

## EXECUTIVE SUMMARY

The University of Nebraska–Lincoln’s (UNL) School of Natural Resource Sciences (SNRS) was established in 1997 as a cross-campus enterprise spanning both the Institute of Agriculture and Natural Resources (IANR) and the UNL College of Arts and Sciences (CAS). With the merger of the Conservation and Survey Division (CSD) and the Water Center in 2003, SNRS became the School of Natural Resources (SNR). In many respects, SNR is a new model for interdisciplinary research and education at UNL. SNR faculty, staff, and students come from many backgrounds, including ecology, climate science, geography, geology, soil science, water science, and the social sciences. Our diverse backgrounds are, however, focused on a single mission: to be an international leader in natural resources education, research, and outreach, and the primary provider of natural resources information to the citizens of Nebraska.

During the past six years, SNR has made important and substantial progress toward our vision. Certainly, public (and student) interest in natural resources and environmental issues has increased. SNR has expanded to include nearly 150 faculty and staff and more than 400 students, and each year serves hundreds of clients in Nebraska and elsewhere. To better address increasing demands for information about natural resources, SNR has developed new approaches to strategic planning and to improving internal integration and external collaboration. Strategic planning, for example, has been undertaken to focus SNR efforts on five current and emerging issues that must be addressed in the near future. SNR is particularly well equipped to deal with these issues:

1. Increasing understanding of the potential impacts of **climate variability and change** on natural resources and agricultural productivity.
2. Enhancing **water resources quantity and quality** by improving water consumption and conservation practices as well as social systems for management of aquatic ecosystems.
3. Addressing **emerging ecological challenges** including invasive species, wildlife-related diseases, threatened and endangered species, adaptation to environmental stressors, and maintenance of biodiversity.
4. Enhancing understanding of **human-environment interaction**, including social/human factors in natural resources management and policy that are critical for establishing and maintaining sustainable environmental systems.
5. Improving **natural resources and environmental science education** for undergraduate and graduate students and the general public to enhance informed decision making and policy formulation.

These issues form the framework around which this report is written.

To improve our ability to respond to such issues, in January 2009 SNR was restructured into “faculties,” a unique organizational model that sets SNR apart from most academic units. These faculty areas are: applied climate science, applied ecology, geography/GIScience, geology and soils, human dimensions, and water. Our faculties are designed to maintain disciplinary strengths, but, at the same time, encourage and facilitate interdisciplinary teaching and research. SNR has also counted many other significant achievements over the past five years. In 2004, for

example, the U.S. Geological Survey (USGS) established the Nebraska Cooperative Fish and Wildlife Research Unit (CFWRU) within SNR. In 2006, SNR faculty, staff, and students moved to a new home in Hardin Hall, a modern research and classroom facility located on UNL's East Campus. And in 2008, UNL's geography program was integrated into SNR, adding new undergraduate and graduate degrees, faculty, and students. Today, SNR faculty, staff, and students are working together to address critical issues related to water quality and quantity, climate change, drought, severe storms, fisheries and wildlife management, invasive species, environmental restoration, energy, geologic resources, outdoor recreation, and land use.

### **Teaching, Research, Extension/Outreach and Survey Programs**

SNR faculty and staff focus on four principal cross-cutting missions: teaching, research, extension/outreach, and natural resources survey. SNR offers BS, MS, and PhD degrees in natural resource sciences and, since July 2008, the BA, BS, MA, and PhD in geography. All degree programs have experienced significant growth since 2003. A continuing challenge for SNR over the next five years will be allocation of sufficient faculty FTE to meet growing student enrollments, especially in high-demand areas such as adaptive management, climate change, ecosystem science, and GIScience. This challenge will be exacerbated by the number of faculty who will be reaching retirement-eligible age by 2014.

Since its inception, SNR has been one of the most productive research units within IANR. External grant support and publications/FTE have increased steadily, and SNR will strive to continue this trend in the future. However, because of reduced state funding for UNL, it is anticipated that grants will increasingly be required to cover acquisition, replacement, and maintenance of equipment and laboratory facilities, travel and field work, and support of graduate students and technical staff. SNR extension and outreach programs focusing on drought, wildlife damage, agroforestry, and water issues have received national and international recognition. During the next five years, SNR will enhance the scope and effectiveness of information delivery to our clients, with special emphasis on the Internet. SNR survey faculty and staff provide critical data and outreach regarding Nebraska's geological and mineral resources, weather and climate, water resources, and soils. During the next five years, SNR will continue to develop synergism among survey programs, faculty and staff, and the School's programs in extension, research, and teaching.

SNR is one of the most interdisciplinary and diverse academic units at UNL. It has experienced almost continual change since its formation in 1997; yet, SNR faculty and staff have forged an exceptionally well-integrated and focused enterprise, manifested in an "integrated systems approach" paradigm that guides SNR's teaching, research, extension/outreach, and survey missions. During the next five years, integration of these missions will be re-energized and focused through efforts to address five critical areas of concern: climate variability and change, water resources quantity and quality, ecological challenges, human-environment interaction, and natural resources and environmental science education. In addition, SNR will continue to enhance and enlarge its external linkages and collaborations, now numbering well over 250, and the scope of international activities.

## **Addressing Current and Emerging Issues in Natural Resources (2009–14)**

The SNR mission statement asserts that the operational paradigm for SNR will be an “*integrated systems approach*” to natural resources science. SNR faculty and staff recognize that, in order to explicitly embody the “systems” paradigm, integration needs to be defined to include specific actions designed to bring together, in a synergistic way, the specialized knowledge and expertise of professionals in different, but related fields, in order to advance natural resource science, better achieve our personal and collective goals, and benefit our partners and stakeholders, especially students. In 2007 the SNR director formed an ad hoc integration advisory team (IAT), comprising faculty from across SNR, to identify critical and emerging issues in natural resources and ways in which these issues can be addressed through integrated approaches that involve the full range of SNR’s teaching, research, extension/outreach, and natural resources survey activities. The IAT met throughout 2008, initiating an issues-based strategic planning process that is manifested in the organization of this report. From September 2008 to March 2009, each of the five issues identified by the IAT was discussed in a series of future-directed listening and planning sessions to which all SNR faculty, staff, and students were invited. The outcomes of these sessions are summarized below (and presented in Chapter 4).

**Increasing understanding of potential impacts of climate variability and change:** The applied climate science (ACS) program continues the tradition of excellence established in the Department of Agricultural Meteorology and its predecessors, traditionally leaders in research and graduate education. The research, outreach, and service areas of the ACS program are highly collaborative with faculty in SNR and across campus. Our research/outreach/service efforts focusing on the issue of climate variability and change can be divided into four broad categories: climate monitoring and climate data utilization; climate and crop modeling; carbon, water, and energy exchanges; and human dimensions. To address undergraduate education (a high priority at UNL), an undergraduate option in applied climate science was recently established as part of the environmental studies major. In addition, a major in applied climate science and a minor in climate change studies are under development to further enhance ACS’s undergraduate involvement. Future initiatives will include (1) development of a summer institute on climate change, (2) further development of outreach and education efforts in climate change and variability, (3) ecosystem modeling to quantify interactions between biological and physical processes, including abiotic and biotic stress of different (managed and unmanaged) ecosystems important to Nebraska, and (4) environmental economic modeling to develop an integrated ecosystem-economic modeling approach to analyze the impacts of climate change.

**Enhancing water resources quantity and quality:** Effective management of the quality and quantity of Nebraska’s groundwater and surface water is critical in preserving this resource for future use. SNR is the focal point for water resource research and teaching at UNL. Researchers in SNR investigate hydrologic connections between river systems and adjacent aquifers, the effects of water flow on wildlife habitats, and the hydrology of groundwater-dependent wetlands, lakes, and streams. Hydrologic models have been developed to characterize the hydrologic connectivity between streams and aquifers and to analyze the impact of groundwater irrigation on stream flow. New tools and methods for studying evapotranspiration and recharge to groundwater are being developed and will be even more critical as the local climate changes. The impact of water flow on managed ecosystems has been investigated through the study of water

use of cropping systems and the application of windbreak technology and evapotranspiration across various ecosystems. SNR researchers team with other faculty in science and engineering to develop and apply new methods to investigate and mitigate agricultural and other anthropogenic impacts on surface and groundwater quantity and quality. Research and extension programs help improve the quality of water in lakes, streams, and groundwater through the adoption of practical nutrient loading within the TMDL (Total Maximum Daily Load) requirements, better wastewater treatment systems, and the detection, migration characterization, and/or remediation of contaminants such as nitrogen, phosphorous, arsenic, hormones, pharmaceuticals, pesticides, munitions, sediments, and algal toxins. Landscape watershed contamination vulnerability models and remote sensing techniques are used to identify impacted areas. Water resource outreach and extension programs are shaped through efforts in the UNL Water Center and other SNR-based centers. Students in natural resources, through the undergraduate programs of water science and environmental restoration science and graduate programs via specializations in hydrologic sciences (MS and PhD) and aquatic ecology (MS only), are trained to provide expertise for future generations of effective stewardship of this precious resource.

**Addressing emerging ecological challenges:** Global ecological challenges, which present potentially dire consequences if they are unmet, face humankind in the immediate future. Nebraska is far from immune to ecological challenges presented by global climate change; wildlife management (including wildlife damage), agroecosystems, land cover and land use change, the preservation of unique ecosystems and threatened and endangered (T&E) species, and other issues have risen to the forefront in the state. SNR is making key contributions in four focus areas: (1) assessing biodiversity and ecosystem functions and services, (2) researching ecological resilience and its applications in management, (3) promoting effective resource management using adaptive management, and (4) promoting widespread ecological literacy, especially through existing graduate and undergraduate education programs. SNR is well positioned to make such contributions, but additional resources and new strategies will be necessary, particularly as enrollments remain at current levels or, more likely, increase. A wetland ecologist position identified as part of a prioritization process for new faculty in spring 2008 has yet to be filled. Creative approaches toward solving shortfalls in teaching FTEs will need to be implemented. Additional goals in education, research, and outreach include implementing a new National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship (IGERT) grant, producing a sustainable graduate program in adaptive management, increasing the analytical and quantitative rigor of the fish and wildlife major, effectively articulating natural resources management and conservation with production agriculture in Nebraska, developing ecosystem modeling, and improving ecological informatics, statistics, and survey.

**Enhancing understanding of human-environment interaction:** SNR has a substantial record of achievement in addressing the human dimensions of natural resources (HDNR). SNR faculty and staff are well recognized for their research and extension programs that address issues including ecological decision making, human-wildlife conflicts, water policy, human impacts of drought and other natural hazards, agroforestry, and natural resources economics. Yet, in many respects the SNR HDNR program today is not as “mature” as SNR’s other major focal areas, especially in the academic arena. During the past five years, SNR has established MS and PhD

specializations in HDNR that have shown steady growth, but faculty teaching FTE has not kept pace. To enhance its HDNR programs, SNR should proceed as quickly as possible to create a new tenure-track faculty position in HDNR with principal support from CAS, encourage the integration of Geography and Survey faculty in the HDNR program, improve coordination of the SNR HDNR program with other UNL academic units, improve the HDNR undergraduate program and develop a “marketing” plan to better engage prospective students and students from other units in SNR HDNR programs, initiate a graduate-level seminar in HDNR, enhance use of SNR field facilities in HDNR programs, and explore placing more emphasis on international concerns.

**Improving natural resources and environmental science education:** SNR aspires to be an international leader in natural resources and environmental education and the primary provider of natural resources and environmental information in Nebraska. SNR serves an academic audience consisting of undergraduate and graduate students, and a public audience, which includes policy makers, professional audiences, and K-12 educators. Substantial growth and expansion of SNR educational programs has occurred since 2003. Recent funding of science education projects in the unit, the hiring of an Extension Educator in Climate Variability and Change, and a Summer Institute on Climate Change are all excellent examples of new initiatives that will continue to enhance our programming in natural resources and environmental science education. As we look toward the future, SNR’s long-term goals are to (1) enhance the natural resources educational program so that it is recognized for its up-to-date, high-quality educational experience; (2) establish a well-supported infrastructure that provides for the educational needs of undergraduate and graduate students; (3) strengthen the recruitment and retention program to increase the number, diversity, and retention of undergraduate and graduate students; and (4) build an integrated public education network within the SNR faculty and staff, students, and the community at large.

## **Challenges**

The ability of SNR to achieve its goals over the next five years will be founded on the creativity, hard work, and resourcefulness of its existing faculty and staff. In this respect, SNR is fortunate to have a body of employees who are highly motivated and inventive and work together extremely well. Moreover, SNR faculty, staff, and students have excellent physical and support facilities with which to work. Like most academic units, however, SNR is confronted with resource limitations with which it will have to contend. It is anticipated that during the next five years some faculty research FTE may need to be redirected to support greater demands for teaching, and grant funds may increasingly be required to support technical staff and to purchase equipment and supplies. Retention of existing faculty is also a concern. However, the prospect of having to replace many faculty who will be reaching retirement-eligible age over the next five years is perhaps the greatest challenge facing SNR. However, these retirements also provide SNR with a significant opportunity to redirect faculty resources into higher priority areas. Changing technologies, methodologies, and paradigms in natural resource sciences will require that SNR’s faculty be composed of people conversant with the state of the art in modeling, GIScience, adaptive management, and other critical areas.

During the period from January through April 2008, SNR faculty engaged in a process to evaluate priorities for future faculty positions in SNR. The five highest priorities for SNR (listed in alphabetical order) were determined to be a climate change scientist, environmental microbiologist, GIScientist, human-environment interactions specialist, and wetland ecologist. In spring 2009, SNR was able to fill the climate change scientist and GIScientist positions. Martha Shulski, an applied climate scientist and the director of the High Plains Regional Climate Center, will focus largely on climate variability and change in her research, teaching, and extension program. The GIScientist position was recently filled through the hiring of Qingfeng (Gene) Guan. He will be conducting research on advanced GIS techniques and teaching GIS courses. The GIS position is funded 50/50 between IANR and CAS. In addition, we have had approval from the dean of Extension to hire a climate change educator to develop a comprehensive extension program in climate variability and change. This position will address a need for a natural resources educator. And SNR has also recently submitted a request to the dean of Arts and Sciences for a new faculty position in human-environment interactions. Two critical positions remain to be addressed: the environmental microbiologist and the wetland ecologist.

Throughout SNR's issue-based strategic planning process there have been significant discussions regarding additional faculty and staff positions that will be necessary for the unit to achieve its longer-term vision. Although the two unfilled faculty positions from our 2008 prioritization process mentioned above remain our highest priority (i.e., wetland ecologist and environmental microbiologist), the five-year review planning process has identified numerous other faculty positions of critical importance to the unit's ability to achieve our vision. However, SNR's faculty have not yet had the opportunity to fully discuss these proposed faculty positions and prioritize them following the procedures and criteria used previously for other positions. These faculty positions include a regional climate modeler, drought risk management scientist, ecohydrologist, environmental/economic modeler, human-environment interaction scientist/geographer, and surface water hydrologist. The SNR director will engage faculty in a discussion to prioritize these positions during fall 2009. Once this process is completed, strategies to fill the positions of highest priority will likely need to rely on the redirection of existing faculty lines when SNR faculty retire, external funding, or reliance on adjunct faculty members.

The outlook for the continued success of SNR is bright. Our issue-based planning process has helped to focus our efforts on five key areas where we feel the unit has both the strength and dedication to make a difference. We are fortunate to have a talented faculty and staff that are meeting the current needs of the state while, at the same time, responding effectively to future national needs and priorities. With stable leadership at the unit level and the continued support of IANR, CAS, and UNL administration, we are convinced that the growth and success SNR has achieved in recent years will continue. Society's growing interest in natural resources and environmental issues has placed SNR in a pivotal position to provide leadership at the state, national, and international levels. We are meeting, and we will continue to meet, this challenge.