

Rec'd
2/2/98

The U.S. Geological Survey Recent Highlights—Information Management - Innovative Earth Science Databases

Introduction

The national databases of the U.S. Geological Survey (USGS) are essential foundations for scientific research and daily decision making by government agencies, industry, and the public. These databases, which characterize conditions from ocean depths to planetary frontiers, are relevant to public safety, environmental restoration, natural resources planning, policy making, and economics. Many of the databases represent joint efforts and partnerships with other agencies and are applied to societal needs as they arise. Containing unbiased observations of physical, chemical, and biological phenomena, the strength of these databases lies in their breadth, consistency, long-term maintenance, and innovative delivery using CD-ROM and the Internet. This fact sheet describes a selected set of USGS earth science databases and demonstrates their relevance to the Nation.

Nonindigenous Aquatic Species Database and Geographic Information System

Nonindigenous aquatic species are a major source of both socioeconomic benefits and costs to many sectors of American society. These species also present a significant threat to the maintenance of biological diversity. Primarily in response to the introduction of zebra mussels into the Great Lakes, Congress enacted the Nonindigenous Aquatic Species Prevention and Control Act of 1990. The major focus of the act was to reduce the risk of unintentional introductions and to monitor and control nonindigenous aquatic nuisance species. A core element of the Act was to create an information service to provide timely, reliable data about the presence and distribution of nonindigenous aquatic species.

The USGS National Nonindigenous Aquatic Species Geographic Information System provides online access to over 40,000 geographically referenced accounts of over 750 species of aquatic vertebrates, invertebrates, and plants. This service also provides maps (fig. 1), fact sheets, and

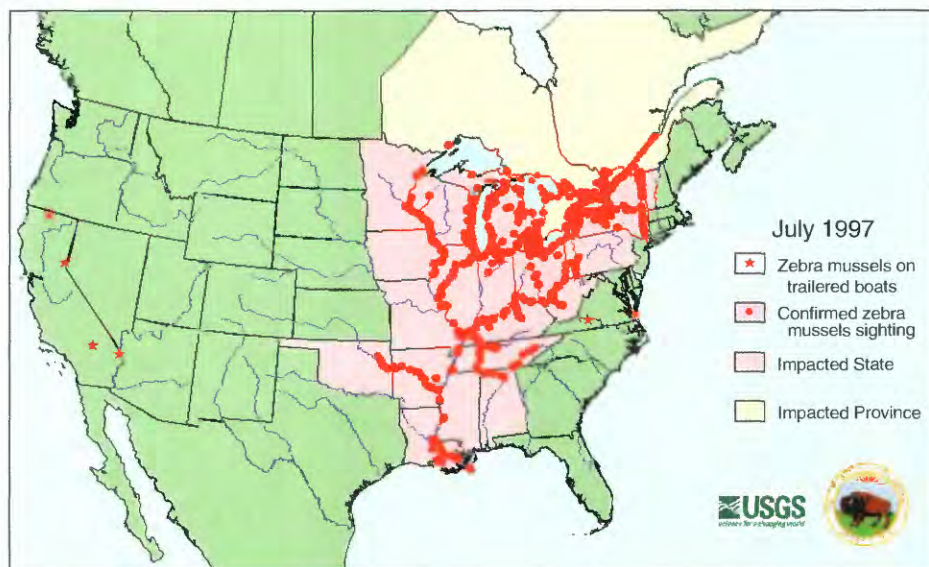


Figure 1.—Zebra mussel (*Dreissena polymorpha*) distribution in North America.

scientific reports regarding aquatic introductions reported since 1850.

This service is routinely used by the Department of the Interior Bureaus, NOAA, the Department of Agriculture, State agencies, universities, and numerous U.S. and Canadian private industries to monitor the distribution of these organisms and to enable regional and national assessments of important species for management and control. The system has also been recognized as the model for developing a joint United States/Canada/Mexico monitoring system under the auspices of the North American Free Trade Agreement (NAFTA).

Although USGS staff can provide custom queries, maps, and reports, the system is available for public access at <URL: <http://nas.er.usgs.gov>>. To date the site has been accessed by nearly 100,000 unique users from around the globe.

Readily Accessible Planetary Image Data

USGS astrogeologists are supporting NASA's Planetary Data System (PDS), which contains a variety of planetary science data collections acquired by NASA flight projects. The USGS and the Jet Propulsion Laboratory jointly maintain and distribute the PDS component containing

archives of planetary image data. The image data, now approaching a terabyte in volume, provide a foundation for remote sensing research for virtually all the planetary systems in our solar system (except for Pluto). The image data available through the World Wide Web (WWW) include data from NASA's Mariner 9 and 10, Viking, Voyager, Magellan, and Galileo missions and from the joint Department of Defense and NASA Clementine Mission.

With the shift from distribution on physical media to remote access, all interested scientists and the public can now obtain data on CD-ROM (fig.2) or immediately at



Figure 2.—Image from the Mission to Mars: Digital Color Mosaics, Volume 14, CD-ROM.

no cost over the Internet at <URL: <http://www-pdsimage.jpl.nasa.gov/PDS/>>. The USGS also maintains Internet access to public-release image products from active flight projects, such as the Mars Pathfinder, at the NASA Photojournal WWW site, <URL: <http://photojournal.wr.usgs.gov>>

The USGS provides digital image processing tools and specialized information necessary to understand the image collections, and it restores data sets from past missions in danger of being lost. Future data sets will be obtained from NASA's Galileo (observations of the Jovian system), Mars Pathfinder, Cassini, and Mars Surveyor missions. One priority area for future work will be developing related data sets, such as the Magellan F-MAP's, three-dimensional rendered images, movies of planet surfaces, and other specially processed images of wide community interest.

Assessing the Mineral Resources of the Nation

Most mineral resource investigations begin with the question, "Where are the known deposits?" USGS mineral resource databases contain this information and additional mineral resource data that are beneficial for sustainable resource use. These data are available to mining and exploration companies, environmental groups, academia, other Federal agencies, and the general public.

At present, the USGS has two large mineral resource databases. The Mineral Resource Data System was built and is maintained by the USGS and contains mineralogic and geologic data. The Minerals Availability System was built by the former Bureau of Mines and transferred to the USGS when the agency was abolished. This database contains minerals industry data, including reserves, production information, costs, and details of mining methods. Combined, the databases contain approximately 300,000 unique domestic and international sites and are useful for natural resource conservation.

The USGS uses these databases to perform mineral resource assessments of Federal lands, primarily at the request of the Bureau of Land Management (BLM) and the Forest Service. By combining the information in the databases with other scientific information, such as regional geology, geophysics, and geochemistry, the USGS produced a national assessment of favorable areas for discovering resources of gold, silver, copper, lead, and



Figure 3.—Map showing favorable areas for silver-rich deposits in the Great Basin.

zinc. As a result of this assessment, maps such as the one in figure 3 were produced. Products such as these, when applied to BLM Resource Areas or National Forests, are valuable tools for land use planning and for determining probable areas where exploration and mineral development may take place in the foreseeable future.

In addition to providing mineral resource assessments, the databases support research on the environmental consequences of mining and supply scientific information needed to formulate plans for effective and cost-efficient cleanup of abandoned mine lands. Combining data from these two databases with other geological information, USGS scientists developed a model that was one of the tools used by BLM, the Forest

Service, and the State of Montana to establish priorities for cleanup efforts on the various watersheds in that State. Both databases are available on CD-ROM. The USGS will also be placing some parts of the databases on the WWW in 1998.

Cooperative Research and Development Agreement will Facilitate Access to USGS Image Database

The USGS supplies the Nation with an extensive database of digital, multipurpose map and image data. To make high-resolution image products more accessible to the public, the USGS and the Microsoft Corporation of Redmond, Wash., have entered into a cooperative research and development agreement (CRADA) to make more than 3 terabytes of digital orthophoto quadrangle (DOQ) data available through the Internet. DOQ's are digital images of aerial photographs in which displacements caused by the camera and the terrain have been removed (fig. 4) and the image characteristics of a photograph are combined with the geometric qualities of a map. The standard image has a 1-meter ground resolution.

The agreement, which began in May 1997, is a 36-month joint effort to create a public-oriented image browsing and retrieval site capable of serving millions of customers per day. The agreement benefits the USGS by attracting an entirely new user community for USGS spatial data; this was done by implementing an intuitive user interface that enables nonspecialized users to navigate a large dataset as if it were a single image.



Figure 4.—Part of a USGS digital orthophoto quadrangle showing the White House in Washington, D.C.

Water Quality Data for Monitoring the Health of the Nation's Waterways

A nationally consistent and well-documented collection of water-quality data compiled during the past 30 years for streams and rivers in the United States was recently published as a set of two CD-ROM's.

The data describe water quality conditions in major rivers and selected small streams during a period when considerable change, brought about in part by regulatory actions, occurred in terrestrial and atmospheric sources of water pollutants in the United States. The data have been used to track changes in water quality and investigate the effects on water quality from the natural environment and anthropogenic contaminant sources, such as agricultural fertilizers, livestock wastes, atmospheric deposition, and wastewater treatment plant discharges.

The stream-monitoring data include measurements for 122 physical, chemical, and biological properties of water collected in two national networks. The Hydrologic Benchmark Network (HBN) data were collected from 63 small, minimally disturbed watersheds during the years 1962-1995 and are used for investigating naturally induced changes in streamflow and water quality and the effects of airborne substances on water quality. The National Stream Quality Accounting Network (NASQAN), consisting of 618 larger, more culturally influenced watersheds, provides data on water-quality conditions in major U.S. rivers and streams for the period 1973-1995. The water-quality data are geographically identified by river name, station locations, State, county, and hydrologic drainage basin.

The CD-ROM's also contain quality-assurance information on network operations and historical records documenting the sample-collection agencies, laboratories, analytical methods, and other information to assist in the proper use of the stream water-quality data, and a bibliography containing references to national, regional, and local summaries and interpretations of the water-quality data.

The CD-ROM set is available from the USGS Digital Data Series as DDS-37. All data are available in ASCII format on the "ASCII disc" and can be accessed from a user's WWW browser or spreadsheet program. Internet access is also provided to the disc at <URL: <http://www.wrvaes.er.usgs.gov/wqn96/>>.

A second disc, the "DOS disc," includes software (operational on Windows

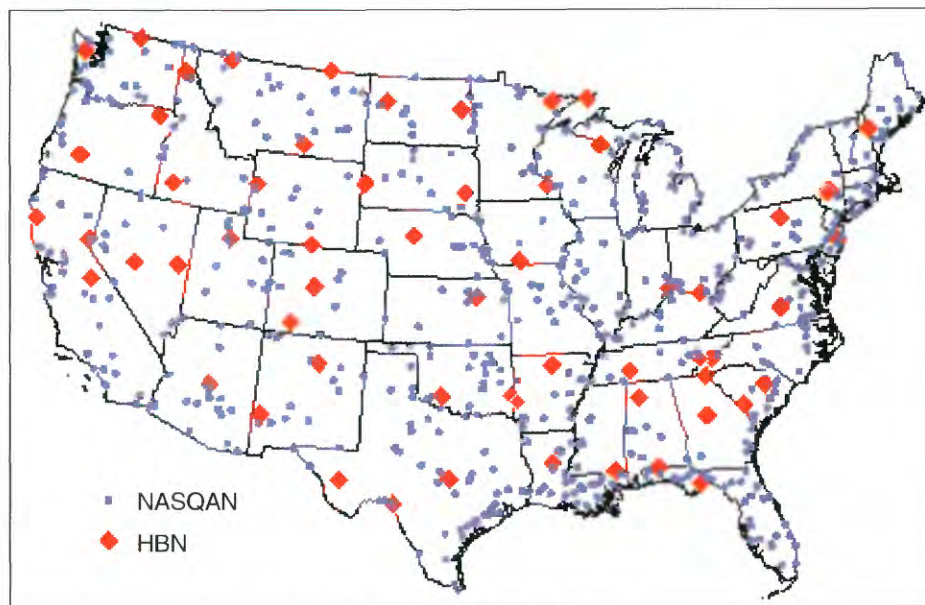


Figure 5.—Station-monitoring locations in the conterminous United States.

systems) that is capable of browsing text files and retrieving and printing data according to user-specified criteria.

North American Amphibian Malformations Database

The issue of malformed amphibians has captured both scientific and public attention. The USGS's North American Reporting Center for Amphibian Malformations is consolidating observations in a database so that scientists can look for and find patterns and trends in the types and incidences of malformations. The database observations are geographically referenced, which will make it possible to examine spatial associations with other variables of interest. As the database matures, it will also reflect temporal trends in malformations, and data synthesis will provide land managers with objective means to assess the extent of the problem in their areas of concern. The work is funded cooperatively by the USGS and the U.S. Environmental Protection Agency.

The Reporting Center uses the WWW (<URL: <http://www.npwrc.usgs.gov/narcam/>>) to provide a two-way flow of information. Scientists and the public can visit the site to obtain information on where malformations have been found, the rates at which they were recorded, the species involved, and the types of malformations noted. Conversely, suspected or confirmed malformation observations can be reported to the center and, if appropriate, the center alerts a responsible State or Provincial agency or nearby herpetologist for confirmation and further investigation.

The Reporting Center's information components include a database of confirmed records by county, including details of species examined, as well as maps, related scientific information and reference materials, and data forms for on-line entry of information. To facilitate reporting, the Reporting Center has also established a toll-free number (1-800-238-9801) that can be used to report observations of malformed amphibians or results of systematic surveys. The Reporting Center has been very active since its inception in June 1997, having received 170 confirmed and 200 unconfirmed reports from 45 States and Provinces. The database is updated every 2 weeks to reflect the latest reports.

National Water-Use Data System

The USGS has compiled and disseminated national estimates of water use in the United States at 5-year intervals since 1950. In response to a congressional mandate in 1977, the USGS developed the National Water-Use Data System, which represents the largest database of water-use information in the United States. The results of the 1990 and 1995 national water-use compilations are available on the WWW through the National Water-Use Home Page at <URL: <http://water.usgs.gov/public/watuse/>>.

The utility of water-use data can be illustrated in relation to the Western Water Policy Review Act of 1992. As a result of the act, the USGS investigated the status and trends of water use for the 19 Western States. The USGS was able to respond in a timely and comprehensive manner because of the availability

of water-use estimates in the National Water-Use Data System. Some of the major findings were that while human population in the West increased 90 percent between 1960 and 1995, which is nearly double the national population growth rate during the same period, total water use increased 35 percent from 1960 to 1975 and then decreased 2 percent from 1975 to 1995. During the same period, withdrawals for irrigation and livestock increased 28 percent from 1960 to 1975 and decreased 7 percent from 1975 to 1995. These patterns show that the rate of change in total water use in the West is more closely linked to irrigation, which is the dominant use, than to population growth (fig. 6).

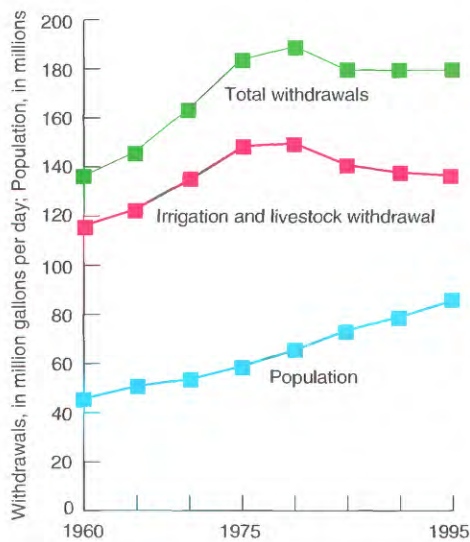


Figure 6.—Water withdrawals and population in the 19 Western States.

There is a wide range of other applications of water-use data. For example, the Forest Service, using USGS automated water-use estimates at the county level, examined a series of relations among changing patterns of demography, economics, and water use. The Forest Service and the Natural Resource Conservation Service are also using the USGS water-use data system to help forecast water demand for assessing the future of the Nation's natural resources.

Model Environmental Information System for the San Francisco Bay Ecosystem

California's San Francisco Bay estuary and delta have been radically altered over the past 150 years by mining and agriculture in the Bay's watershed, diversion of fresh water, filling of bay wetlands, urban and industrial expansion, dredging of bay channels and harbors, waste disposal, and the introduction of exotic species. Recognizing the need to understand how coastal ecosystems function and are altered by

human disturbances, the USGS began interdisciplinary research in 1968 using San Francisco Bay as a "national laboratory" to study the physics, chemistry, biology, and geology of an estuarine ecosystem.

The research has involved the regular collection of water-quality data (salinity, temperature, oxygen, chlorophyll, and suspended particulate matter) along a 145-kilometer transect spanning the entire length of the Bay's estuarine system from South Bay to the Sacramento River (fig. 7). After 30 years, this work has produced one of the longest and most comprehensive observational records for a U.S. coastal ecosystem and is recognized nationally and internationally as a "model" for the study of coastal ecosystems.

The information and data from this study are being made available at a USGS website that provides an overall description of the USGS water-quality program in San Francisco Bay, the most recent water quality condition of the Bay, and summaries of seasonal changes over 3 recent years. The goal is to make the full 30-year record of data available by the end of 1998. The data are being organized and displayed for ready use by decision makers and the regulatory activities of Federal, State, and local agencies with regard to waste allocation, land use, establishing water quality standards, evaluating environmental impacts of dredging and spoils disposal, developing wetlands restoration strategies, protecting endangered species, and managing fresh water inflows. The data are also being widely used by university scientists and their students, and by private companies. The WWW address is <URL <http://sfbay.wr.usgs.gov/access/wqdata/>>

Use of Satellite Data to Reduce Fire Hazards

The USGS supplies vegetation information to the Department of the Interior and Forest Service land managers for assessment of fire danger. Each day the USGS receives 250 megabytes of image data showing the land surface of the conterminous United States and Alaska from a NOAA satellite. The USGS uses these data to produce daily images of the health and vigor, or "greenness," of the vegetation. The daily images are summarized into maps that show the greenest condition of the vegetation each week. These weekly maps have been produced since 1989.

Every week the latest greenness map is transmitted to the National Interagency Fire Center where the Department of the



Figure 7.—**A**—The USGS research vessel Polaris, a floating laboratory dedicated to San Francisco Bay research and monitoring for over 30 years. **B**—Biologist takes a water sample. **C**—Biologist determines oxygen concentrations in San Francisco Bay.

Interior agencies and the U.S. Forest Service use the maps for predicting fire danger conditions nationwide. The greenness maps are combined with daily weather information to produce a fire potential index of the United States. The fire potential index is determined by using the greenness maps as an indicator of live vegetation moisture and using the daily weather measurements to calculate dead fuel moisture. The fuel type is determined from a vegetation map of North America produced by the USGS. The National Interagency Fire Center serves the fire potential index map over the WWW for operational use in fire management. The URL for the daily fire potential index is <URL: http://www.fs.fed.us/land/wfas/exp_fp_1.gif>.

Information

For information on these and other USGS products and services, call 1-800-USA-MAPS, or use the EARTHFAX fax-on-demand system, which is available 24 hours a day at 703-648-4888.

Please visit the USGS home page at <URL: <http://www.usgs.gov/>>.

The address for the Information Management Theme home page is <URL: <http://www.usgs.gov/themes/info.html>>.