parkbreak perspectives

Integrating natural and social sciences for effective natural resource management

Galli Basson
San Jose State University

Michelle Dela Cruz
Northern Arizona University

GEORGE WRIGHT SOCIETY
P.O. Box 65
Hancock, Michigan 49930-0065 USA
www.georgewright.org

Scientists and managers must work together to most effectively address the many complex environmental problems ahead. To give managers the information they need, natural resource scientists need to not only have strong scientific skills, but also skills in policy, communication, law, economics, and sociology. In order to gain these skills, an interdisciplinary education that incorporates social science with natural science is necessary. Such a background allows scientists to recognize their own values and avoid inserting them into analyses. Equally important, natural science-social science training gives researchers the skills to incorporate important social and economic considerations into analyses, and to engage with multiple stakeholders.

Lessons from Delaware Water Gap

The desire for an interdisciplinary education led us to the attend Park Break 2008 seminar in Conservation Policy at Delaware Water Gap National Recreation Area (NRA), located in Pennsylvania and New Jersey. Federal agencies such as the U.S. Geological Survey (USGS) and National Park Service (NPS) are facing a shortage of scientists and managers in the upcoming years due to projections of high retirement rates. Graduate students studying natural resource science are part of the next generation poised to fill this void. As the need to recruit young conservation-minded professionals in the Park Service increases (Gross 2004), workshops like Park Break provide a venue for graduate students to engage in dialogue with potential employers. During the Park Break workshop we were presented with information from conservation professionals and federal employees who have had in-depth experience with the evolution of conservation policy over the last few decades, including the shift in policies for increased science in national parks (Parsons 2004; Sellars 1997). It was clear from the seminar that Park Service employees will need to incorporate both natural science and social science skills to be effective conservation stewards in the 21st century.

Delaware Water Gap was created in 1978 to preserve the scenic and resource values of the Delaware River. Until the 1990s this area was a little-known gem providing recreation that includes swimming, fishing, hunting, boating, hiking, natural and cultural history, and solitude. Currently Delaware Water Gap administers 63,000 acres within a 70,000-acre boundary and receives over 5 million visitors annually (Delaware Water Gap NRA 2007). Due to the increase in housing costs in the New York metropolitan area and suburbs, and its proximity to these areas, Delaware Water Gap is facing intense developmental pressures adjacent to its borders. The surrounding counties are some of the fastest-growing counties per capita in the nation. In Pike County (Pennsylvania) alone, the population increased by 25.7% between 2000 and 2006 (Pike County 2007). As an NRA, Delaware Water Gap's mission is to provide outdoor recreation opportunities while conserving the natural, cultural and scenic resources. The park's mission requires its staff to have both political skills and scientific information in order to address development challenges outside the park, and resource concerns within its jurisdictional boundary.

Delaware Water Gap NRA is entrenched in political issues at multiple levels since it crosses two states, five counties, and 22 townships. The park's major natural resource is 40 miles of the Delaware River, which has been designated as a scenic and recreational river under the Wild and Scenic Rivers Act (US Public Law 95-625, 1978). In order to protect the ecological integrity of the river amidst increasing development in the surrounding area, a regional conservation plan is critical.

Local and regional residents benefit in maintaining the Delaware River's "outstanding basin water" (Delaware River Basin Commission) since the supply is not only valuable to wildlife, but also is a water source for the neighboring communities and greater metropolitan New York area. To develop monitoring strategies for Delaware River tributaries, the park is currently collaborating with USGS ,which will become increasingly important as home building increases and septic tanks are constructed in close proximity to the river. DeNise Cooke Bauer, a resource planner with Delaware Water Gap, is responsible for water quality monitoring. She also incorporates education into her role and relates to the public how development negatively impacts the river. Although the park cannot stop homeowners from building in the vicinity, water quality monitoring data coupled with public education can be an effective tool to identify unsustainable building practices that can negatively impact park resources.

Park managers are cognizant that they need to foster relationships with surrounding communities that include a new population of homeowners with diverse cultural and socioeconomic backgrounds; these residents will have a great influence on recreation and economics in the area. Park managers also realize that they must interact with the different jurisdictional agencies in the surrounding area. Park Superintendent John Donahue highlighted one example of Delaware Water Gap working with developers to reduce the negative effects of development near the park. A housing project is in progress on 225,000 acres of land that stands between Delaware Water Gap and state land. Donahue worked with the developer to design a building layout that includes an open space corridor that links Delaware Water Gap with state park land. Donahue is working closely with the Pike County Office of Planning to implement its open space, greenways, and recreation plan, "Growing … Naturally" (Pike County 2008). This example substantiates that in order to fulfill the NPS management mandate, current and future park resource managers need interdisciplinary expertise to understand scientific data, engage with stakeholders, and work within the political framework to protect the park's resources.

Another topic of the Park Break seminar focused on criticism of NPS for its historical lack of science-based resource management (NPS Advisory Board 2001). We also learned of the controversial history that shifted NPS biological research staff and their funding into the Biological Resources Division of the USGS (Parsons 2004). There are many different viewpoints regarding this shift; some former NPS scientists feel frustrated by the separation of science from the NPS, while others feel independence from the politics of management, which allows them increased autonomy (Parsons 2004). Although the final outcome of separating science from NPS management will not be known for some time (Kaiser 2000), this issue highlights the need to examine the relationship between science, values, advocacy, and management. An interdisciplinary education is invaluable in developing natural resource scientists who are able to examine how their values influence their work, how research is communicated, and how to engage and assist managers, policy makers, and the public to solve complex issues with interlinking components.

Science and values

Natural resource scientists are often drawn to the field of conservation because they have strong values about protecting the environment and want to assist managers in resource sustainability; however, such values have the potential to bias research and polarize the public. All science is based on subjective vision and judged for quality based on subjective criteria (Costanza 2001). The fact that we are humans introduces a value-based element to science (Franz 2001). Environmental scientists dedicate their lives to problems whose answers they value, problems as complex as global climate change, endangered and threatened species, and depletion of resources. These type of problems, also deemed "wicked problems" for their complexity, require an integration of academic disciplines and knowledge to solve (Ludwig 2001). Indeed, the roots of conservation biology are founded on work that incorporated information from different scientific disciplines, examined problems from a multitude of scales, and blended methods and tools from a variety of disciplines (Kessler and Thomas 2006). These methods resulted in a shift from the traditional, sustained-yield paradigm in which management of natural resources was based on the capability to yield desired products and uses, to the new paradigm of ecosystem management, which seeks the sustainability of ecosystems (Kessler and Thomas 2006).

Fields such as conservation biology are widely recognized as "mission-driven" fields. For example, the Society of Conservation Biology states that this discipline is dedicated not just to the collection of data on nature but "to advance the science and practice of conserving the Earth's biological diversity" (www.conbio.org). Noss (2007) states: "A conservation biologist can be an objective scientist and an advocate for diversity of life and other normative values at the same time, with no contradiction. We have a responsibility to be both." However, we must be careful about how we become advocates. Communication of one's area of expertise to managers, policy makers, and the public is known as professional advocacy (Brussard and Tull 2006). When scientists communicate with managers, a distinction must exist between what the researcher knows for sure, what they thought they knew, and their opinion about what should be done for conservation (Brussard and Tull 2006). An example of using this method effectively is the work of Brussard and Tull (2006) in conserving the Carson wandering skipper (*Pseudocopaeodes eunus obscurus*). This butterfly had been collected in only two sites in 1998, one of which had since been developed as a shopping mall. The other site was located directly in the path of a proposed freeway bypass. Their research, involving two years of monitoring, showed *P. e. obscurus* had been extirpated from this site, but they did discover two other populations located 50 and 70 miles away from the freeway site. While communicating their results to the Nevada Department of Transportation, they made clear distinctions regarding their data, informed conjecture, and opinion. Their data showed that there are two extant populations (what they knew for sure). They concluded that the subspecies would likely go extinct without active management of the other populations (what they thought they knew), and that federal highway funds should be used to conserve the species (their opinion). They were successful at receiving federal highway funds for conservation and believe their success resulted from the clear distinctions they made (Brussard and Tull 2006).

Co-existence of values and professional advocacy is not unique to the ecological sciences, and is acceptable in other fields. For example, a medical researcher who cares about human health may choose to study a disease in order to relieve human suffering. If a medical researcher finds a result that can lead to improved human health, and advocates for such a thing, then why can a conservation biologist not engage in advocacy? Although scientists may have values about what issues are important research questions, the scientific method provides a system to ensure data collection and analysis are as objective as possible. The process of generating and testing multiple hypotheses, developing unbiased experimental design, using the most appropriate analytical tools, and peer review all help ensure that results and interpretations are bias-free. The goal of conservation biologists and natural resource managers is conservation, and the means to achieve this goal is research which is subject to scientific rigor (Noss 2007). While this rigorous system is effective at removing bias, scientists do need to be personally honest about the values they advocate and, despite these values, be willing to question assumptions and change opinions based on what the data reveal (Noss 2007). When scientists clearly distinguish between advocacy and science, their research is provided greater public credibility, particularly in politically contentious battles. The grey area between using science to inform policy and management, and advocating for a particular position or policy choice, should be examined closely by the researcher in order to ensure the reliability and effectiveness of their science, and to ensure it has a positive influence in conservation (Kessler and Thomas 2006). Interdisciplinary educations help scientists make the distinction between science and advocacy. This is very valuable because it provides scientists training in problem definition based on scientific uncertainties versus human values and biases. These skills can help scientists work in situations that require consensus building.

Applied science

A significant amount of research is conducted in order to be applied towards practical, social, or management questions, also known as applied science. The *Journal of Applied Ecology* is an example of a peer-reviewed journal on ecological research whose research informs management practice (Freckleton et al. 2005). The scientific process is only one input into natural resource management, which involves defining objectives and taking actions to achieve these objectives (Kroll 2007). The other inputs that are part of this process are socioeconomic, cultural, and political considerations. Applied science requires an understanding of the political and social framework under which managers operate. Real-world conservation problems are complex and require an understanding of how human activities affect the environment, and an understanding of human institutions. In order for conservation biology to move beyond science and into conservation policy, we must become engaged with the real world. To do this, Robinson (2006) sets forth five recommendations:

1. Reach scientific conclusions.
2. Incorporate conservation values in definition of research questions (structure research around policy and values).
3. Incorporate social science and humanities analysis—go beyond biology.
4. Address conservation in human-dominated landscapes.
5. Evaluate contribution of conservation to human livelihoods, and vice versa.

These guidelines and tools help bridge the gap between scientific research and implementation of conservation measures, and are skills that graduate students in conservation biology or natural resource management should be learning. When reviewing articles that address percentages of areas for conservation targets, (Svancara et al. 2005) found that evidence-based conservation targets were nearly three times more numerous than policy-driven targets. Their work highlights the need for scientists to be engaged in real-world conservation and to influence policy. Scientists need to be frequently engaged in dialogue with the managers, policymakers, and planners whose decisions can have a large impact on ecological systems. This dialogue can then lead to relevant research that can provide evidence for biologically based conservation goals, as opposed to policy-driven goals. In order for wildlife students to become more engaged with the real world, we need more than just training in ecological understanding, but also an education in conservation ethics, problem solving, communication, and an understanding of the big picture (Kessler 1995). Skills in leadership and integrated thinking are also necessary for scientists to move into upper level management positions and become effective managers (Kessler 1995).

An example of a conservation project that highlights the integration of social-scientific skills is the South Bay Salt Pond Restoration Project (SBSPRP), the largest tidal wetland restoration project on the West Coast of the United States. The project, located in the San Francisco Bay, is integrating restoration with flood management, while also providing for public access, wildlife-oriented recreation, and education opportunities. One of the many challenges managers and scientists face is balancing the often conflicting needs of multiple endangered species with human-oriented needs such as flood control and recreation. Due to the multiple stakeholders involved, skills such as social interaction, social learning, engaging participants, contributing to collective knowledge, and identifying policy choices are required as information flows between policy-makers, scientists, and managers (McLain and Lee 1996). In order to address these issues, the SBSPRP went through a five-year planning phase that included dialogue among scientists in many disciplines, managers, and community members. This project will utilize adaptive management, which uses continual monitoring of actions to adjust the management plan, to generate science-based information for managers which can then be used to make effective management decisions (McCarthy and Possingham 2007; Trulio et al. 2007).

The planning phase identified the goals and management steps necessary to achieve ecological objectives. Graduate students working on the SBSPRP interact directly with wildlife managers while conducting applied research that bridges the gap between science and management. By directly working with managers, students are engaged with the political and social climate of agency objectives and public discourse. For instance, project managers need information on how increased trail use will affect the behavior and distribution of migratory ducks that use the South Bay prior to creating new trails. White's thesis research (unpublished data 2008) on trail use effects of wintering ducks will be incorporated into trail design to ensure the least possible impact to ducks while still providing a quality trail use experience for recreationists. In addition to conducting rigorous science, students are able to see how their research contributes to management planning and decisions, and how scientific and social uncertainties affect management. This type of training is invaluable in providing skills that enhance scientific learning, public discourse, communication, and dissemination of results.

A key issue wildlife managers encounter in the San Francisco Bay is balancing the creation of recreation trails with wildlife needs. The number and placement of trails can become a politically contentious issue as different interest groups advocate for different scenarios. One proposed scenario is a water trail along the Bair Island Refuge in the South Bay. The area proposed is an urban refuge where harbor seals (*Phoca vitulina*) exist. Although both seals and boaters have been known to utilize this area for a long time, no data existed on the number of seals, their behavior towards boats, or the number and types of boats that they encounter—information managers needed to draft a boating policy. Fox (unpublished data 2008) found that during daylight hours seals encounter boats less than 1% of the time. While motorized boats represented a larger percentage of total craft using the slough, non-motorized craft produced somewhat higher levels of disturbance. Seals were most disturbed by boats that approached closely and/or lingered off shore to watch the seals rather than traveling steadily through the slough. Fox makes social recommendations that involve raising awareness of boaters to their potential impacts by strategically placing signs on how to minimize impacts to the seals (e.g., not lingering near the seals). This example highlights the value of including sociological analyses in natural scientific research that supports managers developing policy that is based on scientific data.

Scientists and managers need to engage in meaningful dialogue that meets the needs of managers and preserves the integrity of science (Soukup 2007). Scientists who understand the socio-economic and political framework managers operate under will be better equipped to offer effective solutions (Kroll 2007). Managers and policy-makers have to justify their decisions to the public, which is often why they encounter obstacles with scientific data. For example, managers may not receive an answer to their management question because the scientist is investigating different questions than those they want addressed. Other problems occur when results are not exact or are inconsistent (Trulio 1999). In order to overcome these problems, scientists must understand the needs of managers. Managers and their staff do not have the time for extensive and current literature searches, therefore the dialogue between the scientist and the manager is critical to disseminating information (Brussard and Tull 2006). Dialogue should begin when developing the research question and continue through interpretation of the scientific data, and implementation of management decisions. Scientists with an interdisciplinary social-science education are often well equipped to incorporate socioeconomic considerations into analyses of conservation problems and make practical recommendations.

When scientists understand the needs of natural resource managers, they can take steps to solve management problems when conducting their research. An example of research that considers the needs of managers is the work of McCarthy and Possingham (2007), who used decision theory to determine how to best allocate resources to two different management decisions. The two management options were to re-vegetate the Merri Creek corridor in Melbourne, Australia, at either a high or low density. High-density planting is likely to be more successful than low-density planting in terms of reaching a specified target, but the costs are higher. Therefore, less area can be planted with a higher density, given budget constraints. Using decision theory they were able to optimize management decisions and incorporate uncertainty and learning through adaptive management.

Managers, policy-makers, and the public also need to shift their thinking towards understanding the uncertainties inherent in scientific research that lead to hypothesis-testing, experimentation, and decision-making (Bradshaw and Borchers 2000). Science and government have different behaviors and attributes that contribute to the difficulties in translating scientific information into policy and decisions (Bradshaw and Borchers 2000). Bradshaw and Borchers (2000) define the science–policy gap as the difference in confidence levels for scientific results expressed by the scientific community and by society. One way to bridge this gap is for scientists to reduce uncertainty with data using tools such as adaptive management and decision theory (McCarthy and Possingham 2007). Scientists can increase public confidence by educating managers, policy-makers and the public on the scientific process, and the need for uncertainty in science (Brussard and Tull 2006). Activities such as monitoring that are designed and performed in partnership with citizens, students, scientists, and managers, can improve learning, especially if used in a statistically sound manner that can be used for decision-making (Lee and Bradshaw 1998). For example, one of the co-authors (Basson) is researching site use and abundance of the southern subspecies of the salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*) (Basson, unpublished data 2008). The salt marsh harvest mouse, endemic to the San Francisco Bay, has been placed on the federal endangered species list since 1970 due to habitat destruction of salt marshes. This research is designed to assist U.S. Fish and Wildlife biologists with management of this species. Basson regularly uses volunteers in the field to assist with her research. These volunteers range from biologists at various agencies, environmental planners, undergraduate and graduate students, and interested members of the public. Since this species is seldom seen, Basson used this opportunity to generate interest in the salt marsh harvest mouse and educate volunteers on the threats to the species' existence.

The lessons from Park Break integrated a number of topics that are relevant for graduate students interested in applied conservation. As students in natural resource science, we had the opportunity to learn multiple perspectives involved in conservation, participate in a dialogue about our own conservation values, and reflect on our futures in resource management. As we progress in our careers, we are likely to encounter complex social situations, often with multiple resource goals, stakeholders, and management needs. Students who are firmly grounded in scientific rigor, but who also have an interdisciplinary background, are well equipped to undertake the applied science that managers need for complex questions, and to coordinate the adaptive management processes that link practical and social concerns to research.

References

Basson, Galli. 2008. Site use and abundance of salt marsh harvest mice (*Reithrodontomys raviventris raviventris*) in a managed marsh. Master's thesis, San Jose State University.

Bradshaw, G.A., and Jeffrey G. Borchers. 2000. Uncertainty as information: Narrowing the science-policy gap. *Conservation Ecology* 4(1), Article 7.

Brussard, Peter F., and John C. Tull. 2006. Conservation biology and four types of

advocacy. *Conservation Biology* 21(1): 21–24.
Costanza, Robert. 2001. Visions, values, valuation, and the need for an ecological economics. *BioScience* 51(6): 459–468.
Delaware River Basin Commission.1996. *Administrative manual, water quality regulations*. Bushkill, Pa.: Delaware River Basin Commission.
Delaware Water Gap National Recreation Area. 2007. *First annual centennial strategy for Delaware Water Gap National Recreation Area*. Bushkill, Pa.: National Park Service.
Franz, Eldon H. 2001. Ecology, values, and policy. *BioScience* 51(6): 469–485.
Fox, Kathy. 2008. Sharing habitat: Can harbor seals and recreational boaters co-exist in an urban refuge? Master's thesis, San Jose State University.
Freckleton, Robert P., Phil Hulme, Paul Giller, and Gillian Kerby. 2005. The changing face of applied ecology. *Journal of Applied Ecology* 42: 1–3.
Gross, Katherine. 2004. Promoting ecological research in national parks by investing in the next generation of scientists. *Ecological Applications* 14(1): 15–17.
Kaiser, Jocelyn. 2000. Bringing science to the national parks. *Science* 288: 24–37.
Kessler, Winifred B. 1995. Wanted: A new generation of environmental problem-solvers. *Wildlife Society Bulletin* 23(4): 594–599.
Kessler, Winifred B., and Jack Ward Thomas. 2006. Conservation biology from the perspective of natural resource management disciplines. *Conservation Biology* 20(3): 670–673.
Kroll, A.J. 2007. Integrating professional skills in wildlife student education. *Journal of Wildlife Management* 71(1): 226–230.
Lee, Danny C., and Gay A. Bradshaw. 1998. *Making monitoring work for managers.* U.S. Forest Service. On-line at www.icbemp.gov/spatial/lee_monitor/begin.html.
Ludwig, Donald. 2001. The era of management is over. *Ecosystems* 4(8): 758–764.
McCarthy, Michael A., and Hugh P. Possingham. 2007. Active adaptive management for conservation. *Conservation Biology* 21(4): 956–963.
McLain, Rebecca J., and Robert G. Lee. 1996. Adaptive management: promises and pitfalls. *Environmental Management* 20(4): 437–448.
National Park System Advisory Board. 2001. *Rethinking the national parks for the 21st century.* Washington, D.C.: National Geographic Society.
Noss, Reed F. 2007. Values area a good thing in conservation biology. *Conservation Biology* 21(1): 18–20.
Parsons, D.J. 2004. Supporting basic ecological research in U.S. national parks: Challenges and opportunities. *Ecological Applications* 14(1): 5–13.
Pike County Office of Community Planning. 2007. *Pike County, Pennsylvania population estimates 2000–2006*. Shohola, Pa.: Pike County Office of Community Planning.
Pike County Office of Community Planning. 2008. *Growing … Naturally: Pike County open space, greenways and recreation plan* (draft). Shohola, Pa.: Pike County Office of Community Planning.
Robinson, John G. 2006. Conservation biology and real-world conservation. *Conservation Biology* 20(3): 658–669.
Sellars, R.W. 1997. *Preserving nature in national parks: A history*. New Haven: Yale University Press.
Soukup, Michael. 2007. Integrating science and management: Becoming who we thought we were. *The George Wright Forum* 24(2): 26–29.
Svancara, Leona K., Ree Brannon, J. Michael Scott, Craig R. Groves, Reed F. Noss, and Robert L. Pressey. 2005. Policy driven versus evidence based conservation: A review of political targets and biological needs. *BioScience* 55(11): 989–995.
Trulio, Lynne. 1999. Science and policy. *Ecological Restoration* 17(4): 193–195.
Trulio, Lynne, Deborah Clark, Steve Ritchie, Amy Hutzel, and Science Team. 2007. *Adaptive management plan: Appendix D, South Bay Salt Pond Restoration Pro-*

ject final environmental impact statement/report.
White, Heather. 2008. Trail use effects on wintering ducks. Master's thesis, San Jose State University.
U.S. Public Law 95-625. 95th Congress. 1978. Wild and Scenic Rivers Act Amendments.