GUIDE TO INFORMATION FOR ASSESSING QUALITY OF AND THREATS TO BIODIVERSITY OF FRESHWATER SYSTEMS

March 1999

Michele DePhilip
Freshwater Initiative, Strategy One
The Nature Conservancy
8 S. Michigan Avenue, Suite 2301
Chicago, IL 60603
(312) 759-8017
mdephilip@tnc.org

CONTENTS

I. INTRODUCTION

This guide was developed to help ecoregional and site conservation planning teams identify data sources that can be used to evaluate quality of and threats to natural biodiversity of freshwater systems. The guide was developed primarily to assess streams and lakes, although much of the information could be applied to wetland and riparian areas. Sources listed refer to spatial data, tabular data, and written reports that are primarily available on the internet. This guide focuses on nationwide or region-wide data sources that summarize water quality information at the watershed, reach, and/or point scale. Priority was given to sources that were spatially referenced and could be easily integrated into a geographic information system (GIS). Whenever possible a "hot link" to the data source is provided to make the document dynamic. Instead of reporting information that may soon be outdated, links allow the user to access to the most current information available at any time. Major changes in data availability occurred during the time that this guide was written and forthcoming updates to other data sets are noted in the text.

This guide presents information in three sections. **Section II. General Resources** contains brief summaries of two major sources of data and threats assessment tools: EPA's Index of Watershed Indicators (IWI) and EPA's Better Assessment Science Integrating Point and Non-point Sources (BASINS). **Section III. Sources of Data That Address Particular Stresses** organizes information by four leading stresses to aquatic systems: hydrologic alteration, sedimentation, water quality, and biological alteration. These categories are further divided into possible sources of stresses and data sources are listed under each one. Many categories also include a section suggesting additional analyses that could be done using available data. References to methods are provided. **Section III** also includes more detailed explanations of 16 indicators (IWI 1, IWI 5-12, IWI 14, and IWI 16-21) and corresponding source data that might be appropriate for evaluating threats specific to aquatic biodiversity. Finally, **Section IV. Other Resources** lists other sites that link to useful sources of information.

This guide does not provide an exhaustive list of all resources available for quality and threats assessment. It was intended to summarize the most readily available data sources and to provide enough information to get teams started on assessments. The use of data from a combination of these sources would likely result in a valuable preliminary assessment of threats to streams and lakes in any ecoregion.

Threats and quality assessments for the Mid-Atlantic Region (Jones et al. 1997) and Great Lakes Assessment (**http://econ.usfs.msu.edu/gla**) have used information from several of the sources listed in this guide. In addition, aquatic conservation efforts in the Great Lakes basin (Higgins et al. 1998), the Illinois River basin (Miller et al. 1998), and the Central Shortgrass Prairie Ecoregion (Baumgartner 1998) used sources listed here in their evaluations of quality of aquatic conservation sites. This guide indicates how information sources listed were used in these assessments.

This guide will be updated to include new resources for threats and quality assessment. Ideally, as assessments are conducted across the country, this document will be supplemented with additional methods for using threats information. Please submit any suggested methods or available data sources to Michele DePhilip at the Great Lakes Program (**mdephilip@tnc.org**).

II. GENERAL RESOURCES

1. EPA's Index of Watershed Indicators (IWI)

The Index of Watershed Indicators (IWI) is a compilation of information on the condition of aquatic resources in the United States. The IWI summarizes 15 indicators to determine the "health" of aquatic systems and to indicate whether land use activities within the watershed increase the risk of aquatic ecosystem degradation. The U.S. Environmental Protection Agency (EPA) describes the IWI at **http://www.epa.gov/surf2/iwi/**.

The IWI organizes information at the scale of the 8-digit hydrologic cataloging unit, as defined by the USGS. The IWI refers to these units as watersheds. Each of the 15 indicators summarize data collected by federal and state agencies and organizations including EPA, USGS, U.S. Fish and Wildlife Service (FWS), U.S. Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), U.S. Army Corps of Engineers (USACE), and The Nature Conservancy (TNC). The 15 indicators are divided into condition indicators (7) and vulnerability indicators (8). Each condition indicator has three possible ranks: *Watersheds with Better Water Quality, Watersheds with Less Serious Water Quality Problems,* or *Watersheds with More Serious Water Quality Problems*. Condition indicators include:

1. Meeting Designated Uses Set in State/Tribal Water Quality Standards
2. Fish and Wildlife Consumption Advisories
3. Source Water Quality Indicators—Drinking Water Systems
4. Contaminated Sediments
5. Ambient Water Quality Data—Four Toxic Pollutants
6. Ambient Water Quality Data—Four Conventional Pollutants
7. Wetland Loss Index

Each vulnerability indicator has two possible ranks: *Watersheds with Lower Vulnerability to Stressors or Watersheds with Higher Vulnerability to Stressors*. Vulnerability indicators include:

8. Aquatic/Wetland Species at Risk
9. Discharge Loads Above Permitted Discharge Limits—Toxic Pollutants
10. Discharge Loads Above Permitted Discharge Limits—Conventional Pollutants
11. Urban Runoff Potential
12. Index of Agricultural Runoff Impact
13. Population Change
14. Hydrologic Modification Caused By Dams
15. Estuarine Pollution Susceptibility Index

IWI uses the ranks from these 15 indicators to calculate a composite score. For each watershed with sufficient data, a composite score is calculated based on a minimum of 10 of 15 indicators. Composite scores are not necessarily good measures of biological integrity. The indicators used to calculate the composite score differ depending on which data are available for a particular watershed. When calculating the composite score, IWI 1, Meeting Designated Uses Set in State/Tribal Water Quality Standards, is weighted more heavily than other indicator scores. If the source data are not sufficient to calculate IWI 1, other condition indicator scores (IWI 2-IWI 7) are tripled. Detailed procedures for characterizing watershed condition and vulnerability are explained at **http://www.epa.gov/surf2/iwi/pro.html**. The composite score places the watershed into one of the following seven categories:

Watersheds with better water quality and lower vulnerability to stressors such as pollutant loadings.
Watersheds with better water quality and higher vulnerability to stressors such as pollutant loadings.
Watersheds with less serious water quality problems and lower vulnerability to stressors such as pollutant loadings.
Watersheds with less serious water quality problems and higher vulnerability to stressors such as pollutant loadings.
Watersheds with more serious water quality problems and lower vulnerability to stressors such as pollutant loadings.
Watersheds with more serious water quality problems and higher vulnerability to stressors such as pollutant loadings.
Watersheds for which insufficient data exist to make an assertion of condition or vulnerability.

The IWI is described in a series of web pages that underwent a major reorganization in November 1998. One of the most useful pages is entitled "National Maps, Factsheets, & Data Documentation and Download" **http://www.epa.gov/surf2/iwi/national/index.html**. It includes explanations of all 15 indicators, regional and nationwide maps, a measure of nationwide completeness of the data, and links to online data. For each indicator there exists a National Difference Map that shows the change in rank from the first iteration of the IWI to the second, if new data were available. This feature documents trends in watershed condition.

In order to download indicator data and source data from the above page, EPA routes users through Environmental Information Management System (EIMS). However, it may be easier to use the IWI directory at the EPA ftp site (**ftp://ftp.epa.gov/pub/iwisurf**) to download data. At the ftp site, each indicator has a sub-directory that contains all relevant maps, documentation, and database files. The directory structure is similar within each indicator folder. Three files will likely be most useful: the data profile, which describes the source data, data vintage and update frequency, database owner, and data sufficiency threshold; the data dictionary, which defines the fields in the database files; and the database files, which contain the indicator data. There are a few

inconsistencies in directory and file structure among indicators, but most are organized in a similar manner.

EPA also presents six proposed indicators called candidate indicators. These indicators may be incorporated into the composite score calculation in future iterations of the IWI. National maps, fact sheets, and data files for the candidate indicators are available at **http://www.epa.gov/surf2/iwi/national/canindex.html**. Data profiles, data dictionaries, and database files for these candidate indicators are also available in directories at the EPA ftp site. The candidate indicators include:

16. Forest Riparian Habitat
17. Atmospheric Deposition
18. Agricultural/Urban Riparian Habitat
19. Nutrient Export
20. Soil Permeability
21. Risk of Ground Water Nitrate Contamination

IWI composite scores have limited application for conservation analysis because of the incompleteness in the geographic coverage of data used to calculate them. Also, several indicators (e.g. IWI 2 Fish and Wildlife Consumption Advisories and IWI 3 Source Water Quality Indicators—Drinking Water Systems) may be heavily weighted in the composite score but do not measure factors that are directly related to biodiversity. In the Central Shortgrass Prairie Ecoregion, Baumgartner (1998) used a subset of the indicators, IWI 7 Wetland Loss Index, IWI 11 Urban Runoff Potential, IWI 12 Index of Agricultural Runoff Impact, and IWI 14 Hydrologic Modification Caused by Dams, to identify threatened watersheds. These indicators were thought to reflect major hydrologic and water quality impacts to biota and ecological processes in that ecoregion. The simple average of these four indicator scores was calculated as a "watershed health index."

In general, individual indicators and corresponding source data are more useful than IWI composite scores. The IWI indicator scores report an average for each 8-digit catalog unit and are therefore not useful for evaluating quality of individual streams or lakes. However, source data are often available at the point or reach scale, offering better resolution than the watershed summary. Also, even if the indicator has not been calculated nationwide, the source data might be helpful for assessing threats to a region for which data have been collected. The converse situation also occurs: source data are collected over a geographical area larger than the watershed (e.g. the 6-digit accounting unit) and then the same value is assigned to every watershed within the larger area. A closer look at the data profile for each indicator reveals the extent and scale of the source data and, thus, the indicator.

2. EPA's Better Assessment Science Integrating Point and Non-point Sources (BASINS) http://www.epa.gov/OST/BASINS/basinsv1.htm

In response to the trend toward watershed-based management and conservation, EPA has developed Better Assessment Science Integrating Point and Non-point Sources (BASINS). The BASINS system integrates an ArcView-based GIS, national watershed data, and modeling tools into one convenient package that is available at no charge.

BASINS 1.0 was initially released in 1996 and BASINS 2.0 in 1998. BASINS 2.0 is available in both an online version **http://www.epa.gov/OST/BASINS/download.htm** and a CD version. BASINS 2.0 CD sets are available for each of the 10 EPA regions in the coterminous US and can be ordered online or by calling 1-800-490-9198.

BASINS is a concentrated source of spatial data layers and modeling tools. Most data layers contained within BASINS are also available online from the source agencies, but BASINS CDs package them in convenient, region-wide data layers. The online version of BASINS 2.0 organizes data by 8-digit catalog unit. Most data, with the exception of the meteorological data and the digital elevation model (DEM), are contained in "BASINS Core Data" for a specified catalog unit. Data for each catalog unit must be downloaded separately, making analysis of large areas cumbersome. BASINS 2.0 data layers include (an asterisk indicates layers that were not included in BASINS 1.0):

Spatially Distributed Data
- Land use/land cover (Anderson Level II, 1:250,000)
- Urbanized areas
- Populated place locations
- Stream Reach File, version 1 (RF1, 1:500,000)
- *Stream Reach File, version 3 alpha (RF3, 1:100,000)
- *Soils (STATSGO, 1:250,000)
- *Elevation (DEM, 1:250,000)
- Major roads
- USGS hydrologic unit boundaries (6-digit accounting unit, 8-digit catalog unit)
- Drinking water supply sites
- Dam sites
- EPA regional, state, and county boundaries
- *Federal and Indian Lands
- *Ecoregions (from Omernik Level III, 78 classes in North America)

Environmental Monitoring Data
- Water quality monitoring station summaries
- *Water quality observation data
- Bacteria monitoring station summaries
- Weather station sites
- USGS gauging stations
- *Fish and wildlife advisories
- National sediment inventory (NSI)
- *Shellfish classified areas
- *Clean Water Needs Survey

Point Source Data
- Permit Compliance System (PCS) sites and computed loadings
- Industrial Facilities Discharge (IFD) sites
- Toxic Release Inventory (TRI) sites
- Superfund National Priority List (NPL) sites

*Resource Conservation and Recovery Act (RCRA) sites
*Mineral Industry Locations

BASINS 2.0 also includes several tools for evaluation of water quality; three in particular may be useful for evaluating threats at an 8-digit catalog unit, user-defined watershed, or point scale. The TARGET tool allows broad scale evaluations of water quality and point source loadings. It was designed to compare condition among watersheds (8-digit catalog units or user-defined areas) across a region or state. For example, using TARGET to evaluate water quality for nitrate, TARGET summarizes nitrate point source loadings by watershed and reports one value for each catalog unit. A second tool, ASSESS, focuses on the status of water quality stations (points) within a catalog unit or limited set of catalog units. A third model, the Nonpoint Source Model (NPSM), estimates non-point source loadings for selected pollutants in an 8-digit catalog unit or user-defined area. This model uses catalog unit boundaries and land use distribution to generate its estimates. Further explanation of these BASINS tools and several additional tools and utilities is available at
http://www.epa.gov/OST/BASINS/basinsv1.htm#tools.

EPA offers free week-long BASINS training courses in each EPA regions. Training schedules are available at the BASINS website.

III. SOURCES OF DATA THAT ADDRESS PARTICULAR STRESSES

➔Indicates "top hits," based on completeness of geographical coverage, accessibility of spatial data, and/or detail of information available.

1. HYDROLOGIC ALTERATIONS

1.1 Dams

➔National Inventory of Dams database (USACE).
ftp://corpsgeo1.usace.army.mil/headquarters/geo_data/damdata.
This site includes links to database files, a data dictionary, description of fields, and documentation describing the National Inventory of Dams (NID); all files can be downloaded. The database files contain information collected in the NID, including dam size, ownership, type of draw, location, dam usage, date constructed, hazard rating, which river it impounds, drainage area affected, etc. This database is updated annually; currently the database summarizes the 1995-96 inventory. This database is the most comprehensive source of dam data and is the source for other summaries of hydrologic alterations by EPA and USGS. Latitude/longitude coordinates are given for each dam. A GIS point layer can be created using these coordinates.

Dam locations (EPA, BASINS). BASINS includes GIS files showing dams within each EPA region. Even though BASINS uses USACE data as its source of dam information, there exist some discrepancies between USACE and BASINS because BASINS has

different criteria for including dams in their file. BASINS provides the best GIS layer that is immediately available, but USACE supplies more information about each dam and latitude/longitude coordinates for each dam allow USACE data to be easily converted to a GIS layer.

Hydrologic modification cause by dams (EPA, IWI 14).
ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/hydro_mod
IWI 14 uses source data from USACE. For each 8-digit catalog unit, it reports total volume of water impounded but neither indicates which rivers within the catalog unit are impounded nor provides any measure of fragmentation. These files contain no spatial references other than catalog unit. The source data from USACE provides much more information about each dam, gives a spatial reference, and is easily accessible.

This indicator contains two types of database files. One series of files lists dams within an EPA region that are over six feet high and impound at least 50 acre-feet or are over 25 feet high and impound at least 15 acre-feet. These files includes the following fields: dam ID, normal storage capacity, USGS catalog unit, dam name, reservoir name, state, and EPA region. The second file, *data14p2.dbf*, has only two fields: USGS HUC and the total volume of water retained by all dams within each catalog unit.

Dam locations (USGS). USGS also has a GIS layer with dam locations that is available to download from USGS Map Layers Warehouse at **http://www-atlas.usgs.gov/atlasftp.html**. The data include dams in the USACE NID over 50 feet in height, or with a normal storage capacity of at least 5,000 acre-feet, or with a maximum storage capacity of 25,000 acre-feet. The database file includes dam name, river, storage capacity, owner, and year of construction. Due to the criteria for inclusion, this file includes fewer dams than the file available in BASINS.

Dams—Additional analyses
Indicators of Hydrologic Alteration (TNC). The Indicators of Hydrologic Alteration (IHA) provides a method for assessing the degree of hydrologic alteration attributable to human impacts associated with dam construction and flow alteration. This analysis is based on hydrologic parameters taken from USGS gauge data collected before and after dam construction. Detailed methods for calculating this index and an example of its application in the Roanoke River, Virginia, are found in Richter et al. (1996). Richter et al. (1997) and Richter et al. (1998) provide additional description of the application of the IHA.

Fragmentation. Dynesius and Nilsson (1994) provide a method for evaluating fragmentation of rivers caused by dams. In the calculation, the length of the main channel that is not dammed is divided by the total length of the main river channel and the resulting percentage is used to classify each river as unaffected, moderately affected, or strongly affected by channel fragmentation and flow regulation. This calculation requires a GIS layer showing dam locations and a stream layer (RF1 or RF3); lengths of segments between dams and total stream length can be measured using ArcView tools.

Such a calculation could be useful in comparing the degree of fragmentation among similarly sized rivers.

1.2 Water Use

➔**Water use data (USGS).** Summarized 1995 water use data are available in three types of tab-delimited data files: county data by state, watershed (8-digit catalog unit) data by state, and US data by state. All files are can be downloaded from **http://water.usgs.gov/public/watuse/spread95.html**. USGS compiles all state information every five years; data are summarized from multiple sources within each state. Water use data are broken down into specific categories (e.g. public, commercial, domestic, industrial, thermoelectric, mining, livestock, irrigation, hydroelectric, wastewater treatment, reservoir evaporation, and totals); all data are in million gallons per day (M/gal). A data dictionary defining all 248 fields is available at **http://water.usgs.gov/public/watuse/spread95/dictionary95.txt**. USGS also generated maps of water consumption by state using the above water use data. These maps are indexed at **http://www.epa.gov/ceisweb1/ceishome/atlas/nationalatlas/water_uses.htm**.

Water use map (USDA-NRCS). Water use is reported as a percentage of annual precipitation. This map shows average annual freshwater consumption from all sources (residential, agricultural, industrial, etc.) as a percentage of local average annual precipitation. Average annual freshwater consumption was determined for the six year period between 1985 and 1990. Average annual precipitation, including snowfall, was determined for the 30 year period between 1960 and 1989. Sample measurements were weighted and averaged for each 8-digit catalog unit. This map and database file are available at **http://www.nhq.nrcs.usda.gov/land/meta/m2137.html**.

1.3 Channelization, drains, and stream diversions.

➔**Reach file, version 3 (RF3)-alpha (EPA, BASINS).** These GIS layers show hydrography, including streams, lake shorelines, and wetland boundaries and include attributes such as stream name and segment length; each file contains hydrography for one 8-digit catalog unit. RF3 files are available for the coterminous US and can be downloaded from BASINS at **http://www.epa.gov/OST/BASINS/download.htm** or obtained from EPA offices in each region. Drains, channelized reaches, and stream diversions usually appear as straight line segments, but they are not consistently classified in the attribute table. When using the RF3, the degree of channelization in a stream network must be visually interpreted.

Digital line graph (USGS). Drains, channelized reaches, and stream diversions usually appear as straight line segments in the Digital Line Graph (DLG) stream layer and are usually classified as “ditch or canal” (minor code 0414), “flume” (minor code 415), or “aqueduct” (minor code 0416). The classification of these segments should be checked against topographical maps or aerial photographs before calculating the proportion of channelized stream segments in a stream network. DLG files can be downloaded from **http://edcwww.cr.usgs.gov/doc/edchome/ndcdb/ndcdb.html**.

➔**Levee locations (USGS).** The Scientific Assessment and Strategy Team (SAST) database provides a GIS file with locations of levees in the Upper Mississippi/Lower Missouri River Basins. This can be downloaded from **http://edcwww2.cr.usgs.gov/HTML/** by clicking on "Levee database." The GIS file includes levees in most of Illinois, Wisconsin, Missouri, all of Iowa, and parts of Minnesota, South Dakota, North Dakota, Nebraska, and Kansas. Attributes include protection rating, levee material, and levee ownership. Associated metadata is also available online.

1.4 Land use/land cover change

Urban runoff potential (EPA, IWI 11).
ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/urban_runoff/.
Increases in the amount of impervious surface in a catchment can alter stream hydrology by increasing runoff volume and rate and by decreasing the capacity of a stream to handle floods. The Urban Runoff Potential Measure database uses data from the 1990 census to estimate the amount of urban area within census block groups. An explanation of the model development is given in the IWI 11 profile. Model results are summarized by 8-digit catalog unit to generate a value for P25LAND, which is equal to the percentage of land area per catalog unit that has greater than 25% imperviousness. To generate the IWI 11 map, these percentages are aggregated into a score of 0 (0-1%), 1 (1-4%), or 2 (>4%).

Forest riparian cover (EPA, IWI 16).
ftp://ftp.epa.gov/pub/iwisurf/iwi98_v2/forest_riparian/
This is a coarse measure of the percent forest cover within riparian zones of all streams within an 8-digit catalog unit. Each catalog unit receives a PRFINDEX value equal to the percentage of the 1-km grid cells adjacent to streams in the USGS 1:2,000,000 DLG that are classified as containing forested land. Since individual cells can be classified as multiple types (e.g. forest, grass, and agriculture), the PRFINDEX value may not be equal to the percentage of total land adjacent to streams that is actually covered with forest. For example, every riparian cell could contain a small amount of forest, with the remainder of each cell made up of developed and agricultural land. According to this index, the PRFINDEX value would be 100 even though only a small percentage of the riparian area is actually forested. The index values are converted to a score of 0 (<25% forested), 1 (25-75% forested), or 2 (>75% forested) to generate the IWI 16 map. As expected, the catalog units in the Great Plains and desert portions of the US have low scores. This could reflect the natural condition of the riparian zones of these streams, not necessarily their compromised quality.

IWI 16 provides a rough estimate of riparian composition because it uses land use grids with a large cell size and a coarse stream layer. A buffer analyses using 1:250,000 land use grids and 1:100,000 stream layer (e.g. RF3) might be more meaningful for evaluating riparian land use at the 8-digit catalog unit or reach scale. Higgins et al. (1998) and Miller et al. (1998) conducted analyses to determine the percentage of forest and wetland riparian cover for streams in the Great Lakes basin and Illinois River basin, respectively. Methods for buffer analysis are available in Higgins et al. (1998).

Agriculture/Urban Riparian cover (EPA, IWI 18).
ftp://ftp.epa.gov/pub/iwisurf/iwi98_v2/ag-urb_riparian/
This is a coarse index, similar to IWI 16, to determine the percent agriculture/urban land cover in riparian zones along all streams within an 8-digit catalog unit. Each catalog unit receives a PRUINDEX value equal to the percentage of 1-km grid cells adjacent to streams in the USGS 1:2,000,000 DLG that have land uses classified as agriculture or urban. The PRUINDEX value may not be equal to the percentage of total land adjacent to streams that is actually covered with agricultural or urban land. The index values are converted to a score of 0 (<20%), 1 (20-50%) or 2 (>50%) to generate the IWI 18 map.

IWI 18 provides a rough estimate of riparian composition because it uses land use grids with a large cell size and a coarse stream layer. A buffer analyses using 1:250,000 land use grids and 1:100,000 stream layer might be more meaningful for evaluating riparian land use at the 8-digit catalog unit or reach scale. This type of analysis was conducted for streams in the Great Lakes basin (Higgins et al. 1998) and Illinois River basin (Miller et al. 1998).

➔**Land use/land cover data (USGS).** Land use layers at 1:100,000 (for limited areas) and at 1:250,000 (for entire US) are available for download from **http://nsdi.usgs.gov/nsdi/products/lulc.html**. These layers are the source data for most land use/land cover analyses. The 1:250,000 land use layers are included on BASINS CDs (in BASINS 2.0 online, all tiles needed to cover one catalog unit are packaged by HUC). All land use polygons are classified according to the Anderson Level II classification scheme. A list of the Anderson Level II land use/land cover classes is available at **ftp://mapping.usgs.gov/pub/ti/LULC/lulcguide/dug4lulc.txt**. Anderson et al. (1976) includes a complete description of all classes.

Land use/land cover change--additional analyses
Human use index (EPA). The human use index (UNIDEX) measures the proportion of an area that is urbanized or used for agriculture. This index is conceptually similar to **IWI 18 Agriculture/Urban Riparian cover.** The main difference is that in IWI 18, the proportion of agriculture/urban land cover was calculated within riparian buffer zones only; the UINDEX included the proportion of agriculture/urban land cover in the entire area within the 8-digit catalog unit. This analysis was conducted as part of the Ecological Assessment of the United States Mid-Atlantic Region (Jones et al. 1997). A watershed map was produced using a cookie-cutter procedure to extract land cover information (at 7-hectare resolution) for each catalog unit. The UINDEX was calculated for all catalog units in Pennsylvania, West Virginia, Delaware, Maryland, Washington D.C. and Virginia. The results of this analysis are not electronically available, but methods and results are presented in the appendix of Jones et al. (1997). This analysis could be replicated for any region using an 8-digit catalog unit layer and a land use layer. Miller et al. (1998) conducted a modified version of this analysis.

Roads along streams (EPA). Roads increase the amount of impervious surface and are often sources of transportation-related chemicals, including petroleum, antifreeze, and road salt, that may enter a stream. To assess the potential impacts of roads along streams,

the proportion of streamlength within 30 m of road was calculated by overlaying maps of streams and roads. This index value was calculated as part of the Ecological Assessment of the United States Mid-Atlantic Region. The results of this analysis are not electronically available. Methods and results are presented in the appendix of Jones et al. (1997).

1.5 Wetland loss

Wetland loss index (EPA, IWI 7). All data and associated documents are available at **ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/wetland_loss/**. IWI 7a reports the percent wetland change on non-federal lands between 1982 and 1992 by 6-digit accounting unit using source data from the 1992 Natural Resources Inventory (NRI). The NRI, conducted every five years, is a nationwide survey of private land use that includes over 800,000 sampling points within the lower 48 states. IWI 7b reports the historic wetland loss (between 1780 and 1982) on federal and non-federal lands for each state, as determined by the National Wetlands Inventory (NWI). IWI 7c combines this information into one index, as described in the profile document, for each 8-digit catalog unit. The data file *data07.dbf* combines wetland loss information from both sources and summarizes it by catalog unit; it includes the percent historic wetland loss, the percent recent wetland loss, and reports the probabilities of each catalog unit having a net gain, no change, or net loss greater than 2% over the next 10 years. All data are reported as percentages only; IWI 7 does not include actual acres gained or lost.

➔**Wetlands index of maps, facts, and figures (USDA-NRCS).**
http://www.nhq.nrcs.usda.gov/land/index/wetlands.html. This page is similar in format to other USDA-NRCS map indexes (e.g. soil erosion, water quality, etc.) in that it links to map images and associated ASCII data files quantifying wetland statistics such as Total Wetland Acres, 1992; Net Change in Wetland Acreage, 1982-1992; and Riverine Wetland Acres, 1992; (24 maps total). These figures only include wetlands on non-federal lands. A subset of these data are the NRI source data for IWI 7a, but these files also report wetland acreage broken into finer categories of wetland type and land cover. Most values are summarized by 8-digit catalog unit, but some are also summarized by county.

Wetland change—additional analyses

National Wetlands Inventory (FWS). http://www.nwi.fws.gov/nwi.htm.
All available National Wetlands Inventory (NWI) 7.5' quad maps that have been digitized for use in a GIS and are available to download in ArcExport format. Maps are organized by USGS 1:250,000 map name so a USGS index book will be helpful for locating desired quads. These files contain a great deal of detailed wetland information but require considerable interpretation.

2. SEDIMENTATION

➔Soil erosion maps (USDA-NRCS).
http://www.nhq.nrcs.usda.gov/land/index/erosionmaps.html
This site contains over 25 maps summarizing sources of soil erosion by 8-digit catalog unit (e.g. Average Annual Soil Erosion by Wind and Water on Cropland and CRP Land, 1992; Average Annual Soil Erosion by Wind and Water on Cultivated Cropland as a Proportion of the Tolerable Rate (T), 1992; Sediment Delivered to Rivers and Streams from Sheet & Rill Erosion; Average Annual Soil Erosion Where Corn is Grown, 1992). Maps are based on the 1992 NRI. Several maps indicate average erosion as a proportion of the tolerable rate (T), which highlights those 8-digit catalog units that are losing soil at a rate above the rate at which soil can be replenished through natural soil regeneration processes. These maps have associated data files that can be downloaded by clicking on "ASCII data file" in the upper left corner of the map image. Files include some explanatory text, a column that contains the 8-digit HUC, and one or more columns containing the data values.

Sediment delivery to rivers and streams from cropland and pastureland (EPA, IWI 12c). Eight-digit catalog units are assigned a nationwide rank based on modeled sediment delivery to streams from cropland and pastureland. The source of these data is the 1992 NRI. Data and maps are available from **ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/ag_runoff**. The data table (contained in *data12c.zip*) has a score of low (0), moderate (1), or high (2) potential sediment delivery for each catalog unit as well as a nationwide rank (1-2106) for all catalog units. This table can be linked to a GIS layer and displayed for a particular region of interest to evaluate relative potential sediment loss among catalog units.

Sedimentation—additional analyses
STATSGO (USDA-NRCS) http://edcwww.cr.usgs.gov/glis/hyper/guide/statsgo. Soil maps for the State Soil Geographic (STATSGO) database are made by generalizing detailed soil survey data. The mapping scale for STATSGO maps is 1:250,000 (with the exception of Alaska, which is 1:1,000,000). The level of mapping is designed to be used for broad planning and management of state, regional, and multi-state areas. STATSGO data can be downloaded or CDs can be ordered online at **http://www.ncg.nrcs.usda.gov/stat_data.html**. STATSGO soil data are also included in BASINS.

SSURGO (USDA-NRCS). http://www.ftw.nrcs.usda.gov/ssurgo.html. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO is the most detailed level of soil mapping done by the NRCS; mapping scales generally range from 1:12,000 to 1:63,360. SSURGO digitizing duplicates original soil survey maps. This level of mapping is designed for use by landowners, townships, and county natural resource planners and managers. The user should be knowledgeable of soils data and their characteristics. SSURGO data are only available by county for limited parts of the country. SSURGO

data can be downloaded or CDs can be ordered online at **http://www.ftw.nrcs.usda.gov/ssur_data.html.**

3. WATER QUALITY

3.1 Nutrient and Pesticide Loading

➔Potential Priority Watersheds for Protection of Water Quality from Non-point Sources Related to Agriculture (USDA-NRCS).
http://www.nhq.nrcs.usda.gov/land/pubs/wqpost2.html
This report summarizes work on nutrient and pesticide loading to watersheds conducted by USDA-NRCS and researchers from the Texas Agricultural Experiment Station. The report provides a detailed description of data collection and modeling procedures, as well as information about how model results can be interpreted. All statistics are summarized by 8-digit catalog unit. From this report, the data used in the figures can be obtained by clicking on "Watershed Database (Pipe delimited ASCII file)" at the end of the report or at **http://www.nhq.nrcs.usda.gov/land.pubs/wqdata.txt**. This table can easily be linked to a GIS using the 8-digit HUC. Field descriptions are available at **http://www.nhq.nrcs.usda.gov/land/pubs/wqmaps.html**. These are the source data for the USDA-NRCS water quality maps and IWI 12a, 12b, and 12c.

Water quality maps (USDA-NRCS).
http://www.nhq.nrcs.usda.gov/land/index/wqual.html
The index includes links to maps and associated data files describing potential nutrient loads from croplands (e.g. Potential Nitrogen Fertilizer Loss from Farm Fields, Based on Production of 7 Major Crops; Potential Phosphate Fertilizer Loss from Farm Fields, Based on Production of 7 Major Crops; Pesticide Runoff Potential for 13 Crops). The purpose of these estimates was to show which 8-digit catalog units had the greatest potential for water quality problems associated with nutrient loss from agricultural lands. Estimates were made by combining 1992 NRI land use data with data on commercial fertilizer use and crop yields from the National Agricultural Statistics Service. As with USDA-NRCS maps describing soil erosion and wetland loss, these maps have associated data files.

Potential pesticide runoff from farm fields (EPA, IWI 12a).
This indicator was developed to show which watersheds have the greatest potential for movement of agricultural pesticides through surface water runoff. This indicator predicts pesticide loss based on soil characteristics, historical pesticide use, chemical properties of the pesticide, annual rainfall, and field crops grown. Data and maps are available from **ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/ag_runoff**. The data table (contained in *data12a.zip*) has a score 0 (low), 1 (moderate), or 2 (high) potential pesticide runoff and a national rank (1-2106) for each 8-digit catalog unit. While this summary may be of some use, the source data for IWI 12a are readily available from USDA-NRCS and provide more detailed information.

Potential nitrogen runoff from farm fields (EPA, IWI 12b).

This indicator was developed to determine which 8-digit catalog units have the greatest potential for nitrogen loading to surface water from agricultural sources. Data and maps are available from **ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/ag_runoff**. The data table *data12b.dbf* has a score 0 (low), 1 (moderate), or 2 (high) potential nitrogen runoff as well as a national rank (1-2106) for each catalog unit. This indicator summarizes data from USDA-NRCS described above.

Nutrient export (EPA, IWI 19).
ftp://ftp.epa.gov/pub/iwisurf/iwi98_v2/nitrogen_export/
Local total nitrogen (TN) export refers to the annual quantity of total nitrogen that comes from pollution sources within a watershed and is transported to a downstream watershed via streams or rivers. Total nitrogen, including nitrogen from point sources, fertilizer, livestock, atmospheric deposition, and non-agricultural sources, is presented as yield (pounds per acre of watershed area). IWI 19 summarizes data from USGS surface water-quality modeling based on nutrient sampling at key locations.

➔**Nutrient export (USGS)** Source data for IWI 19 is available from **http://wwwrvares.er.usgs.gov/nawqa/sparrow/** by clicking on "Nutrients in streams of the conterminous United States." This page explains the modeling procedure and model results (including estimates of standard error) for total phosphorous (TP) as well as TN.

Herbicide use (USGS). Estimates of herbicide use are available for the top 96 most-used herbicides in the lower 48 states in a series of five files (*herbicide1-herbicide5*) available to download at **http://water.usgs.gov/lookup/getgislist**. Files summarize application by county. Estimates are reported as acres treated, pounds of active ingredient used, and pounds used per square mile for all herbicides. Metadata describing all attribute fields are also available.

Soil permeability (EPA, IWI 20).
ftp://ftp.epa.gov/pub/iwisurf/iwi98_v2/soil_permeability/
Soil permeability can be used as an indicator of potential groundwater contamination at the watershed level. The potential of groundwater contamination from surface releases is greatly affected by the properties of the overlying soil. Soil permeability is a controlling factor for the rate at which a contaminant travels in the subsurface. Soils with higher permeability will facilitate pollutant transport and may increase risk of groundwater contamination. Soil properties are based on the STATSGO database.
The file *ii20a_usdvw_2.dbf* includes a PFI value (permeability index ranging from 1 [slow]-10 [rapid]), 8-digit HUC, and data vintage (year). This index is further summarized into an IWI score of slow (0), moderate (1), or rapid (2); these scores are displayed on the maps for each EPA region.

Risk of groundwater contamination by nitrate (EPA, IWI 21).
ftp://ftp.epa.gov/pub/iwisurf/iwi98_v2/nitrate_concentration/
IWI 21 summarizes risk of nitrate in groundwater for each 8-digit catalog unit. The USGS source data incorporates "input" factors (population density and nitrogen contribution) and "aquatic vulnerability" factors (soil drainage characteristics and

woodland/cropland ratio in agricultural areas) to generate a grid map (1 square kilometer cell size) of the US. IWI 21 further summarizes this grid map and assigns a low, moderate, or high risk rating for each catalog unit.

➔**Groundwater Risk Map (USGS).** The USGS digital groundwater risk map was generated by overlaying population data from the 1990 US census, county nitrogen input data from multiple sources, soil drainage characteristics from the STATSGO database, and woodland/cropland ratio from the 1992 Census of Agriculture. One output grid (1 square kilometer cell size) was generated from these layers. An explanation of the mapping process and the USGS digital groundwater risk map are available at **http://water.usgs.gov/lookup/getspatial?gwrisk**. This source grid may be more useful than IWI 21 because it reveals high risk areas at a finer scale than the 8-digit catalog unit.

Ambient water quality—four toxic pollutants (EPA, IWI 5).
ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/water_quality/
This indicator reports the number of water quality observations that exceed EPA's national freshwater criteria for copper, nickel, zinc, and chromium. This indicator is based on an EPA database that contains over 250 million observations of water quality monitoring data from public and private sources. For each 8-digit catalog unit, the total number of observations for each of the four toxic pollutants are reported along with the number of observations that exceed the criteria for each pollutant. The indicator does not reveal the amount by which observations exceed water quality criteria.

Ambient water quality—four conventional pollutants (EPA, IWI 6).
ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/water_quality/
This indicator summarizes the number of water quality observations that exceed EPA's national freshwater criteria for ammonia, dissolved oxygen, phosphorous, and pH. Indicator data are reported as number of observations exceeding criteria for each conventional pollutant. As with IWI 5, the data reveal nothing about the amount by which each observation exceeds water quality criteria.

Data points used in IWI 5 and IWI 6 appear as a data layer in the **Enviromapper for Watersheds** (described in **Section IV. Other Resources**). At an 8-digit catalog unit scale, querying source data will reveal the amount by which an observation exceeds criteria and the date of the observation. These point data may be useful for evaluating threats at a point or reach scale even though the way these data are summarized in IWI 5 and IWI 6 reveals little about water quality in an 8-digit catalog unit.

➔**Pollutant loads discharged above permitted limits—toxic pollutants (IWI 9) and conventional pollutants (EPA, IWI 10).**
ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/pollutant_loads/
These indicators use data from EPA's Permit Compliance System (PCS) to evaluate the extent to which permitted facilities are discharging within established limits for toxic and conventional pollutants. IWI 9 and IWI 10 report the average percent by which discharged loads of all toxic and conventional pollutants, respectively, exceed the permitted limits for each pollutant. This summary is not a very useful indicator of water

quality within an 8-digit catalog unit. However, the database files contained within *lolrXX.zip* (where *rXX* is the EPA region) list all permitted discharges within a catalog unit. Attributes include the name of the permit holder, whether it is toxic or conventional, and the percent by which the discharge exceeds the permitted limit. Also, a list of permit holders and specific information about the nature of the discharge can be obtained through EPA's "Surf you Watershed" pages. After navigating to the catalog unit of interest, clicking on "Water Dischargers" will bring up a list of numbered permits. Selecting a permit number will bring up detailed information from the PCS database. Although IWI 9 and IW 10 are not particularly useful in assessing water quality at a catalog unit scale, point-specific data may be of use at a reach scale.

Atmospheric deposition (EPA, IWI 17).
ftp://ftp.epa.gov/pub/iwisurf/iwi98_v2/air_dep/
Atmospheric deposition estimates for total nitrogen are summarized from coarse data to estimate a value for each 8-digit catalog unit. The yearly nitrogen deposition from nitrate and ammonium is expressed in kilograms per hectare. This index was calculated using data from sampling sites in the National Atmospheric Deposition Program (NADP). Within the continental US, there are approximately 270 NADP sampling sites. Data from these sites are used to construct isopleth maps that estimate atmospheric deposition across the US. These maps are then used to estimate catalog unit values for IWI 17. Isopleth maps and source data for total nitrogen and other chemicals are available from **http://nadp.sws.uiuc.edu/nadpdata/**.

3.2 Mines

➔**Mine locations (USGS).** GIS files indicating mine locations are available for the following eight mineral operations: agricultural, construction, ferrous metal mines, ferrous metal processing plants, miscellaneous industrial, non-ferrous metal mines, non-ferrous metal processing plants, and refactory, abrasive and other industrial. All are available to download at **http://www-atlas.usgs.gov/atlasftp.html**. Each file is a point layer showing all mines of a given type. The attribute fields include commodity mined, site name, company name, state and county location, and latitude/longitude coordinates.

Mine locations (EPA, BASINS). Mine locations can be found in a BASINS 2.0 file called Mineral Data (mines.shp); mine locations were not available in BASINS 1.0. These locations come from the U.S. Bureau of Mines; the data table includes latitude/longitude coordinates, watershed name, owner, type (surface or underground), and what is mined. The file only includes mineral mines (including iron, sand, gravel, stone, and coal). These data contain only a subset of the mines included in the USGS files.

4. BIOLOGICAL ALTERATION

4.1 Invasive Species

➔**Nonindigenous aquatic species (USGS-BRD). http://nas.nfrcg.gov**
The Florida Caribbean Science Center (FCSC), a research facility of the USGS Biological Resource Division (BRD), maintains a nonindigenous aquatic species (NAS)

database that includes records of exotic vertebrates, invertebrates, and plants, as well as diseases and parasites. Data can be queried online by state or by major (2-digit) hydrologic unit, which produces a list of all non-native taxa within the selected area. Lists include nonindigenous organisms that are established populations, single specimens, and eradicated populations documented since 1850. The lists do not distinguish between historical and current occurrences, although in some cases clicking on a particular species (or family) links to a map showing native and non-native ranges for that species, references for all sources/sightings, probable source of introduction, and information about whether the populations are established, etc. The online database includes a good literature cited section that references reported observations.

This database integrates reports from many sources including state and federal agencies, land managers, researchers, taxonomists, and museum curators. Source data for the NAS database are reported at a range of scales. It may be worth contacting the FCSC directly to see if information is available at the 8-digit catalog unit scale for a particular region of interest. If the information is summarized to that scale, FCSC can run a query by 8-digit catalog unit and send the results. However, an online query is not available at that scale. Currently, USGS-BRD is working on an online query by 6-digit HUC that will be similar to the 2-digit query currently available.

4.2 Vulnerable Species

➔Aquatic/Wetland species at risk (EPA, IWI 8; TNC).
ftp://ftp.epa.gov/pub/iwisurf/iwi97/aquatic_species
This index summarizes the number of vulnerable aquatic plants and animals that have been documented by state natural heritage data centers. For each 8-digit catalog unit, the data table reports the number of wetland and/or aquatic species classified as critically imperiled (G1), imperiled (G2), or vulnerable (G3). In addition, IWI 8 includes an index of relative vulnerability calculated by dividing the number of vulnerable (G1-G3) species in that catalog unit by the maximum number of vulnerable species in any catalog unit (47).

Heritage programs compile data from multiple sources including state surveys, systematics collections, non-game programs, county inventories, government agency field searches, and observations by individual biologists. State heritage data includes more detailed information than is available in IWI 8. Heritage data are continuously updated; IWI 8 is current to 1996 for most states.

The Nature Conservancy compiled state natural heritage data and summarized occurrences of G1-G3 fish and mussel species in *Rivers of Life* (Master et al. 1998). These data are not centrally available and must be obtained on a state-by-state basis from each state's heritage program. State heritage programs have current occurrence records for G1-G3 mussels and fishes, summarized by 8-digit catalog unit. These files include the source of information used to place a species in a particular catalog unit. Future plans include expanding these databases to include imperiled and vulnerable turtles and crayfishes and to include lists of G4 (apparently secure) and G5 (secure) fish and mussel species for each catalog unit. Contact information for all state heritage programs is

available by clicking on the state map at
http://www.heritage.tnc.org/nhp/us/usmap.html.

Much of the species occurrence data stored in the state heritage databases originated with some other state or federal agency. It may be worth supplementing species occurrence data from the state heritage programs with data obtained from other agencies.

4.3 Biological Assessment Programs

➔Assessed rivers meeting all designated uses set in state/tribal water quality standards (1994/1996) (EPA, IWI 1).
ftp://ftp.epa.gov/pub/iwisurf/iwi97_v1/designated_uses/
This index summarizes the results of each state's report submitted to EPA under section 305(b) of the Clean Water Act. Section 305(b) requires that all states prepare and submit a water quality assessment report to EPA every two years.

EPA examines the effects of specific pollutants on plankton, fish, shellfish, wildlife, plants and recreational activities to help states determine the levels of pollutants that can exist without harming human and aquatic life. The states also determine the designated uses of a particular water body. Possible uses include (1) as a drinking water supply, (2) for fish consumption, (3) shellfish harvesting, (4) a source of agricultural irrigation, (5) for recreational uses such as boating and/or swimming, (6) aquatic life support, or (7) as wildlife habitat. The states then use water quality criteria to determine whether a particular water body is attaining its designated uses.

A complete description of the state water quality reporting process, including definitions of terminology used, is available at **http://www.epa.gov/indicator/about305.html**. Most waterbodies have "aquatic life support" listed as one of the designated uses, although there may be waterbodies that are designated to for other uses only (e.g. recreation or a source of irrigation water). Also, EPA encourages states to include biological metrics in their water quality assessment, especially for determining whether a given waterbody supports aquatic life. However, some states only use chemical and physical criteria to determine whether a waterbody will support aquatic life. States that do use biological metrics often incorporate an Index of Biological Integrity (IBI) for fish and/or a Hilsenhoff Biotic Index (HBI) for macroinvertebrates.

IWI 1 is based on a 1994 summary of state water quality assessment programs. If at least 20% of the perennial stream miles (as expressed in RF3) were assessed for use attainment status, the state assessments were considered sufficient to evaluate the condition of the 8-digit catalog unit. For each catalog unit, IWI 1 summarizes the percent of assessed stream miles that attained their designated uses. The data table includes the following fields: ratio of nonimpaired stream miles to number of miles assessed, number of nonimpaired stream miles, number of miles assessed, total stream miles (perennial and intermittent) in RF3, number of perennial stream miles in RF3, and data vintage.

State biological assessment programs are at various stages of development. A general summary of current status of these programs/protocols are available at

http://www.epa.gov/owow/monitoring/bio/section2.htm. State fact sheets with links to the individual state reports can be found at **http://epainotes1.rtpnc.epa.gov:7777/water/bioassessment.nsf/State?OpenView&ExpandView**.

It is important to note that all states do not use identical methods and criteria to rate their water quality. For this reason, caution must be used when comparing water quality assessments prepared by different states. IWI 1 does not distinguish those that use biological criteria from those that do not. The state reports provide detailed information about each state's bioassessment criteria, data collection methods, name of the assessed waterbodies, and their attainment status. IWI 1 reports the statistics related to the proportion of assessed stream miles within the catalog unit that have nonimpaired status but says nothing about the condition of individual streams. State bioassessment reports also evaluate lakes for designated uses; this information is not included in IWI 1.

➔**TMDL Program/303(d) reports (EPA, states) http://www.epa.gov/OWOW/tmdl/**
Under section 303(d) of the Clean Water Act, all states are required to identify the waters that do not meet their designated uses under section 305(b) and develop plans for their rehabilitation, specifically total maximum daily loads (TMDLs). This is a two step process by the states. First, each state must identify the stream reaches that do not meet their designated uses and list them (i.e. create the 303(d) list). Second, the state develops a TMDL for each stream reach on the 303(d) list.

The status of state 303(d) lists found at **http://www.epa.gov/OWOW/tmdl/tmdlmap.htm**. This site indicates the progress that each state has made toward getting EPA approval for their 303(d) list. A second site, **http://www.epa.gov/OWOW/tmdl/links.html**, links to the state 303(d) lists which may include details about each stream reach that fails to meet its designated uses, the possible cause of impairment, and, whether or not TMDL development is a high priority.

Montana maintains an excellent website for stream reaches that fail to meet their designated uses. The site includes specific location information (i.e. which reach is impaired), TMDL development priority, probable impaired uses, probable causes, and probable sources of impairment.
http://water.montana.edu/docs/tmdl/303d/303dlist.htm. Other good examples are Oregon: **http://waterquality.deq.state.or.us/wq/303dlist/303dpage.htm**; West Virginia: **http://www.dep.state.wv.us/wr/pubs.html**.

4.4 Fisheries Management Activities (states).
Fish stocking records and survey reports conducted by government agencies are public record. Some states' stocking records are available online and all can be accessed upon request to the office with jurisdiction over the waterbody of interest. For example, Michigan's fish stocking records are available online and document stocking by the Michigan Department of Natural Resources, the U.S. Fish and Wildlife Service, and permitted individuals (Go to **http://www.state.mi.us** choose "Fisheries," then "Hatcheries", then "Stocking" and then choose a year. Within each year, records are

organized by county). Indiana and Maryland trout stocking records are also available online from **http://www.state.in.us/dnr/fishwild/trout/trout_regs.htm** and **http://www.dnr.state.md.us/fisheries/fishingreport/troutstock.html**, respectively.

IV. OTHER RESOURCES

1. Other Sources of Spatial Data

➔**List of USGS spatial data sets for water. http://water.usgs.gov/lookup/getgislist**
This is a great source of GIS data available for download. It includes approximately 100 data layers, many of which were discussed in other parts of this document. Some layers cover the entire US (e.g. estimates of land in agricultural production, estimated herbicide use, landfill locations, WATSTORE stream flow basin characteristics), and some are the result of regional projects (e.g. digital map of hydraulic conductivity for the High Plains aquifer).

➔**Stream gauge information (USGS).** USGS WATSTORE stream flow basin characteristics (SFBC) are available from **http://water.usgs.gov/lookup/getgislist**. This point layer spatially references over 15,000 USGS stream flow gauge sites in the coterminous US. Attributes of each gauge include catchment area, percent forest in catchment, mean annual precipitation, average flow, and other flow parameters (e.g. two year flood flow). This is a very convenient source of spatially referenced stream gauge data.

Hydro-climatic data network (USGS). The Hydro-climatic data network (HCDN) derives stream gauge information primarily from WATSTORE. HCDN was designed to contain only records that are appropriate for the study of the relationship between stream flow and climate variation. It includes stream gauge locations across the US that meet certain criteria (data in electronic form, coverage for entire year over a 20 year period of record, accurate, with unimpaired basin characteristics). HCDN is described in a USGS report available at **http://wwwrvares.er.usgs.gov/hcdn_report/content.html**; the report includes links to flow data from included gauge stations.

North American Water Quality Assessment (NAWQA) Program (USGS). **http://wwwrvares.er.usgs.gov/nawqa/nawqa_home.html** The NAWQA Program was designed to describe the status and quality of ground- and surfacewater resources and add to the understanding of factors that affect their quality. Investigations are being conducted in 59 “study units” across the US. This site includes links to selected water quality publications, digital map products, GIS layers, and contacts for each of the 59 study units are included.

USDA-NRCS GIS Links. http://www.nhq.nrcs.usda.gov/land/tools/nrcsgis.html This site links to GIS layers showing state, county, federal land, and 8-digit catalog unit boundaries, as well as soil data and models for use with spatial data.

Guide To Mostly On-line And Mostly Free U.S. Geospatial and Attribute Data. **http://cast.uark.edu/local/hunt/index.html** This index is compiled and sponsored by

Center For Advanced Spatial Technologies (CAST) at the University of Arkansas, Fayetteville. It is an excellent source of links to spatial data provided by federal and state agencies, organized both by topic and geographic area.

Center for Environmental Information and Statistics (CEIS) Water Atlas.
http://www.epa.gov/ceisweb1/ceishome/atlas/nationalatlas/wateratlas.html
This site contains links to national maps generated by EPA, NRCS, USGS NAWQA Program, and TNC. Most maps and data currently available have already been referenced in this document, but it might be worth a check to see if any new information has become available. This page also links to electronic documents published by these agencies.

EPA Surf Your Watershed http://www.epa.gov/surf2/locate/
This site accesses watershed information through map, zip code, or landmark queries. There is a page for each 8-digit catalog unit that includes links to IWI scores, USGS water use, watershed assessments, and citizen action groups or conservation projects within that catalog unit.

New York State Spatial data clearinghouse. http://www.ctg.albany.edu/gisny.html
This site includes links to socioeconomic boundaries (school districts, tax maps, zoning coverages), geological data (bedrock aquifers, statewide surficial geology), and tourism/recreation layers (Scenic Areas of Statewide Significance [SASS]). Some are statewide coverages, some are detailed maps and data for limited areas. Other states have similar clearinghouses.

2. Interactive Mapping Tools
➔EPA Enviromapper for Watersheds.
http://www.epa.gov/surf2/iwimapper/enviromapper/
This interactive mapping site is user-friendly and presents source and summary data for the IWI. Enviromapper is a useful tool both for looking at watershed (again defined as 8-digit catalog units) characterizations across a broad area and for extracting detailed, point-specific information about factors affecting water quality within a catalog unit. Initially, maps are generated by state, county, or zip code. At the state and national level, maps show catalog units coded by composite score or any one of the indicators (15) or candidate indicators (6) of the IWI. Interstate highways, Indian lands, and state and county boundaries may be added for reference. By zooming in, additional data layers are added. At the county and zip code level, maps include data points that are used to calculate IWI scores (e.g. permitted discharges, toxic and conventional pollutants) as well as landmarks and reference points (e.g. streets, schools, and churches) on a backdrop of any of the 21 watershed indicators. Point data can be queried by activating a specific theme and clicking on the point of interest.

Most GIS layers and associated data tables in the Enviromapper can be downloaded from EIMS at **http://www.epa.gov:6713/surfdcd/owa/CRBSearch1.ListFrame**.

US Census Tiger Map Service. http://www.census.gov/datamap/www/
Select a state, select a county, then choose "Browse Tiger Map of area," which allows viewing of many data layers: city labels; grid (latitude/longitude); census block groups (points); census block groups (boundaries); congressional districts; counties; Indian reservations; highways; parks; metropolitan statistical areas (MSA)/consolidated metropolitan statistical areas (CMSA); cities/towns; railroads; shoreline; streets; census tracts; interstate labels; state highway labels; state boundaries; US highway labels; water bodies; and zip code points. Technical documentation is also available online. Maps are public domain and can be used without restriction. Map images can be easily downloaded, but component GIS layers are not available online.

National Atlas of the United States (USGS). http://www-atlas.usgs.gov/atlasvue.html
USGS also has an interactive map browser similar to US Census Tiger Map Service. In comparison with the US Census Tiger Map Service, USGS National Atlas contains more GIS files directly related to water resources and geologic events. Also, all GIS files are available for download from the Map Layers Warehouse at **http://www-atlas.usgs.gov/atlasftp.html**. These data layers include airports, cities and towns, county boundaries, dams, federal lands, mortality, parkways and scenic rivers, principal aquifers, railroads, roads, seismic events, states, urban areas, volcanoes, water features (areas), and water features (lines).

V. ACKNOWLEDGEMENTS

Jonathan Higgins, Brian Richter, Robert Wigington, Jeff Baumgartner, and Leni Wilsman helped outline objectives for this guide and provided comments on draft versions; Mary Lammert, Mark Bryer, and Karen Poiani also provided comments on draft versions. Michael Mendelson and Ruth Mathews gathered much of the initial information that was incorporated into this report. Many others contributed details about available data sources and possible analyses: Larry Master (TNC, Eastern Regional Office), Shelly Miller (TNC of Illinois, Peoria), Roy Smogor (Illinois DNR), Pam Fuller (USGS-BRD), Howard Perlman (USGS), Andrew Battin (EPA), and Eunice Padley (USFS).

VI. LITERATURE CITED

Anderson, J.R., E.E. Hardy, and J.T. Roach. 1976. Land use and land cover classification system for use with remote sensing data. Washington, D.C.: U.S. Government Printing Office, Geological Survey Professional Paper 964 (A Revision of the Land Use Classification System as Presented in U.S. Geological Circular 671).

Baumgartner, J.V. 1998. A watershed-scale approach for selecting occurrences of aquatic conservation targets in the Central Shortgrass Prairie Ecoregion. Boulder, CO: The Nature Conservancy.

Dynesius, M. and C. Nilsson. 1994. Fragmentation and flow regulation of river systems in the northern third of the world. Science 226:753-762.

Higgins, J.V., M. Lammert, M.B. Bryer, M.M. DePhilip, and D.H. Grossman. 1998. Freshwater conservation in the Great Lakes basin: development and application of an aquatic community classification framework. Chicago, IL: The Nature Conservancy Great Lakes Program.

Jones, K.B., K.H. Riitters, J.D. Wickham, R.D. Tankersley, Jr., R.V. O'Neill, D.J. Chaloud, E.R. Smith, and A.C. Neale. 1997. An ecological assessment of the United States mid-Atlantic region: a landscape atlas. EPA/600/R-97/130 Washington, D.C.: U.S. Environmental Protection Agency, Office of Research and Development.

Master, L.M., S.R. Flack, and B.A. Stein, eds. 1998. Rivers of life: critical watersheds for protecting freshwater biodiversity. Arlington, VA: The Nature Conservancy.

Miller, S., K. Poiani, M. Merrill. 1998. Threats to the Illinois River Ecosystem. Peoria, IL: The Nature Conservancy of Illinois.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. Conservation Biology 10(4):1163-1174.

Richter, B.D., J.V. Baumgartner, R. Wigington, and D.P. Braun. 1997. How much water does a river need? Freshwater Biology 37:231-249.

Richter, B.D., J.V. Baumgartner, D.P. Braun, and J. Powell. 1998. A spatial assessment of hydrologic alteration within a river network. Regulated rivers: Research and management 14: 329-340.