#3

PERSONAL STATEMENT: LEAH R. GERBER

Research

My research program integrates field and modeling approaches to address questions at the interface of conservation science and policy. I work on developing tools that incorporate scientific uncertainty in the decision-making process in endangered species recovery, marine reserve design, and disease and conservation. My field program aims to estimate key parameters that may be incorporated into models that are useful for decision-making. During my time at ASU, I have focused on empirical and theoretical aspects of marine reserves and linking disease into population analyses. I have also initiated a long-term research program on integrating behavior and conservation, with sea lions in the Gulf of California as a study system. This work has developed into an international program involving ASU undergraduates, graduate students, postdocs, conservation organizations and Mexican natural resource agencies.

MARINE RESERVES

Note: references refer to publications listed in attached CV

The success of marine reserves depends on establishing evidence that proves that they are useful conservation tools in the long term (25). At the same time, few marine reserves have been designed and managed using rigorous scientific methods (28). I am interested in developing approaches to identify reserve efficacy and optimal monitoring strategies (6, 10). While most reserves have focused on nearshore and benthic fish and invertebrates, my work has advanced the idea that reserves may benefit wide-ranging species (17). In this work I have embraced the international policy implications of marine reserves in developing strategies at on an international scale (e.g., International Whaling Commission Sanctuaries, 8, 9). These approaches are being applied in the Gulf of California, where a network of marine reserves to conserve marine biodiversity and enhance fisheries is being developed. With funding from the David and Lucile Packard Foundation, the Tinker Foundation, the World Wildlife Fund and Conservation International and in collaboration with Dr. Enric Sala at UC San Diego, my group is developing predictive capabilities for the management of marine reserve networks. We are developing novel ecological and socioeconomic models to determine the efficacy of marine reserves in the Gulf of California and the policy changes needed to achieve these goals. My approach consists of 1) identifying conservation goals, 2) forecasting changes in the ecosystem after reserve establishment, 3) monitoring the state of the ecosystem, 4) evaluating the efficacy of the reserves, and 5) evaluating different management alternatives to achieve conservation goals. The evaluation of different management alternatives is based on the costs and benefits of political decisions, from both ecological and economic points of view. In addition, we are developing a practical handbook and user-friendly software that will be presented to Mexican decision makers, conservation organizations, and scientists for use in the Gulf of California and other regions. My developing decision tool relies on an innovative mix of ecological modeling and decision theory. This work will provide the first unambiguous and scientifically defensible set of tools for Mexican decision makers to manage the marine reserves in the Gulf of California.

DISEASE AND CONSERVATION

Despite the importance of pathogens in natural populations, little attention has been given to host-pathogen dynamics in population viability analysis (PVA). To study the effect of infectious pathogens on extinction risk estimates generated from population viability analysis, I develop models to test hypotheses about the role of disease in extinction risk analyses. Using this modeling framework, I have examined how disease affects variability in abundance and thus, population viability and how viability estimates of real populations suffering from disease require explicit modeling (7, 29). Results suggest that ignoring disease in PVA leads to several erroneous conclusions. Attempts to model epidemics as increased stochastic mortality grossly overestimate the probability of extinction. Another effect of disease is to change the predicted relationship between population growth rate and median time to extinction. Populations with high growth rates that would normally be in little danger of extinction were more likely to exceed the host-density threshold and suffer virulent epidemics. Including a carrying capacity for the host lessens the extent to which a disease depressed population growth and increased the time to extinction because populations with logistic growth were less likely to reach densities where

epidemic outbreaks occurred. These results suggest that populations ordinarily not susceptible to extinction (i.e., increasing) but confronted by disease could be more susceptible to extinction compared to populations that were susceptible to extinction even without the presence of a disease. If potential management actions involve manipulating pathogens, then it may be useful to model disease explicitly (3, 14, 29).

A second dimension of my work in the area of disease and conservation is in developing practical approaches for empiricists to use data on disease in population-level analyses of extinction risk. Currently, there are no generally recognized approaches for linking detailed mortality and pathology data to population-level analyses of extinction risk. We developed a model to examine the sensitivity of sea otter population growth to different sources of mortality (15). In particular, we are evaluating the potential population-level impacts of several putative sources of mortality on southern sea otters and identifying key information gaps that can be resolved in the ongoing necropsy and salvage programs. Our analyses suggest management actions that are likely and unlikely to promote recovery of the southern sea otter. More broadly, our new method provides a general approach to use individual-based information (i.e., disease, behavior) in conservation decision-making.

BEHAVIOR AND DEMOGRAPHY

Individual differences in behavior and social status can in theory determine the rate of population change and thus the threat that imperiled species face in the real world. While there has been an increase in the number of studies addressing the interface between behavior and conservation theory, a paradigm for applying behavioral knowledge to real-world conservation problems has not yet been developed (1). The goal of the research supported by my NSF Career Award is to integrate theories from behavioral ecology with quantitative techniques in demography in order to examine the effects of a variety of reproductive behaviors on extinction risk. Trained as a population biologist, most of my research to date has focused on the effects of density dependence, environmental stochasticity, and catastrophic mortality events on the viability of endangered populations. Recognizing that this coarse approach ignores the finer subtleties of animal behavior, in the next few years I seek to bridge the gap between behavioral ecology and population dynamics. Findings from this basic research will provide practitioners with guidelines for understanding when behavior should be an important component of a particular management strategy. The specific goals of this work include: 1) establishing a long-term field research program on behavior and demography of California sea lions (*Zalophus californianus*) in the Gulf of California, 2) developing a theoretical framework to integrate behavioral data into extinction risk models, and 3) incorporating these results into management decisions. First, my empirical research program seeks to test particular hypotheses regarding the degree to which the demography of sea lions depends on three commonly studied groups of behavior—conspecific attraction, territoriality and parental investment. I have initiated two lines of investigation, which my group has carried out on 6 islands spanning a wide latitudinal gradient in the Gulf of California for populations exhibiting diverging trends: 1) behavioral observations coupled with paternity analysis, and 2) point estimates of population parameters. Second, I have initiated a theoretical research program that links behavioral data collected in the field to models that describe the demography of sea lions and more generally of populations of conservation concern (5, 45, 47, 48). My goal is to integrate empirical data on behavior into a demographic framework and then use independent estimates of population growth from time series of abundance data to select best-fit behavioral models describing population dynamics. In the next several years I plan to use empirical data combined with my previous work on risk assessment to develop a general framework for integrating behaviors and the demographic consequences of these behaviors into estimates of extinction risk. In this phase of my work, I will apply results from extinction risk analysis to classifying endangered species and collaborate with Mexican natural resource agencies to determine the best approach to reversing the current decline of numerous sea lion populations in the Gulf of California.

ESTIMATING EXTINCTION RISK

The major innovation of my approach to viability analysis is to decompose sources of uncertainty and clearly connect that uncertainty to precautions in Endangered Species Act (ESA) classification decisions (19, 22, 23, 24, 36). Using conventional metrics of uncertainty (e.g., 95% confidence intervals) my original work showed that there are ample data to support a decision to delist gray whales from the ESA (37). Further, while delisting charismatic species such as whales is contentious in the eye of the public, it is important to acknowledge recovery so that recovery funds can be more efficiently allocated to more severely threatened species that are often less charismatic (26, 27, 31, 35). I plan to continue to work with graduate students and recovery teams on developing ESA classification criteria for a variety of species in collaboration.

Teaching and Mentoring

My research forms the basis for much of my teaching by providing real world case studies. With this as an underlying theme, in my teaching I seek to: 1) transfer current information on the subject in a systematic and comprehensible way, 2) convey the inherent excitement of the topic, and 3) help students to think analytically about the subject material. Although lecturing is a highly efficient way to transfer information, students tend to record passively rather than actively think. Therefore, my approach emphasizes real-world problem solving using the tools conveyed in lecture. For example, students may apply quantitative tools taught in lecture to address local conservation issues. Similarly, in all of my research endeavors I attempt to include students and postdocs in the actual process of research. Most of my recent papers (published, in press or in preparation) involve School of Life Sciences (SoLS) undergraduate and graduate students. This has proved to be an effective way to encourage promising undergraduates to become involved in the research process.

Since I have been at ASU, I have developed four new courses in conservation biology (syllabi available at http://lifesciences.asu.edu/biology/faculty/gerber.htm). For example, my advanced conservation biology class is designed for senior undergraduates and graduate students interested in quantitative conservation biology. In this class, we explore the theory and application of demography and extinction models to the management of threatened and endangered plant and animal populations. Classes are comprised of lectures, discussion and computer laboratories. Students learn how to estimate population parameters and evaluate the elasticity and sensitivity of demographic parameters to perturbation. Students use these techniques to work collaboratively on research projects formatted for publication.

I am also committed to leadership and building new programs through curricular development. I aim to cultivate an integrated environment for research and education, in which education is integrated with the goal of discovery and research is informed by the needs of the learning process. Over the past five years, I have initiated an in-depth examination of the undergraduate curriculum in conservation biology, developed a web page for our program (http://lsvl.la.asu.edu/conservbio), and worked with the undergraduate programs committee to implement new curricular ideas. Developing the conservation biology and ecology curriculum in SoLS is an ambitious plan that I hope to implement in close collaboration with other faculty members over the next five years. My plan is to identify a package of classes (new and existing), seminars, field courses and internships that will effectively deliver the needed skills and concepts. These tools will be infused into existing and new courses to strengthen and unify our program in SoLS. My initial focus has been on the undergraduate program, and I eventually plan to develop a concentration in conservation biology for graduate students. The University of Washington provides a useful model, which offers a Certificate Program in Conservation Biology Policy.

During my time at ASU I have mentored 18 undergraduates in conducting independent research projects. Graduating students have had success in both obtaining positions in competitive graduate programs (e.g., UC Santa Barbara, Duke University, San Diego State University), as well as positions with natural resource agencies (Arizona Game and Fish Department, Bureau of Land Management). Project descriptions for these students, as well as the current undergraduates in the lab are listed at http://lsweb.la.asu.edu/lgerber/people.htm. One exceptional student (Kate

Buenau) not only completed an outstanding honors thesis but also collaborated on three publications (8, 17, 36). Currently, I advise three postdoctoral fellows, four doctoral students, one Masters student, five undergraduates, and serve on twelve PhD committees. My lab has developed into a "well oiled machine" where graduates mentor and supervise undergraduates in research activities, whose work in turn enhances graduate research projects.

International collaboration is increasingly important in conservation biology. I am developing a bi-national education program with Universidad Autonoma de Baja California Sur (UABCS) and Centro Interdisciplinario de Ciencias Marinas Instituto Politecino Nacional (CICIMAR) that will integrate research and education in the Gulf of California. This program trains graduate students from the US and Mexico in genetic, behavioral, population and community level processes in conservation biology. In addition, we have recruited US minority students to participate in a hands-on field course in marine mammal biology and conservation. This education program has enhanced my research program by recruiting experienced graduate students from Mexico who are familiar with marine mammals in the Gulf. Over the past 2 years, I have laid the groundwork for a formal program with Mexican institutions. For example, for the past 2 summers we have implemented a large-scale field research program that included 20 Mexican and US minority undergraduates working together in the field. This summer (2006) we are offering this research experience as a 6-credit intensive field class. Students are trained in behavioral data collection, capture and tagging, morphometric measurements, and biopsy sampling of sea lions), and each student develops an individual research project. Clearly, my research program relies heavily on undergraduates (see at http://lifesciences.asu.edu/biology/faculty/gerber.htm for description of undergraduate research projects). In addition to field research experience described above, undergraduates gain analytical skills working in the lab during the academic year. In this way, students are exposed to all dimensions of the scientific method, learning not just about field biology, but also about data analysis and lab discussions about research ideas. My goal with this program is to foster the development of skills and attitudes that permit students to seek resolutions to questions and issues while constructing new knowledge.

Service

My research has impacts not only at ASU, but also in local, Federal and international conservation arenas. I work with Federal agencies such as the National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (USFWS) to develop criteria for classifying species under the ESA. I also serve on the editorial board for *Conservation Biology*, and a number of relevant advisory panels (e.g., USFWS and NMFS Recovery Teams). I have extensive experience in conveying technical quantitative material to general audiences. For example, I have led hands-on seminars for a number of government agencies on how to apply quantitative approaches to environmental problem solving. In this way, my service activities *are* primary research activities. Other recent synergistic activities include invitations to review policies of the International Whaling Commission, to participate in an NSF mathematical biology symposium, the AAAS meeting, and the Ecological Society of America's "Rising Stars in Ecology" symposium. I was also invited to give seminars at Yale University, Columbia University, Georgetown University, Texas A&M University and the University of Chicago.

Summary of Accomplishments at ASU and Future Directions

Since my arrival at ASU in 2002, I have established an active and exciting research program involving undergraduates, graduate students and postdocs. My breadth of experience in both basic and applied population biology research is unique, and with this foundation I will continue to be an active contributor to the community of scholars at ASU. Over the next decade, I hope to develop as a leader in the field of marine conservation biology, continue to develop my teaching and mentoring skills, and contribute to a local, national, and international vision of the sustainable use of marine resources.