National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
Water Resources Division

Water Resources Division
SUMMARY OF FISCAL YEAR 2011 ACCOMPLISHMENTS

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Natural Resource Stewardship and Science
Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80525

www.nature.nps.gov/water

Cover: Parks Climate Challenge participants snorkel on Ross Lake to conduct a fish survey, North Cascades National Park Complex (Washington). NORTH CASCADES INSTITUTE/BENJ DRUMMOND

If there is magic on this planet,
it is contained in water.
Loren Eiseley

Snowy Egret at Cape Hatteras National Seashore (North Carolina). NPS/PAUL DOSHKOV

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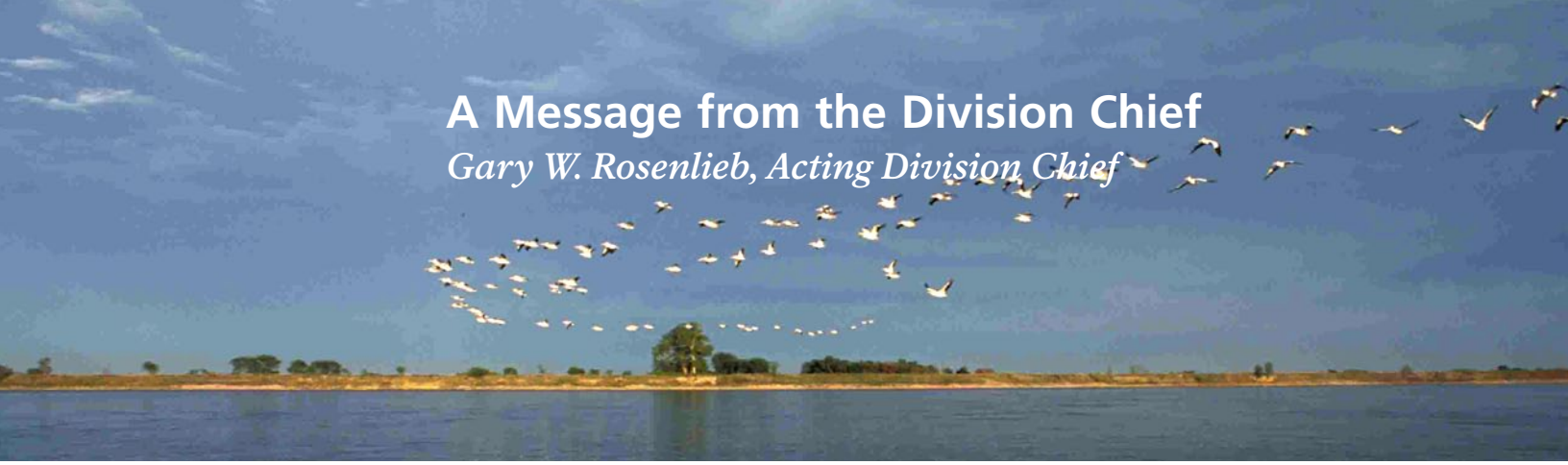
The Water Resources Division (WRD) is one of eight divisions that make up the NPS Natural Resource Stewardship and Science Directorate and was established to provide servicewide program management and specialized advice and assistance to parks in the protection and management of natural resources.

The mission of WRD is to provide leadership and senior-level technical, scientific, policy, and resource management expertise in the protection, preservation, and restoration of water resources and water-dependent environments within the National Park System. WRD provides its services directly to parks through a broad range of programs in the areas of hydrology, water quality, wetlands, fisheries, marine resources, water rights, information management, watershed condition assessments, and planning.

The primary focus of WRD is, as it always has been, to provide the highest level of support possible to parks in addressing their water and aquatic resource-related issues.

Researchers at Ozark National Scenic Riverways (Missouri). NPS COLLECTION



A Message from the Division Chief

Gary W. Rosenlieb, Acting Division Chief

American white pelicans, Missouri National Recreational River (Nebraska). NPS COLLECTION

THIS REPORT PROVIDES A SUMMARY of the accomplishments and an accounting of the budget for the Water Resources Division (WRD) of the National Park Service in Fiscal Year (FY) 2011. As you review the reports that have been contributed by the WRD staff, I believe you will see that we have endeavored to provide the highest level of support to park units on wide variety of water and aquatic resources–related issues.

In 2011 WRD continued to provide management and support for the water resources component of the Natural Resource Challenge. Water quality monitoring was supported in 32 networks; Natural Resource Condition Assessments were completed in 19 parks; fifteen aquatic resources professionals were funded with a vacant position filled in the National Capital Region; and the Water Rights Branch supported the protection of park water rights at many parks.

The Ocean and Coastal Resources Branch is in its second operating year and continued implementing the Ocean Park Stewardship Action Plan. In 2011 the branch completed and published Reference Manual 39-1, NPS Ocean and Coastal Park Jurisdiction Handbook; completed benthic habitat maps for two parks; and provided support for the Deepwater Horizon Oil Spill Natural Resource Damage Assessment by co-chairing the Vegetation Technical Working Group for the Deepwater Horizon oil spill.

High-profile restoration projects were the focus of WRD's hydrologists and wetland scientists. After almost 20 years of planning and environmental studies, the physical restoration of the Elwha River in Olympic National Park started in 2011 with the beginning of the removal of the Elwha and Glines Canyon dams. In another project, the result of eight years of hard work by the wetlands staffs of WRD and Channel Islands National Park was realized when the restoration of Prisoners Harbor began in late 2011.

WRD continued to provide high-visibility assistance to the Department of the Interior's renewable and fossil energy initiatives. In conjunction with staffs of the Inventory and Monitoring Program, regions, and parks, WRD continued to support NPS efforts to identify protected areas for the Bureau of Land Management's Supplement to the Draft Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States. The NPS relied on best-available geospatial information for viewsheds, night skies, wetlands, sensitive soils, watersheds, and critical habitat to identify where high potential for resource conflicts might occur with proposed solar energy development near parks in the six-state study area.

With the Geologic Resources Division, WRD continued to track the numerous areas of high geologic potential for shale gas development, also known as shale gas *plays*, throughout the country and in particular

Mabry Mill in autumn, Blue Ridge Parkway (North Carolina, Virginia). NPS/JIM EVANS

the expansive Marcellus Shale gas play surrounding Delaware Water Gap National Recreation Area and other parks in the Northeast Region.

WRD continued to support numerous Colorado River issues in 2011. WRD remained active in the Glen Canyon Adaptive Management. The Water Rights Branch completed the draft Arches Water Rights Agreement and provided technical assistance to Dinosaur National Monument and the Intermountain Region to assess the 2011 high flows on the Yampa and Green rivers. WRD continued to provide leadership for the NPS Wild and Scenic Rivers Program by completing the Interagency Wild and Scenic Rivers Coordinating Council's Section 7 flowchart.

The latter part of 2011 brought the implementation of a new organizational structure that will realign WRD beginning in FY 2012 to better address emerging issues in renewable energy, climate change water shortages, and aquatic invasive species. The restructuring established an Aquatic Systems Branch which combines functions of the former Water Operations Branch (floodplain and groundwater management and water quality) with the wetlands, fisheries, and aquatic invasive species functions that were formerly managed in the Planning and Evaluation Branch. The Planning and Evaluation Branch has been reformed as the Planning and Information Branch (PIB) and will receive two programs from the former Water Operations Branch: the Data and Information Management Program and the Natural Resource Condition Assessment Program. PIB will provide assistance for water resource management planning, climate change scenario planning, and resource stewardship strategy planning. The Water Rights Branch and the Ocean and Coastal Resources Branch will largely retain their existing missions and functions.

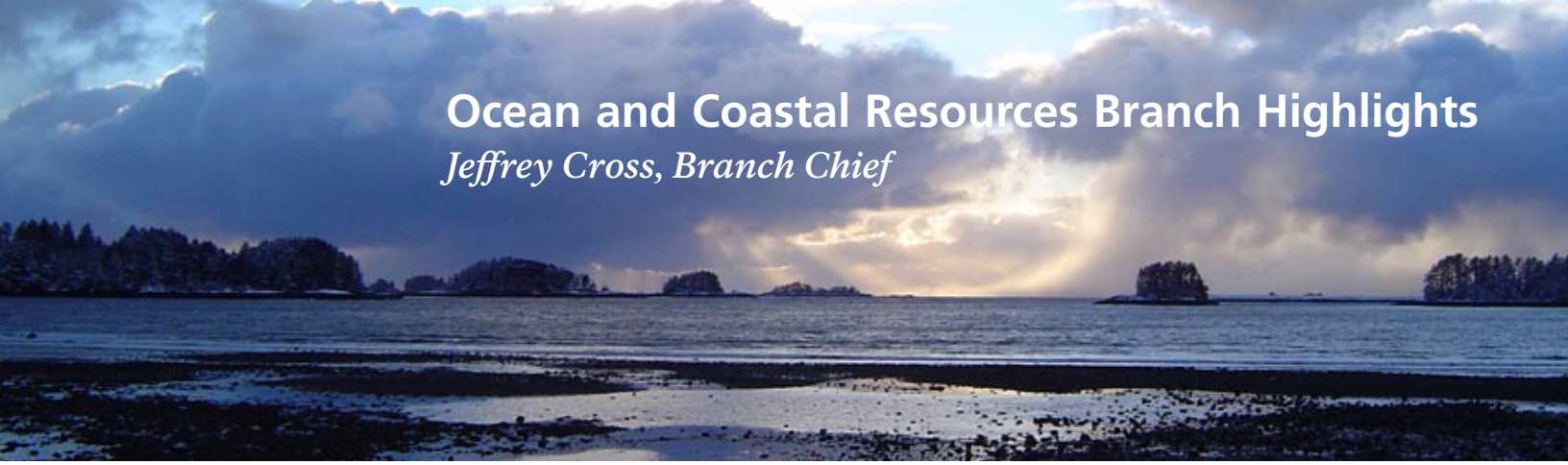
Finally, 2011 saw the retirement of three key WRD personnel. Dr. Bill Jackson retired from the National Park Service on 1 October 2011 following a 31-year federal career that included 22 years with the National Park Service Water Resources Division, nearly five of those as the chief of the Water Resources Divisions. Bill had substantive roles in establishing servicewide programs in water quality protection and ocean and coastal resources stewardship. He provided leadership to the implementation of elements of the NPS Natural Resource Challenge, including servicewide water quality monitoring, the establishment of the field-based aquatic resource professionals program, implementation of the servicewide natural resource condition assessments, and the establishment of the servicewide Ocean and Coastal Resources Branch. Also retired in 2011 are Sharon Kliwinski, who has been referred to by many as the moral compass for the Natural Resource Stewardship and Science directorate and served as the WRD liaison since 1992, and Dr. Roy Irwin, senior contaminants specialist for the NPS. Sharon retired in March 2011. Roy retired on 31 December 2011. We thank them all for their service.

I am pleased with the accomplishments of WRD this past year. It is indicative of the professionalism of WRD and the ability of our staff to work with management and staff in parks, regions, and the Washington Office to address water resources issues at every level of the organization. I can speak for all of our WRD staff in saying that we enjoy working with the parks on any water resources management issue, and I am extremely proud to provide leadership, if only for a short time, for a dedicated and meticulous group of professionals.

The harvest that comes from well-directed and thorough scientific research has no fleeting value, but abides through the years, as the greatest agency for the welfare of mankind.

John Wesley Powell

Heidi Kristenson, Yukon–Charley hydrologic technician, enters field data on the edge of a lake in Kobuk Valley National Park (Alaska). NPS/ERIC SIEH



Ocean and Coastal Resources Branch Highlights

Jeffrey Cross, Branch Chief

Sitka Sound from the visitor center at Sitka National Historical Park (Alaska). NPS/CLARENCE WADKINS

THE OCEAN AND COASTAL RESOURCES Branch (OCRB) is responsible for leadership and coordination of NPS ocean responsibilities, policies, and interests in the Natural Resource Stewardship and Science (NRSS) directorate. The goals of the branch are to acquire broad-based support in ocean and coastal sciences and technologies, develop servicewide ocean policies and programs, and provide technical assistance and support to parks.

The NPS 2006 Ocean Park Stewardship Action Plan called for increasing the organizational and scientific emphasis to manage 11,200 miles (18,021 km) of coast and 2,490,000 acres (1,007,703 ha) of ocean and Great Lakes waters across 22 states and four territories. OCRB provides organizational structure and focus for coordination within the NRSS and with parks, regional offices, the Submerged Resources Center, and other entities to meet servicewide goals for ocean and coastal resources stewardship.

The branch provides leadership in developing short- and long-term strategies for enhancing NPS scientific, technical, and organizational capacity for ocean and coastal resources stewardship. The branch works closely with the Geologic Resources, Biological Resources Management, and Environmental Quality divisions on critical park science and management needs. The branch also works closely with the National Oceanic and Atmospheric Administration, USGS, EPA, other federal and state agencies, universities, and private partners to further the goals of ocean and coastal stewardship.

During FY 2011 OCRB staff provided a variety of servicewide and park-specific technical assistance, coordinated multiple Coastal Watershed Assessment and Benthic Habitat Mapping Program projects in parks, and provided policy guidance and support to parks and regions. Significant accomplishments under the Ocean Park Stewardship Action Plan include participation on the Department of the Interior's Senior Ocean Policy Team which contributed to the development of the Administration's National Ocean Policy; publication of the jurisdiction handbook for ocean and coastal parks; and participation in the response to the Deepwater Horizon Oil Spill.

Sheephead and diver, Channel Islands National Park (California). CALIFORNIA DEPARTMENT OF FISH AND GAME

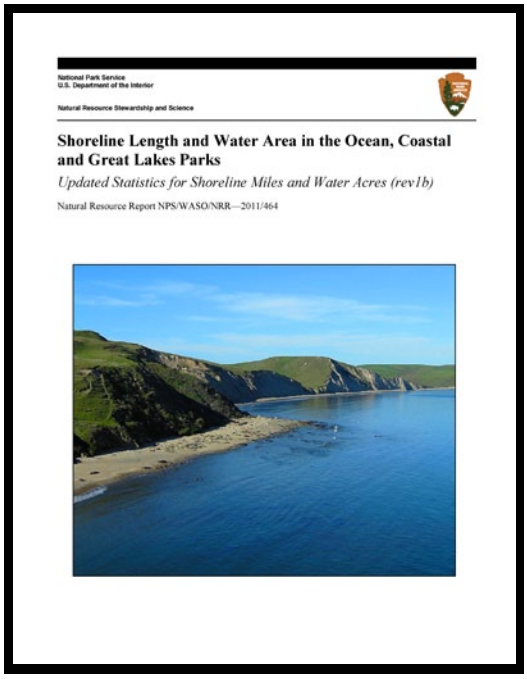
OCRB Projects
www.nature.nps.gov/water/oceans.cfm

Coastal Watershed Assessments
www.nature.nps.gov/water/nrca/coastalreports.cfm

Estimating Shoreline Length and Water Area in Ocean, Coastal, and Great Lakes Parks

Thom Curdts, GIS and Remote Sensing Specialist

WIDELY DIFFERING STATISTICS HAVE been published for total shoreline length and water surface area in ocean and coastal parks. The low-end estimate of shoreline length, and perhaps the most frequently quoted figure, is 5,100 miles (8,206 km). Other estimates put the figure for National Park Service shoreline length over 15,000 miles (24,135 km). Estimates for water surface area range from 2.4 to 3.2 million acres (.97 to 1.3 million ha). The discrepancies are due to multiple factors, including the scale, methodology, accuracy, and timeframe of the source data as well as the specific parks included in an analysis.



Report cover with photo of Drakes Bay, Point Reyes National Seashore (California). https://irma.nps.gov/App/Reference/Profile/2170770

In 2010 the Ocean and Coastal Resources Branch began to address these inconsistencies. A clearly defined, well-documented, and repeatable methodology was developed to estimate cumulative shoreline length and water area in marine, estuarine, and Great Lakes park units using a geographic information system (GIS). Many shoreline data sets from a variety of sources were examined park-by-park to identify the ones that most accurately reflected the shoreline as depicted in recent aerial or satellite imagery. Shoreline data included several National Oceanic and Atmospheric Administration (NOAA) data sets, USGS's National Hydrography Dataset, and NPS boundary files. For most parks, reference imagery was obtained from the Esri, Inc., image service.

Due to the dynamic nature of park shorelines and boundaries and the timing and methods of data collection, there will never be a definitive, static set of statistics for NPS shoreline miles and water area. However, this project developed an updated shoreline data set for ocean, coastal, and Great Lakes units; documented the methods; and published the results in an NRSS report. The report and resulting geospatial data sets are available on the Integrated Resource Management Applications (IRMA) Data Store. Statistics for shoreline length and water area will be updated periodically as NPS boundary and shoreline data sets are updated or improved and as resources permit.

A New Digital Shoreline for Alaska Coastal Parks

Joel Cusick, Cartographic Specialist, Alaska Regional Office

THE NEED FOR ACCURATE DATA AND its synthesis drives much of the work of the Water Resource Division. In FY 2011 WRD funded a project that will provide much-needed shoreline information for five Alaska coastal parks. The digital shoreline project is replacing inaccurate and poorly documented digital coastlines in the National Hydrographic Dataset (NHD) with best available tidal-datum–based shorelines from the NOAA Office of Coast Survey. The pilot phase of the project began in FY 2010 and included data acquisition and protocol development that defined data source preferences and metadata. The Alaska Regional Office worked with GeoSpatial Services of Saint Mary's University of Minnesota (SMUMN) through FY 2011 to place 95% of the approximately 2,000 kilometers (1,243 mi) of new shoreline data into NHD "edit-ready" status. The data can then be integrated into NHD final form.

The NHD shorelines for some remote parks cannot be replaced until NOAA acquires newer and higher quality data. At this time, four of the five parks are in NHD edit-ready status: Aniakchak NM&P, Lake Clark NP&P, Kenai Fjords NP, and Cape Krusenstern NM. Bering Land Bridge NP has approximately 20% of its shoreline in the final verification process. About 186 kilometers (116 mi) of estimated mean high water shoreline at Bering Land Bridge was digitized by a SMUMN staff photo interpreter. The digitizing effort was not anticipated, but due to recent imagery and small localized tidal ranges, the process was a valuable addition to the project. All NHD updates will meet Federal Geographic Data Committee metadata standards for feature level source citations and processes. The USGS will complete GeoEdit tools in early 2012, which will allow the new Alaska park shoreline data to be integrated into NHD.

The differences between old and new mapped shorelines are quite dramatic. For example, marine and marine-influenced vector data for Lake Clark National Park & Preserve increased in length by over 88% in areas of overlapping data sets. The project also discovered greater than 100 meters (328 ft) differences between marine charted shorelines and GPS confirmed shorelines. The NHD shoreline (blue) is a USGS high water line based on 1950s data. The 1986 NOAA shoreline (red) was derived from field surveys. NPS/JOEL CUSICK

Benthic Habitat Mapping at Point Reyes National Seashore

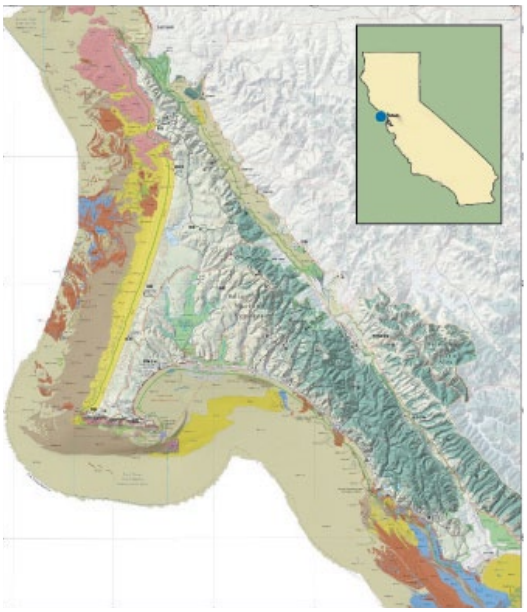
Thom Curdts, GIS and Remote Sensing Specialist

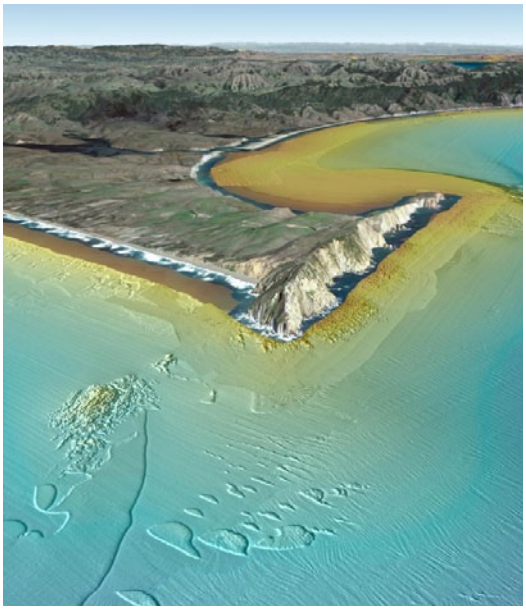
THE OBJECTIVES OF THE BENTHIC Habitat Mapping Project at Point Reyes National Seashore (California) were to compile available regional seafloor mapping data, interpret newly collected data, and construct benthic habitat and geologic maps of the seashore's submerged lands. The habitat maps were constructed using the habitat classification scheme and mapping code used by the California State Mapping Program and used for benthic habitat maps of Golden Gate National Recreational Area. The classification scheme uses a coding system to distinguish benthic habitats based on surface geology.

Six map sheets (1:48,000) and one perspective view sheet of specific areas of interest were constructed for Point Reyes. They depict bathymetry, geology, and benthic habitats. Thirty-nine benthic habitat types covering 429 square kilometers (166 mi^2) were defined from the interpreted data; 11 are located in estuaries and 28 on the continental shelf. Of the habitat types mapped on the continental shelf, 80% are unconsolidated sediment (greens, yellow-greens, khakis, and light browns on the map below); 16% are hard substrate (deep pink and browns); and 4% are a mixture of hard and soft substrates (blues and violets). In the estuaries, 99.7% of the habitat is soft, unconsolidated sediment and 0.3% is hard substrate.

The seashore's submerged lands are a diverse and dynamic environment. The region is relatively unaffected by urban and industrial activity and inputs—with the exception of past and declining agricultural activities. The maps show two rock seafloor exposures on the continental shelf with textural complexity (rugosity) that provides suitable habitat for rockfish and lingcod. Granitic rocks are the predominant hard substrate along the southern margin of Point Reyes Headlands. These exposed rocks extend offshore of the eastern point of the headland where they are kept clean of sediments by strong bottom currents sweeping past the point into Drakes Bay. This area is also a promising location for rockfish and lingcod.

This work is the most comprehensive, deep-water benthic habitat interpretation to date of Point Reyes submerged lands and the continental shelf. The maps create a good foundation for future ecologic, geologic, and oceanographic studies.





Near right: Map sheet, Point Reyes National Seashore (California). H. GARY GREENE

Far right: 3-D Point Reyes bathymetry shows mobile sand bedforms and dunes that are swept by bottom currents around Point Reyes Headlands (Drakes Bay in the background). The bedrock outcrop on seafloor is an extension of the headlands. The striations on the seafloor are artifacts from the roll of the survey vessel. MOSS LANDING MARINE LABORATORIES CENTER FOR HABITAT STUDIES

Marine Recreational Fisheries of Fire Island National Seashore

Karl Brookins, Marine Fisheries Scientist

NUMEROUS SPECIES OF FISH HAVE been recorded in the waters around Fire Island National Seashore (New York), and sport fishing is a popular activity among seashore visitors. Fire Island finfish (true fish, unlike shellfish or jellyfish) include transients like striped bass, menhaden, eels, and weakfish, and fish that use Fire Island as nursery grounds and as adults, such as summer flounder (fluke), winter flounder, and tautog. The rich ecological value of Fire Island fish habitat likely exceeds its proportional contribution to coastline (Conover, Cerrato, and Wise 2005).

Recreational finfish fisheries occurring around the seashore were determined using 2007–2009 angler interview data from NOAA's Marine Recreational Information Program (MRIP) (NOAA 2011). Most interviews occurred at boat ramps near—but outside—the boundaries of the national seashore; interviews were conducted at one location within the seashore. Atlantic States Marine Fisheries Commission (ASMFC) stock assessments were reviewed to determine the status of each species.

Three hook-and-line fisheries were identified: (1) ocean striped bass and bluefish shore fishery west of Fire Island; (2) bay shore fishery for bluefish, striped bass, and summer flounder in eastern Fire Island; and (3) inland vessel-based fisheries, including private and party boats. Anglers caught striped bass, summer flounder, bluefish, winter flounder, tautog, menhaden, scup, weakfish, black sea bass, herring, harlequin bass, and skates.

The frequency of recent MRIP sampling within the seashore is inadequate to monitor, assess, and manage Fire Island fisheries. Sampling at marinas adjacent to the seashore is also inadequate due to limited inland sampling and the inability to distinguish fishing inside the seashore boundary from fishing that takes place outside.

The ASMFC identifies weakfish as depleted, winter flounder as overfished, and tautog as overfished with overfishing occurring. Bluefish, black sea bass, striped bass, and summer flounder are rebuilt to optimum harvest levels, although older age classes may not have had time to recover.

WRD analysis of MRIP data supports: (1) discussions with party, charter, rental, and private boat operators about documenting fishing location; (2) monitoring and managing angling use along ocean and inland shores; (3) listing weakfish, winter flounder, and tautog as recovering populations; and (4) developing a fishery management plan and regulations for striped bass, summer flounder, bluefish, menhaden, scup, black sea bass, herring, harlequin bass, and skate.

Above: Aerial view of Watch Hill Marina from the bay side of Fire Island.

Below: Boats docked at Sailors Haven Marina. Fire Island National Seashore (New York). NPS COLLECTION

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National Oceanic and Atmospheric Administration. 2011. Marine recreation informaton program. www.countmyfish.noaa.gov/index.html

A Database for Aquatic Invasive Species in Ocean, Coastal, and Great Lakes Parks

Eva DiDonato, Marine Pollution Specialist
Andrew Maguire, Chicago Botanic Garden

THE NATIONAL PARK SERVICE defines an invasive species as any species that is introduced or non-indigenous to an ecosystem, and whose presence does or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112, 1999). The abundance of marine invasive species in ocean, coastal, and Great Lakes parks is poorly documented. The NPS has taken this first step of data compilation and website development to assess these invasive species.

WRD partnered with the Biological Resources Management Division Invasive Species Program to develop an aquatic invasive species database and website. With the help of three interns from Chicago Botanic Garden, a database was developed that houses data on confirmed and potential aquatic invasive species for 84 ocean, coastal, and Great Lakes parks.

The database allows queries by park, species, or taxa; data on life histories, distribution, and threats can be downloaded from the website. The species in the database were determined from available data; updates to the list will occur with cooperation from individual parks and external agencies. The database will enhance communication among natural resource managers, park staff, and the public and contribute to effective management of invasive species.

A sea lamprey captured at Pictured Rocks National Lakeshore (Michigan). NPS COLLECTION

A boat propeller covered with Quagga mussels at Lake Mead National Recreation Area (Nevada, Arizona). NPS COLLECTION

For more information on aquatic invasive species in our marine and Great Lakes parks, please visit our website at www.nature.nps.gov/water/oceancoastal/index.cfm

The Great Lakes database profiles 331 species, and 654 species are profiled in the marine invasive species database. You can discover many additional facts about aquatic invasives in the databases through the NPS Intranet website and through the public NPS website:

- The Asian clam (*Corbicula fluminea*) was the most widely distributed marine species; it was found in 38 parks.
- World War II Valor in the Pacific National Monument (Hawaii, Alaska, California) had the most documented invasive marine species: 218.
- Indiana Dunes National Lakeshore (Indiana) had the most documented invasive species in the Great Lakes: 125.
- Twenty-one aquatic species were documented in all five Great Lakes parks.

NPS Responds to a Marine Invader

Cliff McCreedy, Marine Fisheries Scientist

DIVERS AND SNORKELERS VISITING coral reefs in national parks in south Florida and the Virgin Islands are likely to encounter a beautiful occupant with red stripes and long, quill-like fins. Despite its enchanting appearance, the lionfish *(Pterois volitans)* is a dangerous, uninvited guest. They are native to the western Pacific and probably entered our waters from an aquarium release in south Florida in the 1980s. The consequences are potentially severe, including impacts to park resources and values and threats to visitor safety and experience.

Lionfish are voracious predators on native fishes and invertebrates, and competitors with them for food. Lionfish threaten herbivorous fishes that maintain optimal conditions for coral recruitment and growth. These impacts will likely exacerbate the stresses of pollution, overfishing, and climate change, which undermine the ecological integrity of coral reefs. The venomous spines of the lionfish also pose a threat of injury and illness to visitors.

Efforts to monitor and control lionfish have increased as they expand their range in the Atlantic Ocean and Caribbean Sea. Biscayne National Park (Florida) established a lionfish monitoring program in 2008; the first lionfish was sighted in 2009. Since then, over 1,000 individuals have been removed by divers. Lionfish have been detected at Virgin Islands National Park and Buck Island Reef National Monument in the Virgin Islands and Dry Tortugas and Everglades national parks in Florida.

Above right: Snorklers at Buck Island Reef National Monument (Virgin Islands). NPS COLLECTION

Lionfish. USGS/DON DEMARIA

Read more from *Lionfish Response Plan: A Systematic Approach to Managing Impacts from the Lionfish, an Invasive Species, in Units of the National Park System* at www.nature.nps.gov/publications/nrpm

WRD and the Southeast Region held a workshop in Miami in September 2011 to develop a lionfish response plan for parks in the Caribbean, Gulf of Mexico, and southern states along the Atlantic Ocean. It was attended by resource managers, interpreters, and risk managers from NPS units, regional offices, and Washington D.C., as well as experts in lionfish biology and control. Although participants agreed that eradication is impossible, a plan emerged that park managers can use to develop local actions. Targeted actions include (1) evaluating and prioritizing areas for lionfish control and setting numeric targets for reducing populations; (2) reporting lionfish presence and using available tools and resources for removal; (3) monitoring lionfish and native species populations and using adaptive management approaches; (4) interpreting the lionfish invasion, communicating the impacts, and engaging the public in park stewardship and invasive species response; and (5) reducing and communicating risks, ensuring safety of visitors, park staff, and volunteers, and providing training in safe lionfish handling.

Planning and Evaluation Branch Highlights

Patrick Mangan, Branch Chief

Lewis River, Yellowstone National Park (Montana, Wyoming, Idaho). NPS/JOHN APEL

THE PLANNING AND EVALUATION Branch (PEB) provides technical assistance and program management for water resources planning, wetland protection and restoration, and fisheries management. In 2011 the branch was renamed and reassigned programs as part of a larger reorganization of the Water Resources Division. Two of the restructuring goals were to strengthen water quality technical assistance and broaden the division's planning function in order to provide directorate-wide leadership. To that end PEB was renamed the Planning and Information Branch (PIB), and acquired the Natural Resource Challenge, Natural Resource Condition Assessment, and Water Resources Information Management programs. PEB's fisheries management, wetland protection, and restoration functions were reassigned to the Aquatic Systems Branch.

The WRD Planning Program focused on the integration of Resource Stewardship Strategy (RSS) into parks' planning processes, assistance to the Climate Change Response Program, and the review of General Management Plans. The outcomes have resulted in consideration of climate change on park resources and quantifying goals for resource management.

The Wetlands Program provided extensive support on wetlands regulatory issues, wetland condition and functional assessments, and wetlands restoration to 57 parks throughout the system. Technical assistance for wetland restoration at Great Basin National Park and Riparian Condition Evaluations to support a Natural Resource Condition Assessment and RSS at Pecos National Historical Park are featured in the following pages of this report. The Wetlands Program also served as the servicewide expert in determining federal jurisdiction of "waters of the United States" and reviewing the Clean Water Cooperative Federalism Act.

In FY 2011 Fisheries Program staff assisted parks on issues such as fish community composition and health, impacts associated with hatchery operations and hatchery-produced fish, fishing regulations, lead fishing tackle, aquatic nuisance species prevention, and aquatic habitat degradation. Program staff also edited Proceedings of the Fourth Interagency Conference on Research in the Watershed; a Field Manual for the Use of Fintrol (Antimycin A) for Restoration of Native Fish Populations; and the Devils Hole Ecosystem Monitoring Plan. In addition, program staff represented NPS in a wide range of multi-interest groups such as the Aquatic Nuisance Species Task Force, the National Fish Habitat Partnership (NFHP), and several regional fish habitat partnerships under NFHP.

As part of our Emeritus Program, retired PEB Chief Mark Flora has taken the lead in a partnership with Project WET, a non-governmental organization that provides water education for teachers and their students. Mark also provided technical assistance to the Kingdom of Jordan through the International Technical Assistance Program.

Gearing Up for the New Challenge: Climate Change

Don Weeks, Climate Change Resource Planner

WE ARE WATCHING A CHANGING climate unfold in front of our eyes; rising temperatures are influencing many aspects of Earth's hydrologic systems, such as precipitation, snow, ice, and permafrost. Considering climate change in park planning is now required, and in response, WRD added a new climate change resource planner position in 2011.

One of the FY 2011 projects supported by this new position was the development of the Foundation Document for Hot Springs National Park in Arkansas. The purpose of Hot Springs National Park is to protect its unique geothermal spring water and associated lands for a range of experiences and uses, making the hot springs a fundamental park resource. These geothermal springs are recharged by rainwater infiltrating through higher-elevation rock exposures of chert and novaculite. Any changes in the recharge/runoff ratio within the recharge area could affect the discharge and temperature of the hot springs (Kresse and Hays 2009). Discharge from the springs includes a small but important shallow component of cold-water recharge (Bell and Hays 2007).

The climate change projected for the Hot Springs region could influence both discharge and temperature of the park's hot springs. Based on climate models for the region, air temperature is projected to increase between 2.6°C and 4.4°C (4.7°F and 7.9°F) and precipitation is projected to decrease between 2% and 8% between 1990 and 2100 (Gonzalez et al. 2010, IPCC 2007, Mitchell and Jones 2005). Under this projected climate future, one would expect less shallow groundwater mixing resulting in less spring discharge with warmer temperatures.

Hot Springs National Park (Arkansas) geothermal area. NPS/ DON WEEKS

This projected climate future and the potential influences to Hot Springs National Park's fundamental resources have been incorporated into the park's Foundation Document. The basic understanding of potential climate futures can now be further developed in the more comprehensive planning efforts that tier off the Foundation Document, such as the Resource Stewardship Strategy (RSS). The NPS Park Planning and Special Studies Program, with support from Hot Springs National Park, is now funding a USGS watershed modeling effort for analysis of future scenarios of development within the Hot Springs recharge area, along with plausible climate futures.

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Bear Creek Campground Wetland Restoration

Kevin F. Noon, Wetlands Specialist

PARK MANAGERS AT GREAT BASIN National Park (Nevada) are developing a plan, based on a solid understanding of the geology and hydrology of the area, to remove fill from Bear Creek Campground in order to re-establish pre-disturbance hydrologic conditions across a three-acre (1.2-ha) wetland area. Water Resources Division staff are working with park staff to determine the best course of action for removing a 1,215-foot (370-m) campground loop road, associated camping spaces, and a vault toilet.

WRD staff reviewed specific hydrologic conditions and discussed numerous treatment options around the entire length of the loop road. For example, park and WRD staff discussed the treatment of a ditch and culvert system that was put in place by the engineers that designed the campground road. Rather than maintain the function of a ditch, which essentially channels water and drains the hydric condition of the wetland, staff agreed to fill the ditch and recreate surface water, sheet-flow conditions.

WRD also recommends removal of two culverts that direct the flow of channels under the main campground access road. These channels transmit infrequent flows from severe local storms or snow melt from an area just above the restoration site. The culverts direct these flows under the access road and into the emergent wetland in the restoration area. Instead of culverts, WRD recommends the road be re-graded and fitted with concrete pads or low-flow structures.

Part of the restoration will include removing a deep-vault toilet. WRD staff believe that part of the vault is below the groundwater table during the spring wet season. Burying the vault in place will be the least disruptive and cheapest solution once it has been cleansed of contaminants. Using a jack hammer attachment on a back hoe, the top one-third of the vault walls will be broken off and placed inside the vault along with large boulders. Then the vault cavity can be backfilled up to the surface or finish grade with appropriate soil material. This process will weigh the vault down, eliminate any movement from groundwater pressure, and provide a gap above the vault walls to allow for an uninterrupted root zone for plant growth. The Bear Creek Campground restoration is scheduled for completion in 2012.

Above right: Plan view of the Bear Creek restoration area. NPS/K. NOON

A campground parking space on the fill. Note the concrete pad and table also in the wetland with groundwater exposed in the firepit. Great Basin National Park (Nevada). NPS/K. NOON

Riparian Condition Evaluations Support Park Assessment and Planning Efforts

Joel Wagner, Wetlands Program Lead
Michael Martin, Hydrologist

Riparian areas along the Pecos River were rated as being in "proper functioning condition." This photo from the southernmost assessment reach shows a large and topographically complex riparian zone with a diverse riparian/wetland vegetation community. NPS/MICHAEL MARTIN

PECOS NATIONAL HISTORICAL PARK (New Mexico) preserves 12,000 years of history including Pecos Pueblo and Spanish Mission ruins, the Santa Fe Trail, and the site of the Civil War Battle of Glorieta Pass. These cultural resources lie amidst piñon, juniper, and pine woodlands; the Pecos River; Glorieta Creek; and other natural resource features of the park.

In 2010 and 2011 the NPS and cooperators conducted a Natural Resource Condition Assessment (NRCA) for the park. An NRCA evaluates current conditions, critical data gaps, and threat and stressor influences on important park natural resources, including riparian areas. Although previous park studies mapped riparian vegetation communities and collected vegetation data suitable for evaluating change over time, they weren't designed to evaluate riparian functional condition or ecological health. Therefore park managers asked WRD to conduct riparian condition assessments for the Pecos River and lower Glorieta Creek in support of the NRCA study.

We used Bureau of Land Management "proper functioning condition" (PFC) procedures for our riparian assessments. All Pecos River reaches were determined to be in PFC (highest possible rating). However, the lower Glorieta Creek reach was rated "functional—at risk with a downward trend" due to a manufactured levee adjacent to the stream channel. The levee constrains the channel to an artificially narrow riparian corridor, which limits its potential size, structural complexity, and habitat value. In addition, floods have the potential to erode through the levee and deposit excessive sediment into adjacent, recently restored wetlands and downstream aquatic habitats. We published our findings in an NRSS report titled "Riparian Condition Assessments for the Pecos River and Lower Glorieta Creek, Pecos National Historical Park, NM" (NPS/NRSS/WRD/NRR—2011/422). The report recommends removal of the levee to connect the restored wetland area to the stream corridor, allow the riparian system to reach its full ecological potential, and eliminate the threat of excessive sediment deposition in aquatic environments.

Using information from the NRCA and other sources, park managers are now developing a Resource Stewardship Strategy (RSS). An RSS is a planning process and document that serves as a planning link between the desired conditions identified in a park's GMP and the actions needed to achieve them. The WRD riparian assessments provided essential resource condition information to help park managers develop a successful RSS.

A manufactured levee (center) separates recently restored riparian/wetland habitat (left) from Glorieta Creek (right, hidden by vegetation). The levee constrains natural biological and hydrologic processes in the riparian corridor and is a potential source of excess sediment deposition into nearby aquatic systems. Pecos National Historical Park (New Mexico). NPS/JOEL WAGNER

Monitoring an Endangered Tallgrass Prairie Fish

Nic Medley, Fisheries Biologist

THE FEDERALLY ENDANGERED Topeka shiner (*Notropis topeka*) is a small minnow that inhabits small, cool, headwater streams within the tallgrass prairie ecosystem of the American Midwest. The fish was once abundant and widely distributed, but development and agriculture have degraded stream habitat and caused the local extinction (extirpation) of many populations.

The Topeka shiner has been documented within the Tallgrass Prairie National Preserve located in the Flint Hills Region of Kansas. Because the fish is endangered, the NPS is required to protect and recover this species. The preserve is owned almost entirely by The Nature Conservancy but administered cooperatively with the NPS. The purpose of Tallgrass Prairie is to preserve, protect, and interpret an example of a tallgrass prairie ecosystem and the cultural features that tell the story of human interaction with the prairie environment. Much of the preserve is managed as a working cattle ranch. Park managers seek a healthy balance between the seemingly contradictory goals of preserving the ranching heritage while preserving unimpaired the small streams within this unique ecosystem.

NPS inventory and monitoring data suggest that the Topeka shiner population within the preserve has declined in the last decade. While the data suggests a possible change in the status of the fish, the monitoring program was not designed to provide accurate data on the status of a species so rare and difficult to detect or to understand cause and effect relationships between the species' status and management activities. At this time, the true status of the Topeka shiner populations within Tallgrass Prairie is uncertain. Preserve managers need to better understand the population status and distribution of the fish so that management actions can be taken to protect the fish and its habitat.

WRD staff are working with the preserve to develop a monitoring plan. The objectives are to conduct detailed presence/absence surveys to document the spatial and temporal occupancy of sites within Tallgrass Prairie and to conduct population estimates. A better understanding of Topeka shiner populations will provide important data to test specific hypotheses regarding the fish's status and its response to environmental change and management activities.

Near right: An ungrazed stream within Tallgrass Prairie National Preserve. Far right: A grazed stream within Tallgrass Prairie National Preserve (Kansas). NPS/ NIC MEDLEY

Restoration of Aimakapa Fishpond

Kevin F. Noon, Wetlands Specialist
John Wullschleger, Fisheries Program Leader

AIMAKAPA FISHPOND IN KALOKO-Honokōhau National Historical Park (Hawaii) is a *loko pu'uone*, a large natural water body trapped behind sand dunes. Historically it was connected to the ocean by a stone-lined channel and used by native Hawaiians for aquaculture. In addition to its historic and cultural values, the 30-acre (12-ha) pond provides mud flat foraging and upland nesting habitat for the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*) and Hawaiian coot (*Fulica alai*). The contiguous complex supports the native sedges kaluha and makaloa (*Bolboschoenus maritimus* and *Cyperus laevigatus*) as well the Hawaiian o`pae ula (the shrimp *Metabetaeus lohena*) and a damselfly (*Megalagrion xanthomelas*), which are candidates for listing under the Endangered Species Act.

The challenge facing Aimakapa Fishpond is the spread of two invasive plants, pickleweed (*Batis maritime*) and paspalum (*Paspalum* sp.). These invasives threaten the ecologically important mud flats, reducing the open water area of the pond to 15 acres (6 ha). This has altered the abundance, composition, and diversity of soil microbe and animal communities, resulting in a shift from a detritus-based to an algae-based food web and reducing food for endemic fish and shorebirds. In addition, the shift from open tidal flat to vegetated marsh has resulted in physical conditions that limit the access of most foraging birds and fish species to food sources.

The restoration of the Aimakapa Fishpond system is a priority for Kaloko-Honokōhau and WRD. Contractors from the University of California Davis Cooperative Ecosystem Studies Unit are developing a vegetation management plan that will guide eradication of the invasive plants and restore the mud flat wetlands.

Since this effort began, WRD staff has recognized that tilapia, an invasive fish established in the pond, needs to be addressed as a component of restoration. One possibility is that removal of non-native vegetation could actually allow the tilapia population to expand. Thus, WRD High Priority funds are supporting a separate environmental assessment (EA) that will be developed by the USGS Southeast Ecological Science Center. This will include a literature review, field assessments, characterization of the fish community, and the evaluation of alternative eradication methods for tilapia. As time permits this effort may also consider non-native fish in waters of nearby NPS units such as Pu'uhonua o Hōnaunau National Historical Park.

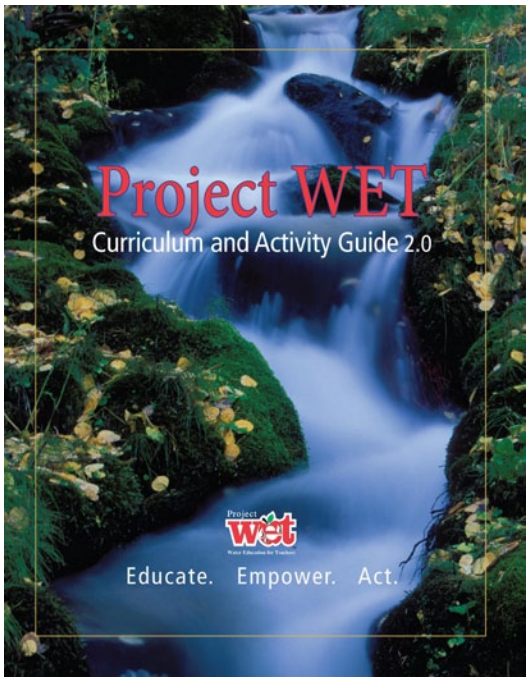
Above: Hawaiian coot and Hawaiian stilt in Aimakapa Fishpond. Right: Aerial view of Aimakapa Fishpond, Kaloko-Honokōhau National Historical Park (Hawaii). NPS COLLECTION

A Partnership with Project WET to Enhance Water Education

Mark Flora, Emeritus Volunteer

IN *A CALL TO ACTION*, THE NPS identifies "Advancing the NPS Education Mission" as one of four priority actions to lead the bureau into its second century. In 2011 WRD entered a partnership with the Project WET Foundation, an award-winning and internationally recognized water education program, to develop products that educate youth and other park visitors about aquatic resources and issues within the National Park System.

Linda Drees, NRSS partnership manager, and Dennis Nelson, Project WET president, announced the partnership project at *Sustaining the Blue Planet–Global Water Education Conference*. PROJECT WET/HALE THOMAS-HILBURN



The *Discover the Waters of our National Parks* partnership will use national and state curriculum standards in conjunction with park-specific resource information to create materials that tell the stories of a park's water. Specially designed workshops will engage park staff, teachers, informal educators (including youth mentors), and other environmental education advocates for the purpose of teaching water resource concepts applicable to their home environments. Both partners will work cooperatively in the development and implementation of hands-on, science-based activities that serve to protect the resource, provide high-quality education, and appeal to multiple generations. Products will make use of diverse media (including publications, training, film, and internet) and will be available to the park's local communities and classrooms across the country.

The *Discover the Waters of our National Parks* partnership was announced at the *Sustaining the Blue Planet–Global Water Education Conference* in September 2011. This conference attracted over 200 participants interested in water-related environmental education from more than 40 countries. The first phase of the partnership has been completed with a collaborative lesson included in *Project WET Curriculum and Activity Guide 2.0*, published in 2011. Currently, fundraising efforts are underway for the next phase—working with five pilot parks to create and implement site-specific education projects. The pilot parks will each represent one of five different aquatic environment categories: montane (top of mountain), Great Lakes, big river, coastal/estuarine, and urban river. A selection of the five pilot parks and an alternative in each category will be made early in 2012. As the project develops, more parks will be included in this exciting collaborative endeavor.

Thinking Globally, Sharing Locally

Mark Flora, Emeritus Volunteer

IN 2011 THE WATER RESOURCES Division supported the International Technical Assistance Program in developing and leading two study tours that paired visiting park officials from the Kingdom of Jordan with National Park Service counterparts to share knowledge, ideas, and best management practices for the preservation of natural and cultural resources.

The "Mediterranean Forest Management Study Tour" in May was developed as part of the USAID-funded Jordan Parks Project under the auspices of the U.S. Department of the Interior Office of International Affairs. The purpose of this study tour was to provide Jordanian NGOs whose responsibilities include managing protected Mediterranean forest habitats with an opportunity to observe and discuss management protocols used within similar Mediterranean ecosystem protected areas managed by the U.S. Department of the Interior. With input from the NPS Pacific West Regional Office, we decided to focus this tour on Santa Monica Mountains National Recreation Area and Pinnacles National Monument in California. Study tour participants had the opportunity to interact with their U.S. counterparts and share expertise in natural resource management disciplines including habitat fragmentation, altered fire regime, non-native invasive species management, and the implementation of effective inventory and monitoring techniques.

The "Petra Park Managers Study Tour" in September provided mid-level managers from Petra Archaeological Park in Jordan with an opportunity to meet with their U.S. counterparts and observe and discuss management protocols used in the protection and preservation of cultural resources in the United States. Park managers from Jordan, including a cultural resource management specialist and park operations specialist, met and interacted with peers at Grand Canyon National Park (Arizona), Mesa Verde National Park (Colorado), and Pecos National Historical Park (New Mexico), as well as discussing topics of mutual interest with program managers with NPS Vanishing Treasures Program, NPS Western Archaeological and Conservation Center, and State of New Mexico Office of Cultural Affairs. In addition, broader topics related to protected area management were included relating to visitor use and services, concessions management, interpretation and environmental education, and developing effective partnerships in with local communities and interest groups.

Above right: Vegetation Program Lead John Tizler reviewing park boundary and management zoning in Santa Monica Mountains National Recreation Area (California) with Loay Al Azzam (Dibeen Forest Reserve), Yaseen Ananbeh (RSCN Biological Inventories and Field Studies Program), and Sameh Al Khatatbeh (Ajloun Forest Reserve). NPS/MARK FLORA

Near right: Tahani al-Salhi (Petra Archaeological Park) and Victor Ortiz (historic mason) discuss restoration and maintenance techniques used in the preservation of free-standing adobe structures at Pecos National Historical Park (Texas). NPS/MARK FLORA

Water Operations Branch Highlights

Gary M. Smillie, Acting Branch Chief

Kayaking on Jackson Lake, Grand Teton National Park (Wyoming). NPS COLLECTION

FISCAL YEAR 2011 WAS ANOTHER eventful and successful year for the staff of the Water Operations Branch (WOB). Staff members contributed in many and varied ways to the management, protection, and restoration of the waters and related habitats of numerous National Park Service units. WOB has been a part of the Water Resources Division for over 20 years, providing technical assistance and funding project oversight in the areas of surface water and groundwater hydrology, water quality, contaminant transport, natural resource condition assessment, information management, erosion and sedimentation, floodplain management, hydraulic modeling, and fluvial and wetland restoration. This assistance has been provided at the park level as well as regional and WASO levels and includes servicewide programs such as the Natural Resource Condition Assessment (NRCA) Program, Vital Signs Water Quality Monitoring, and the USGS–NPS Water Quality Partnership.

WOB staff contributed significantly to an exciting milestone achieved by the NPS in FY 2011—the start of the removal of two dams on the Elwha River on the Olympic Peninsula in Washington State. Also during FY 2011 WOB water quality staff, in conjunction with the Geologic Resources Division, provided critical reviews of a number of documents dealing with potential threats and impacts to parks from Marcellus Shale development. Other achievements for the water quality program for FY 2011 included working with Yellowstone National Park staff and Montana Department of Environmental Quality to coordinate various monitoring activities at the McLaren tailings site, providing Indiana Dunes National Lakeshore assistance in conducting a comprehensive review of the Baseline Environment Risk Assessment of the Bailly Generating Plant RCRA site, and playing an instrumental role in having a responsible party undertake active remediation of a Leaking Underground Storage Tank (LUST) site at Mesa Verde National Park.

Other important branch projects included continuing NPSTORET development with increased functionality and a growing servicewide database. The NRCA Program funded project starts at 25 park units in FY 2011 and provided technical support to a number of ongoing projects. The hydrology program carried a heavy technical assistance load in FY 2011 as is the norm and provided coordination and support on several funded projects including such issues as climate change, wells and public water supplies, wetlands restorations, and hydraulic modeling of park rivers.

As of FY 2012 a new branch structure has been adopted by the WRD, and the WOB will no longer exist as an entity. Staff members from the former WOB and other WRD branches have been realigned into a new branch structure that conforms more closely to evolving agency needs. Parks, regions, and WASO offices can rest assured, however, that all former functions provided by the Water Operations Branch will continue to be effectively addressed by the new organizational structure.

Dam Removals on the Elwha River Began in FY 2011

Gary M. Smillie, Hydrologist

FOLLOWING NEARLY TWO DECADES of planning by NPS and other federal agencies, deconstruction of two dams on the Elwha River in Washington State—the Elwha and Glines Canyon Dams—began near the end of FY 2011. The larger of the two dams, Glines Canyon, and its reservoir, Lake Mills, are entirely within the boundaries of Olympic National Park. Elwha Dam impounds Lake Aldwell, downstream from the park, and is located about five miles (8 km) upstream from the sea. Removal of these dams is part of a project to restore an anadromous fishery and related ecosystem in Olympic National Park and to restore, to the extent possible, natural geomorphology and vegetation in the former lake beds. Once removed, the length of river and tributaries available to anadromous fish, those that spend most of their lives at sea but spawn in fresh water, will increase from about five miles (8 km) to about 80 miles (129 km).

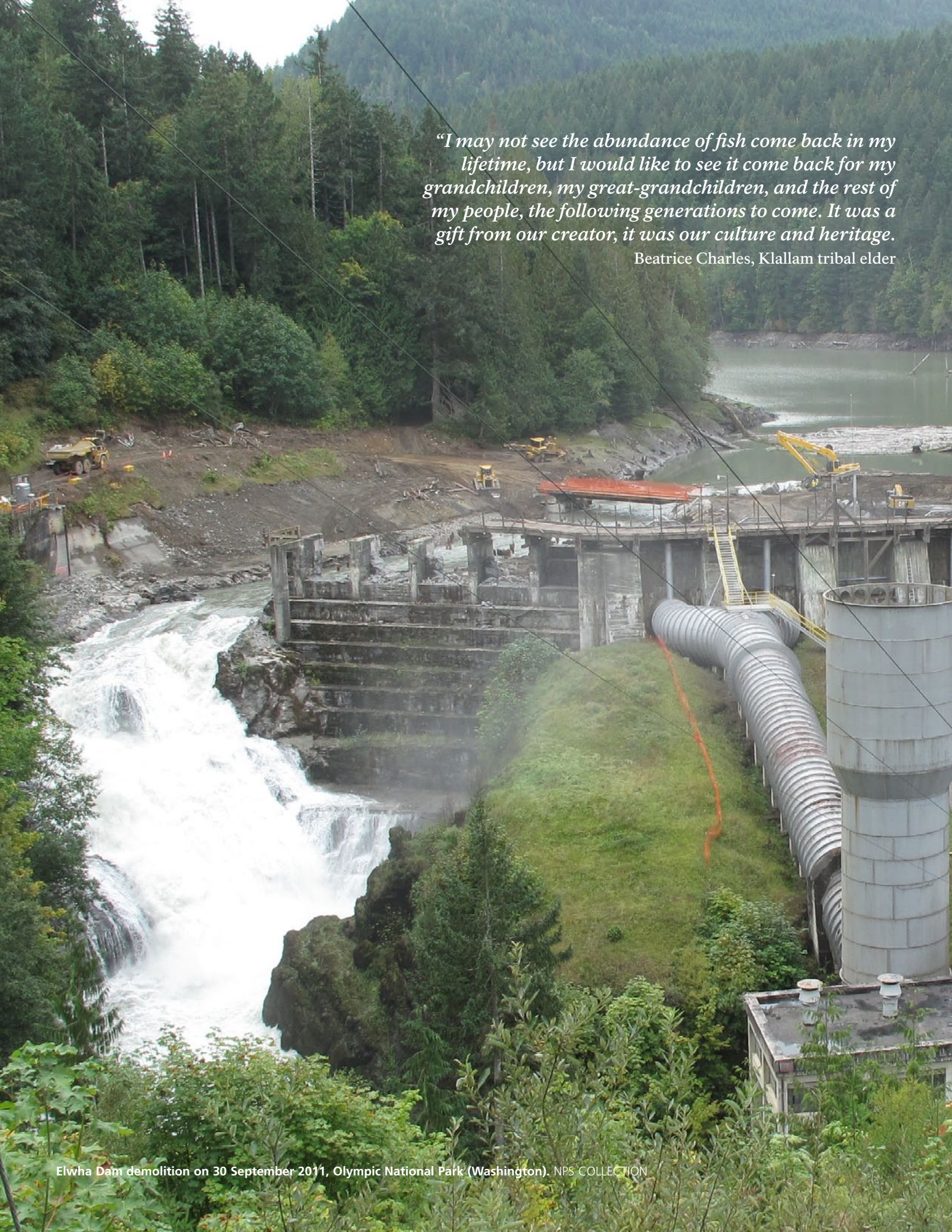
The removal of these dams is a high-profile project in the National Park Service. These are the largest dams to date to be removed in North America, and the restoration effort will be the second-largest ever undertaken by the NPS (second only to the Everglades restoration). In attendance at the 17 September 2011 Ground Breaking Ceremony were Secretary of the Interior Ken Salazar, NPS Director Jon Jarvis, Washington State Governor Chris Gregoire, and a host of other national, local, and tribal dignitaries.

Elwha Dam from downstream with Lake Aldwell impounded in the background, taken from the webcam on 24 August 2011. Olympic National Park (Washington). NPS COLLECTION

Water Operations Branch staff have been involved with the Elwha Project since the early 1990s and have assisted in the development of sediment management aspects of the project. The contract to deconstruct the two dams was awarded to Barnard Construction of Bozeman, Montana, and is being administered by the Denver Service Center. The project is expected to take about three years and includes periods of dam removal "pauses" to lessen sediment impacts to the river downstream during critical fish life-stages. The structures are being incrementally removed from the top down. Initially, only turbidity impacts are anticipated downstream, but eventually coarse sediments eroded from the reservoir deltas will be released downstream. The release of coarse sediment is not anticipated until at least late 2012.

Because of the scale of the project and its scientific opportunities, professional interest in the project is high and many agencies and other institutions are collaborating in various studies. "The restoration project is a testament to what can happen when diverse groups find a way to work together and achieve shared goals of restoration for a river, a people, an ecosystem, and a national park," said Director Jarvis.

Updates to the project can be found at www.nps.gov/olym, and dam removal progress and fluvial processes on the deltas can be observed in essentially real time at: www.video-monitoring.com/construction/olympic/js.htm



"I may not see the abundance of fish come back in my lifetime, but I would like to see it come back for my grandchildren, my great-grandchildren, and the rest of my people, the following generations to come. It was a gift from our creator, it was our culture and heritage.

Beatrice Charles, Klallam tribal elder

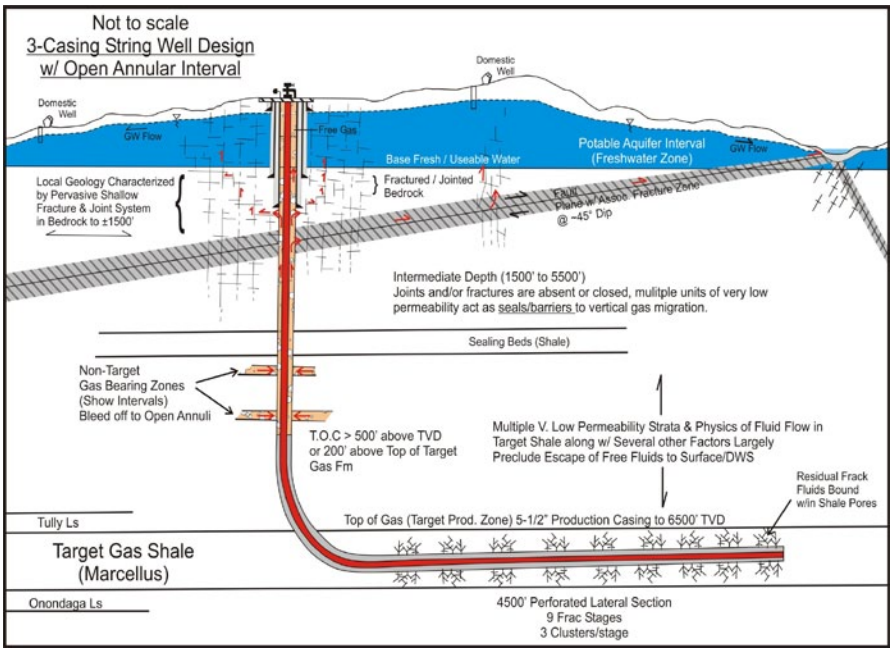
Elwha Dam demolition on 30 September 2011, Olympic National Park (Washington). NPS COLLECTION

The Real Threats from Hydraulic Fracturing and Natural Gas Development

Pete Penoyer, Hydrogeologist

IN SUPPORT OF THE NORTHEAST Region parks, WRD staff conducted research on threats posed by deep underground hydraulic fracturing (fracking) from Marcellus Shale gas development. The primary concern was the threat of fracking chemicals contaminating potable aquifers and drinking water supplies. Research consisted of a review of literature; discussions with state regulators and industry representatives; and participation in several hydraulic fracturing symposiums, forums, conferences, and an EPA workshop on migration of hydraulic fracturing chemicals.

Among subject matter experts there appears to be a strong consensus that risk of chemical migration to drinking water supplies and potable aquifers when hydraulic fracturing is conducted deep underground is extremely remote. This is largely due to the absence of viable migration pathways, the isolated conditions and physical constraints under which deep hydraulic fracturing in lateral boreholes occurs, and the monitoring measures taken by industry to detect and limit the potential for fracking chemicals to extend beyond the Marcellus Shale formation. Surface chemical spills are also a concern, but these are largely localized and manageable in operations of this scale.



Hydraulic fracturing schematic of Marcellus Shale gas development illustrating stray gas migration pathways. NPS/PETE PENOYER

The problem that staff did discover in its analysis is the potential for stray gas migration via the annulus, the space between the borehole wall, and the casing, or production string, which carries the gas to the surface. This more common phenomenon can impact a drinking water supply through poor well design or when significant sections of the annulus are left open or uncemented. When a well is drilled, the borehole cuts through many rock layers to reach the targeted Marcellus Shale. If natural fractures in these shallow bedrock layers occur, the annular path coupled with migration through shallow fractures can allow non-target gas to reach the shallow aquifer thereby circumventing the intended protections of the surface casing (steel and cement) to isolate drinking water supplies. Risks include overpressurized gas in the annulus contributing to levels of methane in drinking water supplies sufficient to cause an explosive hazard.

WRD staff concluded that stray gas migration from gas-bearing intervals above the target formation is a more significant long-term threat to drinking water supplies than the actual release of chemicals used in the fracking process. These chemicals are well isolated during the fracking and production phases of Marcellus Shale development. Instead, parks should focus on the consequence of stray gas migration as the most significant and potentially more widespread threat to drinking water supplies from natural gas development.

NPS Hydrographic and Impairment Statistics

Dean Tucker, Information Management Program Leader
Jia Ling, Impaired Waters Database Manager

HAVE YOU EVER WONDERED HOW many miles of streams or acres of lakes exist in a particular park or within the entire National Park System; or how many miles of streams or acres of lakes are considered "impaired" by states under the Clean Water Act? Using WRD's recently updated Hydrographic and Impairments Statistics (HIS) database (www.nature.nps.gov/water/HIS) you can find the answers to these and other hydrographic questions.

The HIS database unites data from three sources: (1) USGS's high-resolution National Hydrography Dataset (NHD); (2) NPS Administrative Park Boundaries Dataset; and (3) the latest state Clean Water Act reports. The HIS database is dynamic. Calculated statistics will change as larger scale hydrography slowly replace the 1:24,000 (1:63,360 for Alaska) scale hydrography that currently comprise the lion's share of the NHD; park boundaries are revised by the Land Resources Division or new parks are added; and states report their impairment lists to the EPA biennially.

During FY 2012 the HIS will be enhanced to allow users to obtain lists of parks impaired by specific pollutants and to view impairments on a map.

According to the latest statistics, the National Park System contains approximately 168,250 miles (270,714 km) of perennial, intermittent, and ephemeral streams/rivers and canals (waterways). Of these miles, approximately 7,940 miles (12,775 km) are considered impaired by states under section 303(d) of the Clean Water Act. The most common *waterway* impairments are mercury, impaired biota, salinity, PCBs, and metals.

Table 1. Top 10 national park units arrayed for waterway mileage and impaired waterway mileage according to HIS

#	Park Unit	Total Waterway Miles	Total Waterway Kilometers	#	Park Unit	Impaired Waterway Miles	Impaired Waterway Kilometers
1	Gates of the Arctic	16,227	26,109	1	Everglades	1,741	2,801
2	Wrangell–St. Elias	13,765	22,148	2	Great Smoky Mnts.	1,111	1,788
3	Death Valley	12,972	20,872	3	Capitol Reef	682	1,097
4	Noatak	12,182	19,601	4	C & O Canal	404	650
5	Denali	10,100	16,251	5	Zion	302	486
6	Yellowstone	6,540	10,523	6	Rocky Mountain	298	479
7	Mojave	6,133	9,868	7	Big Cypress	274	441
8	Lake Clark	6,080	9,783	8	Timucuan	269	433
9	Katmai	5,800	9,332	9	Cuyahoga Valley	228	367
10	Big Bend	5,253	8,452	10	Rio Grande	184	296

The National Park System also contains approximately 4,410,200 acres (1,784,807 ha) of lakes, reservoirs, and oceans (waterbodies) of which approximately 1,471,622 acres (595,582 ha) are impaired. The most common *waterbody* impairments are mercury, PCBs, pesticides, and dioxins.

Table 2. Top 10 national park units arrayed for waterbody acreage and impaired waterbody acreage according to HIS

#	Park Unit	Total Waterbody Acres	Total Waterbody Hectares	#	Park Unit	Impaired Waterbody Acres	Impaired Waterbody Hectares
1	Glacier Bay	629,522	254,768	1	Everglades	578,261	234,022
2	Everglades	588,013	237,969	2	Isle Royale	412,273	166,847
3	Isle Royale	417,103	168,802	3	Voyageurs	84,344	34,134
4	Katmai	327,017	132,344	4	Padre Island	70,522	28,540
5	Bering Land Bridge	221,662	89,707	5	Lake Roosevelt	69,988	28,324
6	Biscayne	165,111	66,820	6	Dry Tortugas	65,476	26,498
7	Lake Mead	161,965	65,547	7	Canaveral	31,798	12,869
8	Glen Canyon	157,318	63,667	8	Apostle Islands	27,125	10,977
9	Lake Clark	143,861	58,221	9	Cape Lookout	16,574	6,707
10	Channel Islands	119,167	48,227	10	Lake Meredith	16,321	6,605

Restoration of Quitobaquito Pond

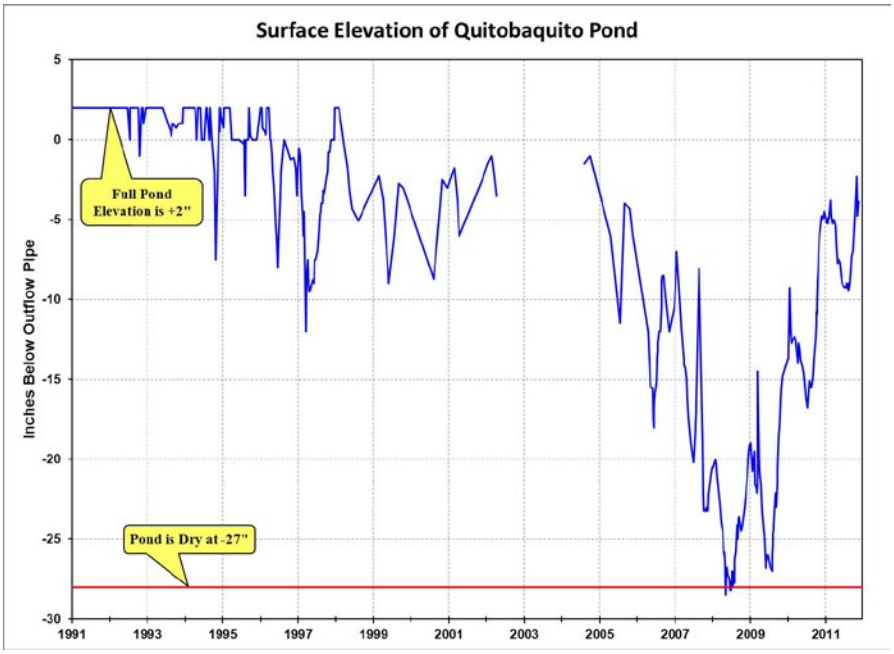
Larry Martin, Hydrologist

THE POND AT QUITOBAQUITO Springs in Organ Pipe Cactus National Monument (Arizona) is a refuge for the Rio Sonoyta pupfish (*Cyprinodon eremus*) and Sonoyta mud turtle (*Kinosternon sonoriense longifemorale*). Water flows into the pond from several local springs. In the mid-1990s, park staff noticed that the pond was not being maintained at its full level. Beginning in 2005, and through 2006–2009, the surface elevation of Quitobaquito Pond fell to extremely low levels, unprecedented since it was dredged and deepened in 1962. Normally averaging about 25 to 40 inches (64 to 102 cm) deep and about 27,000 ft^2 (2,508 m^2) in surface area, by 2008 the pond averaged 1.5 inches (4 cm) deep and 40% of its normal surface area. This loss of surface area and total water volume presented imminent threats to the Rio Sonoyta pupfish and the Sonoyta mud turtle. At first, the loss of water was attributed to drought conditions causing a decrease of flow from the springs. Investigations at the site eventually identified excessive leakage from the pond as the primary cause of water level decline.

Actions taken during 2007–2010 to mitigate the threats to Quitobaquito Pond included (1) evacuating pupfish and mud turtles to temporary holding facilities; (2) calculating a water budget for the system; (3) trucking over 83,000 gallons of water to the pond in mid-summer 2008; (4) clearing vegetation from strategic areas including the manual removal of bulrush; (5) making physical repairs to the pond's infrastructure including relining the bottom, rehabilitating the berm, and repairing the channel; and (7) ensuring regulatory compliance.

It appears that these actions have stopped the leak. The pond is currently holding at about the "minus 5 inches" level or higher, which is the highest stable level since 2005 or earlier. The pond was essentially dead and gone in midsummer 2008 and 2009. We regained 24 inches (61 cm) of water depth (so far), which is 85% or more of the maximum pond volume.

Quitobaquito Pond is 70 meters (230 ft) north of the U.S.–Mexico border, and about two hundred meters (656 ft) north of Mexico Highway 2. The Quitobaquito area has been closed to the public for seven years, and all NPS work parties must be accompanied by NPS law enforcement. Work at the site entails considerable logistical challenges and employee security issues.



Pond data from 1991–2011. NPS/LARRY MARTIN

Right: Quitobaquito Pond near its lowest point on 26 July 2008 (above) and at minus 5 pond level on 13 December 2010 (below). Organ Pipe Cactus National Monument (Arizona). NPS COLLECTION

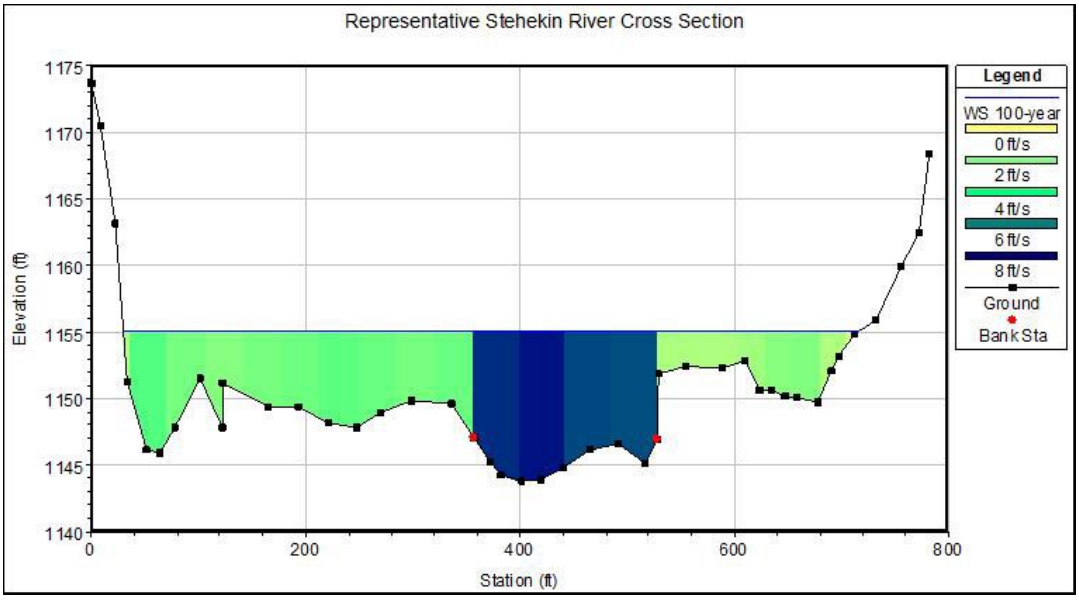
Hydraulic Modeling of the Stehekin River

Michael Martin, Hydrologist
Katherine Converse, Hydrology SCEP
Jon Riedle, Geologist, North Cascades National Park Complex

IN RESPONSE TO SEVERAL SEVERE flood events over the past 15 years, North Cascades National Park Complex (Washington) is developing the Stehekin River Corridor Implementation Plan. The plan is intended to protect natural riparian values, facilitate park operations, and foster cooperation between the park and local residents along the river. In support of the plan, WRD and park staff completed a multi-phase data compilation exercise to create a hydraulic model and analyze a variety of flows along the Stehekin River. The topographic information was derived from two different ground surveys and a digital elevation model (DEM) based on LIDAR data. Merging these three data sets presented several challenges as the two ground surveys used different datums and the DEM required post-processing of the raw LIDAR data to achieve desired accuracy. We projected these three data sets into a common datum and then extracted 56 individual channel and floodplain cross sections to complete a HEC-RAS model representing over 3,000 feet (914 m) of the Stehekin River.

The overall purpose of the modeling exercise is to evaluate how the 100-year floodplain may have changed over the last few decades as a result of several substantial flow events and geomorphic evolution of the channel. Additionally, park staff is interested in using output from the model to understand how hydraulic parameters such as velocity and stream power affect the sediment dynamics of the river, especially the large woody debris that forms extensive logjams and may cause dramatic shifts in channel morphology. Answers to these questions are expected in FY 2012, while continued application of this model to other hydrologic questions will be ongoing.

Above right: View of the Stehekin River along a prominent meander bend. Note the presence of large woody debris on the overbank area. North Cascades National Park Complex (Washington). NPS/MICHAEL MARTIN



Output from HEC-RAS model showing a representative channel and floodplain cross section for the Stehekin River with the modeled 100-year flow water surface and the calculated velocity profile. NPS/MICHAEL MARTIN

Water Rights Branch Highlights

Bill Hansen, Branch Chief

Obed Wild and Scenic River in Tennessee. NPS COLLECTION

THE WATER RIGHTS BRANCH (WRB) completed a period of transition in FY 2011, and I was honored to be selected as the fourth branch chief in our 25-year history. I look forward to leading a very talented group of professionals that are well suited to continue our tradition of using sound science and creative solutions to protect water resources in national parks.

WRB manages the servicewide program to secure and protect NPS water and water rights through all available mechanisms. Challenges such as water allocation shortages, energy development, and climate change continue to make our work interesting and complex. WRB is becoming more involved in other processes (environmental assessments, federal agency permitting, Wild and Scenic River management, and state rule development) to protect flows and groundwater levels, particularly in the Midwest and Eastern United States.

During 2011 WRB continued to represent the NPS as a cooperator on the BLM Solar Programmatic Environmental Impact Statement; the BLM Draft EIS for the Southern Nevada Water Authority's pipeline right-of-way in Clark, Lincoln, and White Pine counties; and Indian water right negotiation teams for the Blackfeet Nation, the Navajo Nation-Hopi Tribe, the Hualapai Tribe, the Havasupai Tribe, and the Yavapai-Apache Nation. These efforts required closely working with parks, other NRSS divisions, the directorate, and the Department of the Interior to develop and recommend park protection strategies. The branch also continued to provide leadership of the NPS Wild and Scenic Rivers Program, including providing technical and policy guidance to Saint Croix National Scenic Riverway, the directorate, and the department regarding the controversial Stillwater Bridge crossing. In addition, WRB staff helped facilitate three Outstandingly Remarkable Value workshops and continued to provide technical support in conducting water resource project evaluations.

WRB continued to develop high-quality science products including the completion of 16 gauge station folders (Death Valley NP, Grand Teton NP, and Montezuma Castle NM); the Upper Great Salt Lake Desert Groundwater System Model (Great Basin NP); vegetation monitoring of reservoir releases on the Gunnison River (Black Canyon of the Gunnison NP); gain/loss investigation on the Niobrara and Rio Grande Rivers (Niobrara NSR and Big Bend NP); and a numerical groundwater model to simulate effects of groundwater withdrawals near Kaloko-Honokōhau National Historical Park. WRB staff describe some of our efforts to protect water in Chickasaw National Recreation Area, Dinosaur National Monument, Grand Teton National Park, Point Reyes National Seashore, White Sands National Monument, and Wind Cave National Park in the following articles.

WRB wants to thank dedicated park and regional staff for supporting our efforts in 2011, and we encourage you to call on WRB whenever water resources or water rights are at risk.

Arbuckle Simpson Hydrologic Study Completed

Jennifer Back, Hydrologist

THE LANDS THAT ENCOMPASS THE Historic Travertine District in Chickasaw National Recreation Area in south-central Oklahoma were set aside in 1902 to protect the flow of springs and streams. Since that time, many of the smallest springs have been lost. The two largest remaining springs, Antelope and Buffalo springs, obtain their discharge from the Arbuckle Simpson aquifer.

In 2003 efforts to construct a pipeline to convey water from the Arbuckle Simpson aquifer to communities 50 miles (80 km) away near Oklahoma City generated concern from local citizens. The project proposed to withdraw as much as 80,000 acre-feet (98.6 million m^3) of water per year, more than fifteen times the reported average annual use at that time. Local citizens—neighbors of Chickasaw—responded by creating a local aquifer protection group and successfully lobbying for the passage of new state legislation. This precedent-setting legislation was the first in Oklahoma to recognize the connection between groundwater and surface water.

Senate Bill 288 imposed a moratorium on the issuance of groundwater permits for use outside the counties that overlay the aquifer until such time as a hydrologic study was completed. The goal of the mandated hydrologic study was to determine a maximum annual yield for the aquifer that would not reduce the flow of water from springs or streams, including springs in the recreation area. The Water Rights Branch has represented Chickasaw throughout the multi-year hydrologic study by attending numerous stakeholder meetings, participating on technical advisory panels, and providing formal comments at public meetings. Results from the recently completed study indicate that the amount of water allocated in temporary permits prior to the legislation was not sustainable and the amount available for appropriation is much less than originally thought.

The final determination of maximum annual yield will have important implications for Chickasaw managers and their efforts to protect remaining spring flows. The Oklahoma Water Resources Board is expected to issue management recommendations and a determination of maximum annual yield in 2012. WRB will continue to work on behalf of the recreation area to support a determination of maximum annual yield that maintains the springs at Chickasaw.

Antelope Spring, Chickasaw National Recreation Area (Oklahoma). NPS/JENNIFER BACK

2011 Flood Flows on the Green and Yampa Rivers

Mark Wondzell, Hydrologist

THE WINTER OF 2010/2011 BROUGHT near-record snowpack to southwest Wyoming and northwest Colorado, producing the largest flood events in recent history on the Green and Yampa rivers in Dinosaur National Monument (Colorado, Utah).

On 9 June 2011 the Yampa River peaked at 27,400 cubic feet per second (cfs, 776 m^3/s), more than twice the average annual peak and second only to the 18 May 1984 record flood of 32,300 cfs (915 m^3/s). Flows on the Yampa remained above 15,000 cfs (425 m^3/s) for more than 50 days (compared to only 35 days in 1984). Similarly, the Green River—although controlled upstream by Flaming Gorge Dam—experienced its fourth-highest peak flow in over 100 years.

These near-record high flows lasting for weeks or even months are rare hydrologic events and have unmatched potential to (1) scour the stream channel and adjacent banks, (2) transport and deposit sediments, (3) remove trees and/or create surfaces for establishment of new trees, and (4) create new secondary channels or back channels and fill others. In late 2011 scientists and staff from the USGS, Utah State University, and the NPS (Dinosaur National Monument, Northern Colorado Plateau Inventory and Monitoring Network, and WRD) joined forces to document post-flood channel topography and riparian vegetation conditions along the combined 105-mile (169 km) river corridor. On-the-ground topographic surveys and vegetation sampling, coupled with airborne remote sensing that used both downward-looking Light Detection And Ranging (LIDAR) and multispectral image technology, were used to capture and define local channel conditions and vegetative cover along the banks and floodplains.

This 2011 data set will define "baseline" conditions for long-term monitoring against which future channel and vegetation change/response will be gauged. This data set will also allow immediate comparison to pre-flood LIDAR and multispectral imagery acquired in 2008 and 2010 and channel topographies and vegetation conditions captured in earlier sampling trips.

Long-term monitoring will allow park managers to document resource response to, and recovery from, these rare disturbance events, better inform reservoir management decisions, and illustrate the role of natural flows in maintaining the unique resources of Dinosaur National Monument.

Yampa River, 2010, in Dinosaur National Monument (Colorado, Utah). NPS/BILL HANSEN

The Feasibility of Restoring Streamflow to the Lower Gros Ventre River

Gwen Gerber, Hydrologist

THE GROS VENTRE RIVER (GVR) IS A major tributary of the Snake River and forms part of the southern boundary of Grand Teton National Park (Wyoming). Park resource managers are concerned that water diversions are potentially impacting natural resources along the lower GVR. Historically, the lower GVR has been seasonally dry from just downstream of the Highway 89/191 bridge to the Spring Gulch Road bridge, a short distance upstream from where the GVR enters the Snake. Grand Teton National Park requested assistance from WRD to determine the feasibility of restoring and/or maintaining perennial flow in this seasonally dry reach. In 2006 WRD initiated a study to evaluate water rights, inventory and measure diversions, conduct a seepage run, and develop a water budget for the lower GVR.

Discharge measurement on the lower Gros Ventre River, Grand Teton National Park (Wyoming).
NPS/GWEN GERBER

Twenty-four ditches existed along the lower GVR dating back to the 1890s. Only eight ditches conveyed water during the 2006 to 2009 study period due to ditch consolidation, non-use, source changes, or changes in points of diversion. Direct flow and supplemental water rights for these ditches total approximately 221 cubic feet per second (cfs, 6.3 m^3/s); 44% are owned by the United States and 56% are privately owned. A total of 147 discharge measurements were collected on these ditches with 54% exceeding total adjudicated direct and supplemental water rights and 28% exceeding direct, surplus, excess, and supplemental water rights.

WRD conducted a seepage run on 22 October 2008 to measure natural gains and losses. Natural gains of 43 cfs (1.2 m^3/s) occurred between the upstream park boundary and Kelly, Wyoming, and 42 cfs (1.2 m^3/s) occurred between the Spring Gulch Road bridge and the Snake River confluence. Natural losses of 120 cfs (3.4 m^3/s) occurred between Kelly and the Spring Gulch Road bridge.

An initial water budget, considering diversions and natural gains and losses, indicates that flows of about 220 cfs (6.2 m^3/s) are required at Kelly to meet total direct flow water rights and maintain perennial flow in the seasonally dry reach (364 cfs [10.3 m^3/s] for direct flow, surplus, excess, and supplemental). Based on these findings it appears that opportunities exist to manage water use on the lower GVR to restore perennial flows and protect valuable park resources.

Returning Water Rights to Nature at Point Reyes National Seashore

Eric Lord, Water Rights Specialist

THE ENABLING LEGISLATION OF Point Reyes National Seashore (California) in 1962 authorized the park unit to continue to acquire land as it became available, and as funding allowed, within described boundaries. The acquired lands often came with state appropriative water rights. Some of these rights are licensed for consumptive uses—including dairy operations, irrigation, livestock, and domestic purposes—on historic ranches that operate within park boundaries. As a general policy, park managers do not continue such consumptive uses since doing so may be contrary to park purposes. In accordance with state law, an existing right can be changed from a consumptive use to an instream use to enhance flow for the benefit of fish and wildlife.

In 2000 the National Park Service acquired the Waldo Giacomini Ranch at the south end of Tomales Bay. What was once a large tidal marsh complex had been degraded, and the hydrological and ecological function was reduced. Park staff and partners are now engaged in a multi-year and multi-faceted wetlands restoration project.

In 2010, as an essential part of the restoration project, the Water Rights Branch (WRB) filed petitions to amend four water rights licenses held by Point Reyes National Seashore from consumptive use to instream use. In total, approximately 2.5 cubic feet per second (.07 m^3/s) of water flow were returned to three streams—Olema, Lagunitas, and Fish Hatchery creeks—within and adjacent to the former ranch property. This change was the first of its kind accomplished by WRB in California. A number of national park units in California face similar state law-based water rights situations. WRB hopes to build on this success to change such water rights into a form more beneficial to the fish, wildlife, and natural ecosystems in the parks.

Above: Lagunitas Creek point of diversion. Below: Olema Creek point of diversion. Point Reyes National Seashore (California).
NPS/ERIC LORD

Groundwater Studies Help Protect Largest Gypsum Dunefield in the World

James Harte, Hydrologist

IN THE HEART OF THE TULAROSA Basin of south-central New Mexico sits the world's largest gypsum dunefield covering 275 square miles (712 km^2) of the Chihuahuan Desert. White Sands National Monument was established in 1933 to preserve and protect the most impressive portion of the dunefield along with the plant and animal species that have developed special adaptations to live in the gypsum dune environment, including the evolution of a white coloration that provides camouflage in the dunes. The dunes are underlain by a shallow water table which is essential to the functioning and maintenance of the dunefield and its associated ecosystem.

The Tularosa Basin is also home to Holloman Air Force Base, the city of Alamogordo, and the village of Tularosa, located on the east side of the basin at the foot of the Sacramento Mountains. Municipalities and the military rely on surface water from the Sacramento Mountains and groundwater pumped from shallow aquifers located along the east side of the basin. As the basin's population has grown, groundwater development in the Alamogordo–Tularosa area has increased to the extent that the state engineer declared the basin a "mined basin" and established the Alamogordo–Tularosa Administrative Area with limits on allowable aquifer water level decline.

White Sands, 15 miles (24 km) west of Alamogordo, is concerned that declining groundwater levels in the Alamogordo area could lower the shallow water table beneath the dunefield, destabilizing the dunes and associated ecosystem. WRD hydrologists helped park managers develop a scope of work and facilitated a cooperative agreement between the monument and the New Mexico Institute of Mining and Technology to investigate the source of water in the shallow aquifer underlying the dunefield.

Over the next two years ongoing studies will investigate whether the source of shallow groundwater is local precipitation, upwelling of deep groundwater, shallow groundwater flow from the east side of the Tularosa basin, or some combination. Results will give monument managers a better understanding of how a declining water table on the east side of the Tularosa Basin might affect shallow groundwater levels at White Sands and assist them in making management decisions that protect and preserve the largest gypsum dunefield in the world.

USGS Central Region Research Drilling Project crew completes a deep groundwater monitoring well at White Sands National Monument (New Mexico). NPS/ JAMES HARTE

Preliminary Results of Microbial Organism Study at Calcite Lake

Jeff Hughes, Hydrologist

THE WATER RIGHTS BRANCH IS working with Wind Cave National Park (South Dakota) to address proposed groundwater development concerns. As part of a continuing effort to determine the role that groundwater plays in cave evolution within Wind Cave National Park, a study was conducted to identify microbial life forms found in groundwater in the Wind Cave area. It is thought that microbes initiate many of the formations found within the cave. This information will be used as part of NPS efforts to describe groundwater flow-dependent processes in Wind Cave.

Dr. Hazel Barton, associate professor of biology at the University of Akron, collected water samples to be filtered for microbial analysis from several wells and springs within and in the vicinity of the park. Samples were also collected from Calcite Lake, an underground lake found approximately 500 feet (152 m) below the ground surface, formed where the groundwater table intersects the cave. The lake is located within the Pahasapa (or Madison) geologic formation, a limestone aquifer that is increasingly being considered for groundwater development.

Juan Giarrizzo prepares the pump and filter to collect a sample for microbial analysis in Calcite Lake, Wind Cave National Park (South Dakota). NPS COLLECTION

Collecting water samples at Calcite Lake was challenging; accessing the lake required a strenuous, several-hour trip that included carrying all the sampling equipment. This included a pump and specially designed filtration system that was small enough to fit through several narrow cave passages, able to operate for hours on battery power, and powerful enough to filter approximately 200 liters (53 gal) of water through a 0.22-micron membrane without clogging.

Preliminary results present unique discoveries. Microbial cell counts for Calcite Lake groundwater suggest this water contains one of the lowest cell concentrations ever recorded on earth (on the order of 1.47 to $3.48x10^3$ cells/mL [5.56 to $13.2x10^6$ cells/gal]). Also, the DNA extracted from these samples may document previously undiscovered genus, species, and possibly phyla. Overall study results suggest that microbial interaction with the rocks is an ongoing and important process in the creation of Wind Cave's world renowned cave formations.

Technical Assistance Highlights

WRD Staff and Aquatic Field Professionals

Dwarf arctic char captured during a feeding ecology study, Lake Clark National Park & Preserve. NPS/DAN YOUNG

FUNDING FROM THE NATURAL Resource Challenge once again helped support 15 field-based aquatic resource professional positions in FY 2011. The aquatic resource professional positions were developed to provide the National Park Service with both an extention and an expansion of the functions and capabilities provided by the Water Resources Division and the handful of water and aquatic resource professional positions base-funded in parks and regions.

The work of these field professionals and the day-to-day support that WRD staff provide to park units are described in the Technical Assistance Highlights. Technical assistance is the bread and butter of WRD operations. In the following pages, you can read a few selections that represent our work in the field. To find a comprehensive list of our technical assistance for FY 2011, please see Appendix B. You can also find a list of WRD staff and aquatic field professionals in Appendix D.

SERVICEWIDE

Represented the NPS on the BLM Solar Energy Programmatic Environmental Impact Statement. ¤ Represented the NPS on the Navajo Nation-Hopi Tribe, Hualapai Tribe, Havasupai Tribe, and Yavapai-Apache Nation Indian Federal Water Rights Negotiation and Assessment Teams. ¤ Served as the co-lead for the NPS Wild and Scenic Rivers (WSR) Program and member of the NPS WSR Steering Committee and Interagency WSR Coordinating Council. ¤ Represented NRSS on NPS Dive Control Board. ¤ Updated the website for Vital Signs Water Quality Data Management and Archiving at www.nature.nps.gov/water/vitalsigns/vitalsignsmgt.cfm. ¤ Set up WRD's WetNet mailing list as a true self-maintaining listserve rather than a series of Lotus Notes email groups. ¤ Provided ongoing support for a collaborative project with NatureServe, the National Interagency Fire Center, and the NPS Biological Resource Management Division to develop and pilot a set of landscape-scale interpretive products (resource condition narratives and maps) for use in NRCA projects. ¤ Worked with the Geologic Resources Division staff in advising Northeast Region development on the possible collateral effects of Marcellus Shale gas development and participated in bi-weekly conference calls. ¤ Participated in Climate Change Response Program meetings related to floodplain management and was project coordinator for Climate Change funded project. ¤ Reviewed Floodplain Statements of Findings for projects at many parks. ¤ Uploaded data from many parks to STORET. ¤

National Park Service Alaska Region: 54.65 million acres (gross area), 23 units*

* Regional acreage and unit totals from "Listing of Acreage as of 12/31/2011," NPS Land Resources Division

Top: NPS volunteer Helen Keeling holding a lake trout captured for contaminants analysis, Lake Clark National Park & Preserve (Alaska). NPS/DAN YOUNG

Bottom: USGS employee Charlie Couvillion measuring discharge in the Chulitna River drainage, Lake Clark National Park & Preserve (Alaska). NPS/DAN YOUNG

ALASKA REGION

Alaska Region Collaborated with USFS, FSWCD, and USFWS on *Elodea nuttallii* infestation on Chena Slough, Fairbanks; acquired aerial photography for Elodea infestation along Chena Slough; Elodea steering committee member. ¤

Katmai National Park & Preserve Participated on the NPS Resource Management Team regarding the Pebble Mine, a proposed copper and gold mine in southwest Alaska; attended meetings, reviewed study plans, and commented on fisheries resource issues. ¤

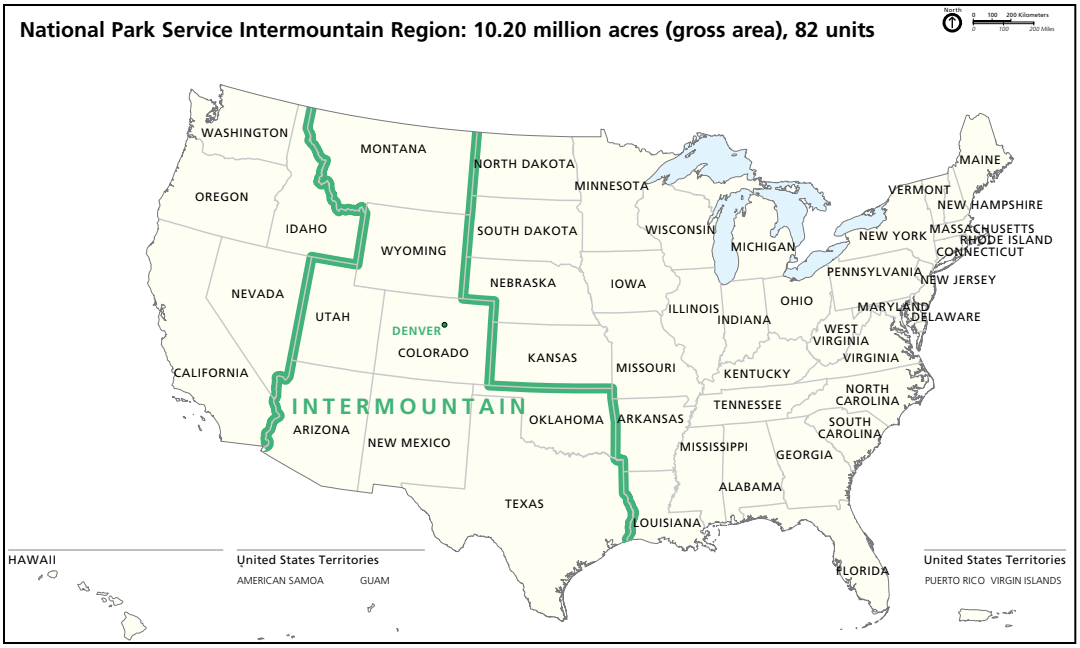
Lake Clark National Park & Preserve Provided project oversight, completed data analysis, and wrote an annual report for a monitoring project estimating the number of sockeye salmon returning to Lake Clark. ¤ Worked cooperatively with the Alaska Department of Fish and Game to coordinate logistics, hiring, and implementation of a sockeye salmon escapement project in the Kuskokwim River drainage in southwest Alaska. ¤ Coordinated logistics and sampling for a study assessing the feeding ecology of Arctic char in Lower Tazimina Lake. ¤

Sitka National Historic Site Provided guidance regarding protection of instream flows and the validity of non-NPS water rights on the Indian River. ¤

Yukon–Charley Rivers National Preserve and Gates of the Arctic National Park & Preserve Provided input on objectives for resource condition assessment. ¤ Provided input on Gates of the Arctic General Management Plan. ¤

Arctic Network Continued investigating the mechanisms of lake drainage in Kobuk Valley and helped develop a vulnerability model for lake drainage. Maintained contract with ABR Inc. ¤ Continued development of interactive geodatabase for observing large scale lake drying and thermokarst events in network parks. ¤

Southwest Alaska Network Planned and facilitated collection of bathymetry data for Upper and Lower Twin Lakes, Upper and Lower Tazimina Lakes, and Lachbuna Lake. ¤



NPS Hydrologist Jalyn Cummings identifies mussel species in Village Creek for mussel survey, Big Thicket National Preserve (Texas). NPS COLLECTION

INTERMOUNTAIN REGION

Intermountain Region Served as NPS Hydrologist on Intermountain Regional Burned Area Emergency Response (BAER) Team for Horseshoe 2 fire in Coronado National Forest and Chiricahua National Monument. ¤ Served as chair of the Biology Committee/Management Committee representative of the Upper Colorado River Endangered Fish Recovery Program from January 2011 to December 2011. ¤

Arches National Park (Utah) Prepared Scope of Work for "A Hydrologic Evaluation of Waters of the Entrada and Navajo Aquifers in the Courthouse Wash Area, Arches National Park, Grand County, Utah." ¤

Bandelier National Park (New Mexico) Provided advice on best ways to prepare for flooding after very large fires occurred this year; planned trip to park in autumn to get a better idea of conditions and will help in future planning-related activities. ¤

Big Bend National Park/Rio Grande Wild & Scenic River (Texas) Participated in gain/loss study to quantify groundwater contributions via spring flows to the mainstem of the Rio Grande River. ¤ Faciliated the Outstandingly Remarkable Values workshop for the Rio Grande River. ¤

Big Thicket National Preserve (Texas) Provided hydrologic oversight for the Chevron pipe removal project at the preserve, requiring multiple site visits and coordination of multiple stakeholders. ¤

Black Canyon of the Gunnison National Park (Colorado) Participated in the design/implementation of a long-term monitoring program to document changes in riparian vegetation as a function of upstream reservoir releases. ¤

Bryce Canyon National Park (Utah) Conducted analyses of radius of groundwater travel time to the water-supply wells in the East Creek wellfield. ¤

Chiricahua National Monument (Arizona) Coordinated planning and installation of an ALERT precipitation gauge in the upper Bonita and Rhyolite Creeks watershed area with state and county early flood warning programs and park resource staff. ¤

Jeanette Haegele (USGS) checks a minnow trap in Iceberg Canyon, Glen Canyon National Recreation Area (Arizona, Utah). NPS/MELISSA TRAMMELL

Fort Bowie National Historic Site (Arizona) Developed scope of work and shepherded contracting documents for Southwest Conservation Corps crew to implement erosion control treatments in upper Apache Spring watershed; worked with park staff to develop treatment plans and purchase supplies for project. ¤

Grand Canyon National Park (Arizona) Removed nonnative fish from Bright Angel Creek by electrofishing, and operated and maintained fish weir to block upstream movement and remove nonnative trout; the project is funded by the Bureau of Reclamation and NPS and conducted in cooperation with the University of Missouri and Grand Canyon Trust. This multi-agency group is working together to restore the native fish community in Bright Angel Creek with help from many volunteers. ¤

Mesa Verde National Park (Colorado) Initiated wetlands restoration project to rehabilitate an abandoned sewage lagoon. ¤

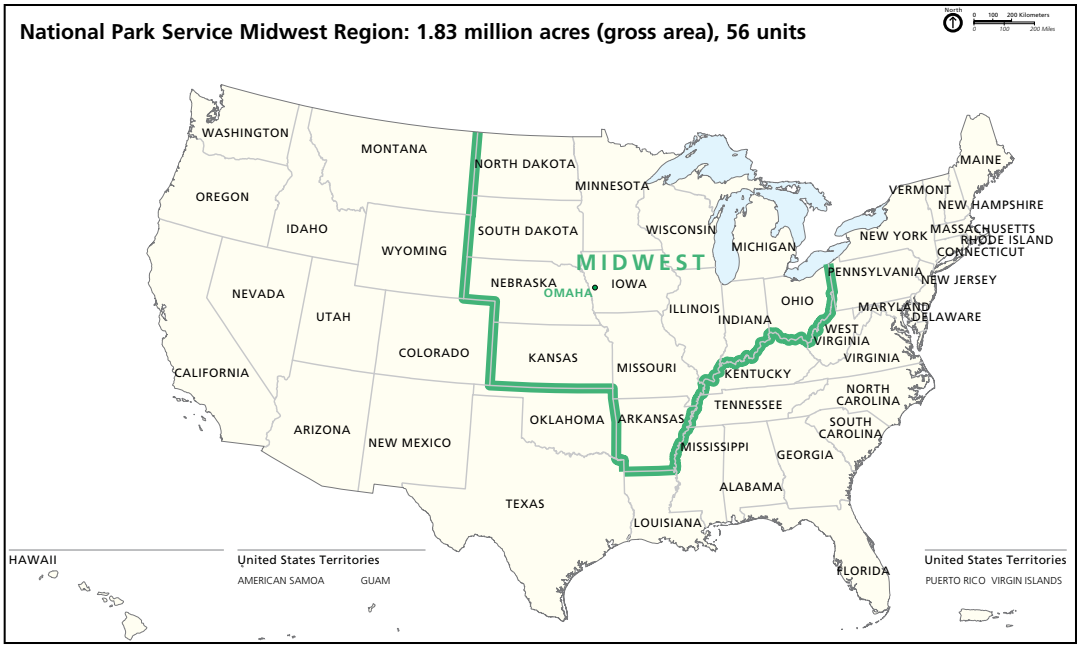
Montezuma Castle National Monument (Arizona) Monitored USGS investigation to determine source and flowpaths of groundwater in Montezuma Well. ¤

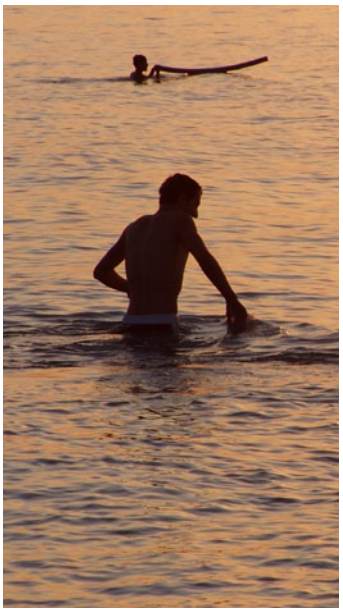
Organ Pipe Cactus National Monument (Arizona) Assessed causes of pictograph deterioration at Wild Horse Tanks site, identified measures to reduce water-related impacts to the pictographs. Submitted trip report with management recommendations to park resource staff; the recommendations were subsequently acted on by the park. ¤

Tonto National Monument (Arizona) Provided technical support to ongoing study of soil moisture dynamics and groundwater percolation at the unique Hidden Ridge woodland site. ¤

Tuzigoot National Monument (Arizona) Provided technical review and comments on the Environmental Assessment for the Tavasci Marsh Management and Habitat Enhancement Plan. ¤

Northern Colorado Plateau Network Conducted a training for Arches and Northern Colorado Plateau Network staff regarding detailed survey methods and riparian monitoring techniques. ¤





Swimmers in the sunset light at Indiana Dunes National Lakeshore (Indiana). NPS/CHRISTOPHER LIGHT

MIDWEST REGION

Midwest Region Developed a successful proposal to the NPS Air Resources Division to investigate nitrogen deposition histories for Great Lakes Network lakes, using archived sediment core material; prepared related agreement documents. ¤ Worked with NPS staff, Minnesota Department of Natural Resources staff, and Michigan Technological University to coordinate data analysis and reporting aspects of the multi-park spiny water flea project. ¤

Cuyahoga Valley National Park (Ohio) Reviewed the results of additional sampling requested by WRD staff to ensure that appropriate due diligence was performed prior to land acquisition by NPS where potential existed for historic dumping of hazardous wastes. Further sampling recommendations were made after completing reviews of Phase I and Phase II site pre-acquisition assessment reports, and these results were favorable toward continuing the acquisition process. ¤

Grand Portage National Monument (Minnesota) Conducted simple hydraulic modeling assessment of proposed road crossing and provided advice on low-water crossing design. ¤

Indiana Dunes National Lakeshore (Indiana) Provided baseline water quality data inventory and analysis report data and advised on its use and interpretation. ¤ Provided review of the Baseline Environmental Risk Assessment (BERA) for the Bailly Generating Plant RCRA site. ¤

Isle Royale National Park (Michigan) Provided technical and logistical assistance to university cooperators conducting the Isle Royale/Acadia nitrogen critical loads project. ¤ Worked with staff to finalize revised northern pike regulations for inland lakes of Isle Royale. ¤

Knife River Indian Villages National Historic Site (North Dakota) Investigated extent and implications of river erosion at Knife River, developed and implemented an erosion monitoring plan for park staff, and made recommendations to park management on watershed management solutions. ¤ Reviewed and commented on technical memo regarding streambank erosion. ¤

Citizen scientist at Beaver Marsh, Cuyahoga Valley National Park (Ohio). NPS/MEG PLONA

Niobrara National Scenic River (Nebraska, South Dakota) Provided advice to support hydrologic, economic, and fish and wildlife studies to support state-based in-stream flows on the Niobrara River. ¤

Ozark National Scenic Riverways (Missouri) Investigated potential impacts from a proposed large-scale dairy within the recharge area of Big Spring. ¤

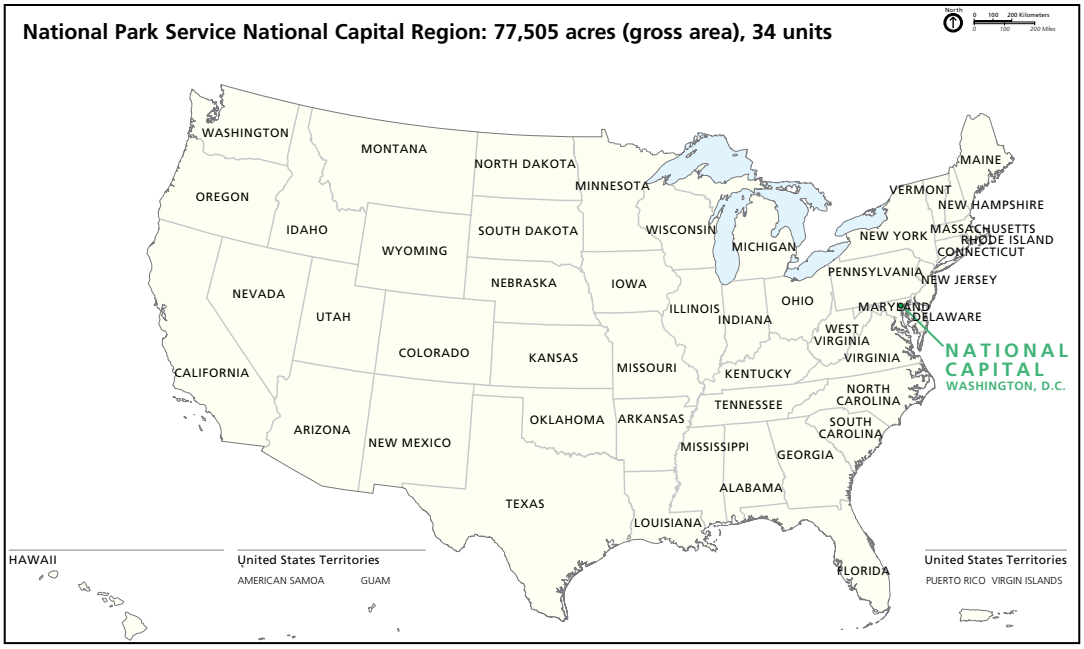
Pictured Rocks National Lakeshore (Michigan) Coordinated field sampling for native mussel and fish host investigations. Purchased fisheries field equipment for park's use on project. ¤

Saint Croix National Scenic Riverway (Minnesota, Wisconsin) Provided field and analytical assistance for USGS zebra mussel effects study and climate change effects studies. ¤

Sleeping Bear Dunes National Lakeshore (Michigan) Published "Links between type E botulism outbreaks, lake levels, and surface water temperatures in Lake Michigan, 1963–2008" in Journal of Great Lakes Research. ¤ Obtained bathymetry and historical aerial imagery and created GIS data of historic shorelines in support of dock relocation analysis on North and South Manitou Islands. ¤

Theodore Roosevelt National Park (North Dakota) Initiated a USGS study to determine drought stress on cottonwood trees on the Little Missouri River. ¤

Voyageurs National Park (Minnesota) Helped plan for collection and mercury analysis of additional native crayfish and invasive rusty crayfish from a recently invaded Voyageurs site. ¤

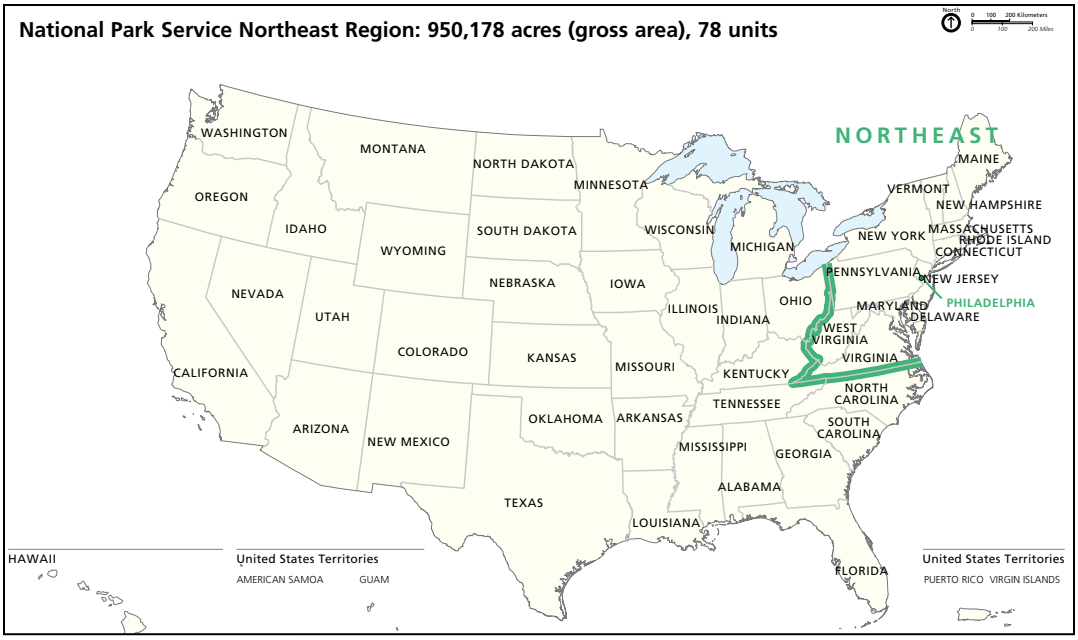


NATIONAL CAPITAL REGION

National Capital Region The hiring process for an NCR–NER shared Aquatic Ecologist position was completed with the new employee entering on duty on 9 October 2011. Equipment and computers were purchased to establish the aquatic ecology program. Each region will contribute $25,000 or more to the position, augmenting the WRD base by $80,000. ¤ Provided support and advice in the use of NPSTORET, troubleshooting data and coding issues, and retrieving data from the STORET Data Warehouse. ¤

Rock Creek Park (District of Columbia) Provided hyrologic and hydraulic support related to the recent compliance and erosion problems associated with a road-widening project in the park. ¤

Rock Creek Park (Washington, DC) NPS/DWIGHT MADISON



A volunteer citizen scientist releases a tagged horseshoe crab into Great South Bay, Fire Island National Seashore (New York).
NPS/PATRICIA RAFFERTY

NORTHEAST REGION

Northeast Region Provided input to Federal Chesapeake Bay Watershed Implementation Plan guide. Evaluated list and provided compliance contacts for National Parks within the watershed.

Appalachian National Scenic Trail (Maine to Georgia) Organized first year progress review of the Appalachian Trail Atmospheric Deposition Study; this study includes more than ten independent researchers with various affiliations and examines effects and potential for recovery of air, soil, water, and vegetation along the entire AT. The study serves as an example for using the trail as a MEGA-transect to evaluate environmental change across a sensitive corridor that includes most of the eastern states. Collected water and soil samples to support this research. ¤

Boston Harbor Islands National Recreation Area (Massachusetts) Evaluated wetland condition and potential for restoration with NER team; assisted with development of trip report to describe findings. ¤

Cape Cod National Seashore (Massachusetts) Provided review of municipal water supply projects at Wellfleet and Eastham. ¤ Funded Woods Hole Oceanographic Institution to investigate the dynamics of anthropogenic nutrient discharges and harmful algal blooms, and to produce tools to assist park managers in developing policy and management for nutrient control and remediation. ¤

Delaware Water Gap National Recreation Area (New Jersey, Pennsylvania) Developed proposal with Delaware Water Gap and State University of New York College of Environmental Science and Forestry as a CESU partner to evaluate historic flows along the river pre-forest harvesting, pre-dam construction, and modern day. ¤

Student Conservation Association volunteers assist with nekton sampling adjacent to the Sailors Haven Marina, Fire Island National Seashore (New York).
NPS/PATRICIA RAFFERTY

Gateway National Recreation Area (New Jersey, New York) Implemented ecological monitoring to evaluate restoration of 69 acres (28 ha) of salt marsh at Elders Point East and West, Jamaica Bay. Monitoring parameters include nekton, vegetation, and avian species composition and abundance; above- and below-ground primary production; and macrobenthic infauna and epifauna. As a result, received Coastal America Spirit Award for exceptional partnering to protect and conserve coastal ecosystems; this award recognized efforts of the multiagency partnership that worked cooperatively. ¤

Hopewell Furnace National Historic Site (Pennsylvania) Provided written and verbal reviews of Corps of Engineers hydrologic and hydraulic models designed to evaluate alternatives to reduce flooding of park buildings. ¤

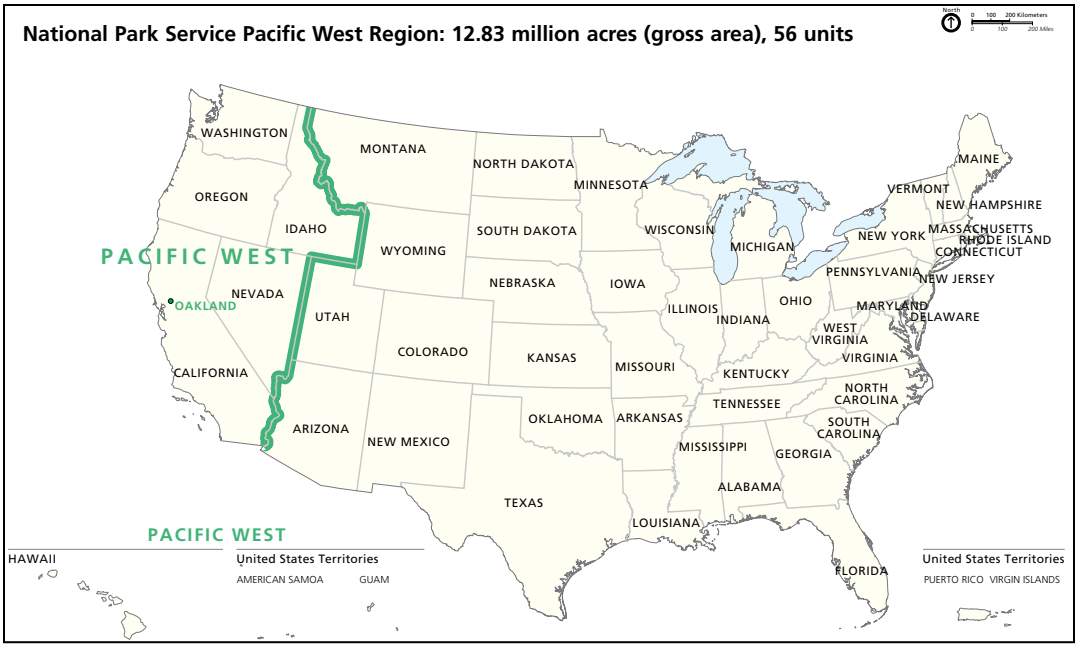
National Parks of New York Harbor (New Jersey, New York) Contributed technical knowledge on ecosystem ecology and restoration via participation in the National Parks of New York Harbor: A Strategy to Become America's Premier Urban National Park Planning Charette. ¤ Worked cooperatively with National Parks of New York Harbor Education Center on a Youth-in-Parks application and mentored one YIP participant in July and August 2011. ¤

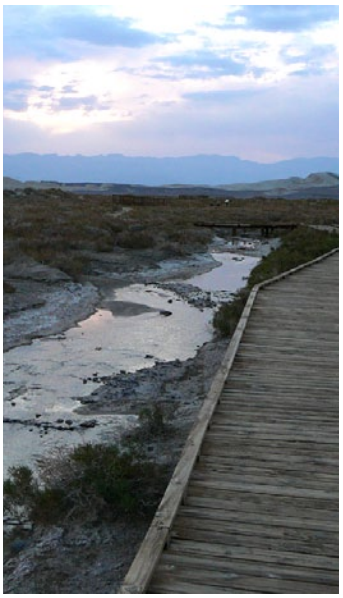
Sagamore Hill National Historic Site (New York) Assisted University of Rhode Island CESU cooperator in presenting a horseshoe crab interpretive program. ¤

Saugus Iron Works National Historic Site (Massachusetts) Funded project to monitor *E. coli* in the Saugus River. ¤

Shenandoah National Park (Virginia) Provided review and comments on the Shenandoah Watershed Study Monitoring Protocol Narrative and SOPs. ¤ Provided support to the University of Virginia and the USGS on water quality and fisheries-related databases for the park. ¤

Valley Forge National Historical Park (Pennsylvania) Provided written comments on water resource stewardship strategies for planning. ¤ Provided written review of Natural Resource Condition Assessment. ¤





Salt Creek and boardwalk in Death Valley National Park (California). NPS COLLECTION

PACIFIC WEST REGION

Pacific West Region Provided technical assistance for Natural Resource Managers in PWR for reviewing and improving proposals seeking funding for ecological restoration and monitoring projects. ¤ Served as NPS liaison to National Ocean Policy planning team for water quality and coastal land management practices. ¤ With interagency government team, facilitated by USFS Hydrologist, co-authored recommendations to California State Water Plan Update regarding protection of wet meadow habitats. ¤

Channel Islands National Park (California) Co-led project to design Prisoners Harbor Coastal Lagoon Restoration Project to restore degraded wetland on Santa Cruz Island; project to benefit migratory birds and archeological resources. In FY 2011 completed needed permits, drafted monitoring plan, completed contracting for earthmoving and plant grow-out, and completed proposals seeking additional funding; project to be completed FY 2012.

Death Valley National Park (California) Participated in Amargosa Desert Managers Group meetings, an interagency work group established to discuss water resource concerns in the Amargosa Desert basin—including Devils Hole, a detached unit of Death Valley National Park. ¤

Devils Postpile National Monument (California) Conducted field reconnaissance of Devils Postpile and Mammoth Mountain area to evaluate water resources, the hydrogeologic setting, and evidence of groundwater–surface water interactions. ¤ Provided comments for the draft Natural Resource Condition Assessment. ¤

Grand Canyon–Parashant National Monument (Arizona) Provided technical oversight on the implementation of a phased reconnaissance-level study conducted by the USGS to evaluate the water source of Tassi Spring and Pakoon Spring. ¤

Engineered logjam construction to stop stream bank erosion threatening the Carbon River Entrance Station at Mount Rainier National Park (Washington). NPS/ BEN WRIGHT

Great Basin National Park (Nevada) Assisted WRD, Great Basin National Park, and Lake Mead National Recreation Area in developing cooperating agency comments to the administrative draft EIS and the draft EIS for the Clark, Lincoln, and White Pine counties groundwater development pipeline project. ¤ Assisted the WRD in implementing an interagency supported field program near Great Basin to characterize the potential for impacts to surface water and groundwater resources in and around the park from proposed groundwater development in Snake Valley, Nevada. ¤

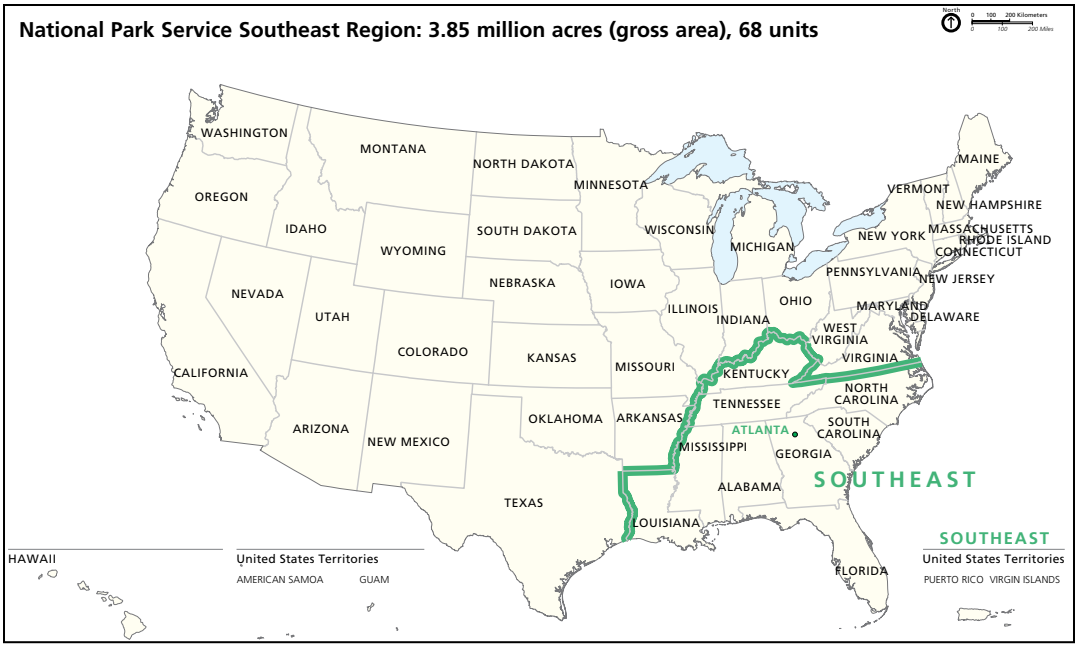
Minidoka National Historic Site (Idaho) Provided assessment of potential impact of a nearby Concentrated Animal Feeding Operation and assisted park in developing a groundwater monitoring plan. ¤

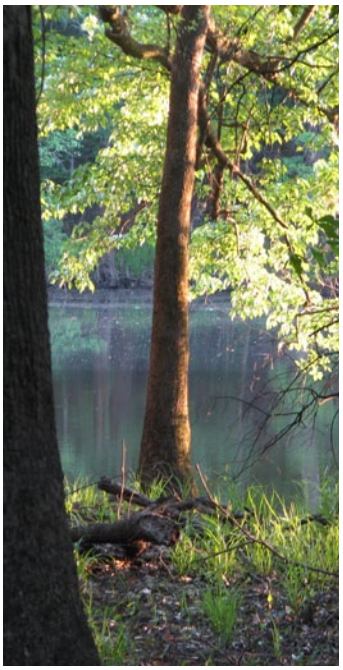
Mojave National Preserve (California) Formulated and submitted scoping comments outlining NPS concerns with potential impacts to Mojave National Preserve's groundwater resources associated with the resurrected Cadiz Valley Water Conservation, Recovery, and Storage Project. Assisted park with development of a management plan for springs and guzzlers. ¤

Mount Rainier National Park (Washington) Provided technical assistance on engineered logjam placement locations for the Carbon River and interim barb installation near entrance; engineered logjams provide permanent, superior erosion protection, while minimizing impacts to fish habitat. ¤

National Park of American Samoa (American Samoa) Advised superintendent, PWR, and DOI on proposed expansion of Fagatele Bay National Marine Sanctuary and overlay of national park marine area. ¤

Sequoia and Kings Canyon National Parks (California) Assisted with developing a scope of work to assess potential impacts of private septic systems in the Mineral King area. ¤





Weston Lake at Congaree National Park (South Carolina). NPS/ THERESA THOM

SOUTHEAST REGION

Southeast Region Continued to develop a sediment budget for restoration in the northern Gulf of Mexico Coast. Participated in administering the annual Servicewide Combined Call including projects that resulted in protection and/or restoration of wetland habitat. ¤

Deepwater Horizon Oil Spill Participated in DWH Oil Spill NRDA activities. ¤ Co-chaired Submerged Aquatic Vegetation Technical Working Group (TWG). ¤ Served as NPS lead on Shoreline TWG; trustee co-lead for Beach Subgroup; hosted TWG meetings at Jean Lafitte National Historical Park and Preserve. ¤

Big South Fork National River and Recreation Area (Kentucky, Tennessee) Assisted park in evaluating potential impacts to aquatic resources associated with the Roberta Landfill. ¤ Drafted formal determination document regarding potential impacts of Roberta Landfill to the park, and negotiated potential mitigation alternatives. ¤

Cane River Creole National Historical Park (Louisiana) Reviewed and provided comments on the Draft Construction Plans for Emergency Stabilization/Erosion Control on the Bank of Cane River Lake. ¤ Reviewed and provided comments on Draft Wetlands Statement of Findings (WSOF). ¤

Cape Lookout National Seashore (North Carolina) Provided GIS and remote sensing support (assembled imagery, provided maps, change analysis, etc.) to park staff and Hurricane Irene Incident Management Team. ¤

Congaree National Park (South Carolina) Reviewed and provided comments for Ramsar Convention designation as a wetland of international significance. ¤

Dry Tortugas National Park (Florida) Reviewed and provided comments on Garden Key Cultural Landscape Report. ¤

Northern gannet rescued for cleaning, West Ship Island, Gulf Islands National Seashore (Florida, Mississippi). NPS/KRISTEN MAXWELL

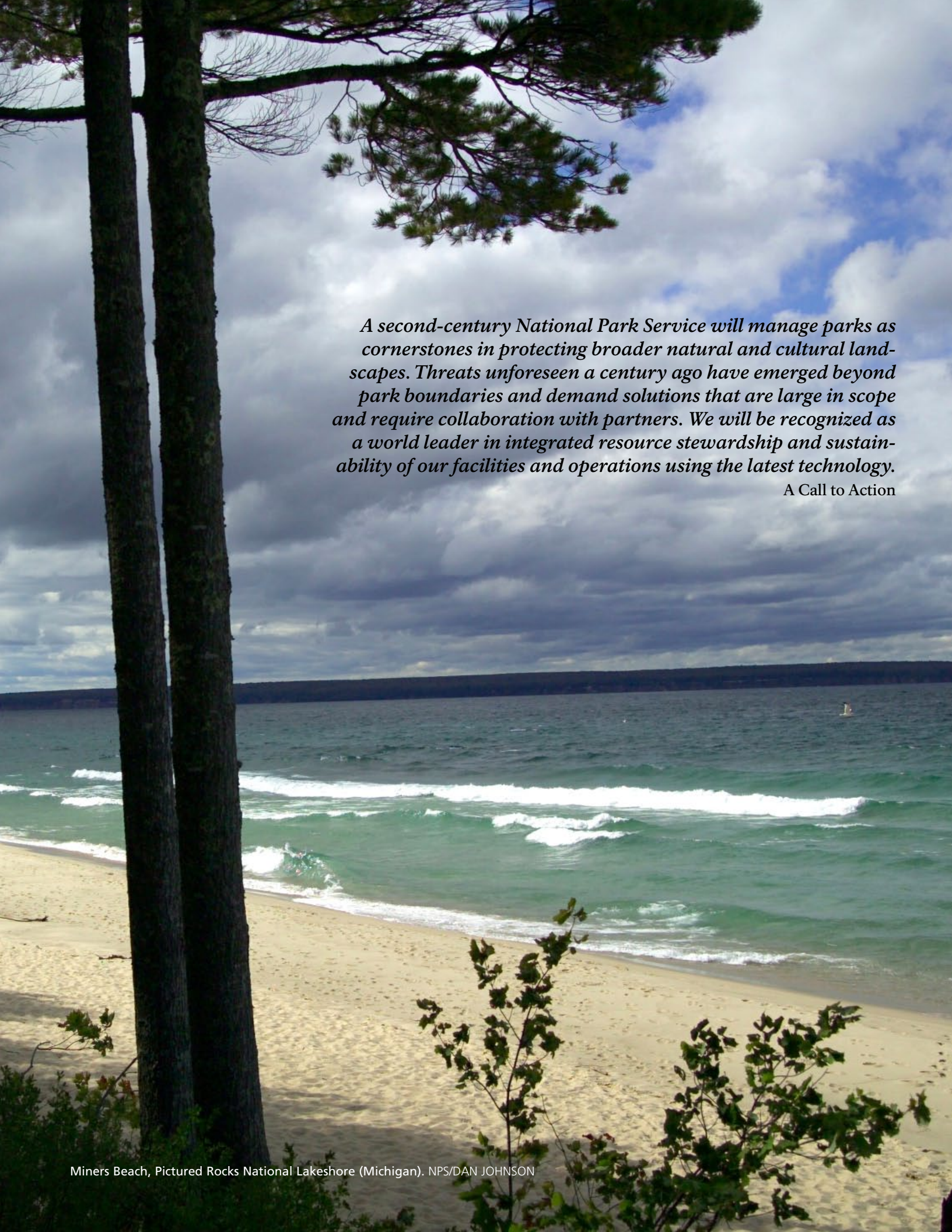
Fort Pulaski National Monument (Georgia) Reviewed and provided comments on the Cockspur Island Cultural Landscape Report. ¤ Reviewed Savannah River Dredging EA for potential impacts to Fort Pulaski for Corps of Engineers. ¤

Great Smoky Mountains National Park (North Carolina, Tennessee) Provided hydrogeological assessment for a new well at Cades Cove. ¤

Gulf Islands National Seashore (Florida, Mississippi) Assisted DOI representatives in evaluating potential restoration alternatives associated with the Deepwater Horizon Incident. ¤ Served as a Resource Advisor overseeing night cleanup of oil deposited on beaches. ¤ Reviewed and provided comments on NRCS Gulf of Mexico Initiative which will impact Gulf Islands. ¤ Funded Dauphin Marine Laboratory to measure the impacts of oil on seagrass beds at Gulf Islands. ¤

Jean Lafitte National Historical Park and Preserve (Louisiana) Assisted staff in obtaining funding for canal restoration project; visited and reviewed the ongoing project as well as data indicating that hydrology is improving and reverting to a natural regime. ¤

Obed Wild and Scenic River (Tennessee) Assisted park in evaluating instream impacts of the proposed Lake Tansi Water Harvesting project. ¤ Worked with park to determine potential impacts of pesticides to control the hemlock woolly adelgid invasion. ¤



A second-century National Park Service will manage parks as cornerstones in protecting broader natural and cultural landscapes. Threats unforeseen a century ago have emerged beyond park boundaries and demand solutions that are large in scope and require collaboration with partners. We will be recognized as a world leader in integrated resource stewardship and sustainability of our facilities and operations using the latest technology.

A Call to Action

Miners Beach, Pictured Rocks National Lakeshore (Michigan). NPS/DAN JOHNSON

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Canoe on Lake McDonald, Glacier National Park (Montana).
NPS/DAVID RESTIVO

Water Resources Division
SUMMARY OF FISCAL YEAR 2011 ACCOMPLISHMENTS

National Park Service
Director — Jonathan B. Jarvis

Natural Resource Stewardship and Science
Associate Director — Bert Frost
Deputy Associate Director for Budget and Policy — Beth Johnson
Deputy Associate Director for Operations and Program Support — George Dickison

Published electronically at www.nature.nps.gov/water/wrdpub.cfm

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Foggy Daybreak at Ponca Access, Buffalo National River (Arkansas). NPS/DALE DOMBROWSKI