Integrated Science and Interdisciplinary Research for Parks and Protected Areas

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THIS PAPER SUMMARIZES PRESENTATIONS AND DISCUSSION THAT FOCUSED ON INTEGRATED SCIENCE and the use of interdisciplinary research during a panel session held at the George Wright Society Meeting in New Orleans, March 14, 2011. The panel brought together nationally recognized members from the social and biological scientific communities, along with decision-makers and managers of parks and protected areas (Figure 1).

The goal of the panel was to spark a discussion among panel members and the audience on the benefits and challenges of utilizing interdisciplinary research and integrated science to answer complex questions at the international, national, regional, and local park levels. The key focus points for the panel presentations and subsequent discussion revolved around the following five questions: How do we define interdisciplinary research and integrated science? What are the benefits, drawbacks, and challenges of interdisciplinary research and integrated science? When should this type of science be used? What are the barriers to employing interdisciplinary research and integrated science, and how can those perceived barriers be overcome? What are some examples of situations where this type of science has worked for you? We will break this paper down into seven sections, each summarizing the results of the panel presentations and subsequent audience discussion:

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Figure 1. Integrated science panel members at the 2011 George Wright Society biennial conference. From left to right: Charles van Riper III, Gary Machlis, Jan van Wagtendonk, Bob Powell, Russell Galipeau, and Carena van Riper (recorder Eick von Ruschkowski not shown). Photograph courtesy of Gary E. Davis.

1. How do we define integrated science and interdisciplinary research?
2. The need for integrated science.
3. The challenges of integrated science and interdisciplinary research.
4. The benefits of integrated science and interdisciplinary research.
5. Integrated science in protected area management.
6. Communicating integrated science.
7. Key components to improve scientific outcomes.

How do we define integrated science and interdisciplinary research?

Integrated science is defined as a *cumulative* approach of scientific study that synthesizes the perspectives of the individual disciplines, and integrates them during all phases of the approach to a question or problem, with the results having an influence on policy and management decisions (Gallagher et. al. 2008). Integrated science is interdisciplinary. We define interdisciplinary research as the use of a wide spectrum of scientific disciplines that are brought together to solve complex problems. Thus, integrated science not only involves personnel with diverse expertise, but also aims at collaborative efforts to examine the linkages among single-disciplinary perspectives, during which new methods, concepts, and approaches are often developed. Interdisciplinary research and integrated science brought to bear on complex management questions are cumulative, synthesizing perspectives of individual disciplines, and integrating them during all phases of work to solve scientific and resource management problems.

The need for integrated science

With the increasing complexity of natural and social issues facing parks and protected areas throughout the world, it is important for managers to recognize the benefits of utilizing and employing interdisciplinary and integrated scientific approaches to solving resource manage-

ment-related problems. Over the past several decades, the need for interdisciplinary research and integrated science has become more apparent. The reasons for this are varied, but several key factors can be identified; there is a rising need to solve some of the "wicked" (Rittel and Webber 1973) societal problems that are complex in nature. Examples of these "wicked" problems might be "How can the National Park Service best adapt to global climate change" or, "How can the National Park Service maintain species diversity throughout all parks in the system?" The needs for addressing such complex questions and problems are not confined to a single management unit or to a single scientific discipline, and require approaches that transcend disciplinary boundaries and political borders. Also, the advancement of today's new technologies, such as geographic information systems (GIS), enhanced computer memory, agent-based modeling, and adaptive management frameworks provides new capabilities for integrating information that has not previously existed (CFIR 2004).

The challenges of integrated science and interdisciplinary research

In general, the increasing complexity of scientific problems leads to challenging management decisions regarding protected areas. Given this complexity, it has become quite clear that management requires not only scientific knowledge about natural resources, but also social processes, and often a combination of both. Even with this knowledge, the challenges for park managers grow constantly. It needs to be recognized that interdisciplinary research and integrated science can lead to lengthy research processes that typically involve people from different scientific backgrounds. With the initiation of such a project, difficulties immediately exist because of different technical information associated with each discipline, and their associated jargon (e.g., a biologist will need some time to understand a social scientist vocabulary and vice versa). Trust must be built among disciplines and all participants must recognize that this is necessary for integrated research to be successful. As different disciplines also use different 'currencies' to communicate their results, defining a common currency, such as probability (e.g., likelihood for a specific scenario to occur), or in what journal to publish the results, will provide a common ground and working platform. These terms are best agreed upon at the early stages of research efforts. In some cases, social science actually proves to be the harder discipline to integrate, as variables such as subject "attitudes" and "perceptions" are difficult to measure, yet vital to understanding complex problems.

Interdisciplinary and integrated approaches usually reach across institutional and organizational boundaries, which can cause additional difficulties, especially when it comes to the money flow for projects involving more than one funding institution. For social and natural scientists, putting the focus on "interdisciplinarity" may also potentially lead to personal disadvantages, such as publication timeliness. Interdisciplinary competence should always be based on a strong disciplinary background in order to avoid the jack-of-all-trades versus master-of-none dilemma (see also von Ruschkowski 2003). With this disciplinary expertise, scientists can then acquire fluency in other disciplines, thus being able to communicate their work to other scientists, which eventually leads to successful interdisciplinary efforts. This education and learning process will always take more time than becoming a single discipline-trained, "traditional" scientist. However, in the extremely competitive world of today's scientific community, selecting the longer and harder path may initially be regarded as a disadvantage, but an interdisciplinary foundation will potentially become an advantage and lay the groundwork for future productivity and long-term success.

Because of the complexity of interdisciplinary research processes, this requirement for a higher personal (and personnel) resource investment not only applies during initial training, but also during the management of interdisciplinary research projects.

Becoming an interdisciplinary scientist requires a high degree of intrinsic motivation and endurance in order to overcome these perceived hindrances. An especially noteworthy mecha-

nism that discourages interdisciplinary science is inherent within the scientific review system. Working within interdisciplinary scientific environments always bears the danger of initially being less productive (usually measured in the form of publication numbers), and longer-than-expected time frames for products, from the beginning to the output of a research project. However, it must be remembered that interdisciplinary research and integrated science products have the potential to be robust and have great impact on management decisions and scientific communities. Thus, at least from a career perspective, embarking on interdisciplinary and integrated science projects can be challenging, but ultimately rewarding.

The benefits of integrated science and interdisciplinary research

In spite of the potential disadvantages outlined above, interdisciplinary research is worthwhile and rewarding. Not only do interdisciplinary projects have potential to better balance different interests and needs, because of their ability to address complex questions, they also seem to have a higher potential for a successful transfer into politics and decision-making processes, hence the close connections between interdisciplinary research and integrated science. If we are to move beyond simply conducting interdisciplinary work to accomplishing integrated science, we must think across disciplinary boundaries, and offer implications for decision-makers and politicians. In summary, most of today's local and global park challenges are issues that have to rely on interdisciplinary scientific research in order to answer the complex issues facing our natural and cultural resources, and to ensure human well-being.

Integrated science in protected area management

Parks and protected areas provide a prime setting for integrating science, as they can be regarded as coupled human-natural systems (Figure 2). Today, many societal challenges arise outside park boundaries, thus parks can serve as control sites from which to measure change. Also, most current threats to natural areas are human-based and societal in nature. Park managers need to view their actions as closely related to a larger context, both in terms of social and ecological processes, and that these connections should be reflected in management guidelines (e.g., Dudley 2008).

Two of today's largest challenges in parks and protected areas—fighting global climate change and stopping the loss of biodiversity—can only be addressed with interdisciplinary research that is integrated into management decision-making. Integrated science also lends itself well to the inventorying and monitoring of natural and, more recently, societal processes, which is now a core activity for the National Park Service (NPS) science programs. By utilizing integrated science, park managers will be better able to fulfill the NPS mission. We recommend that integrated science decision-making be based on three criteria: use of the best available sound science, accurate fidelity to the law, and long-term public interest. Balancing these criteria requires integrated approaches in science.

Communicating integrated science

Interdisciplinary approaches to integrated science seems—at least in U.S. parks and protected areas—to be challenged by several major obstacles. One of the greatest challenges is associated with the communication of scientific results to park managers and the public. The distrust of science among politicians, and sometimes the general public, is a unique development seen throughout the world, and especially in North America over recent years. Climate change and its science is a prime example of this situation. The gap between academia (i.e., the ivory tower) and the rest of society is derived largely from the level of uncertainty associated with predictions of complex issues. Despite knowledge of complex issues, uncertainty is inevitably an accompanying factor. As a precautionary principle for all scientists, this uncertainty needs to be addressed and

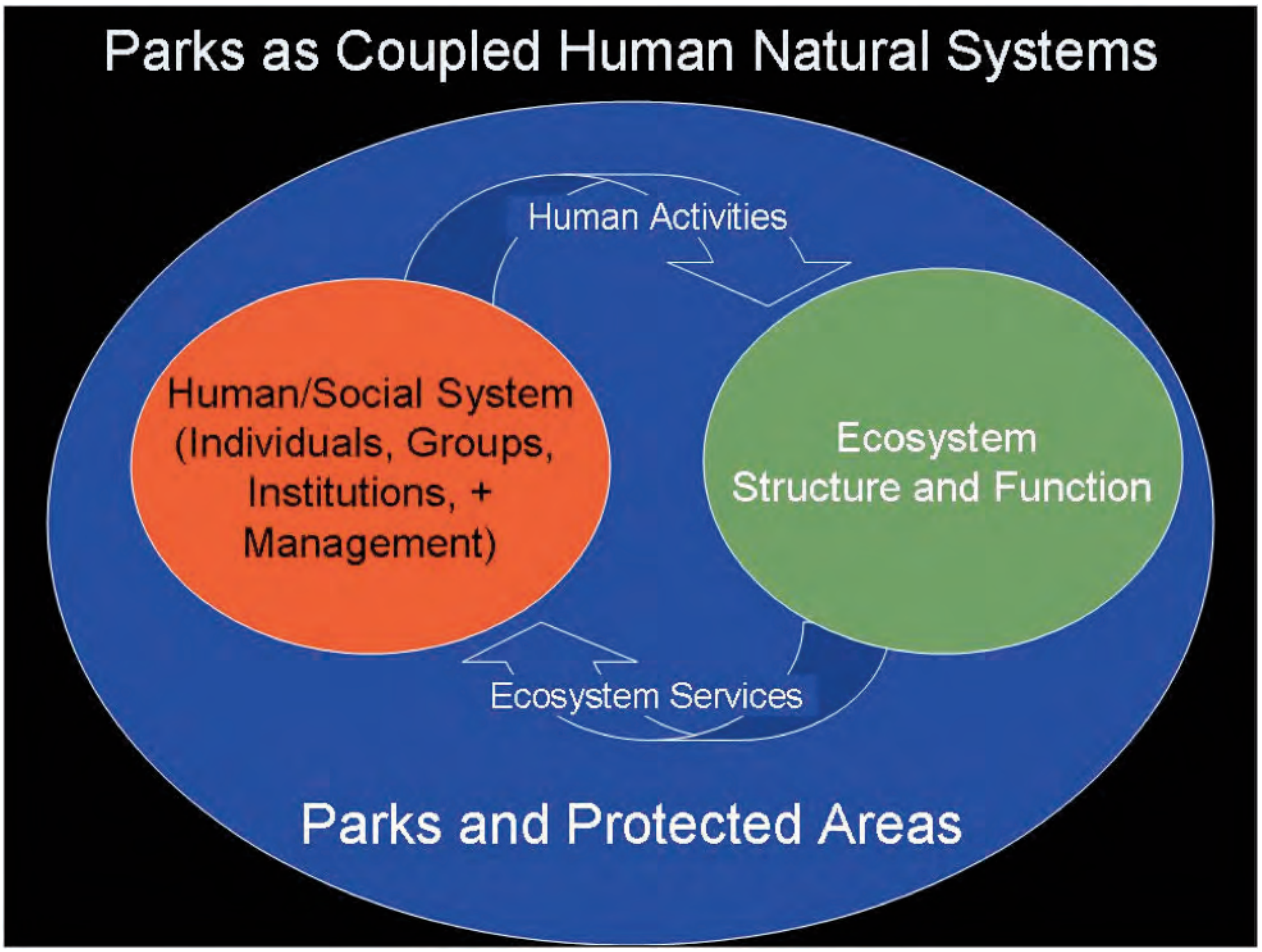

Figure 2. Interrelationships between social and natural components in parks and protected areas (adapted from www.resilience.org and NSF 2010).

labeled in a more systematic way to bridge the gap between long-term scientific processes and short-term decision-making.

In many cases, the science behind certain decisions remains unclear. One reason for this is the lack of public access to research. A second reason is the absence of knowledge transfer from the scientific community to society. Scientists need to work toward clearly communicating with non-technical audiences. What better place to transfer the knowledge than at the park itself? In recent years, institutions have begun to address this task, but again, non-scientific communication and publications are not always rewarded in academia. Park managers are in a perfect position to mediate and translate scientific results into publically digestible information.

Key components to improve scientific outcomes

In summary, integrated science has tremendous potential to help solve complex challenges on both large (global) and small (park) scales. We presently face a tremendous challenge of overcoming the gap between fast-paced demands and timely predictions, and the time needed for high quality research. The combination of interdisciplinary research, and the integration of that research into science, will lead to better-informed decisions. In order to make this happen, science needs faster communication channels and opportunities to brief the public. While doing this, the art of concision becomes a key factor in communicating with non-scientific audiences. This becomes extremely important in crisis situations that demand urgency. Disasters such as the 2010 Deepwater Horizon accident, or the 2011 Japan earthquake and tsunami, are examples of

how the scientific community is being encouraged to develop nimble systems of communication and information transfer (often gathered from long-existing inventorying and monitoring processes) that make information available in a timely manner.

From a scientific standpoint, data should never be delivered with a false sense of accuracy. In some cases, providing a realistic range of findings rather than numbers can be helpful. In other situations, assigning and accepting some systematic level of uncertainty may be the key to successful communication. Additionally, managers should let their decisions play out, but always keep in mind predetermined reversal points whereby decisions can be rescinded.

The integration of interdisciplinary research into scientific outcomes needs to be supported and valued by managers. Within the scientific community, conferences like the George Wright Society meeting play a key role in providing a starting point for interdisciplinary and integrated conversations. Changes can already be seen. Natural and social scientists are quickly moving toward multi- and inter-disciplinary efforts. Academic institutions are now implementing programs for training the future generation of managers and scientists in interdisciplinary research and integrated practices. This movement gives hope for more holistic approaches that will benefit the precious resources protected by parks and protected areas throughout the world.

Audience contributors to the panel discussion

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