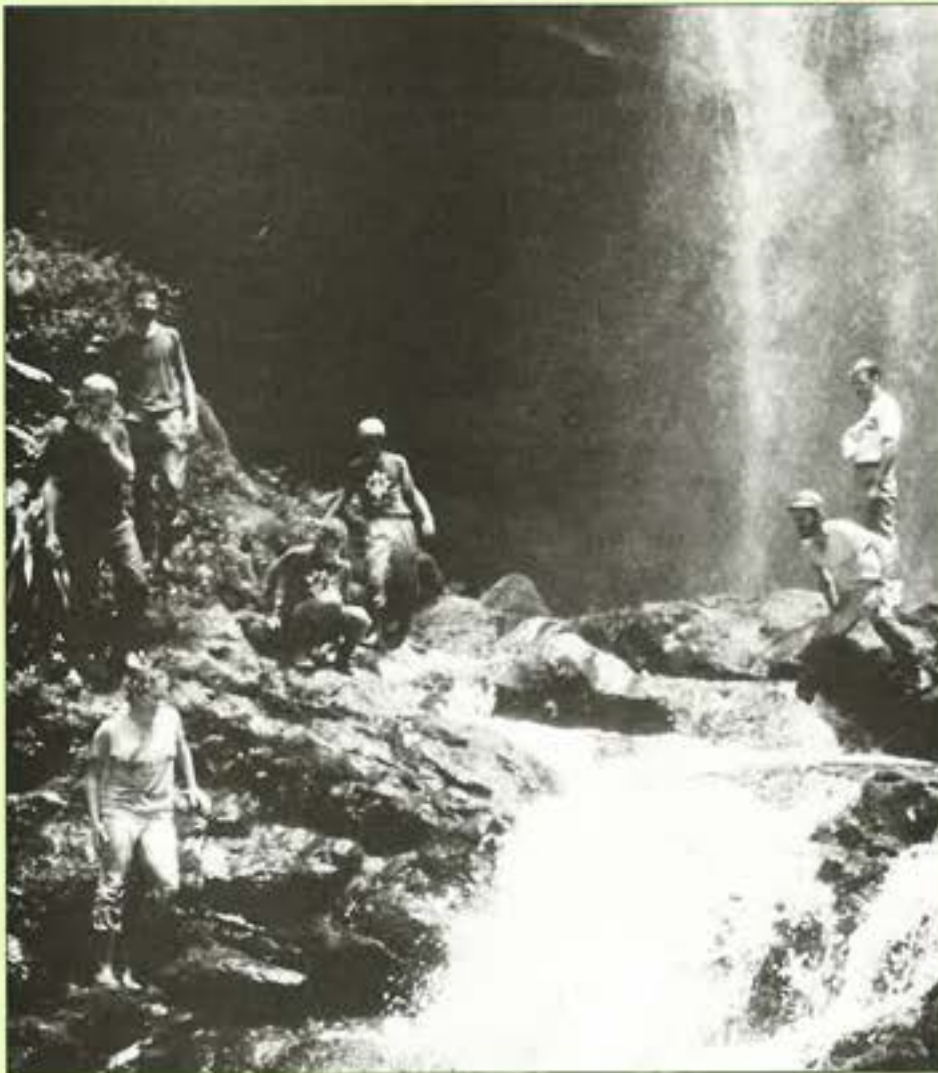


Photo: Chip Isenhart

"Overall, an incredible, informative, intense, irreplaceable experience."

Laurie Wetherbee
Rensselaer Polytechnic Institute

Student Conduct

Participants are expected to conduct themselves in a mature and responsible manner. SFS reserves the right to require any participant to withdraw from any program at any time if the faculty deem a student's conduct to be detrimental to or incompatible with the interests, harmony, comfort, or welfare of the course—including use of alcohol or drugs not authorized by a medical doctor, or uncooperative or disruptive behavior. Should such a decision be made, SFS will notify parents if the student is under 21 years of age and return the student to the point of departure of the course, at which time any and all responsibility on the part of The School for Field Studies will cease.

Responsibility

In organizing and managing these courses, The School for Field Studies (SFS), its agents, employees, and staff give notice that they act solely on behalf of and for the benefit of the participants, on the express agreement that SFS shall not be liable, financially or otherwise, for non-performance or unsatisfactory service; for injury to persons, including death; for loss of, or damage to property; for accident or delay; and/or for expenses arising from strikes, weather, quarantine, sickness, government regulation, or from any act or omission of its agents or employees, and/or airline, railroad, bus company, automobile rental agency, hotel, or other supplier of service.

SFS reserves the right to refuse any applicant admission to any program if he/she is deemed unsuited for the project for any reason.

All courses, fees, and dates are tentative until verified and confirmed in writing by The School for Field Studies.

The School for Field Studies admits students of any sex, religion, race, color, national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students of the School and does not discriminate on the basis of sex, religion, race, color, national and ethnic origin in the administration of its educational policies, admissions policies, scholarship and loan programs, and athletic and other School-administered programs. SFS is an affirmative action, equal opportunity institution.

Application for Admission



The School for Field Studies • 376 Hale Street • Beverly, Massachusetts 01915

Name _____ Home Telephone # _____ Soc. Sec. # _____

Permanent Address _____
Street _____ City _____ State _____ Zip Code _____

Mailing Address _____
Street _____ City _____ State _____ Zip Code _____

College _____ Class/Year _____ Your Telephone # _____
at School _____ ext. _____

Secondary School _____ Class/Year _____

Major (actual or intended) _____ Contact me at Home: _____ School: _____
(dates) _____ (dates) _____

I am applying to:

1st choice _____ Dates _____

2nd choice _____ Dates _____

3rd choice _____ Dates _____

If my first choice is full, ☐ wait list me for my 1st choice, or ☐ assign me to my 2nd or 3rd choice.

☐ Do you need a financial aid application?

☐ Are you interested in the possibility of being a team journalist?

If you are applying to a "B" Level course, do you have the required prerequisite?

☐ Would you like information on applying for academic credit?

☐ A team photographer?

School-related field courses or research in which you have participated:

Other off-campus programs in which you have taken part:

Extracurricular activities/clubs or organizations:

Special skills/certificates/licenses/awards:

Outdoor/camping experience:

Travel (when, where, with whom, how long):

For more information, please contact the SFS Admissions Office at (617) 927-7777

Career plans (if any): _____

Publications you read regularly: _____

Parent(s)/Guardian _____ Telephone # _____

Address _____

Street

City

State

Zip Code

Parent's Occupation(s) _____

☐ Do you wish to be identified as a member of a minority group? If so, which one?

☐ Afro-American
☐ Asian-American
☐ American Indian

☐ Hispanic
☐ Other _____

Height _____ Weight _____ Sex _____ Date of Birth _____

Please detail any physical handicaps, medical requirements, or dietary needs: _____

Previous accidents, injuries, or health problems: _____

How did you first learn about SFS?

☐ SFS poster (where?) _____
☐ SFS catalogue (where?) _____
☐ SFS alumnus/a (who?) _____
☐ SFS campus meeting _____
☐ newspaper/magazine (name?) _____

☐ science teacher/professor
☐ other teacher/professor
☐ guidance/career office
☐ friend
☐ other: _____

Have you attended an SFS presentation on your campus? _____

Attach a 300-word personal statement (please type) of your reasons for wanting to participate in this course, what you hope to gain from it, and what you expect to contribute. **SEND THIS FORM, YOUR ESSAY, AND YOUR \$30 (NON-REFUNDABLE) APPLICATION FEE TO:** Admissions Department, The School for Field Studies, 376 Hale Street, Beverly, MA 01915. Upon receipt of your materials and application fee, we will send you a reference form which must be returned to SFS to complete your application.

Semester Applicants: Please request that an up-to-date transcript be forwarded from your school to SFS to complete your application.

I have read the SFS catalogue thoroughly and feel that I understand and would enjoy and benefit from the experiences it describes.

Applicant signature _____

Date _____

I approve this application (if applicant is under 18).

Parent/Guardian signature _____

Date _____

Please send another catalogue to the person(s) listed below:

Name _____

Address _____

Name _____

Address _____

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