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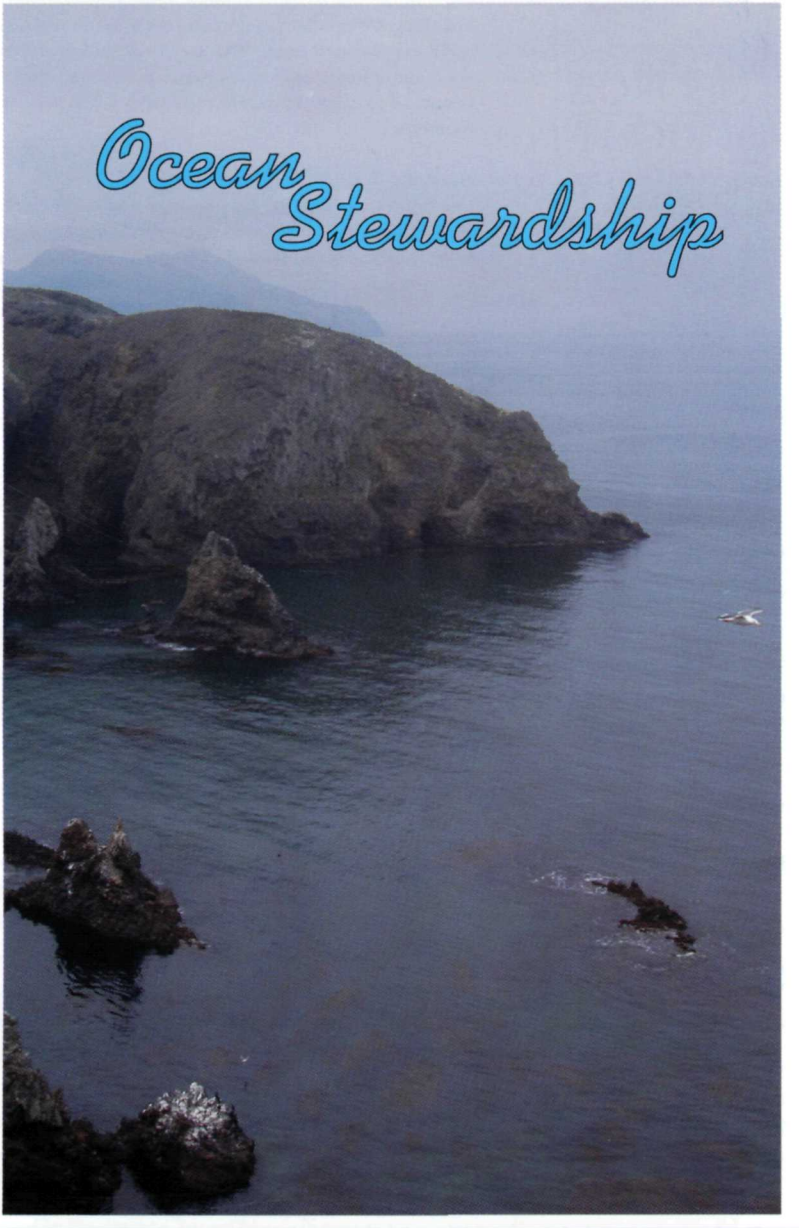

Origins

Founded in 1980, the George Wright Society is organized for the purposes of promoting the application of knowledge, fostering communication, improving resource management, and providing information to improve public understanding and appreciation of the basic purposes of natural and cultural parks and equivalent reserves. The Society is dedicated to the protection, preservation, and management of cultural and natural parks and reserves through research and education.

Mission

The George Wright Society advances the scientific and heritage values of parks and protected areas. The Society promotes professional research and resource stewardship across natural and cultural disciplines, provides avenues of communication, and encourages public policies that embrace these values.

Our Goal

The Society strives to be the premier organization connecting people, places, knowledge, and ideas to foster excellence in natural and cultural resource management, research, protection, and interpretation in parks and equivalent reserves.

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On the cover: Channel Islands National Park, California. *Photo courtesy of Dorothy A. Davis.*

SOCIETY NEWS, NOTES & MAIL

Bound for the City of Brotherly Love: GWS2005 Registration Now Open

Registration is now in full swing for "People, Places, and Parks: Preservation for Future Generations," the 2005 GWS conference on parks, protected areas, and cultural sites. We have 136 sessions on tap, covering the whole spectrum of park-related topics. With the incomparable historic setting of Philadelphia as our backdrop, we are looking forward to a wide-ranging and productive conference. Don't miss it! To register, go to www.george-wright.org/2005register.html.

Lewis Joins GWS Board; Miller Re-Elected, Two Re-Appointed

In the 2004 GWS Board of Directors election, Suzanne Lewis won a seat on the Board while Abby Miller was re-elected to a second three-year term. They defeated Cicely Muldoon, Darla Sidles, and Bill Supernaugh in a well-contested five-way race for the two available seats. Lewis is superintendent of Yellowstone National Park; Miller is the Park Service's deputy associate director for natural resources. In addition, two appointed Board members, Gillian Bowser and Stephen Woodley, were re-appointed to a second three-year term on the Board. Bowser is liaison to the Gulf Coast CESU Network at Texas A&M University, while Woodley is chief scientist of Parks Canada.

Davis Honored for Ocean Conservation Work

Former GWS president Gary E. Davis recently received one of the most prestigious awards of the American Fisheries Society. Davis, the chief of ocean programs for the National Park Service, was given the William E. Ricker Resource Conservation Award for his substantial national and international accomplishments in conservation of aquatic resources. He received the award in August at the AFS's annual meeting in in Madison, Wisconsin. Among his accomplishments are the founding of a prototype ecological monitoring program at Channel Islands National Park, California, to better inform park and ocean stewards. That cooperative, multidisciplinary program became a widely-adopted model for the entire National Park System. While monitoring kelp forest health at the Channel Islands with academic and agency colleagues, Davis discovered that white abalone had nearly disappeared after aggressive fishing in the 1970s left the population scattered on deep reefs. Working together, the scientists sounded a warning that prevented the white abalone's imminent extinction and in 2001 led to its being designated as the first U.S. endangered marine invertebrate. Using 20 years of monitoring to better understand changes in ocean resources, Davis championed a new approach to conservation that led to the establishment of a network of ten marine reserves at the California Channel Islands in 2003. During his 40-year scientific career, Davis has authored or edited more than 150 scientific publications, including the 1996 book *Science and Ecosystem Management in the National Parks*, with William Halvorson.

- **Archeological database—more is better.** More than 110,000 records have been added to the National Archeological Database Reports (NADB-R) module, bringing the total to over 350,000 entries in this publicly accessible, national on-line bibliographic database of gray literature on archeological investigations across the United States and its territories. NADB-R is used in planning archeological projects to reduce redundancy and increase efficiency in cultural resource management efforts. The system is a product of a partnership between the National Park Service, state historic preservation offices, and the Center for Advanced Spatial Technologies at the University of Arkansas. On-line at http://web.cast.uark.edu/other/nps/nadb/nadb.mul.html.
- ***Integrated Resource and Environmental Management: The Human Dimension.*** This book, by A.W. Ewert (Indiana University, USA), D.C. Baker (Queensland University of Technology, Australia), and G.C. Bissix (Acadia University, Canada), presents an overview and history of natural resource management from a global perspective. It discusses the challenges facing IREM by examining issues such as conflict, property rights, and the role of science in the management of natural resources. It also addresses the definition and application of IREM from several different contexts, including real-world applications, planning frameworks, and complex systems. As a special offer to members of the George Wright Society, CABI Publishing is offering a 20% discount off the $50 price. To obtain your discount, go to http://www.us.oup.com/us/catalog/general/, enter the code *L175* in the "Enter Sales Promo Code" box, and then select the appropriate book title.
- ***Managing Mountain Protected Areas: Challenges and Responses for the 21st Century.*** Co-edited by the GWS's David Harmon and Graeme Worboys, Mountain Theme vice chair for IUCN, this book is a state-of-the-art report on managing mountain protected areas worldwide. A product of a field workshop held in South Africa's Drakensbergs just before the 2003 World Parks Congress, the book has 50 chapters from IUCN Mountain Protected Areas Network members presenting personal management experience and lessons learned by experts working in 23 countries. Four hundred and thirty-two large-format pages with a color photo portfolio; cost is 78 euros (about US$105) plus postage. Order directly from the publisher in Italy, Andromeda Editrice: adromedit@tin.it or by phone at 39-08-61-69-9000.

Robert M. Linn, 1926–2004: A Remembrance of the GWS Co-Founder

THIS ISSUE OF *THE GEORGE WRIGHT FORUM* IS DEDICATED TO THE MEMORY OF BOB LINN, the co-founder of the George Wright Society. Bob's death on October 10 of this year marked the end of an era in the history of the GWS, for to him must go the lion's share of credit—credit he never would have sought—for the success of this organization over the course of its first 25 years.

Robert Maurice Linn was born May 12, 1926, in Cleveland, Ohio. As a youth he was active in the Boy Scouts of America, attaining the highest possible rank, that of Eagle Scout. After serving in the Army in World War II, Bob enrolled at nearby Kent State University, majoring in biology. At the same time he became a Scout Leader and also joined the Explorer Scouts, where he again reached the highest rank, that of Explorer Ranger.

It was while leading a scout camping trip to Isle Royale that Bob began a lifelong association with the national park, the place he loved more than any other in the world. His devotion to this island wilderness was nothing short of remarkable. No matter where he was stationed, Bob managed to make at least one trip to the island each year. As anyone who has visited the park can tell you, this is no easy thing to do, since it lies at the far end of Lake Superior, a six-hour ferry ride from Michigan's Upper Peninsula, which itself is roughly nine hours north of anyplace you've ever heard of. In all, he visited Isle Royale for 58 consecutive years, making his last trip in July 2004.

After getting his Bachelor's degree, he continued at Kent State, earning a Master's in plant ecology by doing botanical and ecological research at Isle Royale. He then went on to receive a Ph.D. in plant ecology from Duke University, studying under the eminent ecologist Henry J. Oosting, who authored the classic text *The Study of Plant Communities.* Bob's dissertation, on Isle Royale forest succession, was very much in this tradition.

Following completion of his studies at Duke, Bob joined the National Park Service at Isle Royale, where he became chief park naturalist, serving in that position from 1958 to 1963. During this period he also participated in some of the first winter research sessions of the park's world-renowned moose–wolf study, working closely with that study's founder, Durward Allen.

Bob left Isle Royale in 1963 to work at NPS headquarters in Washington. He made the move with great reluctance, commenting that "a week's enough; a month in Washington would be unbearable." As it turned out, he would spend the heart of his NPS career in the Washington Office. At the time he arrived in the capital, the climate was auspicious for science in NPS. The seminal Leopold and National Academy reports had just come out. Their reviews—and, in the case of the National Academy report, barbed criticism—of NPS science and natural resource management shook the agency out of a 25-year torpor that had descended upon it in the years following the death of George Wright back in 1936. So, just as Bob arrived in Washington, and for the first time in a generation, science seemed poised to become a major factor in NPS decision-making.

The reality proved to be different. As recounted by Richard West Sellars in *Preserving Nature in the National Parks: A*

History, during the 1960s and early 1970s attempts to revive and build scientific management in NPS ran headlong into deeply entrenched agency traditions, such as the indifference of most park superintendents. The bureaucratic tangles that Bob knew lay waiting for him were all too real. Bob worked first with George Sprugel during his tenure as chief scientist from 1964 to 1966. After Sprugel's resignation, Bob was acting chief scientist for a short time until he became deputy to Starker Leopold, who had himself been lured to Washington from the University of California by NPS Director George Hartzog to become chief scientist. Leopold came to Washington even more reluctantly than did Bob, however, and left after just a year to return to Berkeley. Bob then succeeded him as chief scientist, a post he held until 1973, when he was succeeded (under a different title) by Theodore W. Sudia.

Bob Linn on the water at Isle Royale National Park: 1956 and 2004.
(top photo courtesy of Milt Stenlund; bottom, Candy & Rolf Peterson)

Although agency reorganization undercut the high profile that science had briefly achieved while Leopold was with the NPS, and frustrated many of Bob's efforts as chief scientist, he was successful in bringing into the Park Service a cadre of young scientists who formed the core of the agency's research capacity from the late 1960s into the 1980s. Bob's tenure as chief scientist became, in essence, a long-term exercise in scientific capacity-building. This sort of work requires a person of persistence, and, perhaps even more, of vision. That was a quality Bob had in abundance, but it was often hidden to all but his closest associates because of his natural

Escape from Washington: When Bob returned to Michigan in 1973, he received this cartoon as a going-away gift from colleagues at the University of Virginia. The original art was rendered in watercolor and pen-and-ink. (reproduced courtesy of Bruce, Chris, and Holley Linn and families)

reticence and great personal modesty. As it turned out, he would have to wait until his retirement from NPS to give full rein to that vision.

After departing from Washington, Bob finished his NPS career by returning to the Keweenaw Peninsula and helping to create a Cooperative Parks Studies Unit at Michigan Technological University in Houghton, the mainland headquarters of Isle Royale National Park. That CPSU eventually was moved to the campus of the University of Minnesota, where it is now part of the Cooperative Ecosystem Studies Units Network.

Shortly after his retirement, Bob co-founded the George Wright Society in 1980 along with Ted Sudia, and established its headquarters in Hancock, just across the Keweenaw Waterway from Houghton. (There you have the answer to the question we've been asked innumerable times: "Where is Hancock, Michigan, and why is the GWS headquartered there?") The necessity for an organization such as the GWS was deeply felt by Bob and Ted, and, as Bob explained in the first issue of *The George Wright Forum,* "the aims and goals of the Society grew out of intensive discussions":

> The George Wright Society grew out of a need that became apparent during the first and second conferences on Scientific Research in the National Parks [1976 in New Orleans and 1979 in San Francisco]. The need: an instrument of continuing duration, dedicated to the exchange of information within the community of researchers, managers and other professionals, to give continuity to the broad range of topics having to do with cultural and natural park and reserve management and preservation.... The emphasis is on multidisciplinary synthesis and the aim is to promulgate and disseminate integrated information in a form useful to the goal of improved park and reserve management. Existing scientific, cultural and conservation organizations tend to be subject-oriented and do not address such process-oriented issues except peripherally. Existing organizations fill other very important needs.

An initial membership drive targeted registrants at the 1976 and 1979 science conferences; NPS science and technology professionals; NPS historians, archeologists, and anthropologists; and NPS headquarters areas. However, as Bob went on to note, "the Society is designed to include much more" than just NPS employees: "state and provincial park personnel, local area park and reserve system personnel, as well as national park and reserve system personnel worldwide."

Thus the Society was launched with a set of inclusive ideals of global reach. But the basic reality of starting up an organization is more mundane, more local: somebody has to show up every day to do the mailings, write the letters, ask for the donations, and perform all the other thankless tasks that are necessary to get a nonprofit off the ground. For the first ten years of the GWS, Bob was that someone. To be sure, he had strong support from the early Boards of Directors, and many other people contributed to the effort. But Bob was the linchpin. The organization was run from his home on Elevation Street, and—in the tradition of George Wright himself—many of the expenses were paid out of Bob's own pocket.

During the earliest years of the GWS, his house was crammed with the cumbersome machinery that was the do-it-yourself publish-

er's stock in trade before the advent of computer-based desktop publishing. Things like paper-cutting guillotines and collating machines vied for space in his living room with more personal objects, such as a splendid marimba (Bob was an accomplished player of that instrument). Once the personal computer came of age in the mid-1980s, Bob dove right in to the world of digital outputting, becoming a fierce Macintosh partisan. The earliest issues of *The George Wright Forum* had been produced by him on an IBM Selectric typewriter; these gave way to the wonderful world of Macs, with such unheard-of luxuries as an 8-inch black-and-white screen and a whopping 128k of memory. It was, in its own way, a revolution, but still the work had to be done, and it was Bob who was there to do it on a day-today basis.

That was the situation until 1990, when a generous gift from Sherry Wright Brichetto (one of George Wright's daughters) and her husband Dick enabled the GWS to open an executive office. Bob became the Society's first executive director, a position he held until 1998. Characteristically, he declined to be paid, using the money instead to bring me aboard as his assistant. As the years passed, the organization developed to the level that exists today. Bob was instrumental in all parts of that development: building up the biennial conferences, expanding the size and quality of the *Forum*, and extending the influence of the GWS by networking with other groups. After he stepped down from the executive director's position, Bob continued to work daily for the GWS until August of this year, handling membership matters, laying out the *Forum* and other GWS publications, processing payments, coordinating mailings, doing whatever he was asked.

After the GWS opened an executive office in 1990, the Board of Directors began meeting yearly at different locations around the country. Pictured here are most of the members of the Board, ca. 1991 (left to right): George Minnucci, Steve Veirs, Kheryn Klubnikin, Stephanie Toothman, Melody Webb, Gary Davis, Jonathan Bayless, Lloyd Loope, and executive director Bob Linn. (photo courtesy of Dave Harmon)

People today throw around superlatives like "incredible" as if they were so much loose change. What Bob Linn did for the George Wright Society was, quite literally, incredible. All his work for the George Wright Society—24 years of full-time labor—was done entirely on a volunteer basis. He could have had a salary any time he chose; he never asked, and when offered, he refused. His devotion to the

organization and its principles never wavered, no matter what the ups and downs of the moment. He testified before Congress, edited conference proceedings, provided guidance and leadership on all kinds of park matters—and took out the office trash every week because nobody else wanted to do it. He baked legendary chocolate chip cookies and kept the office cookie jar full for years; anybody who walked through the door was welcome to them (and there were people who dropped in just to have a cookie or two). He never complained when things went sour, and never looked to take a bow—not once.

Those who knew Bob solely through his Park Service and GWS careers will not be aware of how important he was to local and regional community groups in Michigan's Upper Peninsula. While working at Isle Royale in the 1950s, he was a founding member of the park's cooperating association, the Isle Royale Natural History Association (IRNHA). Bob was responsible for starting IRNHA's publications program, which has gone on to become nationally recognized for its excellence. IRNHA remains a vibrant, independent park cooperating association today. On top of this, Bob also was instrumental in creating the Upper Peninsula Environmental Coalition (UPEC) in 1975. UPEC remains the only advocacy organization focused exclusively on the environment of Upper Michigan. Bob had a Ben Franklin-like affinity for the printing profession, and over the years supplied letters, brochures, placards, placemats, and other information for such local groups as Kiwanis, the Barbara Kettle Gundlach Women's Shelter Home, Little Brothers–Friends of the Elderly, the League of Women Voters, and more.

In recognition of his many accomplishments in the local community, Bob was honored in 2002 with the Heart and Hands Award, which is given each year to a person who works for peace, justice, and the environment in the Keweenaw region. Bob also received—but only after a lot of persuasion—the GWS's highest honor, The George Melendez Wright Award for Excellence, in 2001, sharing it with Ted Sudia.

Bob richly deserved these honors, but he did not seek them. A man of great personal integrity and humility, he was truly happiest when working quietly in the background, and was always content to let others take the credit. Bob let his actions speak for him. What he said with his life was this: National parks and other protected places deserve the best research and resource management we can muster; if we give them that much, then the public will understand them better and will always support them. Simple enough on paper, but difficult to achieve on the ground. That is why there is a continuing need for organizations like the George Wright Society, and for people like Bob Linn.

— Dave Harmon

Bob is survived by his former wife, Holley Linn, and by two sons, Chris and Bruce, and their families, all of Hancock, Michigan.

Leslie Armstrong
Tennille Williams

Report on the ESRI International User Conference 2004

THE 2004 ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE (ESRI) annual international user conference was held August 9–13 in San Diego, California. Over 12,000 ESRI users attended the conference to learn about new software and technology. This year's conference focused on the "language of geography." In the opening address, Jack Dangermond, president and founder of ESRI, said, "It is possible for us to have a conversation in GIS. This language of geography is helping us to expand our understanding about the world and imagine and create a better future. As our world becomes increasingly complex, advances in science and technology are helping us to address the issues of the world. GIS is promoting better understanding and more collaboration. It is a language for communicating ideas, conceptualizing, and working out agreements."

While geography is the study of the Earth and its features, and of the distribution of life on Earth, including human life and the effects of human activity, GIS is the language that integrates information, work flows, disciplines, and plans to build a common understanding. As GIS evolves into multi-user environments and becomes more distributed, it is also becoming easier to integrate into various projects. Dangermond proposes that there are five main components of geographic knowledge: (1) maps and globes, (2) geodata sets, (3) data models, (4) work flow models, and (5) metadata.

The conference keynote address was given by Rita Colwell, the marine microbiologist and internationally renowned epidemiologist. Colwell uses the spatial analysis capabilities of GIS to understand cholera outbreaks plaguing the people of Bangladesh. By examining relationships between weather, sea temperature, microscopic organisms, and the living patterns of people she was able to devise a simple solution to reduce seasonal cholera outbreaks by nearly 50 percent. Her 25 years of work in Bangladesh has not come without obstacles, but by using the language of geography, and the technology for modeling, sharing data, and GIS, she has been able to overcome many of them. This new form of epi-

demiology, merging health and geography through GIS, has proved beneficial.

The user conference would not be complete without the introduction of new GIS capabilities and services. ESRI's release of ArcGIS 9.0 brings improvements in geoprocessing, visualization, cartography, annotation, and raster imaging. Along with these improvements, ArcGIS extensions such as 3D Analyst, Maplex, Publisher, Spatial Analyst, Streetmap, and Data Interoperability offer the user greater potential. Dangermond states these tools are "not just eye candy. They include tools for advanced surface modeling and analysis, temporal mapping, and data transformation." For detailed product information, see www.esri.com.

ESRI is active in conserving world resources and ecosystems by providing GIS technology and support in many ways. The company constructs data sets such as global and country maps of sustainable environmental data and leverages the Durban Declaration on Sustainable Development to encourage data stewardship relationships and mainstream GIS into national mapping efforts around the world.

Professor Willem Van Riet, chief executive officer of the Peace Parks Foundation, gave a presentation about transfrontier conservation areas, or TFCAs. The foundation assisted in the creation of parks and conservation land use options that cross international borders in order to preserve migratory paths and habitat for endangered wildlife of the southern region of Africa. In Korea, its efforts focus on a conservation plan for the demilitarized zone (DMZ), the border area separating the North and South. More information can be found at the foundation's website, www.peceparks.org.

ESRI is also making strides through the ESRI Conservation Program (ECP). This program has helped numerous nonprofit organizations and individual projects worldwide with training and GIS capabilities. With different levels of grants and training scholarships available, ECP can help users make anything from rudimentary maps to reports using advanced GIS analysis. For more information, go to www.conservationgis.org.

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A Public Opinion Survey on Wildland Fire in Grand Canyon National Park

Introduction

In 1933, George Wright challenged national park managers to recognize naturally occurring fires as a natural part of park ecosystems (Davis and Halvorson 1996). After decades of research by scientists and overcoming resistance by land managers, fire has returned to most national park ecosystems through a wildland fire program resulting in ecological restoration (Covington et al. 1997, 2000; Davis and Halvorson 1996; Fulé 1995). However, the public has not been as supportive of these programs as have biologists (Manfredo 1990). While scientists are privy to the intimate details of the biological reasons behind the role and need for fire as a disturbance in natural ecosystems, the public may not be as aware.

Visitors to national parks, in particular Grand Canyon National Park, may have an awareness of fire's role because of the increase in urban-interface fires with subsequent destruction of homes and businesses (Shindler et al. 2001). This may influence the opinion of those who live in an urban-interface setting. Several surveys have assessed public awareness on a variety of fire and natural resources issues (Cortner et al. 1984; Taylor and Daniel 1984; Carpenter et al. 1986; Manfredo et al. 1990; Bright et al. 1993). Cortner et al. (1984) conducted a poll of Tucson residents in 1981 on fire knowledge and tolerance of management of public lands with regard to the "new" practice of controlled fires (also referred to as *let-burn* and *prescribed* fires). They found respondents were most concerned about local issues and how it would affect them as well as wildlife in the fire area. Those most likely to approve of low-intensity fires were males over 30 years of age with some college education. Cortner et al. (1984) emphasized the importance of educational material and quoted Stankey's (1976) report on fire, which linked public support for fire management to educating the public about fire's role in the ecosystem. To apply this information, knowledge of the public's recreational choices can be beneficial.

In 1984, Stankey and McCool looked at the choices visitors make when they venture out to use recreational areas. They found the setting, what they plan to do there, and how it is managed (e.g., *little* if

they want solitude or *heavily* if they want a guided tour) play a role in visitors' use decisions. They found there is security in routine behavior and that many visitors like to repeat experiences. Perhaps this may explain the angst visitors feel when the setting they prefer is altered—a forest's appearance after a fire, for example. With decades of fire suppression, natural areas in national parks show little evidence of the passing of fire and an expectation of unmarred beauty has entered the national psyche. A study of the acceptability rating of aesthetic views (Taylor and Daniel 1984) found that even in the early 1980s, those who supported and understood the role of fire in the ecosystem still did not like the visual setting that moderate to severe fire created. Interestingly, small fires that brought in new growth for several years post-fire were given a high approval rating. The authors concluded there would be more tolerance for these types of results than crown fires. They, like other authors (Shindler et al. 2001; Stankey and McCool 1984) emphasized the importance of education to develop public acceptance for management decisions.

The importance and credibility of the educational message was illustrated in the Carpenter et al. (1986) study. In a survey using open-ended and closed-ended questions, they found that the message being provided should address the concerns of the target audience. They noted that messages citing the benefits of fire, its effects on wildlife, and its origins, combined with trust in the professionalism of the forest managers, were key components. In this early work, they found no easily defined segment of the population to target and suggested the messages be directed toward all visitors.

Manfredo et al. (1990) assessed the public's preferences for control, let-burn, and prescription fires. They suggested that gaining public support for prescription fire was key in making policies on fire management. After the Yellowstone fires in 1988, prescription fires in National Park Service areas were stopped, due in large part to public sentiment, as well as a re-evaluation of fire's role in the ecosystem and how it would be utilized in future ecological restoration. It was then, more than ever, that fire policy gained a critical sociopolitical component (Manfredo et al. 1990). This study was followed up in Yellowstone by a survey in 1993 (Bright et al. 1993) that studied the effects of changing attitudes and beliefs on support of controlled-burn policies. The investigators first assessed the attitude of visitors to Yellowstone of controlled burns. They followed this up with specific negative messages and a survey to those in support of the fire, with no message and a survey to controls. In turn, positive messages and a survey were sent to non-fire supporters, with no message and a survey to controls. They found some changes in attitude with the targeted messages, but they were not universal. They found it was important to know the character of the audience (sociodemographics) as well as the weight the prior attitude and subjective norm played. They found all messages must have credibility to be effective.

Recent surveys (Shindler et al. 2001; Brunson et al. 2002) have incorporated demographic inquiries along with questions on forest management, forest conditions, and the role of fire. Survey focuses included trust in management and land management agency practices, the effects of smoke, and erosion, as well as asking if fire and mechanical thinning are legitimate tools in land management. Shindler et al.

(2002) found that public opinions are provisional and can change. For instance, following the Los Alamos fire in New Mexico, Shindler et al. (2001) found that there was an increase in negative feelings about the use of prescribed fire.

The ability to influence public opinion and behavior is well documented through the theory of reasoned action (TRA). It has been used to predict respondent behavior by obtaining knowledge of the respondent's attitude toward the behavior and the influence of a subjective norm (e.g., significant others) (Fishbein and Ajzen 1975; Manfredo 1992). If the weight of the influence is sufficient and the discussion specific, attitudes and beliefs can be a good predictor of the respondent's intent to engage in a specific behavior. This predictive relationship among belief, attitude, intention, and behavior allows managers and educators to use effective means of influencing behavior—in this case, supporting fire in national parks. In particular, utilization of active participation (e.g., interpersonal contacts and public speeches) and persuasive communication (brochures and other written information with integrity) are the most effective means of achieving this end (Fishbein and Ajzen 1975; Terry et al. 1993; Dwyer and Williams 2002).

We conducted a survey to obtain data from visitors to Grand Canyon National Park about their knowledge and opinion of fire. The survey consisted of a demographic section, a questions section, and an open comments section. Comparing visitors' opinions with selected demographic variables related to these opinions enabled us to better understand the visitors' opinions about the role of fire in the national park ecosystem. Results of statistical analysis of the answered questions will help managers and educators target populations and groups of people who do not appear to have a grasp of fire's role in national parks. The open comment section of the survey provided additional insight as to the intent of the respondents to perform a given behavior, i.e., support or not support natural and/or prescribed fires, through the TRA (Fishbein and Ajzen 1975).

Materials and Methods

Survey document. The survey document was two pages long with ten questions aimed at soliciting demographic information and opinions from respondents. Questions about age, gender, education, U.S. state or foreign country of origin, residence in an urban or rural community, as well as the number of times participants had visited national parks in America were included. The question, "If there was a way to prevent all fires in national parks, should they be prevented?" asked for a "yes" or "no" answer. A section was left open for written comments, prefaced by the question, "Is there anything else you would like to tell us about fires in national parks in America?" The survey was in English.

Survey administration. Permission to administer the survey was facilitated through the Science Center and Division of Interpretation at Grand Canyon National Park through which a National Park Service (NPS) research permit was obtained. The surveys were placed in two trays on either side of a closed collection box on a portable table (the survey station). Pens and a poster inviting participation in the survey were on the table. The survey station was placed in the Canyon View Information Plaza (CVIP) from April 16, 2001 to September 1, 2001. During that period, 5,000 surveys were made available to visitors. A non-NPS

employee was hired to check the status of the survey station twice a day, keep it supplied, and retrieve completed surveys.

Analysis. The precision and accuracy of the information obtained from a survey hinge on the quality and the quantity of the responses. Based on the manner in which the questionnaire was administered, it is believed that the information provided by the respondents visiting the CVIP is of high quality. The initial goal of obtaining 5,000 survey documents was made in an effort to make precise conclusions about the true proportion of visitors who gave an affirmative answer to the question, "If there were a way to prevent all fires in national parks, should they be prevented?" From April 1, 2001 to September 1, 2001, 2,116,203 visitors entered the park gates on the South Rim. Roughly 4.5 million people visit Grand Canyon National Park each year (National Park Service 2002). The proportion of affirmative responses to the above question from a sample size of 5,000 is within 1.4% of the true proportion with 95% confidence. A sample size of 5,000 would thus yield a precise estimate of the true proportion of affirmative responses to the fire prevention question. In actuality, however, fewer than 5,000 survey documents were filled out. Of 5,000 surveys placed for public participation, 4,618 (92.4%) were returned. Surveys filled out by children younger than 16 years of age were not analyzed. Furthermore, of the questionnaires returned, some were incomplete or contained responses that were obviously incorrect (e.g., age of individual exceeding 120 years). Even with these complications, the sample size in this study is large enough to yield precise results. It is noted that the typical sample size for a Gallup poll designed to represent the U.S. adult population of 187 million is 1,000 (Newport et al. 1997).

The SAS JMP Version 5 Statistical software program (SAS Institute 2002) was used for the database and statistical analyses. Each of the completed surveys was individually entered into the program. The statistical analysis conducted in this paper looks at the relationship between answers to the question, "If there were a way to prevent all fires in national parks, should they be prevented?" and the following characteristics of the individuals: age, gender, number of children with individual on trip, education level, citizenship (U.S. or not), individual's community (urban, rural), and number of visits to U.S. national parks in the individual's lifetime.

Age was recorded as a quantitative variable; the other attributes are qualitative since respondents selected a category for each variable. For example, when answering the question, "About how many times in your life have you visited a national park area in America?" respondents could select one of the following categories: first time, 1–5 times, 6–10 times, or more than 10 times.

To determine if there was a statistically significant relationship between each of the above attributes and the answer to the fire question, appropriate statistical tests were conducted. For each of the categorical variables, a chi-square test of independence was performed to determine if sample evidence suggested an association between the variable and the fire question. To determine if age was related to the "prevent all fires" question, a logistic regression model was used with age as the predictor variable and the response variable being the logit function of the probability of saying "yes" to the fire question. In addition, multiple logistic

regression models were employed to examine how the demographic information considered jointly influences the probability of saying "yes" to the fire question.

The written comments were categorized by opinion and the categories validated by a second reviewer. The categories were: comments in favor of fire in general, specifically in favor of fire, specifically in favor of prescribed fire, in favor of both natural and prescribed fire, not in favor of any fire. Results are given as percentage answers of total respondents.

Results

Survey questions. This section focuses on the attributes of individuals and how they related to opinions concerning fire.

- *Age.* The mean age of 4,598 respondents was 38.6 years. The largest single age group of respondents were 16 years old and numbered 274, or 6% of the surveys. The oldest respondent was 95 years of age.
- *Gender.* Male — 1,724 (38%); female — 2,780 (62%).
- *On this trip, how many children are traveling with you?* None — 2,791 (61%); one — 506 (11%); two — 739 (16%); more than two — 553 (12%).
- *Education.* Less than high school diploma — 357 (8%); high school diploma — 576 (13%); some college studies — 674 (15%); college degree — 1,286 (28%); some graduate studies — 455 (10%); graduate degree — 1,193 (26%).
- *State or country of origin.* Foreign country — 827 (18%); USA — 3,766 (82%). The most state visitors were from California (17%) and Arizona (10%). All 50 states were represented by at least one visitor. The most foreign visitors were from The United Kingdom (26%) and Germany (15%) with 66 other countries represented.
- *Type of community.* Urban — 3,121 (70%); rural —1,366 (30%).
- *Number of visits to U.S. national parks.* First time — 410 (9%); 1–5 times — 1,375 (30%); 6–10 times — 785 (17%); more than 10 times —1,991 (44%).
- *If there were a way to prevent all fires in national parks, should they be prevented?* Yes — 1,355 (33%); No — 2,791 (67%).

To determine if there was a statistically significant relationship between each of the categorical variables and "prevent all fires" question listed above, a chi-square test of independence was performed. The hypotheses under consideration were, Ho: Variable of interest and response to the fire question are not associated, versus Ha: Variable of interest and response to the fire question are associated. Based on the magnitude of the test statistic and accompanying p-value, sample evidence suggested that the following categorical variables are related to the way individuals answer the "prevent all fires" question: gender, number of children with individual on trip, education level, citizenship (U.S. or not), and number of visits to U.S. national parks in the individual's lifetime (Table 1). The p-value for each of these separate tests was less than 0.0001. Sample evidence did not substantiate the hypothesis that there is an association between community type (urban, rural) and response to "prevent all fires" (yes, no) since p-value = 0.73. The logistic regression using age as the predictor variable while the response variable is the logit function of the probability of saying "yes" to the fire question suggested that age is a useful predictor of the logit function. In other

Variable	Yes (%)	No (%)	Frequency
Gender*			
Male	28	72	1564
Female	36	64	2491
Number of children on trip*			
0	30	70	2542
1	34	66	456
2	34	66	654
more than 2	45	55	473
Education*			
Less than high school diploma	51	49	291
High school diploma	47	53	510
Some college studies	31	69	609
College degree	31	69	1133
Some graduate studies	30	70	420
Graduate degree	24	76	1079
Citizenship*			
Foreign country	42	58	719
USA	31	69	3422
Community type			
Urban	32	68	2810
Rural	33	67	1249
Visits to national parks*			
First visit	61	39	351
1-5 visits	44	56	1214
6-10 visits	32	68	711
more than 10 visits	20	80	1945

*Chi-square significant $p < 0.0001$

Table 1. Comparison of select demographic variables and responses to the survey question, "If there were a way to prevent all fires in national parks, should they be prevented?"

words, sample evidence suggested that the proportion of individuals with an affirmative answer to the fire question was different for people of different ages.

The above results are based on examining the relationship between responses to the fire question and each of the other variables individually. A more complete analysis was used to determine how the variables age, gender, number of children with individual on trip, education level, U.S. citizenship, type of community, and number of visits to U.S. national parks in the individual's lifetime considered together were related to responses to the fire question. A multiple logistic regression model was used to accomplish this task. The goodness of fit test indicated that gender, number of chil-

dren with individual on trip, education level, and number of visits to U.S. national parks considered jointly provide a reasonable model. Age, U.S. citizenship, and type of community do not add an appreciable amount of information to the model given that gender, number of children with individual on trip, education level, and number of visits to U.S. national parks are already considered as predictors to the logit function of the probability of saying yes to the fire question.

Survey comments. A section for open-ended comments was provided on each survey. It began with the question, "Is there anything else you would like to tell us about fires in national parks in America? Of the 4,618 returned surveys, 583 (13%) included written comments. These were grouped into the following categories:

- *Comments in favor of fire in general* (66 respondents/surveys = 11%), for example, "Some fires are actually healthy. New trees grow once the old ones are burned. It is a healthy process sometimes."
- *Comments specifically in favor of natural fire* (70 = 12%), for example, "Fires in national parks help to continue the cycle of life. As long as they are naturally started and don't endanger homes or property, they should be let burn."
- *Comments specifically in favor of prescribed fire* (27 = 5%), for example, "Prescribed burns are an important management tool. Something must be done to overcome the damage caused by the fire management policies of the past."
- *Comments in favor of both natural and prescribed fire* (15 = 3%), for example, "A sound fire management program, including natural and prescribed burns, is essential to a healthy ecosystem. Avoid public or political pressure to suppress all fires."
- *Comments not in favor of any fire* (27 = 5%), for example, "I have seen Yellowstone before the fires and after, Yellowstone will never be the same. Please stop! all fires, I believe they destroy more than they save and do good. I am very thankful for seeing it before it burned, I will never see it again;" and, "I wish you national park people would quit starting fires in our parks like you did in Yellowstone and Mesa Verde because that you think some seeds will grow. You destroy the park for years like Yellowstone has been destroyed of its beauty for generations. Quit it."
- *Comments related to fire but opinion unclear or mixed* (147 = 25%), for example, "I always thought any fire was bad. Now I am not so sure!"
- *Comments not related to fire* (205 = 35%), for example, "I think it's interesting that Smokey Bear represents the Forest Service and tells us to protect the trees so they can be given to lumber companies dirt cheap!"
- *Comments not related to fire discussion* (26 = 4%) and eliminated due to offensive language, unreadable text, or personal name given as exclusive answer.

Discussion

Due to the method of survey administration, these results cannot be construed as typical of the average visitor who comes to Grand Canyon National Park. Only those who came to CVIP and filled out the survey are represented. Not all visitors to Grand Canyon from April 1 to September 1 found

their way to CVIP, and of those who did, not all participated in the voluntary survey. However, among those who did participate, there are some intriguing trends based on demographics and opinions about fires in national parks.

Based on the multiple logistic regression model, answers to the question of whether to prevent or allow all fires in national parks showed a trend based on gender, family size, education level, and number of visits to U.S. national parks. If taken literally, females who are traveling with more than two children, possess the lowest education level (i.e., less than high school diploma), and have made the fewest number of visits to U.S. national parks have a greater chance of responding that all fires should be prevented in national parks than do other individuals. Specifically, the estimated probability that females in this category who are visiting a U.S. national park for the first time will say that all fires should be prevented in national parks is 0.82. In contrast, the estimated probability that males having graduate degrees traveling with no children who have visited U.S. national parks more than ten times will say that all fires should be prevented in national parks is 0.12. This is a significant finding.

However, targeting such a specific group could be quite difficult without complete knowledge of visitor demographics. What we have found is that there are specific groups of visitors that may benefit from more specific information about the role of fire in the natural ecosystem of Grand Canyon National Park. Educational material can be targeted to persons visiting Grand Canyon, e.g., those with families and little experience with national parks. For instance, a publication might be titled "Your First Visit, or Natural History for Families." In guided walks, talks, and other interpretive programs, the interpretive ranger can establish group demographics at the start of the program through informal questions and answers and focus their presentation toward the results of this exercise.

The open comments results showed more respondents in favor of fire than opposed to fire. Together, those that support some form of fire in national parks represent 31% of the respondents who provided comments. There is a definite trend among respondents to mention natural fires more than prescribed fires. This may show an attitude to accept natural fires over those started by land managers. Those respondents who opposed all fires represented only 5% of the commenters. Overall, six times more respondents were in favor of fires in some form in national parks than those opposed. While the survey was conducted in Grand Canyon National Park, most respondents did not hesitate to specifically mention other park and natural areas, such as Yellowstone and Mesa Verde national parks, in their comments.

Of the respondents who chose to comment about fire, 35% were either definitely for or against fire. Another 25% made fire-related comments, but gave no clear opinion. This left almost 40% of the commenters who stated no definite opinion on fire. Many of these persons chose the survey as a forum to complain about facilities or comment positively about their overall park experience. It seemed that having a venue to voice their opinion was more important than adhering to the spirit and theme of the fire survey itself.

Using TRA, land managers at Grand Canyon National Park can utilize interpretive and educational means of active participation through ranger-guided activities to

respond to concerns of park visitors. For example, interpretive programs on fire in national parks can focus on reaching families and first-time visitors. In addition, the public participation programs can specifically elicit the knowledge of the participant group and tailor their presentations accordingly. Other means of sharing fire information include persuasive communication in the form of the park newspaper, wayside exhibits, and brochures. These could be produced in multiple languages, if one is concerned with assisting foreign visitors in their understanding of fire's role in national parks.

Utilizing the results of this survey by combining demographic information with public opinion, managers at Grand Canyon National Park can target specific groups of visitors for information dissemination. In addition, specific responsible and positive actions in the natural and prescribed fire program in the park may be the best means of influencing public opinion. These can include manageable prescribed fires that fulfill the park's fire-needs prescriptions and stay within specific parameters. Together, such actions will boost public confidence in and support of the park's fire program.

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Maintaining Unimpaired Ocean Resources and Experiences: A National Park Service Ocean Stewardship Strategy

Foreword

IN 2001, THE NATIONAL PARK SERVICE ADVISORY BOARD PREPARED A REPORT focused broadly on the purposes and prospects for the National Park System for the next 25 years. The board indicated that stewardship of the sea lagged far behind even the lax stewardship of the land, and that the marine world was degrading more rapidly as pollution and overfishing overwhelm the coast. The board strongly suggested that the National Park Service should play a leadership role for the nation to develop a strategically designed system of marine reserves and to "think beyond the vision of maintaining sustainable parks to encourage sustainable communities and ecosystems with parks as part of them" (National Park System Advisory Board 2001).

The National Park Service Leadership Council also recognized the plight of coastal ecosystems and the disparity of stewardship afforded ocean resources in the National Park System (NPS 2002). Director Fran Mainella expressed support for developing National Park Service capacity for coastal conservation. The director instructed Associate Director Mike Soukup to lead a planning effort to explore National Park Service and partner experiences and successes in marine conservation and to develop strategies for the future. This report is a result of that planning effort.

During 2002–2003, we sought and received comments and suggestions from more than 100 coastal national park and national marine sanctuary superintendents and their professional staffs and partners in workshops and interviews. We explored and discussed cooperative ocean conservation strategies with leaders of the National Oceanic and Atmospheric Administration (NOAA) Marine Protected Areas Center, Sanctuary Program, Fisheries, and International Affairs Office (and revitalized a June 2001 NOAA Sanctuaries–NPS agreement). We collaborated with colleagues in scientific symposia to review and evaluate National Park Service ocean stewardship experiences. Finally, we summarized these discussions at the 2003 George Wright Society Conference in San Diego, California, in a series of four workshops on "Marine Protected Area Science," "Political Realities of Ocean Stewardship," "Partner-

ships in Ocean Conservation," and "An Action Plan for National Park Service Ocean Stewardship."

This strategy summarizes the results of these discussions and presents recommendations for how the National Park Service could improve ocean park stewardship and contribute to sustainable communities and ecosystems with parks as part of them. Adoption of this strategy will require additional direction and more detailed action plans to identify responsible parties to execute the recommendations. However, the National Park Service and its partners first need to commit to a shared vision, goals, and actions.

Executive Summary

Americans expect their National Park System to contain unimpaired resources and to exhibit values that represent the nation's heritage in superlative natural, historical, and recreational areas. More than 40 ocean parks, however, currently fail to meet these expectations. The ocean has changed. People can no longer see or catch the fish they could just a few years ago in parks. National parks afford little or no special protection to nature in the ocean, which surprises and upsets many citizens. To address this issue, ocean park superintendents and other park professionals invited people from other agencies and organizations to draft an "Ocean Park Strategy." They identified several major issues. They also recommended ways to address them with a shared vision and goals, and through cooperative actions.

The partners included the National Oceanic and Atmospheric Administration, U.S. Geological Survey, U.S. Fish and Wildlife Service, California State Parks Department, American Fisheries Society, Sport Fishing Institute, Sea Web, The Ocean Conservancy, Environmental Defense, National Parks Conservation Association, Wild Coast, Reef Environmental Education Foundation, Student Conservation Association, Partners in Parks, and a dozen universities. To find common ground among participants and develop the strategy, the partners held six regional workshops and four topical workshops on, respectively, marine protected-area science, political realities of ocean conservation, partnerships and public involvement in ocean conservation, and an action plan to improve coastal conservation in the National Park System.

Ocean stewardship is complicated by many factors. Human-driven global forces that alter climate and sea level render concepts of *natural* and *unimpaired* difficult to grasp when considering the ocean. Coastal watersheds exert powerful influences on nearshore environments. Pollution and invasive non-native species also threaten ocean parks, but the effects of people removing thousands of tons of fish and other sea life from parks every year far exceed those threats. States regulate ocean fishing in most national parks, and don't differentiate parks from surrounding waters. Overfishing that has depleted sea life populations throughout U.S. waters also depleted fish and sea life in the parks. Consequently, parks have lost fishing and other recreational opportunities dependent on living ocean resources. In addition, ecological effects of overfishing have cascaded through parks, dramatically altering entire ecosystems. Except in a few small reserves, flattened, disturbance-adapted sea urchin barrens, algae-covered rocks, and other diminished communities have replaced diverse and productive giant kelp forests, coral reefs, and sea grass meadows in parks.

The four pillars of park stewardship—*Know, Restore, Protect,* and *Connect*—provide a simple way to organize the Ocean Park Strategy. As for what to know, park stewards need to better understand ocean ecosystems and human roles in them. They need resource inventories, submarine habitat maps, monitoring, and more clearly defined ocean boundaries and jurisdictions. On land, the National Park System plays an important role in national conservation strategy and policy, but in the ocean relationships with other resource management agencies are not as clear. The National Park Service also needs to increase its capacity to explore and understand the ocean realms of parks and to revitalize its once-robust and pioneering scientific and public safety diving program. The strategy proposes a "Restore Impaired Ocean Park Resources" initiative to address critical restoration issues and to improve park protection. Ocean parks need to assess performance of newly established marine recovery areas in parks, develop joint systems science-based fishery management plans with states, prevent extirpation of native species, and establish ocean damage assessment teams.

The critical keys to improved ocean conservation in the National Park System are partnerships with other ocean-concerned agencies and communities to facilitate cooperation, collaboration, and communication. But doing a better job of connecting people to ocean parks may be the most important task ahead. The strategy recommends an ocean park task force to coordinate all of these activities. It would help resolve misperceptions about the need to change traditional ocean conservation and improve communication among ocean park professionals and with the public. It would also engage artists, students, and volunteers in parks, and raise NPS awareness about its ocean responsibilities and opportunities. The Natural Resource Challenge addresses these same kinds of stewardship issues for all parks. The Ocean Park Strategy seeks to focus ongoing Natural Resource Challenge efforts on particular common needs of ocean parks to prevent the nation's ocean heritage from being left behind.

Finally, this strategy does not advocate creating more reserves in parks. It does recommend learning from existing reserves in parks by evaluating their performance in terms of improved sustainable fishing, ecological integrity and resilience, and productivity. The strategy also recommends that the National Park Service seek a wide range of solutions with partners to reverse the resource and recreational losses of the last few decades.

Vision for Ocean Parks

The National Park System preserves unimpaired natural and cultural resources and values representative of the nation's ocean heritage in superlative natural, historic, and recreation areas in every region.

National Park Service Ocean Stewardship Goals

1. Preserve unimpaired ocean wildlife, natural processes, wilderness, cultural resources, and recreational opportunities in the National Park System. ("Ocean," in this context, includes all coastal waters, specifically estuaries, bays, open seas, and the Great Lakes.)
2. Restore or rehabilitate impaired ocean wildlife, natural processes, cultural resources, and recreational opportunities in the National Park System.
3. Increase National Park Service capacity

Figure 1. New Bedford Whaling National Historical Park, Massachusetts. (Photo courtesy of Dorothy A. Davis)

for stewardship of ocean natural and cultural heritage.

4. Improve National Park Service partnerships for stewardship of the nation's ocean-related natural and cultural heritage.

Purposes of this Strategy

The purpose of this strategy is to identify how the National Park Service can best achieve its ocean stewardship goals.

The critical keys to improved ocean conservation in the National Park System are partnerships to facilitate cooperation, collaboration, and communication. The National Park Service needs to increase its capacity for ocean conservation to be a credible and effective partner. The following plan presents the major issues and recommendations identified by ocean park superintendents, their partners, and professional staffs during a series of workshops, interviews, and four topical workshops at the 2003 George Wright Society Conference. Those workshops focused on marine protected-area science, political realities of ocean conservation, partnerships and public involvement in ocean conservation, and an action plan to improve coastal conservation in the National Park System.

The most effective partnerships are forged among equals. For the National Park Service to cooperate and collaborate with others engaged in ocean conservation, it must demonstrate equal commitment to excellence and shared outcomes with other agencies and organizations concerned with coastal resources. It is equally important to

recognize that simply hiring more personnel is not an acceptable or effective way to increase National Park Service capacity for this work. Other, more creative and effective ways must be found to achieve the desired outcomes with existing funds and human resources by collaborating with partners.

National Park Service Ocean Responsibilities

The United States of America is a maritime nation founded by people from diverse sea-going cultures. Most Americans live on or near the coasts. The rest visit the coast for recreation often. They all feel a strong affinity to the ocean. Reflecting this history, the National Park System contains many outstanding examples of the nation's ocean heritage, both natural and cultural. More than 70 units of the system include 35 million acres of prime coastal habitats and 3 million acres of water along 4,800 miles of ocean shoreline (Table 1). These ocean sites represent a collective multicultural history and commemorate numerous significant events and places in the nation's past. They provide common ground for recreation, understanding, and inspiration.

Ocean Parks— A Long And Diverse History

Ocean parks have been in the National Park System for more than 70 years. Place-based ocean conservation in U. S. waters began with Glacier Bay National Monument (now Park and Preserve) in 1925, Isle Royale National Park in 1931, Everglades National Park in 1934, Fort Jefferson National Monument (now Dry Tortugas National Park) in 1935, and Channel Islands National Monument (now Park) in 1938. The Antiquities Act of 1906 provided the system with additional national monuments on the coast, such as Cabrillo National Monument in 1913, Buck Island Reef National Monument in 1961, and the latest at Virgin Islands Coral Reef National Monument in 2001. More than a dozen special places along the coast have been designated national seashores or lakeshores, adding Apostle Islands, Assateague Island, Canaveral, Cape Cod, Fire Island, Indiana Dunes, Padre Island and Point Reyes to the system. Tropical parks in Hawaii at Haleakala and Hawaii Volcanoes and the Virgin Islands match cool coastal preserves in Maine at Acadia, and in Alaska at Aniakchak, Bering Land Bridge, Katmai, and Wrangell–St. Elias. Americans enjoy coastal national recreation areas from New York to California at Gateway, Golden Gate, and Santa Monica Mountains. The nation's diverse maritime history is captured at national historical parks as diverse and widespread as New Bedford Whaling in Massachusetts; Castillo de San Marcos and De Soto in Florida; Ebey's Landing and Fort Point in the Pacific Northwest; Kalaupapa, Kaloko–Honokohau, Pu'uhonua o Honaunau in Hawaii; and Salt River Bay in the Virgin Islands. American Memorial in Saipan, War in the Pacific in Guam, and the U.S.S. Arizona in Hawaii all memorialize ocean connections of our more recent history. Timucuan Ecological and Historical Preserve preserves a blend of human history and ecology in north Florida's salt marshes and estuaries.

In spite of this long history, rarely do parks preserve outstanding areas of the marine environment to minimize human influence over natural processes, as they do in wilderness zones on land. The ocean parts of national parks, if considered at all, are largely treated as backcountry, but not protected as wilderness, with a few notable

exceptions in Glacier Bay National Park and Preserve and Everglades National Park.

The National Park System contains a wide variety of sites, established to capture the diversity of the nation's natural and cultural heritage, and every unit of the system is to be valued and treated equally. Congress directed the National Park Service to "promote and regulate the use of … national parks … to conserve the scenery and the natural and historic objects and wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Congress further declared in the General Authorities Act of 1970 "that the areas in every region … and that it is the purpose of this Act to include all such areas in the System" and "that these areas, though distinct in character, are united through their interrelated purposes and resources into one national park system as cumulative expressions of a single national heritage; that, individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all the people...."

Congress amended this act in 1978 to add that "the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of these values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."

Figure 2. Virgin Islands National Park, U.S. Virgin Islands. (Photo courtesy of Dorothy A. Davis)

Americans are clear that they expect their national parks to be among the most protected, special places in the public domain. Fish and other sea life are not excluded from these expectations. Many Americans first encounter nature in ocean

National Park System, which began with the establishment of Yellowstone National Park in 1872, has since grown to include superlative natural, historic, and recreation

Table 1. Ocean and Great Lakes units of the National Park System.

Unit Name	Year Established	NPS Region	State	Size (acres)[1]	Water (acres)	Coast (miles)
Acadia National Park	1916	NE	ME	47,400	11,900	52
Ala Kahakai National Historical Trail	2000	PW	HI	n/a	0	175
American Memorial Park	1978	PW	CNMI	133	0	5
Aniakchak National Monument & Preserve	1978	AK	AK	464,116	0	70
Apostle Islands National Lakeshore	1970	MW	WI	69,372	27,232	154
Assateague National Seashore	1965	SE	MD & VA	39,727	51,411	60
Bering Land Bridge National Preserve	1978	AK	AK	2,697,393	?	175
Biscayne National Park	1968	SE	FL	172,924	106,000	50
Boston Harbor Islands National Recreation Area	1990	NE	MA	1,482	0	?
Buck Island Reef National Monument	1961	SE	VI	19,015	16,659	3
Cabrillo National Monument	1913	PW	CA	160	125	1
Canaveral National Seashore	1975	SE	FL	57,662	59,060	24
Cape Cod National Seashore	1960	NE	MA	43,605	10,525	50
Cape Hatteras National Seashore	1937	SE	NC	30,321	3,993	153
Cape Krusenstern National Monument	1978	AK	AK	649,065	0	116
Cape Lookout National Seashore	1960	SE	NC	28,243	19,074	50
Castillo de San Marcos National Monument	1924	SE	FL	20	0	1
Channel Islands National Park	1938	PW	CA	249,561	124,299	170
Christiansted National Historic Site	1952	SE	VI	27	0	1
Colonial National Historical Park	1930	NE	VA	8,677	?	30
Cumberland Island National Seashore	1972	SE	GA	30,415	10,292	30
De Soto National Memorial	1948	SE	FL	27	0	1
Dry Tortugas National Park	1935	SE	FL	64,701	64,001	4
Ebey's Landing National Historical Reserve	1978	PW	WA	19,324	?	1
Everglades National Park	1934	SE	FL	1,396,905	625,000	155
Fire Island National Seashore	1964	NE	NY	19,579	4,411	52
Fort Caroline National Memorial	1950	SE	FL	138	0	0
Fort Clatsop National Memorial	1958	PW	OR	125	0	1
Fort Frederica National Monument	1950	SE	GA	241	0	1
Fort Matanzas National Monument	1924	SE	FL	300	0	1
Fort McHenry National Monument & Historic Shrine	1925	SE	MD	43	0	1
Fort Point National Historic Site	1970	PW	CA	29	0	1
Fort Pulaski National Monument	1924	SE	GA	5,023	?	?
Fort Raleigh National Historic Site	1941	SE	NC	513	0	1
Fort Sumter National Monument	1948	SE	SC	200	125	1
Gateway National Recreation Area	1972	NE	NY	29,007	17,969	?
Glacier Bay National Park & Preserve	1925	AK	AK	3,224,840	601,000	1,165
Golden Gate National Recreation Area	1972	PW	CA	74,810	3,057	28
Grand Portage National Monument	1951	MW	MN	710	0	1
Gulf Islands National Seashore	1971	SE	FL & MS	137,991	115,169	70
Haleakala National Park	1916	PW	HI	29,094	0	1
Hawaii Volcanoes National Park	1916	PW	HI	323,431	0	45
Indiana Dunes National Lakeshore	1966	MW	IN	15,000	450	25
Isle Royale National Park	1931	MW	MI	571,790	436,009	336

Table 1. Ocean and Great Lakes units of the National Park System (continued).

Unit Name	Year Established	NPS Region	State	Size (acres)[1]	Water (acres)	Coast (miles)
Jean Lafitte National Historical Park & Preserve, Barataria Preserve	1978	SE	LA	20,005	150	16
Kalaupapa National Historical Park	1980	PW	HI	10,779	2,000	1
Kaloko–Honokohau National Historical Park	1978	PW	HI	1,161	597	2
Katmai National Park & Preserve	1918	AK	AK	4,093,229	672,000	497
Kenai Fjords National Park	1978	AK	AK	669,965	0	406
Klondike Gold Rush National Historical Park	1976	AK	AK	15,191	0	1
Lake Clark National Park & Preserve	1978	AK	AK	4,050,025	0	127
National Park of American Samoa	1988	PW	AS	9,500	3,200	55
New Bedford Whaling National Historical Park	1996	NE	MA	34	0	0
Olympic National Park	1938	PW	WA	922,651	15,160	57
Padre Island National Seashore	1962	IM	TX	130,434	32,500	60
Perry's Victory & International Peace Memorial	1936	MI	OH	25	0	1
Pictured Rocks National Lakeshore	1966	MW	MI	73,230	9,770	47
Point Reyes National Seashore	1962	PW	CA	71,068	17,102	160
Pu'uhonua o Honaunau National Historical Park	1955	PW	HI	419	0	1
Puukohola Heiau National Historic Site	1972	PW	HI	60	4	1
Redwood National Park	1968	PW	CA	112,512	5,939	50
Salem Maritime National Historic Site	1938	NE	MA	9	0	0
Salt River Bay National Historical Park & Ecological Preserve	1992	SE	VI	978	600	1
San Francisco Maritime National Historical Park	1988	PW	CA	50	0	0
San Juan Island National Historical Park	1966	PW	WA	1,752	0	1
Santa Monica Mountains National Recreation Area	1978	PW	CA	154,095	0	41
Sitka National Historical Park	1910	AK	AK	113	50	1
Sleeping Bear Dunes National Lakeshore	1970	MW	MI	71,199	12,000	47
Timucuan Ecological & Historical Preserve	1988	SE	FL	40,267	38,000	1
U.S.S. Arizona Memorial	1980	PW	HI	11	0	1
Virgin Islands Coral Reef National Monument	2001	SE	VI	12,893	12,893	3
Virgin Islands National Park	1956	SE	VI	14,089	5,650	22
War in the Pacific National Historical Park	1978	PW	GU	2,057	1,000	4
Wrangell–St. Elias National Park & Preserve	1978	AK	AK	13,175,901	0	129
Total Units: 74			Total Area	84,106,777	3,173,366	5,112

[1] National Park Service, U. S. Department of the Interior, *Statistical Abstract 2003*, pp. 51–67.

parks near their urban and suburban homes. These parks provide them with their first connection to wild things—untamed, untrammeled, and unimpaired. Fishing and other recreational activities in these special places bond people to nature in deeply emotional ways and have become an important part of park experiences. These experiences are in jeopardy.

Ocean Park Stewardship Issues

The National Park Service seeks to preserve unimpaired the natural and cultural resources and values of the National Park

System for the enjoyment, education, and inspiration of this and future generations. The National Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world. Paradoxically, this mission currently does not extend effectively into the ocean, much to the surprise and concern of many citizens and partners of the National Park Service (Table 2).

The ocean portions of parks are stressed by fragmentation of habitats, invasions of alien species, and by pollution and disturbance in watersheds. In addition, legal fishing removes hundreds of thousands of tons of fish, shellfish, and plants from parks every year. Consequently, living resources in many ocean parks are significantly impaired and declining rapidly. For example, in Channel Islands National Park, California, abalone that once produced the state's most valuable sport and commercial fisheries were so depleted by fishing that fisheries were closed indefinitely in the 1990s to protected remnant brood stocks, and one species was federally listed as endangered in 2001. Since 1980, when Channel Islands was redesignated as a national park, cow cod, lingcod, bocaccio, and other groundfish populations also collapsed and their fisheries were closed. At the same time, 80% of the park's extensive giant kelp forests disappeared, except in a small reserve at Anacapa Island that has retained its ecological integrity in the absence of fishing. Recently in Virgin Islands National Park, it took eight weeks of fish surveys to find a single grouper, on coral reefs where grouper were once common. At Biscayne National Park, near Miami, Florida, it took 68 survey dives to find the first grouper on reefs once dominated by these long-lived, resident, key predators. As human-driven global forces change climate and sea level, the concept of unimpaired ocean parks becomes evermore complex, and may already be an anachronism. Shifting baselines continue to degrade people's expectations of the ocean and ocean parks. Consequently, restoration goals are set too low and are still not

Table 2. Ocean issues for the National Park System.

- The National Park Service has significant ocean responsibilities: 35 million acres of coastal habitats, more than 70 ocean parks, over 3 million acres of submerged lands and waters, and over 4,800 miles of coastline.
- Many ocean park fisheries have collapsed—diminishing park fishing opportunities.
- Some ocean species in parks are endangered, and others are declining rapidly.
- Ecological cascades in ocean parks caused by fishing, pollution, and damaged watersheds impair ecosystems and reduce recreational opportunities.
- Water diversion, sound and chemical contamination, and invasive alien species further stress coastal ecosystems.
- Place-based conservation offers best hope for restoration of intact, resilient ocean ecosystems, yet the nation lacks ocean wilderness or a sea ethic to support it.
- Public interest in ocean conservation is increasing and the National Park Service has more potential partners in ocean conservation than ever before.

achieved because they conflict with short-term economic interests.

Some ocean species are even threatened by extinction from fishing, a development most people thought impossible just a few years ago. Recreational opportunities to enjoy these resources are equally threatened and have been substantially diminished. Fisheries and coastal management strategies largely failed to sustain either fishing or nature along American shores in the 20th century. Hunting or egg collection nearly eliminated sea turtles and marine mammals from coastal waters. Fisheries for fin and shellfish have collapsed throughout the country and beyond. The social and economic consequences of these failures are evident in injured coastal communities from New England to the Caribbean, Alaska to California, and across the Pacific Islands. A new ecosystem-based management paradigm is emerging to sustain both sea life and fishing. If managed differently, the National Park System could be a central feature in that new paradigm.

Unfortunately, ocean resources in national parks are rarely managed differently than those in surrounding state waters. In some parks, legislation compels consistency with state rules, while in others state rules were adopted by default. It is as though all terrestrial national parks had adopted general state hunting, trapping, and timber harvest laws and regulations rather than protecting park trees, wildlife, and furbearers. As ocean fisheries fail generally, recreational opportunities and the ecosystems that support them in ocean parks are also being lost at an alarming rate. Parks currently have little to offer visitors in the way of unimpaired resources or recreational opportunities that are different than those along the rest of the coast.

Less than one thousandth (<0.1%) of the nation's coastal waters are held in reserve to sustain nature in the absence of fishing. With the notable exception of three or four parks, most coastal parks afford only controls on watershed development and limit wildlife disturbance. (Buck Island Reef National Monument, Virgin Islands Coral Reef National Monument, and Channel Islands National Park all include substantial marine reserves recently created to restore impaired resources. Dry Tortugas National Park has designated a research natural area that will significantly reduce fishing effects when it is implemented.) Fishing has been an important part of national park experiences for more than a century. National Park Service policy clearly indicates that fishing shall remain an important part of park experiences. It is important to be clear that stewardship that produces "fish forever" is a primary goal of the National Park Service and one that is required to support fishing forever.

The National Park Service has an opportunity to contribute significantly to national efforts to rebuild depleted fish populations, to restore lost integrity and resilience to wild ocean ecosystems, and to provide opportunities for Americans to fish forever and to enjoy nature on the coast as did former generations. The issues are complex and cross park, regional, and national borders. Solutions will likely involve formal partnerships and shared authorities with state and other federal agencies. Greater knowledge of how coastal ecosystems work is needed in order to reduce the uncertainty of decisions and to connect people to coastal parks in new ways, but enough is known today to begin to change the roles that coastal parks can play in ocean conservation.

The most pressing issues are (1) loss of recreational opportunities as fisheries continue to collapse, and (2) the imminent extirpation and extinction of ocean species in parks. Recreational opportunities to view and enjoy coral reefs, kelp forests, and other submarine communities in parks were lost as unintended consequences of fishing cascaded through food webs along ecological chains of cause and consequence. Just as forest and mountain ecosystems lose species and resilience without natural fire and wolves, coral reefs and kelp forests cannot persist without large groupers, snappers, rockfish, lobsters, and abalone (Dayton et al. 2002). For example, when fishing removed the large predators (rockfish and lobsters) and grazers (abalone and red sea urchins) from kelp forests in Channel Islands National Park, it left unfished sea urchin and brittle star populations uncontrolled. Now they carpet the bottom, overgrazing and preventing other species from settling. Since the redesignation of Channel Islands as a national park in 1980, nearly 80% of the park's kelp forests have been lost as a result of this ecological cascade. Healthy Channel Islands kelp forests sheltered nearly 1,000 species of plants and animals, while the urchin barrens that have replaced them support fewer than 100. Similar events have occurred from coral reefs to Alaskan waters and New England cod grounds.

Solutions to these issues are complex and will require ecosystem-based approaches. The traditional collection of species-based fishing regulations have failed to sustain sea life and fisheries in parks, in spite of repeated efforts to improve and refine them with better science and practice. Recently created reserves in parks reduced conflicts among users, and have the potential to allow areas to recover and regain lost ecological integrity. These marine recovery areas in ocean parks follow the same concept that created national parks on land in the 19th century. The scientific community is virtually unanimous that such marine reserves, areas free of fishing impacts, represent the best strategy for rebuilding depleted fishing stocks, restoring productivity and diversity to the coastal ocean, and providing examples of nature for recreation, study, and inspiration. What remain unknown are the optimum sizes, shapes, and distributions of reserves to achieve the desired conservation goals in various types of ecosystems. Public interest and concern regarding the ocean are increasing as ocean resources are depleted below critical levels. The National Park Service needs to explore ways to better protect marine resources in parks to achieve its mission, and how to better partner with others to assure that the nation's ocean heritage is adequately protected and represented in the National Park System.

How to Improve Ocean Park Stewardship

To achieve its mission the National Park Service needs to better protect marine resources in parks. The critical keys to improved ocean conservation in the National Park System, are partnerships to facilitate cooperation, collaboration and communication. The National Park Service needs to better partner with others to assure that the nation's ocean heritage is adequately protected and represented in the National Park System, and to assure that the National Park System is an integral part of the nation's ocean conservation policies.

In order to be a credible and effective partner, the National Park Service also

needs to increase its capacity for ocean conservation. To improve both stewardship efficacy and partnerships, the National Park Service needs to address the top ten impediments identified in Table 3.

Park stewards must know and understand the parks; restore impaired resources and sustain them once restored; protect parks and mitigate threats to them; and connect people to parks deeply. The four pillars of park stewardship—*Know, Restore, Protect* and *Connect*—provide a framework for identifying and organizing actions needed to improve National Park Service ocean stewardship.

Know and Understand Ocean Park Ecosystems and Cultural Resources

The National Park Service needs to inventory, assess, monitor, and better understand ocean wildlife, coastal features, natural processes, and cultural resources in the National Park System to increase understanding of their dynamics, status, and trends. Research is needed to understand ecosystem mechanics to address the cascade effects of pollution and fishing. Parks also need to know and understand the people who are integral parts of ocean ecosystems and to assess the social influences of ocean parks.

Complete basic inventories of ocean park resources. Recently completed basic inventories of ocean parks generally did not extend onto the submerged lands. The following items need to be acquired for the 40 ocean parks with submerged lands:

- *Benthic habitat maps* with resolution <10 m (set mapping standards equivalent to terrestrial vegetation and surficial geology maps);
- Locations and descriptions of *submerged cultural resources;*
- Species lists and status of *invertebrates and non-vascular plants* (in ocean ecosystems such as coral reefs and kelp forests, these organisms are more dominant and influential than the terrestrial vertebrates and vascular plants recently inventoried in all parks);
- *Sediment or substrate maps* (equivalent to terrestrial soils maps); and
- *Oceanographic* environmental condition maps, ocean currents, upwelling sites (equivalent to meteorological data).

Ongoing park inventory efforts could be extended to meet these special ocean park needs with existing NPS inventory and monitoring funds and new partnerships with the U.S. Geological Survey (USGS) and NOAA ocean mapping and analysis centers and with Cooperative Ecosystems Studies Units (CESUs).

Monitor ocean park ecological vital signs. Determine how ocean ecosystems work and respond to stresses. Include ocean parameters in park vital signs monitoring, particularly demographic information of selected taxa following prototype programs at Channel Islands National Park and Virgin Islands National Park, including ocean water quality and biological indicators of resource conditions. Partners include USGS, NOAA, and CESU scientists to help design and evaluate monitoring protocols. Emulate the Minerals Management Service-led southern California Multi-Agency Rocky Intertidal Network program (MARINe) or the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) as models of cooperative, collaborative monitoring organization working across political boundaries within coastal ecosystems.

Table 3. Top ten impediments to effective ocean stewardship in the National Park System.

When asked why ocean park resources were not better protected, park superintendents and their professional staffs identified a common set of major impediments, both perceptual and substantial, that they believe need to be overcome to achieve the National Park Service mission.

1. **Denial** by the public and park professionals that changes or additional conservation actions are needed, based on ignorance or misperceptions about the ocean, such as:
   - Oceans are too big for people to affect;
   - Fish wander so they can't be protected in a place;
   - Resources are "out of sight—out of mind";
   - Existing parks, sanctuaries, and reserves already protect most of the ocean;
   - Global environmental cycles overwhelm effects of fishing on the ocean; and
   - Current fishery management would be effective if properly applied**.**
2. **Multiple jurisdictions** in the sea lead to competition and conflict among governing bodies and uncertainty about accountability (and credit for success), e.g. treaty and states' rights. Uncertainty regarding ownership, authority, and jurisdiction leads to unclear policy and direction from NPS leadership to on-site managers. Threats to ocean parks, such as watershed alterations and contaminants from ocean currents, are thought to be beyond the control of park managers. Ownership of submerged lands in parks is often shared or held by others, and managers lack sufficient knowledge of legal and other remedies available to resolve conflicts and prevent damage from transboundary issues.
3. **Burden of proof** regarding environmental damage is reversed in the sea, i.e., activities in the sea are presumed benign until irreparable damage is documented; only then are activities curtailed. In contrast, on land people must show that proposed activities have acceptable minimal environmental impacts before they may proceed.
4. **Shifting baseline syndrome**—many ocean resources are so impaired that it is difficult to inspire their conservation. Each generation of people believes that what they first personally experience in the sea is normal, even though conditions are already seriously impaired, so they each set progressively lower standards and expectations until the resources are exhausted and beyond recovery. Increasingly diverse and rapidly growing human populations on the U.S. coast increase and diversify demands on ocean resources.
5. **A land-based agency**, the National Park Service lacks inclination and capacity for ocean stewardship, and is overwhelmed by demands for visitor services, which leads to neglect of stewardship responsibilities until crises occur. Site managers want more guidance regarding ocean policy.
6. **Ecological restoration** is more difficult, expensive, and uncertain in the sea than on land; consequently it is often considered a lower priority.
7. **Ocean issues are often contentious** and controversial, especially regarding fishing, where a vocal minority passionately resists changes in stewardship while the general public remains apathetic.
8. **Inconsistent park legislation** often contains conflicting directions to both preserve parks unimpaired and to allow traditional and customary exploitation, such as fishing, that impairs resources.
9. **Lack of knowledge** about the nature and extent of human effects on the sea, especially the cascading ecological consequences of fishing.
10. **Last frontier unfenced**—National Park Service control over ocean resources perceived as a threat to freedom to fish.

Describe ocean park boundaries and jurisdictions. Identify and describe all relevant jurisdictions and park ocean boundaries in cooperation with USGS and NOAA, using modern technologies, i.e., GPS/GIS, with seamless land-sea interfaces (common datum). Ocean parks need help making inventories of spatially explicit, georeferenced boundaries and zones of various jurisdictions and authorities in the parks. This is a mapping issue of describing who's in charge where, not a legal question of authority (see below for legal issues).

Assess ocean park watersheds. Identify and describe coastal watersheds and nearshore receiving waters of ocean parks, and analyze their ecosystem conditions. This assessment should include historic land and water use practices and zoning, rates of sediment transport and deposition, contaminants, eutrophication potential, upstream channelization, jetties, and other human-made structures.

Improve National Park Service technical capacity to explore ocean parks. Assist ocean parks to develop proposals that improve NPS technical capacity to explore ocean realms in parks for both cultural and natural resources. Parks need better access to remotely operated vehicles (ROVs), submersibles, and adequate ocean-going vessels best acquired through cooperative agreements with NOAA, USGS, universities, and private vendors. Develop an agreement with the NOAA National Undersea Research Program (NURP), similar to the one recently executed by NOAA Sanctuaries and NURP. Reinvigorate the once robust and pioneering NPS scientific and public safety diving program.

Participate in the national MPA inventory. Cooperate with NOAA and others to analyze the national marine managed areas inventory, as directed in Executive Order 13158, in order to determine how national parks relate to other MPAs and what role parks play in national ocean conservation strategy and policy.

Increase NPS peer-reviewed publications on ocean conservation. Park professionals need to document findings and results of monitoring, restoration, and protection activities in professional media to assure validity, quality, and persistence of personal knowledge and experiences.

Restore Impaired Ocean Park Resources

Explore marine reserves and other tools to restore or rehabilitate impaired ocean wildlife, estuaries, salt marshes, beaches, reefs, barrier islands, natural processes, cultural resources, and recreational opportunities in the National Park System.

Assess conservation efficacy of existing ocean park reserves. Measure efficacy of new reserves at Channel Islands National Park, Virgin Islands National Park and Coral Reef National Monument, Buck Island Reef National Monument, and Dry Tortugas National Park to determine ecological and social performance and their potential for use as models for future reserve designs. Include social science measures to describe and evaluate personal experiences with new reserves by science and conservation professionals, fishing interests, and the general public.

Develop joint fishery management plans with states. Cooperate with states to restore impaired ocean wildlife at Biscayne National Park, Glacier Bay National Park and Preserve, Isle Royale National Park, and others by developing joint fishery man-

agement plans based on sound systems ecology. Work with partners to identify how living ocean resources in parks can be different than those in surrounding waters, and address management measures that can achieve the desired outcomes with mutual benefits.

Prevent extirpation and extinction of endangered ocean species in parks, and remove alien species. Develop strategies, methods, protocols, and tools to prevent extinction of endangered ocean species (e.g., white abalone) and to restore impaired populations and communities (e.g., reef-building corals, kelp forests, seagrasses, estuaries, and intertidal wetlands). Reduce and prevent damage to marine habitats and native species by removing aquatic invasive species. Expand collaborations with NOAA, states, and universities to track occurrences of invasives and build on successful programs, including the Exotic Plant Management Teams.

Assess vulnerability of coastal parks to extreme events and human disturbances. Assess vulnerability of ocean parks to extreme events, such as storm surges, El Niño, hurricanes, and rising sea level to inform planning decisions for development and resource protection (e.g., historic buildings, middens, and burial sites). Continue to work with USGS on coastal hazard analyses.

Develop ocean damage assessment teams. Establish teams of National Park Service and partner experts (e.g., Submerged Cultural Resources Center, CESUs, Minerals Management Service, and NOAA) to assess effects of extreme natural events (e.g., storms and El Niño) and human-caused events (e.g., ship groundings and oil spills).

Develop a *Restore Impaired Ocean Park Resources* initiative. Develop a *Restore Impaired Ocean Park Resources* initiative that sets national goals for repairing damage to resources and values of ocean parks. Identify specific actions that people can take to help resolve issues. This initiative should identify specific problems, goals, and partnerships and actually restore resources on the ground or underwater.

For example, this initiative would provide resources to locate and remove ghost fishing gear and other marine debris, rebuild depleted populations, mitigate threats from nearby aquaculture ventures, rehabilitate watersheds, and restore submarine soundscapes.

Protect Ocean Parks and Mitigate Threats

Protect and sustain ocean wildlife, coastal features, natural processes, wild ecosystems, recreational opportunities, and historic shipwrecks and other cultural resources in the National Park System.

Analyze efficacy of National Park Service authorities. Review and assess the capacity of NPS authorities and mandates to conserve ocean wildlife and cultural resources (park-level and general regulations), examine apparent inconsistencies with park enabling legislation and other statutes, and recommend a resolution strategy. Explore the application of the Wilderness Act to ocean parks. Ocean parks need legal research and policy guidance to understand the limitations and opportunities in existing statutes to improve ocean conservation in parks. Ocean park managers also need legal and policy advice on potential remedies where statutes conflict or where they lack requisite authority and guidance to achieve the NPS mission and goals.

Mark ocean boundaries with modern technology. Modern technology can be used to save the expense and difficulty of installing and maintaining buoys and other physical structures to mark ocean boundaries—the Federal Aviation Administration and Fishery Management Council regulations may serve as models. The NOAA Coastal Services Center Geographic Information Systems group in Charleston, South Carolina, recently completed a legally defensible, robust system for electronically marking national marine sanctuary boundaries. They are interested in partnering with five coastal parks to do a pilot project.

Improve cooperative law enforcement. Continue to build on the June 2001, formal agreement between the NOAA National Marine Sanctuary Program and National Park Service for law enforcement, education, and monitoring. Improve cooperative law enforcement, especially with NOAA Sanctuaries and states, by establishing a national general agreement, with specific sub-agreements for individual sites or states. Increase National Park Service capacity for ocean patrol, surveillance, and education.

Zone ocean park uses. Employ zoning as a management tool in ocean environments to enhance visitor experiences, to preserve sensitive ocean habitats and features (e.g., sea turtle and avian nesting sites, coral reefs, kelp forests, shipwrecks), and to avoid or reduce conflicts among users.

Designate ocean parks as sensitive areas. Work with the International Maritime Organization (IMO) to establish parks as sensitive areas to be avoided by shipping. Explore voluntary ship routing and reporting schemes with IMO for additional park protection. Improve relationships with the U. S. Army Corps of Engineers regarding regional sediment management to assure parks are not damaged and dredge spoil is effectively used.

Sustain an NPS diving program that complies with Occupational Safety and Health Administration (OSHA) regulations. Revitalize the NPS diving program by offering annual training and other activities necessary to maintain American Academy of Underwater Sciences (AAUS) standards for scientific diving and public safety. Initiate and maintain AAUS organizational membership.

Promulgate regulations to enforce the Dry Tortugas National Park Research Natural Area. NOAA Sanctuaries, National Park Service, NOAA Fisheries, both federal Fishery Management Councils (South Atlantic and Gulf of Mexico), the state of Florida, and community stakeholders recommended a network of three reserves be set aside to begin recovery of the region's ocean resources. Regulations for the two reserves in the sanctuary have been in place since 2001, but the one in the park is still not in effect.

Connect People to Ocean Parks

Increase awareness of ocean resource conditions and lack of protection in the National Park System.

Establish an ocean park task force. Establish a national ocean park task force to lead and guide implementation of this strategy, and to raise visibility of coastal park issues. The task force needs to be multidisciplinary, and include interpreters as professional communicators and partners (e.g., NOAA). It should help resolve misperceptions about the ocean, improve communication among ocean professionals and the public, engage mass-media artists in ocean

Figure 3. Assateague Island National Seashore, Maryland and Virginia. (Photo courtesy of Dorothy A. Davis)

parks, and raise awareness of National Park Service ocean responsibilities. Raising visibility of ocean issues and showing how parks can help resolve them will encourage more National Park Service staff to feel a sense of "ownership" in ocean park issues and motivate them to seek solutions.

The ocean park task force should also develop and apply performance measures to assess the efficacy of the strategy. They should work with existing organizational structures and assign responsibilities for various tasks.

The ocean park task force could also negotiate and serve as an advocate on behalf of ocean parks to consolidate needs and form partnerships that transcend state and regional boundaries. For example, the ocean park task force could seek commitments to conduct invertebrate and algal inventories and submarine habitat maps for all ocean parks from the National Park Service Inventory and Monitoring Program.

Resolve misperceptions about ocean parks. Avoid overwhelming people with apparently insurmountable global ocean concerns. Give people hope that the issues are tractable and that they can make a difference as individuals and collectively. Develop and engage communication strategies to resolve misperceptions about the ocean and place-based conservation in the sea to overcome denial that changes in ocean stewardship are needed. Use the four-step process developed by National

Park Service Natural Resources Information Division (Mike Whatley):

- Develop message (five points, e.g. a seamless system of ocean parks, sanctuaries, and refuges, identify the benefits of ocean protected areas for people and wildlife "fish forever");
- Identify audiences (e.g., internal NPS, other agencies, various publics);
- Select media (e.g., print, web, personal, mass media, K–12 curricula, volunteers); and
- Match audiences and media for effective delivery (traveling exhibit and learning trunk—a packaged program on oceans for use by other parks).

Improve communication among ocean conservation professionals. Create an intranet site for ocean park issues. Encourage ocean park superintendents to join their colleagues to help lead professional coastal zone management organizations, and participate in national and international coastal zone management conferences (e.g., the Coastal Society conference in Newport, Rhode Island, in May 2004, and Coastal Zone '05 in New Orleans, Louisiana) and to seek leadership roles in professional societies such as the Coastal Society (www.coastalsociety.org).

Engage mass-media artists and writers to explicate ocean parks. Develop stories and images with artists and writers. Explore mass-media outlets to deliver messages with better, realistic portrayals, such as the University of Southern California film school's *Ocean Shifting Baseline* project and *In Camera's* high-definition image library project for ocean parks and sanctuaries.

Raise public awareness of ocean parks. Inform the public of the tremendous diversity and breadth of coastal resources in the NPS System. Themes could include (a) beauty, (b) connections (c) values (natural, cultural, economic), and (d) threats to those values. Add outreach components to all NPS marine studies and research projects. Improve ocean park profiles on Capitol Hill and inform elected officials of ocean park status and trends. Develop interpretive tools (e.g., *Exploring the Real Thing* by the NPS Northeast and National Capital regions), formal and informal education programs for marine educators working with National Science Teachers Association, National Marine Educators Association, Professional Association of Diving Instructors, and non-governmental organizations.

Engage more volunteers in ocean parks. Utilize more volunteers for resource monitoring and outreach programs. Cooperate with NOAA Sanctuaries and the Reef Environmental Education Foundation (REEF) to engage local diving communities in the Great Annual Fish Count (GAFC) using volunteer diver protocols. Collaborate with REEF to enter park GAFC data into REEF's established web-based data management system to make information about fish populations in ocean parks available to the public.

Establish ocean park Research Learning Centers. Establish coastal parks and Research Learning Centers as magnet sites where visitors, students, and scientists engage in high-quality marine education and protected area research. Construct and operate joint park–sanctuary visitor centers where public interests coincide.

Establish an ocean park fellowship program. Establish an intake program, like the NOAA Sea Grant fellowships, to hire

graduate students on one-year term appointments. Make the National Park Fellow program competitive, show them parks and issues firsthand, and grow some in-house talent. NPS would provide a few weeks of training on policy and resource stewardship at National Conservation Training Center (NCTC) before assigning them to an ocean park. The National Park Fellows could work with monitoring, education, and outreach programs. With 12 National Park Fellows a year rotated among ocean parks, each coastal park would get the benefit of one every few years. Hold a yearly ocean park meeting in the winter where the twelve National Park Fellows would present results of their year's work, and then discuss future options.

Raise NPS awareness of ocean park responsibilities and opportunities. Raise National Park Service leadership awareness of the agency's responsibilities and opportunities with ocean conservation issues and practices through cooperative NOAA–Department of the Interior (DOI) courses, workshops, sabbaticals, and topical seminars (DOI–NCTC, Shepherdstown, West Virginia; NOAA MPA Training and Technical Assistance Center in Charleston, South Carolina; and Science Institute, Santa Cruz, California).

Continue to organize an ocean parks section of the annual National Park Service *Natural Resource Year in Review.* Expand ocean park seasonal interpretive and volunteer training to include small business owners adjacent to parkland, university professors, and museum professionals.

Provide an ocean parks "Who's who" of successful education and outreach programs to serve as models and mentors. For example:

- Glacier Bay National Park and Preserve—cruise ship industry and Native American outreach programs.
- Acadia National Park—education, public radio, and research learning center programs with distressed fishing communities.
- Channel Islands National Park—education, outreach, live underwater video, and monitoring programs with university museum, and K–12 school partners.
- Cape Cod and Point Reyes national seashores—compare and contrast these two parks (sister parks?) from the point of view of their habitat-based research and education programs with volunteer and student involvement.
- Encourage curriculum-based education guides for ocean parks, such as those done for Virginia and Massachusetts by the NPS Northeast and National Capital regions.

Conclusion

The National Park System contains substantial ocean resources. However, they are impaired, declining, and rapidly approaching critical levels, beyond which recovery may not be possible. As species are extirpated and ecosystems lose resilience and degrade into simplified states, opportunities for restoration fade.

The National Park Service appears to have the authority and policies in place to arrest most of the declines and impairment, but needs to develop public understanding of key issues to engender fierce support to enforce existing laws and policies. Additional and strengthened partnerships with states, federal agencies, and others could resolve many critical issues.

As a premier place-based conservation organization, the National Park Service can

rebuild ecosystems to repair impaired resources and restore damaged recreational opportunities. The opportunity to exercise this option may exist for only a decade or less while native species on the brink of extinction continue to survive and major ecosystem functions remain viable. America's ocean grandeur can be restored and the National Park System is the place to start.

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Bradley W. Barr

A Seamless Network of Ocean Parks and Marine Sanctuaries: The National Park Service / National Marine Sanctuary Partnership

The NPS and the NMSP share a common goal of protecting sensitive marine ecosystems through the management of designated national parks and seashores and national marine sanctuaries with individually tailored management plans. The NPS and the NMSP are faced with many similar management issues, such as habitat loss and damage, fishery harvest, conflicting uses, increasing pressure for natural resource utilization, climate change, and natural and human-induced disasters. In some cases, these responsibilities are in locations where a National Marine Sanctuary is near, adjacent to, or overlapping a National Park area. Both agencies could benefit from a sharing of resources and expertise in carrying out their management responsibilities.

— NPS / NMSP General Agreement, June 2002

Introduction

FEW PROTECTED AREAS PROGRAMS POSSESS GREATER POTENTIAL SYNERGY than the National Marine Sanctuary Program (NMSP) and the National Park Service (NPS). In recognition of this, the NPS and NMSP developed a General Agreement, signed in June 2000, to foster this collaboration, and have been working together to identify and implement joint programs and initiatives that best capture this potential. While this partnership is just gaining momentum at the national program level, many excellent collaborations have been developed and are expanding in areas where NPS and NMSP sites are located in the same region.

Partnerships are nothing new to managers of protected areas. For most, it is the way to get the job done in a time of limited resources, limited staff, and great expectations. In the arena of ocean and coastal management, the expectations for effective management and collaboration have never been higher. The recent report from the National Ocean Policy Commission, submitted to President Bush in October 2004, devotes a large part of its findings to the need for more effective collaboration among the many agencies with stewardship responsibilities for ocean and coastal

resources. Page after page of the lengthy commission report offers examples of lost opportunities for collaboration among the ocean and coastal management agencies, and puts forward many useful and appropriate recommendations for how the conduct of resource management could be improved through effective agency partnerships and coordination. While some might argue, especially protected area managers who devote countless hours to establishing and implementing collaborative programs and initiatives, that the perception of the problem is somewhat greater than it is in practice, there is considerable room for improvement. The bar has been raised.

With regard to marine protected areas, an additional driver for more effective partnerships is the issuance of Executive Order 13158 in May 2000. This executive order directs the National Oceanic and Atmospheric Administration (NOAA) and the Department of the Interior (DOI), as lead agencies in this effort, to come together to "protect the significant natural and cultural resources within the marine environment for the benefit of present and future generations by strengthening and expanding the Nation's system of marine protected areas." In response, NOAA and DOI have established a National Marine Protected Areas Center to coordinate the design and implementation of this national marine protected area system, and to be a focal point for public outreach and education for this initiative. With the assistance of a federal advisory committee, the center is making progress in developing a plan of action to design the national system, and has established centers devoted to science and training and technical assistance to guide and inform the effective operation of that system. This executive order has set the agenda for and the expectation of enhanced collaboration, and the NPS / NMSP general agreement is one of the primary vehicles for achieving the ambitious goals of this directive.

If anything has been learned in the implementation of the executive order it has been that there are a multitude of existing marine protected areas programs playing a role in the management of ocean, coastal, and Great Lakes ecosystems. The marine managed area inventory, established under the executive order (http://mpa.gov), currently includes more than 250 federal sites, and is expected to grow to more than 1,500 sites when all the state, commonwealth, territorial, and tribal marine protected areas are fully inventoried. Each of the implementing agencies has varying authorities, mandates, and policies driving the management of their marine protected areas, but all are focused on managing areas that have been designated to protect valued resources, both natural and cultural. Clearly, opportunities for collaboration, affording more efficient and effective management and protection, are limited only by available resources and our ability to identify and implement the most productive and valuable among them. This is what the executive order was created to accomplish, reiterated by and fully consistent with the recommendations of the National Ocean Policy Commission.

Complementary Programs

While NPS and NMSP both focus on area-based management and protection in coastal, ocean, and Great Lakes waters, the mission and mandate of each is sufficiently different to make them complementary. The many successful partnerships across the country, in such places as Channel Islands off the California coast, Olympic Coast in

the Pacific Northwest, and the Florida Keys, clearly demonstrate the power and utility of programmatic collaboration.

The National Park Service, well known for its terrestrial parks, preserves, historic sites, and wilderness areas, has a surprising number of protected areas in coastal, ocean and Great Lakes waters. According to the recently released National Park Service Ocean Stewardship Strategy (Davis 2004; reprinted in this issue), there are more than 70 units of the National Park System "that include 33 million acres of prime coastal habitats, and three million acres of water, along 4,800 miles of ocean shoreline." Starting in 1925 with the establishment of the Glacier Bay National Monument (now a national park and preserve), to the 2001 expansion of the Buck Island Reef National Monument and creation of the Virgin islands Coral Reef National Monument, NPS has a rich heritage of managing and preserving ocean areas. Yet, despite this ocean stewardship responsibility, NPS has not focused much attention on these areas. Although NPS has developed some marine programs at certain ocean parks, it has generally lacked sufficient resources and manpower with essential expertise in ocean management to be fully successful in its stewardship responsibility for ocean, coastal, and Great Lakes resources. Americans clearly expect their national parks to protect and preserve all the resources and qualities that they were established to protect, and the recently released stewardship strategy, developed with the input and assistance of NMSP, puts NPS on a course that will enable it, when and if it is fully implemented, to meet this expectation.

The National Marine Sanctuary Program, unlike NPS, is focused entirely on place-based ocean protection and management, driven by the dedicated efforts of a highly skilled staff with considerable relevant expertise. With 13 designated sanctuaries encompassing some 18,618 mi^2, and the 131,800-mi^2 Northwestern Hawaiian islands Coral Reef Ecosystem Reserve in the designation process, NMSP is internationally recognized as one of the premier marine protected areas programs. As part of NOAA, the program has growing resources and public support, facilities (both land-based and ships), technology, and expertise in all areas of ocean resource management and science to support this important work.

The NPS and NMSP mandates, as well as the values and qualities upon which management is focused, are somewhat different but yet complement one another. The NPS Organic Act 16 (U.S.C. 1 *et seq.*) directs the NPS to "promote and regulate" the use of national parks "to conserve the scenery and the natural and historic objects and wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The National Marine Sanctuary Act (16 U.S.C. 1431 *et seq.*) directs NOAA to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities. The primary objective of the National Marine Sanctuaries Act is to protect marine resources, both natural and cultural. The act also directs NOAA to facilitate all public and private uses of those resources that are compatible with the primary objective of resource protection. Both authorities emphasize protection of natural and cultural resources while providing for public access and enjoyment, but in practice they

are more complementary than potentially redundant or duplicative.

They complement geographically: while NPS primarily focuses on ocean, coastal, and estuarine resources surrounding or adjacent to terrestrial park areas, national marine sanctuaries are located exclusively in the water. The NPS ocean parks include marine areas generally less than three miles from the shore, as well as shorelines, estuarine resources, and coastal watersheds associated with larger terrestrial park areas. Some national marine sanctuaries start at the water's edge and extend well beyond the three-mile state territorial waters zone, while others are entirely located well offshore in federal waters. There are few areas where the boundary of a national marine sanctuary overlaps with a national park boundary, but more often park boundaries are contiguous with sanctuary boundaries. In such circumstances, collaborative management is not only useful, but perhaps required.

These programs also complement one another in terms of resource protection. Sanctuaries are managed, generally, to facilitate multiple use, but protecting resources and qualities that they were designated to address. In national parks, there is more of a presumption of resource protection being the primary mission and mandate of managers. Sometimes referred to as "ownership-based management" (Barr 2001), terrestrial park managers have more of a sense of "ownership" of resources because parklands are generally held in fee-simple ownership, which carries with it a clear mandate and stewardship responsibility. The oceans are common property, owned by all, but in practice this can translate as "owned by none." Statutory authorities for ocean resource management are well established in law, but marine protected areas managers have a far less developed sense of "ownership" for resources in the areas under their stewardship responsibility than their terrestrial counterparts. Management of ocean and coastal resources can seem more about resolving competing interests and equitable use than protecting or conserving resources. The expertise of NPS in preserving the nation's most important natural areas, when combined with NMSP's experience in managing and protecting ocean resources, has been a good fit where sites have seized the opportunity to establish "bottom-up" partnerships. This can only be enhanced by a coordinated "top-down" collaboration at the national program level. Progress has been made on national program coordination, but considerably more can be done to take advantage of the full potential of these complementary programs.

The Current State of the Partnership

Since the inception of NMSP in 1972, the national marine sanctuaries have looked to NPS as a source of inspiration, expertise, and advice, and many excellent site-based collaborations have been established. In an analysis of weekly reports filed by the sanctuary sites regarding significant activities, covering a period from August 2002 to October 2004, a total of 162 reports were posted identifying joint events, programs, and initiatives involving NPS partners. Encompassing everything from sharing a booth at a community yard sale in the Florida Keys, to major joint initiatives involving education, outreach, research, monitoring, enforcement, managing maritime heritage resources, and collaborative management planning, the scope of the existing partnerships is nothing if not com-

prehensive. Few weekly reports during this period contained no mention of an NPS partner, and all sanctuaries but a very few in the system offered up such reports. The majority of these collaborations highlighted were from the sites where parks and sanctuaries were geographically connected, such as the Olympic Peninsula in the state of Washington, the Florida Keys, and the Channel Islands, and where sanctuary offices are co-located in NPS facilities. Over the three years of reports reviewed, the list of sanctuaries reporting collaborations grew significantly, as did the number of national program partnerships and events. Even the more remote and smaller sites, such as Fagetele Bay National Marine Sanctuary in American Samoa and the MONITOR National Marine Sanctuary, offered examples of partnership activities. Not all activities of the sites are reported weekly, but from those highlighted, it was clearly evident that many of the national marine sanctuaries have strong, well-founded NPS partnerships.

To get a further measure of the institutional arrangements developed over the years between NPS units and national marine sanctuaries, the master files of written agreements, held at the NMSP headquarters in Silver Spring, Maryland, were reviewed. Ten formal interagency agreements between NPS and NMSP were identified in addition to the general agreement signed in 2000. Going back as far as 1995, these agreements included arrangements for the co-location of sanctuaries in NPS facilities, a number of joint education and volunteer programs, collaborative research and monitoring initiatives, and a host of other administrative partnerships. These agreements address on both natural and cultural resource protection initiatives. Undoubtedly, there are more formal agreements not in these files, but what was discovered demonstrated, again, the scope and depth of the existing partnerships between neighboring sanctuaries and parks.

What was also evident from these agreements and reports was that these partnerships were developed opportunistically, and driven by local needs, and local efforts. This is not a bad thing, as "bottom-up" initiatives are generally quite successful. However, what may have been lacking is "top-down" support to make these initiatives even more successful and visible. Also, some "bigger picture" look at the collaborations across the system, identifying larger could be extremely valuable, perhaps national-scale collaborations that could enhance and contribute to these excellent "bottom up" programs. These site-based partnerships represent a solid foundation on which to build a larger structure, but what would be very helpful is a blueprint to guide that work. The general agreement offers a table on which these needed plans can be drawn.

Planning for the Future

The NPS and NMSP have engaged in joint planning, and intend to continue direct, bilateral coordination at the national program level as envisioned in the general agreement. Progress is being made and more is coming.

In 2001, the NMSP and NPS gathered at the National Conservation Training Center in Shepherdstown, West Virginia, to review our existing partnership, identify challenges and mutual interests, share ideas for potential opportunities to enhance collaboration, and set an agenda for moving forward. Some of the important challenges and opportunities that were identified by

the participants include (NOAA NMSP 2002):

- *Communications.* Clarity of interfaces at the park/marine sanctuary level is essential; jointly communicating to and influencing the Administration on marine conservation and protection are critical.
- *Cross-agency coordination.* Much emphasis was placed on putting mechanisms in place to facilitate the joint work of NPS and NMSP. Examples included funding transfer mechanisms, signature authority, exchanging personnel, cross-training, cross-deputization, and joint permits and regulations.
- *Joint potential opportunities.* Many shared opportunities were identified, including education and outreach, implementation of executive orders on coral reefs and marine protected areas, joint digital programming, and establishing a joint focus on critical habitat, reserves, no-take areas, and submerged cultural resources.

The group further identified three potential areas where collaboration would be a high priority:

- *National policy and planning.* Focus on jurisdictional authorities, coordination of permits, review and coordination of strategic and operating plans, and exchange of methods, tools, and management plans.
- *National stewardship development.* Focus on joint science and research strategies, and joint education and outreach programs.
- *Enforcement.* Regulatory activities were deemed significant enough to warrant its own focus and national-level working group. The scope for this group includes coordination and joint assistance in carrying out enforcement and search-and-rescue missions.

This was an ambitious and far-reaching agenda, put on the table with the clear understanding that progress would be incremental, and that the resources of both agencies are quite limited. As expected, progress has been slow and incremental. Site-based partnerships continue produce excellent collaborations, such as the joint visitor center for Olympic National Park and Olympic Coast National Marine Sanctuary, and nearly all NMSP sites with regional NPS partners have on-going and frequent communication, with much cross-participation on site advisory councils. At the national program level, a workshop was held to address issues related to collaborative enforcement, and a memorandum of agreement has been drafted and is in agency clearance. Unfortunately, available resources have severely limited each program's ability to implement all identified priorities, but enthusiasm for the partnership remains high at both NPS and NMSP.

Recently, a draft plan of action has been developed that proposes to engage in a national joint planning program, implemented through a series of regional workshops, as well as seeking guidance and advice from NPS and NMSP personnel and other partners, at sessions held during meetings and conferences sponsored or widely attended by NPS and NMSP staff. Scheduled to be completed by 2006, this process will develop an implementation strategy for the partnership for the period 2007–2010. The on-going site-based partnerships will continue and be sustained during this period, but the national strategy

will offer the "big picture" that has been missing, and will hopefully attract new funding to allow the NMSP / NPS collaboration to move to the next level.

A Rising Tide....

With the release of its Ocean Stewardship Strategy, the National Park Service has made a positive statement of support for its ocean management programs. The National Marine Protected Area Center's efforts to identify and work with marine protected area authorities, including NPS and NMSP, to implement a national system of marine protected areas gives new emphasis to the NPS / NMSP partnership, and the National Ocean Policy Commission recommendations are an additional impetus for action. While the current agenda is to improve and enhance our management of ocean resources in areas where NPS and NMSP have joint stewardship responsibilities, at some point new areas will be identified for protection. The closer the partnership between NMSP and NPS, the more intimately familiar we are with each other's programs, the better able we will be to effectively and efficiently protect ocean and coastal resources at a regional ecosystem scale. Building partnerships on a solid foundation of trust, respect, and mutual interest will help us avoid the usual turf battles and interagency combat associated with competing interests, missions, and mandates. There is, without doubt, more to gain from pursuing collaboration than competition. The ocean is a big place, and there's plenty of room for each program to be fully successful … individually, collaboratively, and as part of a seamless network of ocean parks and marine sanctuaries.

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Paul Morling

The Economics of Marine Protected Areas in the High Seas

Introduction

WORLDWIDE, AN ESTIMATED 200 MILLION PEOPLE MAKE THEIR LIVING directly or indirectly from fisheries, while many more depend on additional economic uses of oceans and coasts (de Fontaubert et al. 1996). Despite this reliance on the marine environment, our understanding of marine ecosystems and the knowledge of what they contain remains low. At the commencement in 2000 of the ten-year "Census of Marine Life" project to document all known sea life, the program director, Jesse Ausubel, stated that 95% of the oceans remain unexplored biologically and that we know more about the surface of the moon. Until recent times, this lack of understanding, together with the sheer vastness of the oceans, allowed for the common presumption that marine resources were inexhaustible. This presumption has been confounded by the collapse of many fisheries and growing evidence of the declining state of the world's oceans. These factors, together with a growing awareness of the fundamental importance of conserving marine biodiversity and maintaining ecosystem services, have now created a critical need for more effective management of the marine environment. Marine protected areas (MPAs) are one means of returning marine ecosystems to healthier states and conserving valuable marine habitats.

This paper looks at the economic rationale for MPAs, with a particular focus on MPAs in the high seas—the area of the ocean lying beyond national jurisdictions. After a review of marine protection principles, the economic value of marine habitats, and critical issues facing the marine realm, the recent upsurge of interest in high-seas MPAs, as evidenced by international conventions and other efforts, is discussed.

MPAs Defined

IUCN–The World Conservation Union defines an MPA as "any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (Kelleher 1999). Marine space can be designated in different ways depending on the management goals for a particular area so that the degree of protection may vary: from reserves prohibiting all extractive activities, such as fishing and mining, to areas that allow various forms of sustainable exploitation. In addition to achieving conservation goals, it is

increasingly being acknowledged that protected areas and reserves can also play a major role in fisheries management. Fishing overcapacity and the global scale of operations continue to have adverse effects on fish stocks, and it is becoming more widely recognized that long-term fisheries management needs to take into account wider environmental considerations (FAO 2002). From a conservation perspective, the pollution and damage associated with human activity further impinge on the functioning of marine environments.

The growing realization of the need to improve our stewardship of marine habitats has also heightened awareness of the inadequacies of their current level of protection. The current total area of MPAs is not known precisely, but is estimated to be below 1% of the total area of the seas, with as little as 0.01% protected from all fishing (Roberts and Hawkins 2000). The need to address the severe under-representation of MPAs in the development of a global network of protected areas is now widely recognized.

As noted above, an assumption underlying the growing support for MPAs is that they not only can increase human well-being through achieving conservation goals, but can also provide direct economic benefits through improved fisheries management. In international meetings, considerable attention has been paid to the serious social, political, and economic losses that can emerge with the collapse of a fishery. In 2001, the American Association for the Advancement of Science released a scientific statement, signed by 150 marine scientists, declaring that there is compelling scientific evidence that marine reserves conserve both biodiversity and fisheries, and could help replenish the seas. After some time lag from the initial establishment of an MPA, the results of protection include increases in biomass and the average size of exploited fish species, as well as increased species diversity within the reserve, with transfer of benefits to fishing areas through adult spillover and larval export. Habitat protection through marine reserves is also, therefore, an important potential management tool for the long-term viability of the world's fisheries.

The Economic Value of Marine Habitats

A consequence of the traditional view of the sea as containing an unlimited supply of renewable resources has been to undervalue them. Traditional economics has also tended to undervalue marine environments by focusing narrowly on the marketable resources they support. By taking into consideration all the benefits afforded by marine environments—ecological, social, and economic—a more comprehensive assessment of their true worth to humanity can be made. Figure 1 outlines a taxonomy of the total economic value of marine environments.

Direct use values. These include both the values derived from the exploitation of marketable goods and the non-extractive use benefits we derive from the sea. Examples range from fishing and oil drilling to benefits such as energy, transport, ecotourism, and nature appreciation.

Indirect use values. Marine environments are complex and dynamic ecosystems that function as an integral part of the global biosphere. In economic jargon, they are multifunctional resources that supply tradable outputs and perform a large number of ecological functions, which not only support economic activity but also the plan-

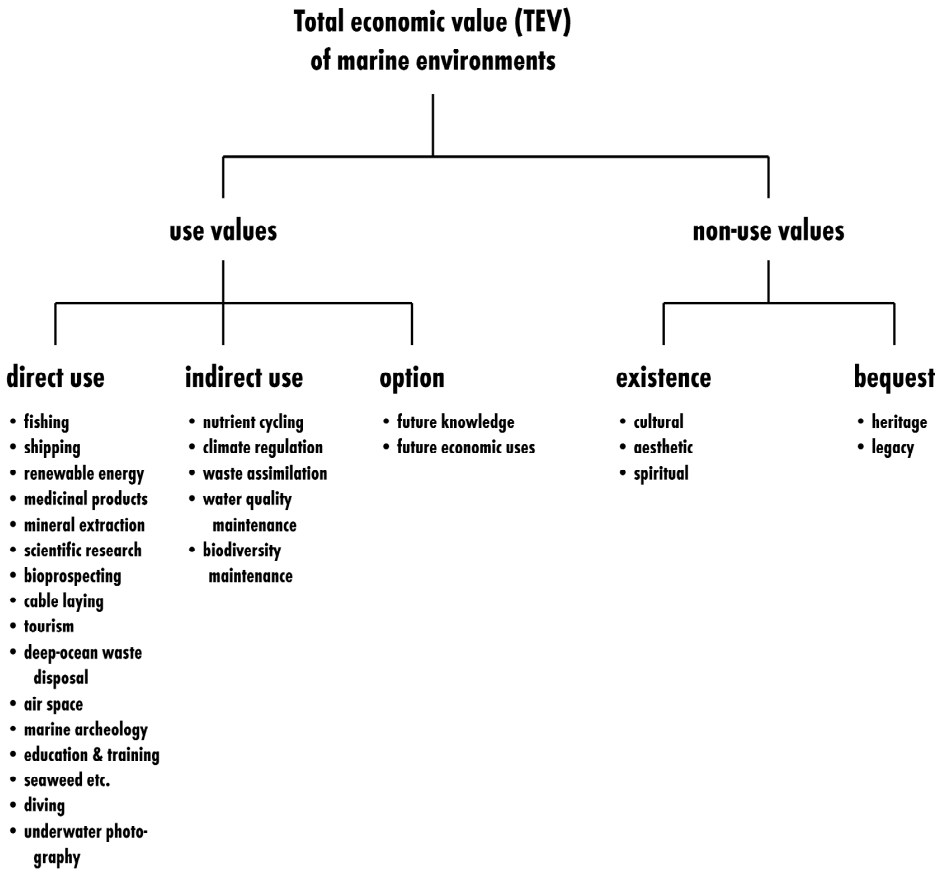

Figure 1. Total economic value of marine environments.

et's life-sustaining biological systems. In economic terms, ecosystem services can be thought of as transformations of natural assets (soil, water, air, and living organisms) into products that are important to humans' well-being. The economic benefits associated with direct uses of the sea, such as fisheries, are well understood; our dependency on indirect services, such as nutrient cycling and waste treatment, is not. As a result, the value of maintaining biodiversity and biological resilience is often unrecognized or discounted.

A major reason why marine biodiversity and many ecosystem services play no part in the cost–benefit calculus driving economic activity is because they are often "public goods." A public good has two defining characteristics. First, one person's use of it does not preclude anyone else's (i.e., it is "non-rival"); second, it is impractical to exclude other people from using it (it is "non-excludable"). These two characteristics mean goods and services, such as climatic regulation, are not amenable to allocation by market methods and, in the absence of regulation, such goods will inevitably be undervalued and overexploited.

However, ecological services generate

benefits to human society well beyond the economic activities they support. Globally, they are far more important than the narrow financial benefits generated by the sale of marketable marine goods and services. In 1997, Costanza and colleagues estimated the indirect use values of marine ecosystems at US$8.4 trillion per annum for open ocean ecosystems and $12.5 trillion for coastal ecosystems. Although these estimates are somewhat crude in nature, they give a clear indication of the critical importance of marine habitats.

Option values. Little is known of what the oceans might provide in the future in the way of new products. There is therefore an option value in conserving marine habitats for purely economic reasons, given the high prospect of developing new resources or new opportunities to create wealth. Economic activity often impinges on biodiversity, resulting in permanent changes to habitats and natural resource availability. When considering changes to habitats for which little is currently known, adopting the precautionary principle means recognizing these option values and the potential scale of permanent loss that may be associated with short-term economic gain.

Technological advances in food production and pharmaceuticals rely heavily on the natural genetic diversity of marine plants and animals because marine organisms have evolved complex chemical compounds and processes for defense and predation, or for survival in such extreme environments as deep-sea hydrothermal vents. These compounds and their underlying genetic diversity have huge potential economic importance that would be foreclosed by the loss of marine biodiversity. The scale of the loss can be gauged from a recent U.N. estimate that the combined market for products derived from genetic resources in the cosmetics and drug industries is currently worth approximately US$100 billion (Zakri and Johnston 2004).

Bequest values. Bequest values refer to the conservation of natural resources for future generations to enjoy. These values can arise because of the uncertainty surrounding the supply of resources or the long-term consequences of altering the natural environment. Bequest values therefore incorporate the precautionary principle, recognizing the prudential benefits of risk-averting behavior in the face of uncertainties and environmental irreversibilities.

Existence values. These relate to individuals' desire to see environmental resources conserved, even though they never intend to use them (either directly or indirectly). Markets cannot capture the spiritual, cultural, or aesthetic regard in which people globally hold the natural world. While it is hard to measure such values directly, they underlie the numerous contributions made by broad and disparate groups of individuals worldwide to conserve or enhance marine habitats and the species that rely upon them.

Critical Marine Issues

Overfishing. World fish consumption has increased from 45 million tons in 1973 to more than 94 million in 2000, at which time the estimated first-sale value of the global catch amounted to US$81 billion. The U.N. Food and Agricultural Organization's (FAO's) catch database of 116 oceanic species (epipelagic and deep-water species that occur principally in the high seas) reveals that catches of oceanic species almost tripled from 3 million tons in 1976 to 8.5 million in 2000.

Evidence of overfishing is also summa-

rized by the FAO in its state of the world's fisheries report, published in 2002. The report states that about 18% of stocks or species groups are overexploited, with an increasing likelihood that stocks will decline further and catches will decrease unless remedial management action is taken. The FAO also reported that 10% of stocks have already become significantly depleted, while approximately 47% of the main fish stocks or species groups were fully exploited and therefore producing catches that have reached, or were close to, their maximum sustainable limits. By the FAO's reckoning, nearly half of the world's marine stocks offer no reasonable expectations for further expansion. The scale of overfishing is also underlined by research from the fisheries group at the University of British Columbia, who have developed models to estimate the total biomass of commercial fish in large regions. Their results show that across the whole North Atlantic, the biomass fell by more than 80% between 1950 and the late 1990s, while recent research has found a similar drop in fish stocks off West Africa.

Faced with increasing evidence of overfishing, efforts to manage fisheries have accelerated. However, fisheries managers and multilateral fisheries conventions have largely ignored ecosystem concerns and have tended to concentrate instead on regulating those species being targeted by specific fisheries.

Discards; birds and mammal bycatch. This refers to fish and other marine life that are incidentally caught alongside targeted species. Bycatch is typically discarded dead at sea, and includes seabirds, marine mammals, turtles, juveniles of the targeted species, and even fish sought after in other fisheries. Based on a review of over 800 papers, Alverson et al. (1996) estimated that between 17.9 and 39.5 million tons (average 27.0 million) of fish are discarded each year in commercial fisheries—roughly a quarter of the total catch. The authors note there are inadequate data to determine the real biological or ecological impacts of discards, but economically they represent losses of millions if not billions of dollars. Economic losses associated with discards include the monetary value of: (1) marketable species that are too small or otherwise prohibited from landings; (2) species for which no current market exists, but which are caught along with commercial or recreational species; (3) species-specific fleet sectors discarding another fishery's target species; (4) marine mammals, turtles, and birds for which human society expresses high existence values; and (5) the opportunity cost of the effort expended in catching and disposing of bycatch.

For seabirds, longlining is a global problem because longline fishing vessels set more than one billion hooks each year, resulting in the death of more than 300,000 seabirds annually. According to BirdLife International, birds affected include both highly charismatic and vulnerable species, with 22 species of albatross and petrel threatened with extinction. This includes 17 of the 21 albatross species. For other marine mammals, the Cetacean Bycatch Resource Center states that accidental capture and entanglement in fishing gear is the biggest threat to whales, dolphins, and porpoises worldwide, killing more than 300,000 animals per year.

Perverse subsidies and overcapacity. Fisheries management effectiveness is further undermined by subsidies that are provided to maintain fisheries-sector income. A World Bank paper estimated that world-

wide fishery subsidies total between US$14.5 and $20.5 billion annually, conceding that even these figures "probably err on the low side, perhaps by a considerable margin" (World Bank 1998). This is equivalent to about 25% of the annual value of the world's commercial marine fish catch, exacerbating the problems of overfishing and overcapacity. The European Union (EU) alone spends around two-thirds of its fisheries budget subsidizing commercial fleets. Subsidies include payments for national access to fish in foreign waters, direct grants for fishers and their vessels, tax breaks for fuelling fishing boats, funds for the construction and maintenance of port facilities, and support for ship building and fish processing. Once a fishery is overfished, subsidized vessels inevitably turn to previously unexploited or uneconomic fisheries or go further offshore. Ineffectual trade policies aggravate these problems.

The seabed. Fishing alters marine ecosystems directly, by removing a large fraction of the biomass, and indirectly, by altering the food supply of the remaining marine predators. It also incurs further environmental costs in terms of the physical damage done to the seabed. Recent scientific explorations of seamounts and cold-water coral reefs have revealed their unique and complex biodiversity, with as many as 50% of the species observed during recent seamount cruises being new to science (Rogers 2004). Seamounts are volcanic peaks that rise to more than 1,000 m above the surrounding ocean floor. They are characterized by high levels of biodiversity and endemic fauna and serve as feeding grounds and sites of reproduction for many open-ocean and deep-sea species of fish, sharks, mammals, and seabirds. They are highly productive environments attracting many pelagic fish species and shoals of fish, shrimp, and squid that feed above them.

The major threats facing seamounts and the wider benthic landscape is the practice of bottom trawling. Seabed trawling is a destructive technique in which the nets can destroy bottom habitats, like thousand-year-old cold-water coral reefs, in a single trawl. There is a clear need to account for this externality, yet bottom trawling on the high seas is almost completely unregulated.

Other threats to marine ecosystems. Illegal, unreported, and unregulated (IUU) fishing remains a serious problem undermining the sustainability of fisheries. The FAO estimates that in some important fisheries IUU fishing accounts for up to 30% of total catches. It occurs in both small-scale and industrial fisheries, in marine and inland water fisheries, as well as in zones of national jurisdiction and on the high seas (Doulman 2001).

The negative impacts of overfishing are often exacerbated by the use of fishing gear that fails to minimize environmental externalities for which the fishers are not held financially accountable. Various gear types and fishing methods are attracting attention for their detrimental impacts on the abundance of target species, bycatch, features of the physical marine environment, and general habitat complexity. In some instances, it is apparent that inexpensive modifications to gear and techniques could reduce environmental damage by decreasing the capture of undersized fish and the bycatch of birds and mammals.

Increasing economic activity and fishing capacity have increased the scope and range of human impacts on the marine environment. The U.N. estimates that 90% of the ever-increasing volume of world trade is transported by ships. The doubling of

large-scale fishing vessels since 1970 has generated rapid growth in the number of fleets plying non-local waters, and technological advances in oil drilling as well as fishing are continually increasing the pressure on deep-sea habitats and species.

Fishing may be the principal anthropogenic factor affecting the structure and functioning of marine ecosystems, but many other activities, such as shipping and seabed mining, have adverse environmental impacts not paid for by private operators. In addition to these direct activities, pollution and climate change also affect the quality and resilience of the marine environment (UNEP 2002). Taken together, these impacts have altered the composition of ecological communities, impairing their structure, function, and productivity.

Lack of coordinated management. The incentive to overfish is created by the common access to the oceans and by the ability of economic agents to avoid paying the true cost of the damage they do. Market failings, such as the absence of property/use rights, and externalities, such as pollution, necessitate some form of market intervention to ensure that marine resources are managed in a way that maximizes their social benefits to society, rather than private financial benefits. Despite some fish stock management strategies and international agreements, current practices have given rise to uncontrolled harvests, especially in international waters, and to the destructive and wasteful capture methods noted earlier, which, in turn, result in the continued overexploitation of many marine species. To date, domestic and oceanic fisheries provide a classic example of how not to manage communal goods.

The Particular Problem of the High Seas: A Global Commons

The high seas are defined in Article 86 of the U.N. Convention on the Law of the Sea (UNCLOS) as areas of the sea not included in the exclusive economic zone (EEZ), the territorial sea, or in the internal or archipelagic waters of an individual country. Approximately 64% of the oceans lies beyond the 200-nautical-mile limit of the EEZs of coastal states. These areas, the high seas, include open oceans and deep-sea environments that are amongst the least explored and researched areas on Earth. While many of the foregoing critical issues are common to both waters within national jurisdictions and high seas, the global commons nature of high seas poses special problems for safeguarding their biodiversity. The problems posed by common access are well understood (the classic exposition being Hardin 1968). In terms of fish stocks, the absence of property/use rights or enforceable agreements means that it is in the interest of fishers to maximize their catch regardless of the overall status of the stock.

There is increasing urgency about the need to redress the declining state of the world's oceans. Market failures are compounded by our growing capacity for exploiting natural resources. Speaking of IUU fishing of Patagonian toothfish in the Southern Ocean in 1998, Australia's environment minister, Robert Hill, noted:

> If the plunder continues, the world will lose a valuable natural and economic resource as stocks in fishing ground after fishing ground crash to commercial extinction. Illegal fishers are also killing huge numbers of seabirds, including thousands of endangered albatrosses. Stocks and eco-

systems are unlikely to recover for decades, if at all (Hill 1998).

Action to Date: UNCLOS as a Foundation for Regulation

While the recognition of the need to conserve marine biodiversity is relatively new, the need to address the public goods and common-access issues in relation to fisheries is not. Since the 1940s, improved understanding of the behavior of highly migratory fish species prompted the creation of a series of intergovernmental scientific fishing organizations, devoted to recommending quotas for maximum and optimum sustainable yield of certain fisheries. Two conferences on the law of the sea held in the 1950s produced a set of international conventions, but the real breakthrough came with the passage of UNCLOS in 1982, which, after a decade of negotiations, provided the world with a "Constitution of the Sea." UNCLOS, one of the major achievements of international treaty-making, covers most uses of ocean space in a framework that integrates issues such as economic development, environmental protection, natural resource management, peace and security, and research and technology.

One of the most important achievements of UNCLOS is its declaration, in part XI, that the resources of the deep seabed are the "common heritage of mankind" (Article 136). The "Area"—the part of the sea covered by this concept—is defined in Article 1.1 as the "seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction." The possibility of extracting minerals from manganese nodules at the bottom of the deep ocean, nodules which contain important mineral resources (e.g., nickel, copper, and cobalt), motivated the creation of part XI. Highly advanced technology is required to extract the minerals found in the deep ocean. This means that developing countries might be unable to benefit from economically important shared resources. Part XI therefore created a detailed regime for deep-seabed mining, which provides for the sharing of benefits and transfer of technology, and the establishment of an International Seabed Authority. Part XI was modified in 1994 to address concerns of industrialized countries, but the concept of sharing the benefits of common resources and assisting developing countries still underpins part XI and UNCLOS.

Exploitation of the genetic resources found on the deep seabed for biotechnology purposes has raised additional legal issues, currently under consideration by both UNCLOS and the Convention on Biological Diversity (CBD). When UNCLOS was negotiated, little was known about life on the deep seabed, and specific provision was not made under part XI. Since then, discoveries related to the rich biological diversity of the deep oceans, such as ecosystems around hydrothermal vents, have highlighted their potential for biotechnology. There is widespread agreement that a legal lacuna currently exists in this regard.

Recent Initiatives on High-seas MPAs

In recent years the issue of MPAs outside national jurisdiction has received considerable attention. This has included recognition in the plan of implementation adopted by the 2002 World Summit on Sustainable Development; a call for urgent action to protect seamounts, cold-water corals, and other vulnerable high-seas features and ecosystems by the 2004 World Parks Congress; consideration by the CBD;

but, most importantly, consideration within the framework of UNCLOS.

The U.N. Open-ended Informal Consultative Process on Oceans and the Law of the Sea considered the issue of the "protection of vulnerable marine ecosystems" at its fourth meeting in June 2003. Later in 2003, the U.N. General Assembly's annual resolution on oceans and the law of the sea reinforced the momentum. The assembly recommended that the fifth meeting of the Open-ended Informal Consultative Process, which took place 7–11 June 2004, organize its discussions around "new and sustainable uses of the oceans," including the conservation and management of the biological diversity of the seabed in areas beyond national jurisdiction.

In February 2004, the Seventh Conference of the Parties to the Convention on Biological Diversity (COP7) noted that "there are increasing risks to biodiversity in marine areas beyond national jurisdiction" and that "marine and coastal protected areas are extremely deficient in purpose, numbers and coverage in these areas" (paragraph 29, decisions VII/5). The COP7 agreed that "there is an urgent need for international cooperation and action to improve conservation and sustainable use of biodiversity in marine areas beyond the limits of national jurisdiction, including the establishment of further marine protected areas consistent with international law, and based on scientific information, including areas such as seamounts, hydrothermal vents, cold-water corals and other vulnerable ecosystems" (paragraph 30). The COP7 recognized that the law of the sea provides a legal framework for regulating activities in marine areas beyond national jurisdiction.

The COP7 expressed its concern about serious threats to biological diversity, stressing the need for rapid action on the basis of the precautionary principle and the ecosystem approach in marine areas beyond the limits of national jurisdiction. It called on the U.N. General Assembly and other international and regional organizations to take measures to eliminate or avoid destructive practices, consistent with international law. For example, consideration should be given, on a case-by-case basis, to the interim prohibition of destructive practices adversely affecting marine biological diversity associated with the areas identified above (paragraph 61).

The COP7 also addressed the issue of deep-seabed genetic resources in areas beyond national jurisdiction. In reference to article 3 of the CBD, the COP7 invited parties to the convention and other states to identify activities and processes under their jurisdiction that may have significant adverse impacts on deep-seabed ecosystems and species beyond national limits.

These positive developments have been given impetus by IUCN, its World Commission on Protected Areas (WCPA), and the Worldwide Fund for Nature (WWF), all of whom have identified the high seas as a gap in a global system of protected areas. In 2005, a strong focus on oceans-related issues at an international meeting of small-island developing countries in Mauritius is likely to add further impetus to the intensifying international debates on high-seas areas.

Threatened marine ecosystems, including those in the high seas, will be a major issue in forthcoming years, as will MPAs—one of the key remedial options for addressing the threat. In the short term, it is extremely important that governments move forward urgently to implement the U.N. Fish Stocks Agreement, through

regional fisheries management organizations (RFMOs), which are the main mechanisms for putting the agreement into practice. The agreement came into force in 2001. However, the agreement has only 51 parties and action by RFMOs seems to have been slow to date.

The Costs of Financing High-seas MPAs

The financing needs of protected areas, including MPAs, are emerging as a priority in international debates. For example, the 2004 World Parks Congress estimated that US$25 billion in additional annual support is required just to maintain effectively the current global system of protected areas (covering approximately 12% of Earth's terrestrial surface and less than 1% of marine space). This stands in stark contrast to the actual worldwide expenditure on protected areas, estimated at US$6.5 billion a year (James et al. 1999). The recent adoption of a new program of work on protected areas by the CBD necessitates a step change in the scale and range of financing arrangements if it is to be successfully implemented.

It is critically important that the full financial costs of individual MPAs are fully understood. These costs will include establishment, administration, employment, monitoring. and enforcement. On the basis of survey data on the financial requirements of 83 MPAs worldwide, Balmford and colleagues (2003) suggest that a global MPA network covering 30% of all the world's seas (both territorial waters and high seas) might cost between US$5 billion and $19 billion annually to run. The survey, however, highlights the fact that costs decrease as the distance from land and the size of the MPA increases, indicating that a viable, sustainable system of high-seas MPAs could be financed for substantially less. The return on such an investment would be substantial, including the continued delivery of marine ecosystem services, improvements to fisheries, and the preservation of option values.

Financing Mechanisms and Sources

This concluding part of the paper introduces some of the options that may be relevant to future discussions about financing high-seas MPAs. An appropriate financing framework will depend to some extent on the legal basis and the precise nature of MPAs. However, the principles of UNCLOS reinforce the need for a shared approach, as does the principle of common but differentiated responsibilities. The failure of developed countries to fulfill intergovernmental commitments related to financing, such as those made in the CBD, is a major concern, and the need to explore a range of financing options is becoming widely recognized.

Multilateral agencies. The Global Environment Facility (GEF) covers a limited number of marine projects under its focal area on international waters, including some global projects. The GEF focuses on global benefits, which could make it well-placed to take on financing high-seas MPAs. Currently, however, the funding available through the GEF is woefully inadequate to address the needs for protected areas in developing countries, so an expansion of its activities might not be desirable. The perception of the GEF as being focused on priorities identified by developed countries may also make it a less desirable option. Other international bodies that might play a role include the World Bank and possibly regional development banks.

National governments. Many individual countries have contributed to the degradation of the marine environment, though no individual country can address the problems by acting alone. Effectively tackling global environmental problems requires a multilateral framework, which will ultimately depend on the support of individual countries. Many developed nations express, as part of their principles governing overseas assistance, a commitment to environmental sustainability, and they should ensure that their policies and activities, such as sectoral subsidies, support rather than undermine conservation efforts.

Charges for the use of global commons. Over the years, many proposals have been made for global fundraising mechanisms. For example, in 1987, the influential World Commission on Environment and Development emphasized the need to widen efforts beyond traditional sources of funding, including exploring automatic sources of funding. The commission identified revenue from international commons and natural resources, including ocean fishing and transportation, as an area warranting particular attention. The idea of an automatic levy of some kind has similarities to proposals related to taxation.

There is, as this paper has noted, a strong economic case for the introduction of such charges to ensure that economic agents meet the full social costs of their activities. The conventional economic solution is to make the consumer and polluter pay either through regulation, taxation, or other market interventions. Conceivably, a variety of revenue sources can be generated from ocean activity. They could relate to extractive and bioprospecting activity on the ocean bed, fishing, overflights, and shipping. Methods could include user charges and permits for commercial activities. As noted by the German Advisory Council on Global Change, the introduction of charges for the use of global commons has two beneficial outcomes: the revenue raised, and the incentive provided to reduce environmentally harmful activities. Appropriate legislation, regulation, and governing authorities would need to be established to implement such market interventions.

Supranational tax. Taxation is the conventional national means of paying for public goods, and, in recent years, a "Tobin Tax" has been proposed as a means of increasing financing for a number of global concerns. Named after the Nobel laureate economist James Tobin, a global Tobin Tax would target international currency transactions. Initially proposed to reduce speculative currency transactions, which can have serious impacts on national economies, the tax would also generate considerable revenue given the size of foreign currency dealings. There is no precedent for such a measure, nor is there a clear relationship between foreign exchange transactions and activities on the high seas. On the other hand, the revenue raised through a globally agreed-upon tax of this type could be directed towards a variety of global objectives. Other national and supranational taxes have been mooted, including a tax on international trade and one on international aviation to account for negative externalities that affect areas beyond national jurisdictions, such as environmental pollution.

Mobilizing private and voluntary support. The existence value placed on marine environments is apparent by the significant worldwide efforts made to conserve it. If MPAs provide the conservation results currently pursued by voluntary groups and individuals, then it is conceivable that a por-

tion of resources needed to maintain a system of high-seas MPAs could come from a portfolio of well-designed and effective investment vehicles, private endowments, trusts, and donations from stakeholders worldwide. The GEF states it will consider as an operational objective "the Demonstration and Implementation of Innovative Financial Mechanisms." This could involve promoting the development and capitalization of conservation trust funds and facilitating systems of payments for environmental services. Innovative public-sector initiatives and programs, by providing the financial mechanisms and marketing the basic biodiversity characteristics of high seas, could increase the number of people willing to invest in its preservation.

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Tony Prato

Multiple Attribute Evaluation for National Parks and Protected Areas

MANAGERS OF NATIONAL PARKS AND PROTECTED AREAS FACE THE CHALLENGE of evaluating management actions and selecting the preferred one for their units. Examples of this challenge abound. Yellowstone National Park must decide whether or not to allow snowmobiles in the park and the most desirable way to handle bison leaving the park. Banff National Park needs to decide how to allow for human use of the park without sacrificing ecological integrity. Great Smoky Mountains National Park must determine the best way to alleviate adverse impacts of air pollution on visibility and public enjoyment. Such decisions can be viewed in terms of selecting the preferred alternative future for national parks and protected areas. These decisions are not easy because different alternative futures provide different social, economic, and environmental values. This paper describes and critiques three analytical methods for identifying and comparing the preferred alternative future for national parks and protected areas.

Hypothetical Ecosystem

To facilitate understanding, the three methods are described in terms of the fictitious Greater Cimarron Ecosystem (GCE). GCE contains Cimarron National Park, two national forests containing wilderness areas, and several gateway communities. The GCE embodies features and issues common to real greater ecosystems in North America. First, there is a symbiotic relationship between protected areas and gateway communities in the GCE. Visitors to the GCE spend money on lodging, food, meals, gifts, entertainment, and other services in gateway communities. These expenditures support income and employment in those communities. Conversely, the social infrastructure and amenities provided by gateway communities benefit visitors to protected areas in the GCE. Second, environmental amenities attract permanent and seasonal residents to the GCE, which contributes to economic development of private lands and landscape fragmentation. Third, the GCE contains a population of grizzly bear, a threatened species whose home range extends beyond the boundaries of the protected areas. Landscape fragmentation from economic development is not only reducing the quality of habitat for grizzly bear and other species, but also increasing the number of encounters between humans and bears. Such encounters have the potential to harm people and increase bear mortality.

The planning staffs for the protected areas and gateway communities, developers, and environmental groups in the GCE have created the Cimarron Landscape Analysis Group (CLAG). The primary goal of CLAG is to identify the preferred alternative future for the GCE—one that balances the benefits of greater regional income and employment (economic development) with potential impairment to the population of grizzly bear caused by development. CLAG decides to use *alternative futures analysis* to achieve this goal (Baker et al. 2004; Steinitz et al. 1996, 2003). Alternative futures analysis defines future development scenarios for a region in terms of growth in human population and economic activity, and evaluates how those scenarios and alternative policies for residential and commercial zoning, infrastructure (road and utilities) expansion, and conservation of biodiversity influence social, economic, and ecological values. Table 1 describes the reasons and advantages for alternative futures analysis, and gives an example of alternative futures.

Benefit–Cost Analysis

The first method CLAG can use to compare alternative futures is *benefit–cost analysis* (BCA; Prato 1998). This method calculates and compares the net present values (NPVs) of alternative futures. The NPV of an alternative future equals discounted total quantifiable benefits minus discounted total costs, namely:

$$NPV = \sum_{t=0}^{T} B_t (1+r)^{-t} - \sum_{t=0}^{T} C_t (1+r)^{-t},$$

where $B_t (1+r)^{-t}$ is discounted total benefits and

$$\sum_{t=0}^{T} C_t (1+r)^{-t}$$

is discounted total costs of an alternative future in year t, r is the discount rate, and T is the number of years over which alternative futures are evaluated. Discounting is done because receiving a dollar now is preferred to receiving a dollar at a future date. It causes the present value of a dollar of benefits or costs to decrease exponentially over time. If an alternative future has a positive NPV, then it is considered efficient because it increases benefits more than costs. Conversely, an alternative future with a negative NPV is not efficient. The most efficient alternative future is the one having the highest NPV. An efficiency criterion that is closely related to NPV is the benefit–cost ratio (BCR). If $NPV \geq 0$, then $BCR \geq 1$. Conversely, if $NPV < 0$, then $BCR < 1$.

Use of NPV or BCR requires all benefits and costs to be expressed in monetary terms. Certain benefits and costs of alternative futures are naturally expressed in dollar terms, such as total economic output, household income, and expenditures for roads, buildings, water, light, power, and other infrastructure. However, impacts of alternative futures on grizzly bear populations are difficult to express in monetary terms because markets do not exist for valuing the ecological services provided by grizzly bear. A lack of markets implies a lack of market prices, and a lack of market prices means there is no direct way to assign monetary values to grizzly bear. While economists have developed several methods to estimate monetary values for ecological services (Prato 1998), those methods have been criticized for a variety of reasons (Mitchell and Carson 1989; Bishop 1993;

Table 1. Elements of alternative futures analysis (ALFA).

Reasons for ALFA

- It is difficult for planners and stakeholders to foresee the potential ecological and economic consequences of their choices, policies, and plans because no one knows for sure what the future will bring.
- No single vision of the future is likely to be accurate or superior to all others. Therefore, it is useful to consider a set of alternative futures for a region that encompasses a spectrum of possibilities.

Advantages of ALFA

- Allows stakeholders to assess the possible outcomes of alternative assumptions about future growth and development in a region.
- Helps stakeholders identify policies to reduce adverse ecological and economic consequences of future growth and development in a region.
- Permits stakeholders to create and evaluate a variety of futures for a region, and identify the most likely way of achieving them.

*Example of alternative futures**

- *Baseline* — Continuation of current land use zoning and regulations, current population projections, and historical rates of economic growth.
- *High Development* — Maximize short-term economic gain. Assumes low-density housing and substantially higher population and economic growth than the baseline.
- *Moderate Development* — Maximize short-term economic gain subject to environmental restrictions. Assumes moderate housing density and moderately higher population and economic growth than the baseline.
- *Low Conservation* — Moderate protection of ecological functions achieved by restricting development in ecologically sensitive areas and requiring moderate use of conservation practices in agricultural and forest lands. Assumes moderately high housing density and population and economic growth slightly lower than the baseline.
- *High Conservation* — Maximum protection of ecological functions achieved by imposing strong restrictions on development in ecologically sensitive areas and requiring extensive use of conservation practices in agricultural and forest lands. Assumes high-density housing and population and economic growth significantly lower than the baseline.

* Adapted from alternative futures used in Oregon's Willamette River Basin (Baker et al. 2004) and the Upper San Pedro River Basin in Arizona and Sonora (Mexico) (Steinitz et al. 2003).

Perrings 1994; Bjornstad and Kahn 1996; Kahn 1996; Cummings 1996; Cameron 1997; Goulder and Kennedy 1997; Smith 1992; Prato 1999). For example, contingent valuation, which is a non-market valuation method, has been criticized because: (1) it is a single-attribute valuation technique that is poorly suited for evaluating the multifaceted ecological impacts of resource management decisions; (2) asking people to assign monetary values to ecological services has been rejected based on ethical considerations; (3) willingness-to-pay measures used in contingent valuation are likely to be biased by imperfect information on the part of the respondent, embedding of the value of other goods in stated willingness-to-pay values and other response biases (Kahn 1996); and (4) survey respondents tend to express their willingness to pay or willingness to accept compensation for a good or service from the viewpoint of a concerned citizen rather than as a consumer or user of that good or service (Sagoff 1988). In summarizing CV's weaknesses, Kahn (1996) indicates that contingent valuation "is associated with controversy and is far from universally accepted, even among environmental economists." In summary, BCA is not sufficient to identify the preferred alternative future for ecosystems encompassing national parks and protected areas.

Cost-Effectiveness Analysis

The second method available to CLAG is a variant of BCA known as *cost-effectiveness analysis* (CEA). This method is appropriate when the costs of alternative futures are known, but not the benefits. In CEA, the preferred alternative future is the one that minimizes the total cost of achieving a certain management objective, such as protecting grizzly bear. For example, suppose alternative futures are arrayed in ascending order of the cost of protecting grizzly bear habitat, which equals the cost of the habitat protection program plus the opportunity cost. An example of the latter is the potential loss in regional income and employment, if any, from eliminating development in critical habitat areas for grizzly bear.

Figure 1 depicts CEA for habitat protection. The shape of the marginal cost curve implies that the cost of achieving an additional unit of habitat protection increases exponentially with the level of protection. If h* is the level of habitat protection needed to recover the population of grizzly bear, then the preferred alternative based on least cost is the one that has a marginal cost of c*. The minimum total cost of achieving h* is the area under the marginal cost curve between 0 and h*. While CLAG can use CEA to identify the habitat protection plan that minimizes the cost of any level of habitat protection, it cannot use CEA to determine the preferred alternative future.

Multiple Attribute Evaluation

The third method CLAG can use to compare alternative futures is *multiple attribute evaluation* (MAE). This method evaluates and ranks alternative futures based on a set of attributes chosen by CLAG members and their preferences for attributes. MAE has several advantages relative to BCA (Joubert et al. 1997) and CEA. First, MAE does not require ecological services to be expressed in monetary terms. Second, unlike CBA which optimizes on monetary benefits and costs, and CEA, which optimizes on just cost, MAE allows alternatives to be compared in terms of multiple attributes, be they quantitative or qualitative. Third, MAE facilitates public partic-

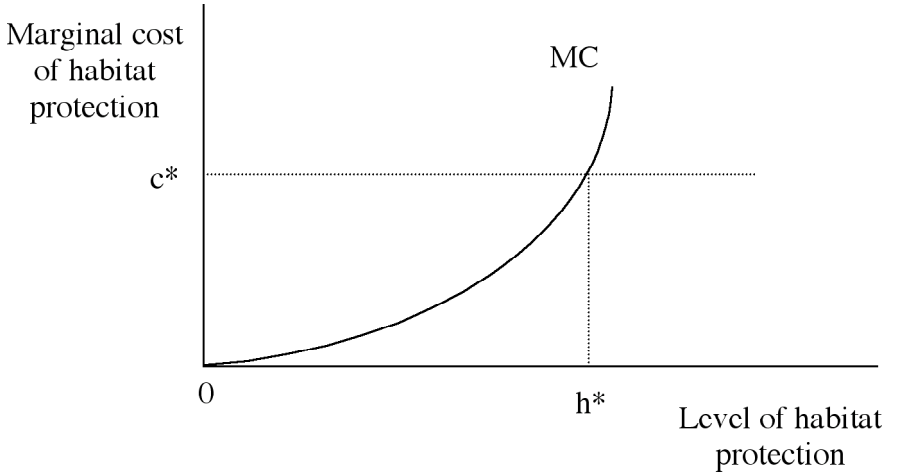

Figure 1. Cost-effective level of habitat protection.

ipation and is well suited for collaborative decision-making (Yaffee and Wondolleck 1997) and scientific assessments (Johnson 1997).

Applying MAE involves five steps: (1) selecting and measuring attributes for alternative futures, (2) determining efficient futures, (3) eliminating unsustainable futures, (4) determining members' preferences for attributes, and (5) ranking alternative futures and resolving conflicts (Prato 1999). Each of these steps is discussed below in the context of the goal of CLAG.

Selecting and measuring attributes. In order to use MAE, CLAG would need to select the multiple attributes of alternative futures. Attributes are typically defined in terms of the potential social, economic, and ecological impacts of alternative futures. Graphical analysis is used to explain how attributes are measured. The graphical analysis uses two attributes because two-dimensional graphs are relatively easy to understand. While MAE can handle any number of attributes, most individuals find it difficult to deal with more than seven attributes.

The two attributes of alternative futures used in the graphical analysis are total economic output, or total output (TO) for short, and habitat conditions (HC) for grizzly bear. TO equals the estimated total final value of economic goods and services produced in the GCE in an alternative future. It is like gross national product, except for an ecosystem instead of the nation. TO for an alternative future can be estimated using IMPLAN. IMPLAN is a menu-driven computer software program that predicts changes in total economic output, household income, and employment in up to 528 economic sectors (Lindall and Olson 1993). To estimate TO for an alternative future, CLAG needs to specify final expenditures in all economic sectors of the GCE for each future time period of interest. HC for grizzly bear can be assessed in terms of the loss or degradation in grizzly bear habitat associated with alternative futures. In particular, CLAG can use a landscape

model to assess the probable landscape fragmentation caused by future economic development and the likely impact of that fragmentation on HC for grizzly bears. TO is measured in dollars and HC by an index that takes on values between 0 and 100, where 0 represents extremely poor habitat and 100 represents excellent habitat for grizzly bear.

Determining efficient alternative futures. The preferred alternative future selected by CLAG must be efficient in terms of the two attributes. Efficient alternative futures can be determined graphically by plotting combinations of TO and HC, as illustrated in Figure 2. The figure illustrates seven alternative futures (F_1, F_2, F_3, F_4, F_5, F_6, and F_7). Each future provides a particular combination of TO and HC. For example, F_2 provides TO_2 and HC_2. Efficient futures provide combinations of TO and HC on the trade-off curve. For all futures on the trade-off curve, achieving more TO (HC) entails receiving less HC (TO). The trade-off curve shows F_2 and F_7 are inefficient futures because they provide less TO and/or HC than F_1, F_3, F_4, F_5, and F_6, which are on the trade-off curve. In other words, F_2 and F_7 are dominated by F_1, F_3, F_4, F_5, and F_6. It is not possible to achieve a combination of TO and HC above the trade-off curve. The trade-off curve can change shape and position over time.

Eliminating unsustainable futures.

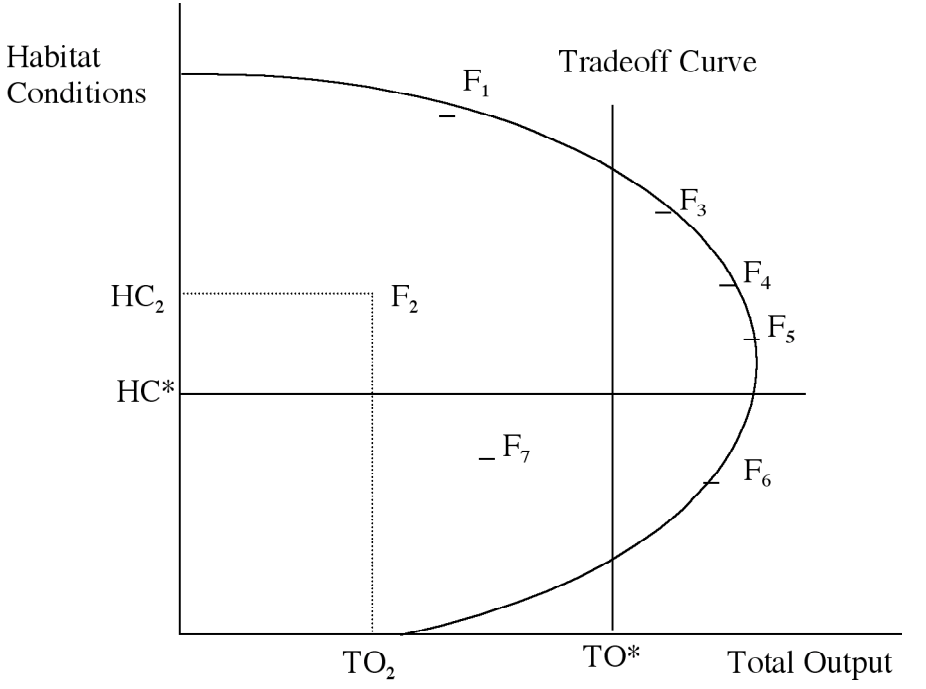

Figure 2. Trade-off curve between habitat conditions (HC) and total output (TO).

Just because an alternative future is biologically and institutionally feasible and efficient does not make it sustainable. In the next step, CLAG eliminates futures that are not sustainable. The strong sustainability criterion is used for this purpose (Pearce et al. 1990; Prato 2000). An alternative future is strongly sustainable if it provides amounts of TO and HC greater than a certain value, namely: TO $\geq$ TO* and HC $\geq$ HC*. CLAG determines TO* and HC* using one of several approaches. In a consensus-based approach, CLAG members reach agreement on TO* and HC* through discussion and compromise. In majority-based decision-making, CLAG members vote on TO* and HC*. In both cases, scientific knowledge about sustainable values of TO and HC should be considered.

Requiring alternative futures to be strongly sustainable influences the selection of a preferred alternative future as illustrated in Figure 2. All alternative futures providing amounts of TO less than TO* and amounts of HC less than HC* are not strongly sustainable. For the values of TO* and HC* illustrated in Figure 2, F_1 is not strongly sustainable because it provides an amount of TO less than TO*. Similarly, F_7 is not strongly sustainable because it provides an amount of HC less than HC*. Therefore, of the seven futures, only F_3, F_4, and F_5 are efficient and sustainable.

Determining members' preferences for attributes. Selection of the preferred efficient and sustainable future is based on members' preferences for TO and HC. If CLAG members have similar preferences for TO and HC, their rankings of futures are likely to be similar. In this case, selecting the preferred future is relatively easy. However, if, as is likely to be the case, CLAG members have dissimilar preferences for TO and HC, then members' rankings of futures are likely to be different. Different preferences for attributes do not necessarily imply a different ranking of futures. Accounting for members' preferences for TO and HC involves two issues. First, what are an individual member's preferences for attributes and ranking of futures? Second, if members have different rankings of alternative futures, then how can those differences (or conflicts) be reconciled? Since graphical analysis is too complicated when there are several members and multiple attributes, preferences are explained mathematically.

Consider the following general mathematical explanation of how to rank alternative futures. Suppose alternative futures are ranked in terms of J socioeconomic attributes ($e_1,\ldots,e_J$) and K environmental attributes ($g_1,\ldots,g_K$). Examples of socioeconomic attributes are total output, total household income, and employment. Examples of environmental attributes are biodiversity, soil conservation, and water quality. Each CLAG member is expected to have unique preferences for attributes that can be represented by the following general utility function:

$$U_i(F_m) = U_k(e_{1m},\ldots,e_{Jm}; g_{1m},\ldots,g_{Km}).$$

This function indicates that the total satisfaction or utility that future F_m provides to the i^{th} member, namely $U_i(F_m)$, depends on the amounts of socioeconomic attributes, $e_{1m},\ldots,e_{Jm}$, and ecological attributes, $g_{1m},\ldots,g_{Km}$, provided by F_m.

In order to rank futures for a member based on the utility function, it is necessary to specify its mathematical form. While there is limited theoretical justification for

selecting a particular mathematical form, the additive form has been widely used due to its simplicity and relevance to real world problems (Keeney and Raiffa 1976; Yakowitz et al. 1993; Foltz et al. 1995; Tecle et al. 1995; Prato and Hajkowicz 1999). The mathematical form of the additive utility function is:

$$U_i(F_m) = \sum_{j=1}^{J} w_{ij}\, e^*_{jm} + \sum_{k=1}^{K} w_{ik}\, g^*_{km}.$$

The term e^*_{jm} is the value of the j^{th} standardized socioeconomic attribute and g^*_{km} is the value of the k^{th} standardized ecological attribute provided by F_m, w_{ij} is the i^{th} member's weight for the j^{th} socioeconomic attribute, and w_{ik} is the i^{th} member's weight for the k^{th} ecological attribute. Each attribute weight is non-negative ($w_{ij} \geq 0$ and $w_{ik} \geq 0$) and weights sum to one :

$$\left(\sum_{j=1}^{J} w_{ij} + \sum_{k=1}^{K} w_{ik} = 1\right).$$

Attribute values are standardized using the following formula to avoid biases in the utility scores that could arise from differences in the measurement units for raw attributes, e.g., TO is measured in dollars and HC in terms of an index. A common standardization formula is:

$s_{im} = (x_{im} - \min x_{im})/\max x_{im} - \min x_{im})$ for positive attributes

$s_{im} = (\max x_{im} - x_{im})/\min x_{im} - \max x_{im})$ for negative attributes

The term x_{im} is the raw value of the i^{th} attribute provided by F_m, $\min x_{im}$ is the minimum value of the i^{th} attribute for F_m, and $\max x_{im}$ is the maximum value of the i^{th} attribute for F_m. TO is an example of a positive attribute and loss of biodiversity is an example of a negative attribute.

While the additive utility function is relatively easy to apply, it is imposes strong restrictions on members' preferences for attributes. In particular, it assumes that each CLAG member is risk neutral and attributes are mutually independent. Risk neutrality implies that additional units of an attribute result in the same (constant) increment in utility. When attributes are mutually independent, the utility provided by an attribute depends only on the amount of that attribute, not on the amounts of other attributes.

Attribute weights for each CLAG member can be estimated using fixed-point scoring, paired comparisons (Saaty 1987), or judgment analysis (Cooksey 1996). Fixed-point scoring requires a member to allocate 100 percentage points among the attributes, and sets each attribute weight equal to the percentage points assigned to that attribute. Fixed-point scoring forces a member to consider trade-offs among attributes because it is not possible to assign a higher weight to one attribute without reducing the weight assigned to one or more of the other attributes. The paired comparisons method uses the Analytic Hierarchy Process (AHP) to derive quantitative weights for attributes. AHP requires each member to score on a scale of 0 to 9 the extent to which one attribute is more, less, or equally important relative to another attribute. In judgment analysis, a member is given the values of attributes for all alternative futures and asked to score those futures on a scale of 1 to 100. Attribute weights are estimated by regressing the scores for futures on their attribute values.

Other MAE methods used to compare alternative futures include the surrogate worth trade-off method (Haimes and Hall 1974, 1977), free iterative search (Tecle et al. 1994), the aspiration–reservation-based decision support system (Makowski 1994; Fischer et al. 1996), and the balancing and ranking method (Strassert and Prato 2002).

Ranking alternative futures and resolving conflicts. Utility scores for alternative futures are calculated by substituting the attribute values for sustainable and efficient alternative futures and a member's weights for attributes into the utility function given earlier. Alternative futures are then ranked from highest to lowest based on their utility scores. The preferred future for a member is the one with the highest utility score. While attribute values for an alternative future are the same for all members of CLAG, attributes weights are likely to differ among members. This can cause different members to have different rankings of futures.

The following empirical example demonstrates how alternative futures are ranked with the additive utility function. To simplify the calculations, the example uses three attributes (TO, HC, and water quality, or WQ), three CLAG members (A, B, and C), and three management actions (F_I, F_{II}, and F_{III}). TO and HC are the same attributes as used in the graphical analysis. F_I, F_{II}, and F_{III} are efficient and sustainable futures.

Hypothetical standardized values of TO, HC, and WQ for F_I, F_{II}, and F_{III} are in the top left portion of Table 2, and attribute weights for TO, HC, and WQ for members A, B, and C are in the top right portion. Standardized attribute values indicate that F_I provides considerably more TO than HC or WQ. It is referred to as the "high development future." F_{II} provides similar amounts of the three attributes. It is called the "neutral future." F_{III} provides more HC than TO and WQ. It is designated as the "conservation future." Since attributes weights for A strongly favor TO relative to HC and WQ, this member is called a "developer." B favors WQ relative to TO and HC and is designated as a "fisher." C assigns a substantially higher weight to HC than TO and a moderately higher weight to HC than WQ. C is called a "conservationist."

Utility scores for the three futures and members are in the bottom left portion of Table 2. Scores are derived using the formula for the additive utility function described in the previous section. In this case, the developer's preference ordering is $F_I > F_{II} > F_{III}$, where > means "is preferred to." The fisher's preference ordering is F_{III} F_{II}, $F_{III} > F_I$, and $F_{II} > F_I$, where means "is equally preferred." The conservationist's preference ordering is $F_{III} > F_{II} > F_I$. Hence, the developer and conservationist have opposite preferences, and the fisher and conservationist have similar preferences for the three futures. If CLAG made decisions based on majority rule, then the group would choose F_{III} as the preferred future. Since the fisher is indifferent between F_{II} and F_{III}, the fisher would not object to choosing F_{III} over F_{II}.

Conflicts in preferences are likely to be greater when there are numerous futures and members. There are several ways that CLAG can resolve conflicts in members' preferences for alternative futures. First, consensus-based decision-making could be used to reach agreement on a compromise set of weights for attributes. In this case, utility scores and rankings of alternative futures are determined using the compro-

Attribute	Management Action			Attribute Weights		
	F_I	F_{II}	F_{III}	Member		
	Attribute Values			A	B	C
TO	0.7	0.5	0.3	0.7	0.2	0.1
HC	0.2	0.4	0.7	0.2	0.3	0.6
WQ	0.3	0.6	0.5	0.1	0.5	0.3
Member	Utility Scores					
A	0.56	0.49	0.4			
B	0.35	0.52	0.52			
C	0.28	0.47	0.6			

Table 2. Hypothetical standardized values of attributes and weights, and utility scores.

mise set of weights. The preferred future is the one with the highest utility score.

Second, consensus-based decision-making could be applied directly to the rankings of futures. In this approach, each member determines his or her own ranking of alternative futures and a nominal group technique is used to develop a consensus ranking of futures. A nominal group technique involves facilitated responses, voting, and discussion (Meffe et al. 2002). A consensus-based approach is more likely to succeed when CLAG has relatively few members with similar preferences for attributes, and more likely to fail when CLAG has several members with diverse preferences for attributes. While not based on MAE, a citizen's advisory committee used a consensus-based approach in reaching agreement on its preferred alternative for reconstruction of the Going-to-the-Sun highway in Glacier National Park (National Park Service 2002).

Third, CLAG can vote on attribute weights or alternative futures. If voting is used, then the weights receiving the most votes are used to calculate utility scores and the resulting scores used to rank futures. The preferred future is the one with the highest rank. Alternatively, members could vote directly for alternative futures. The preferred future is the one receiving a majority of the votes. A problem with both voting approaches is selecting the weights or alternative futures to include on the ballot. In addition, if each member of CLAG has one vote and there are a disproportionate number of members from one interest group, then ballot results would be biased toward that interest group. Voting has a lower transaction cost than consensus-based approaches, especially when there are numerous stakeholders and futures. In this context, "transaction cost" refers to the cost of reaching agreement on the preferred future.

Fourth, CLAG could use the analytical hierarchy process "to develop compromises between competing interests by pointing out areas of agreement, helping to isolate the areas of conflict, and illustrating the trade-offs between different options" (Kangas 1994).

Limitations of MAE

MAE has certain limitations. First, it is a static analysis. In most applications of MAE, the efficient and sustainable futures

depend on the shape and position of the trade-off curve, and the minimum acceptable levels of attributes needed to ensure sustainability. The trade-off curve is likely to change over time in response to improvements in technology and scientific knowledge, and changes in natural and cultural resource conditions. The ranking of futures depends on the preferences for attributes, which are likely to change over time in response to changes in income, education, and attitudes toward economic development and ecological services. For these reasons, a MAE evaluation should be updated periodically.

Second, due to the complexity of economic and ecological systems, planning groups such as CLAG are not likely to know with certainty the combinations of attributes provided by alternative futures. In other words, there is not a one-to-one correspondence between alternative futures and attributes, as is implied by Figure 2. The same alternative future can result in more than one combination of attributes, which complicates the evaluation and ranking of alternative futures. One way to deal with this type of uncertainty is to evaluate alternative futures using fuzzy set theory and fuzzy logic (Klir and Yuan 1995).

Third, determining a member's (or stakeholder's) preferences for attributes is not a simple matter. Several kinds of biases can occur when individuals are asked questions, the responses to which are used to determine preferences for attributes. For example, strategic bias occurs when an environment-oriented person intentionally overstates the weights for environmental attributes, such as HC and WQ, in order to increase the ranking of futures that provide greater environmental protection. Conversely, a development-oriented person might overstate the weight for economic attributes, such as TO, in hopes of increasing the ranking of futures that favor economic development.

Conclusions

Several methods are available to determine the preferred alternative future for national parks and protected areas. BCA compares alternative futures in terms of their NPVs, which is the difference between discounted total benefits and discounted total costs for a future. The preferred alternative future is the one with the highest NPV. A limitation of BCA is that it cannot account for benefits and costs not measured in monetary terms. This is a significant limitation for national parks and protected areas that provide ecological services, such as habitat for grizzly bear and other species. Methods for estimating monetary values for ecological services, such as travel cost, hedonic pricing, and contingent valuation, would allow incorporation of ecological services in BCA, but have several deficiencies. CEA does not require monetizing benefits for ecological services. It selects the alternative future that minimizes the cost of achieving a particular management objective, such as protection of biological diversity. Unfortunately, CEA is based on a single cost criterion.

Advantages of MAE are that it does not require that the ecological services provided by national parks and protected areas be expressed in monetary terms, allowing alternatives to be compared in terms of multiple attributes. In addition, MAE facilitates public participation and is well suited for collaborative decision-making. Application of MAE entails five steps: (1) selecting and measuring attributes for alternative futures, (2) determining efficient alternative futures,

(3) eliminating unsustainable futures, (4) determining members' preferences for attributes, and (5) ranking alternative futures and resolving conflicts in rankings of alternative futures.

Limitations of MAE are that: (1) results need to be periodically updated to account for changes over time in the trade-offs between attributes, and members' preferences for attributes; (2) it does not account for variability or uncertainty in the combination of attributes provided by alternative futures; and (3) it requires determining members' preferences for attributes (attribute weights), which is complex and subject to bias. The advantages of MAE appear to outweigh the disadvantages. Accordingly, national park and protected area managers should consider using MAE to evaluate and rank alternative futures for their areas.

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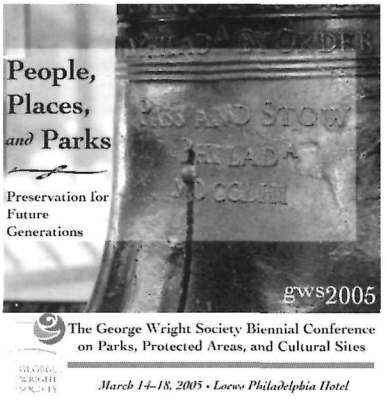

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