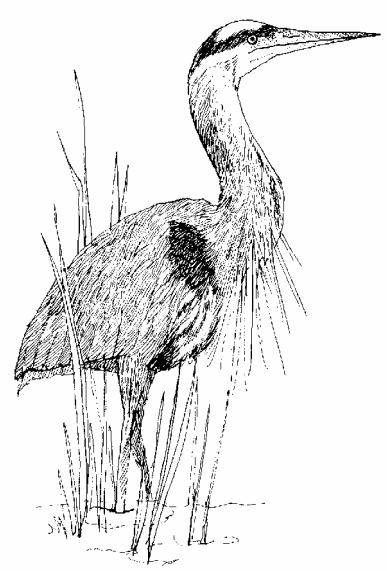

Baseline Inventory Data Recommendations for National Wildlife Refuges

Prepared by:

Fulfilling the Promise
Baseline Inventory Team
WH8.1

January 2004

Table of Contents

Fulfilling the Promise
Baseline Inventory Team

Charter

Purpose The Team will develop detailed guidelines and core baseline biotic data standards for inventories that include the types of information every unit of the National Wildlife Refuge System should have on its resources.

Team is empowered to

Develop standards for baseline data layers appropriate to all refuges for planning and management.

Identify minimum inventory data needed for every refuge.

Adopt standards (where currently lacking or applied inconsistently) for various types of refuge resource data (e.g., vegetation, soils, topography, physical features, hydrology, key wildlife habitats, species lists/distributions, etc.)

Determine appropriate spatial scales for data collection and presentation.

Seek and coordinate internal Service reviews and external partner reviews of draft inventory standards and guidelines.

Convene Team meetings as necessary to complete tasks required to develop baseline inventory standards and guidelines including: addressing comments received from informal and formal internal Service reviews and external public reviews; and briefing *Fulfilling the Promise* Implementation Team, and Washington and Regional Office managers.

Participants The Team consists of representatives from the Regions and the Washington Office. Subject matter experts from other Service programs, other agencies, conservation organizations, and universities could be included as Team members, or consulted as appropriate. The Team will be in place through September 2001.

Process The Team will follow Service procedures for policy formulation; develop products in a timely manner; and coordinate with the *Fulfilling the Promise* Implementation Team to ensure compliance with *Fulfilling the Promise* Recommendation and Action Item. The Team will coordinate with the Regional Refuge Biologists Team involved in an ongoing effort to standardize monitoring protocols, per WH-8.3

Products and Services

The Team will develop baseline inventory standards and guidelines to be incorporated into Service policy through revision of the Inventory and Monitoring Chapter (701 FW 2).

Reporting Relationships

The Team reports to the Promises Team, chaired by the Chief, National Wildlife Refuge System.

_____

Chief, National Wildlife Refuge System Date

Team Members

Fulfilling the Promise **Implementation Team Liaison:**

Vernon Byrd

Washington Representatives:

Bob Adamcik, National Wildlife Refuge System
Morgan McCosh, Division of Fish and Wildlife Management Assistance
(Left Team due to another assignment)

Regional Representatives:

Region 1 - Dennis Woolington
Region 2 - Charles Sexton
Region 3 - Bridget Olson
Region 4 - Jane Griess
Region 5 - John Morton, Jennifer Casey
Region 7 - Steve Talbot

Fulfilling the Promise **Inventory and Monitoring Database Team Members who participated in meetings:**

Mike Long, Region 6
Hal Laskowski, Region 5
Kevin Kilbride, Region 1
Barb White, Region 9, Denver, CO

Executive Summary and Overview

Baseline inventories provide data about abiotic and biotic resources on refuges needed for planning and daily management. The Baseline Inventory Team is an action team chartered by the Promises Implementation Team to recommend minimum abiotic and biotic inventories that every refuge should have. The team reviewed baseline inventory programs of other agencies and organizations, and experts in particular areas were invited to several team meetings to help us complete the task. After review of an earlier draft within the Fish and Wildlife Service, the team produced this report to document recommendations. The intent is to combine this work product with similar output from other action teams dealing with monitoring and database management in a revised Refuge Manual chapter on Inventory and Monitoring.

The Baseline Inventory Team recommends that each refuge have available abiotic "data layers" for topography, aerial photography, hydrography, soils, boundaries, and manmade features. Suggested sources are provided and appropriate scales are recommended. Many of these products are available free to the Service. It is suggested that regional offices provide these data to each refuge. Recommendations for biotic inventory needs include vegetation mapping and National Wetland Inventory data. In addition, lists of vertebrate fauna and flora are discussed and the need to collect supplement data on resource of special interest (e.g., Threatened or Endangered species) is recognized. Finally, an implementation strategy is presented which includes suggested ways to collect and otherwise acquire the types of data needed.

Obviously most refuges will want to ultimately expand beyond the minimum inventories recommended in this document. Nevertheless, if all refuges acquire at least the recommended data, comprehensive conservation planning and habitat management will be enhanced.

I. Baseline Inventory Recommendations

The Baseline Inventory Team has identified the following types of abiotic and biotic information that every National Wildlife Refuge should eventually have at a minimum. The primary abiotic data layers are available digitally (sources are indicated below), and we recommend that these data be centrally gathered (i.e., either in Washington or in the Regions) and synthesized for distribution to the refuges to ensure consistency and avoid redundancy of effort.

The biotic data layers need to be collected at the refuge level, and we recommend that these data be collected for storage and manipulation with a Geographic Information System (GIS) or in other appropriate data bases. Biological data and other information for land management is inherently spatial in nature, i.e., it can be tagged to a particular location on earth. GIS provides a great platform for developing and integrating these myriad data. The table below outlines the data needs and provides information on the sources. As indicated above, the list outlines the minimum types of inventory data needed for each refuge. Obviously most refuges will have a need to collect additional inventory data (e.g., vegetation mapping may need to be done at the association scale rather than alliance for some management purposes). Following the table is an annotated list explaining in more detail each item in the table.

Abiotic Data Needs	***Source of Data***
1. Topography	USGS 7.5' minute topographic map 1:24,000 scale USGS Digital Raster Graphic (DRG) USGS Digital Elevation Model (DEM)
2. Aerial Photography	Digital Orthographic Quarter Quads (DOQQs) 1:12,000, 1:24,000 scale
3. Hydrography	National Hydrography Data Set. 1:100,000 Hydrologic Units, level 3
4. Soils	Natural Resource Conservation Service. 1:24,000 scale
5. Boundaries: (refuge, easements, right-of-ways, wilderness areas, political, etc.)	USFWS Regional Realty Offices Public Lands Survey System for 30 western states. BLM's Geographic Coordinate Data Base where available.
6. Manmade Features:	
Roads:	USGS; Census Bureau; NWR Road Inventory; DOQs
Culverts, dams, water structures, buildings:	USFWS Real Property Inventory which gathered refuge specific structures using GPS; DOQs
Power Lines, underground utilities:	Gather from relevant agencies; DOQs
NGS survey markers, bench marks:	NOAA's Office of National Geodetic Survey (NGS)

Biotic Data Needs	*Data Recommended*	*Method of Collection*
7. Vegetation **A. Vegetation Map** **B. Plant Community Description**	National Vegetation Classification System (NVSC) to the Alliance Level.	The Vegetation Classification Panel of the ESA's document 'Guidelines for Describing Associations and Alliances of the U.S. National Vegetation Classification'. National GAP products may be useful in developing refuge vegetation maps.
8. National Wetlands Inventory Map	Cowardin, Carter and LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. USFWS/OBS-79/31 is the source for the classifications.	Available from National Wetlands Inventory Center.
9. Vertebrate Fauna and Vascular Flora	Species Lists and Checklists	Literature Review. Presence Confirmation based on surveys. Collection of voucher specimens.
10. Resources of Special Interest (determined by the refuge)	Delineate Focal Areas (heron rookeries, rare plant communities, concentration sites). Distribution of Species - spatial location - habitat affinity Quantitative Abundance of Species	Map developed by refuge based on local knowledge. Literature review and Species-specific or species group surveys. Species-specific surveys.

II. Annotated List of Abiotic and Biotic Data Needs

Many of the data layers that are recommended are available free of charge through the USFWS GIS website: *fws.gov/data/gishome.html.* It is essential that this site be visited while gathering data. Links to National and State data sets are gathered in one location as well as GIS tools, data standards and metadata information. This website is maintained by the USFWS National GIS Coordinator. Before a refuge purchases data or develops a contract for GIS work to be done, contact the Coordinator for assistance in determining the current availability of GIS data sets. This is the initial step in developing a GIS. After obtaining the GIS data layers, the time consuming process of consolidation and georeferencing of the data layers needs to be accomplished by someone with GIS expertise before the GIS is complete.

Newer GIS data are referenced to the North American Datum of 1983 (NAD83) and cast on the Universal Transverse Mercator (UTM) projection. All data layers need to be in NAD83 in order for them to all line up properly when they are being used in GIS software such as ArcView. Likewise, all refuge-specific data that is collected with a Global Positioning System (GPS) need to be collected using NAD83. Some of the older GIS data are in the process of being converted to NAD83. Data that is not in NAD83 can be converted with the newer version of ArcView.

1. TOPOGRAPHY

Topographic features have traditionally been displayed on U.S. Geological Survey (USGS) topographic maps. A digital raster graphic (DRG) is simply a scanned image of a USGS topographic paper map, georeferenced to the surface of the Earth, which can be used in a Geographic Information System (GIS) such as ArcView. The scanned image includes all map collar information (Public Land System coordinates, contour interval, latitude-longitude, UTM, State Plane grid ticks, datum, projection, declination, and other source information). When Digital Orthophoto Quadrangles (DOQs) are not available, DRGs can serve as a base map for a Refuge in which other digital information can be overlaid as separate data layers or delineated on-screen. (note, that DOQs are preferred to DRGs as a base map, see Section 2.). Several of the components of a DRG can be separately acquired as digital line graphics (DLGs) allowing for these components to be manipulated independently from the base map (see Section 7. Man-made Features for further details).

DRGs are only a graphic representation of top relief, whereas, digital elevation model data (DEMs) contain the actual elevation data and are often the best source of topographic relief. DEMs can be used in applications such as flood inundation models, view shed analysis, and vegetation mapping. DEMs are used to develop maps of slope, aspect, or shaded relief, or produce 3-D renderings of the land surface that can be draped with other data layers (such as DRGs). DEMs are available free-of-charge at the 1:24,000 scale from USGS at the EROS Data Center website: *edc.usgs.gov/products/elevation/dem.html*.

Between 1995 and 1998, the USGS produced DRGs of topographic maps at several scales. The most widely available DRG is the 1:24,000 (7.5 minute) scale. The map is scanned at a minimum resolution of 250 dots per inch (dpi); if scanned at a finer resolution, the image is resampled to 250 dpi. The digital image is georeferenced to the true ground coordinates of the 2.5-minute grid ticks and projected to the UTM for projection consistency with USGS Digital Orthophoto Quadrangles (see Section 2) and DLGs. In most cases, the datum of the source map is preserved in the DRG, which may be NAD27 or NAD83.

DRGs are in TIFF 6.0 format, with GeoTIFF 0.2 or 1.0 extensions to define georeferencing. The TIFF is accompanied by a metadata file that complies with the Federal Geographic Data Committee=s AContent Standards for Digital Geospatial Metadata@ (8 June 1994). Since 1998, some new DRGs are derived directly from digital data rather than from scans of the paper map. Detailed information about DRGs, including technical standards, DRG viewing software, and status and availability of all DRGs, is available at the USGS website: *mcmcweb.er.usgs.gov/drg*.

The USGS distributes topographic maps on paper and DRGs on a variety of media, including recordable compact disc-read only (CD-R), digital versatile disk (DVD), and from file transfer protocol (FTP) websites as uncompressed files. The 7.5 minute printed paper topographic maps can be ordered from USGS from their MapFinder website: *edcwww.cr.usgs.gov/mapfinder*. At this website, you can enter a zip code or click on a map of the U.S. to find the map you want as well as the nearest map dealer who may have the map you need. Dealer prices may vary, USGS=s price per map is $4.00 with a handling fee of $5.00, regardless of the number of items you order.

The FWS GIS Office will copy DRG CD=s upon request from any Service office for the cost of blank CDs (< $0.50 each) plus shipping costs. There is an interactive map that can be used to find the quads that are needed at the website: *sii.fws.gov/r9data/gis/data_drg.html*. Alternatively, the USGS distributes DRGs on CD-Rs and orders are filled on demand. There is a base charge of $45 per order, plus $5 shipping and $1 for each DRG quadrangle purchased. DRG files are available from the USGS Sales Data Base and can be ordered through the USGS Global Land Information System website: *edcwww.cr.usgs.gov/webglis*, EarthExplorer at *earthexplorer.usgs.gov* or from any Earth Science Information Center (ESIC). For price and ordering information, see the USGS GeoData Digital Raster Graphics order form, available online at *mac.usgs.gov/mac/isb/pubs/drg.pdf*.

2. AERIAL PHOTOGRAPHY

Aerial photography is used in varieties of refuge applications, including vegetation and timber management, routing and habitat analysis, environmental impact assessments, flood analysis, soil erosion assessment, facility management, ground-water and watershed analysis as well as biological inventory assessment. Aerial photography serves as a base

map onto which other map information may be overlaid. There are a number of imagery data sources that can be used in a GIS, the most common and readily available is a digital orthophoto quadrangle (DOQ). The DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief (topography) and camera tilts has been removed by a mathematical process called rectification. It combines the image characteristics of a photograph with the georeferenced qualities of a map.

DOQs may be available in black and white (B/W), natural color or color infrared images (CIR) with 1-meter ground resolution In general, fine vegetative differences are more apparent in natural color or color infrared orthophotos and it is easier to distinguish details when interpreting vegetation coverages than with B/W orthophotos. Another consideration when selecting either B/W or color orthophotos is the notably larger size of the color files and the requisite storage space needed.

Since an orthophoto has uniform-scale, it is possible to measure directly on it like other maps. A DOQ can be used on-screen to collect, review, and revise other digital data, especially digital line graphs (DLG) and topographic maps. The accuracy and extraordinary detail provided by the DOQ allow users to evaluate their data for accuracy and completeness, make real-time modifications to their data, and even generate new files. When the DOQ is combined with other digital products, such as digital raster graphics (DRGs) or digital elevation models (DEMs), the resulting image provides additional visual information for the extraction and revision of base cartographic information.

There are a number of DOQs available within the Service. Check the Service=s GIS homepage on the Intranet: *sii.fws.gov/r9data/gis/* for an index of DOQs already owned by the Service. For coverages of areas not already available through the Service, images may be obtained by the U.S. Geological Survey(USGS) through the website: *edc.usgs.gov/products/aerial/doq.html*. The USGS produces three kinds of DOQs:

1. **3.75-minute (quarter-quad) DOQs** and formerly called DOQQs, are available at a scale of 1:12,000 and cover an area measuring 3.75 minutes longitude by 3.75 minutes latitude. Most of the U.S. is currently available, and the remaining locations should be complete by 2004. To check availability status for your area a status map is available at: *mcmcweb.er.usgs.gov/status/doq_state.html*. Quarter-quad DOQs are distributed on CD-ROM, DVD, 8-mm tape, and File Transfer Protocol (FTP) as uncompressed files.

2. **7.5-minute (full-quad) DOQs** are available at a scale of 1:24,000 and cover an area measuring 7.5 minutes longitude by 7.5 minutes latitude. Full-quad DOQs are mostly available for Oregon, Washington, and Alaska. Limited coverage may also be available for other states. Full-quad DOQs are distributed on CD-ROM, DVD, 8-mm tape, and FTP as uncompressed files.

3. **County DOQs** consist of collections of individual DOQs that have been compiled on a county-by-county basis. There is fairly good coverage for counties in Kansas, Georgia, Minnesota, North Carolina, and Pennsylvania. Other state may also have limited coverage available. The files are cast to the UTM projection and referenced to either NAD 27 or NAD83. County DOQs are packaged as individual JPEG-compressed 8-bit binary files on CD-ROM.

Either GeoTIFF or Native format can be specified, however, GeoTIFF has much smaller file sizes and is recommended format for ArcView per USGS. GeoTIFF format are cast to the UTM projection and referenced to NAD83. DOQ orders are filled on demand. Any combination of files can be ordered. To order by mail, download the order form from the Earth Science Information Center (ESIC) from their website: *ask.usgs.gov* and return the order form and payment to any ESIC or to:

Customer Services
USGS EROS Data Center
Sioux Falls, SD 57198

After obtaining DOQs, they can be combined and compressed into a single file using software such as Mr. Sid, to create a seamless image of compressed data. The Mr. Sid format allows for the 3.75 and 7.5 DOQs to be compressed greatly without sacrificing the visual quality of the image.

Data can also be searched for availability and ordered through the Global Land Information System website: *edcwww.cr.usgs.gov/webglis/*. At the time of writing, prices include: a base charge of $60.00 per DVD order, or $45.00 CD-ROM or tape order, plus $5.00 shipping, and $7.50 for each 3.75 minute black and white (B/W) DOQ file, or $15.00 for color 3.75 DOQ. The full-quad DOQs are only available in B/W at a price of $15.00 per file. The County DOQs start at $32.00. For information or ordering assistance, call 1-888-ASK-USGS.

It is important to note that DOQs are not available for all portions of the US, such as Alaska and Hawaii. There are alternative imagery sources which can be purchased to cover these areas as well as provide the most current land cover conditions. Recent land use or land cover changes are not always visible on DOQs because they are often produced from older photography. Indian Remote Sensing Satellite (IRS) imagery is collected continuously and allows for the assessment of recent landscape changes. It is available in 7.5 minute quad format for the entire US and can be purchased for $250 to $350 per quad. It is panchromatic with a 5 meter pixel resolution. Although IRS imagery is coarser than DOQ, it is adequate for most visually interpretive applications. IRS can be ordered through Space Imaging=s website: *SpaceImaging.com*. There are other higher resolution sensors, which are multi-spectral and panchromatic such as Quick Bird and Iconos. This imagery is expensive, but is an alternative.

3. HYDROGRAPHY

Hydrography is the scientific description and analysis of the physical conditions, boundaries, flow and related characteristics of surface waters such as lakes, ponds, streams, rivers, springs and wells. The U.S. Geological Survey (USGS) has a comprehensive set of digital spatial data, the National Hydrography Dataset (NHD), that contains information about surface water features and drainage networks which are combined to form >reaches=. The linkage enables the analysis and display of water-related data in upstream and downstream order. This abiotic data layer will provide basic surface water data with the added information of flow direction, which will assist the refuge in determining potential contaminant threats, assessing flow rates, etc. Understanding the hydrography of a refuge and surrounding landscape will assist in maintaining or reintroducing natural water flow regimes to encourage ecosystem functions.

The dataset is currently based on the content of the USGS 1:100,000-scale data, giving it accuracy consistent with those data. However, the NHD is designed to incorporate and encourage the development of higher resolution data that is required by many users.

The NHD is available, free of charge, from USGS through either USGS National Hydrography website: *nhd.usgs.gov* or by ordering the data on CD from the Global Land Information System website: *edc.usgs.gov/webglis* at the cost of $45.00 plus $5.00 handling charge. The data are available in cataloging units. The cataloging units for an area can be determined from the National Hydrography website. Hydrography data is also available from the FWS GIS website: *fws.gov/data/gisconv/dlgtools.html.*

Also available are maps of watersheds called hydrologic units. The United States is divided and sub-divided into successively smaller hydrologic units which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions). There are 18 regions within the US which are subdivided into smaller units, ending with 2150 Cataloging Units which are sometimes referred to as watersheds. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. Refuges should be mapped to level three HUC. More information regarding Hydrologic Unit Maps can be found at the USGS website: *water.usgs.gov/GIS/huc.html*.

A single-sheet hydrologic unit map is available at a scale of 1:3,500,000 and measures 41-58 inches. The map is part of The National Atlas of the United States of America series, more information is available at the Atlas=s website: *nationalatlas.gov/atlasmap.html.* The map is also available from USGS at a cost of $7.00 per sheet. There is a Hydrologic Unit Map of the US, East (GHU0057-1T) and one for the West (GHU0057-2T).

Digital hydrologic units at a scale of 1:250,000 are available, free of charge, from the USGS website: *water.usgs.gov/GIS/huc.html.* The coverage may be retrieved as a single file for the entire U.S. or by Water Resources Region which is the first level of

classification. Digital hydrologic units at a scale of 1:2,000,000 are available along with an attribute table showing hydrologic unit names and flow direction can be found at the same website. The coast of the U.S. is included and land/water polygons are distinguished. Unofficial offshore extensions of cataloging units are shown.

The National Oceanic and Atmospheric Administration has a website that provides the current river conditions (*nws.noaa.gov/oh/hic/*). USGS has a website of maps and graphs of current water resource conditions (*water.usgs.gov/waterwatch/*). A hydrology web can be found at: *terrassa.pnl.gov:2080/hydrology/lists.html*. A list of links to information sources for hydrogeology, hydrology and environmental sciences can be found at: *us.net/adept/links.html#keys.*

4. SOILS

Knowledge of soil types on Refuge lands and understanding of their influence on plant and wildlife communities is critical to the proper management of Service trust resources. The U.S. Department of Agriculture (USDA), in cooperation with State agricultural experiment stations and other Federal and State agencies has been making soil surveys and publishing them since 1899. These surveys constitute a nationwide system soil classification, nomenclature, and interpretation, and cover almost all lands of the United States. Published soil surveys contain, in addition to soils maps, general information about the land use and climate of the area, and descriptions of each kind of soil. They include a discussion of the formation and classification of the soils in the area, productivity, land capability, and also laboratory data when available.

Most published soil surveys cover one or more counties and are so named. Most of the surveys published since 1957 contain soil maps printed on a photomosaic base. The usual map scale is 1:24000, 1:12000, or 1:15840, depending on the needs of the area.

Published soil surveys that are still in print may be obtained through contacting the State or local office of the USDA Natural Resources Conservation Service (NRCS), or from the local county agricultural extension agent. Many libraries keep published soil surveys on file for reference. Also, soil conservation district offices and county agricultural extension offices have copies of local soil surveys that can be used for reference.

Digitized versions of the soils maps are available for selected counties and areas throughout the United States and its territories through the Soil Survey Geographic (SSURGO) database website: *ftw.nrsc.usda.gov/stssaid.html* These digitized mapping bases meet national map accuracy standards, and are either orthophoto quads or 7.5 minute topographic quadrangles. SSURGO is linked to a Map Unit Interpretation Record (MUIR) database. The attribute database gives the proportionate extent of the component soils and their properties for each map unit. The MUIR database includes over 25 physical and chemical soil properties.

SSURGO map data are available, either online or on a CD, in modified Digital Line Graph (DLG-3) optional and Arc interchange file formats. To obtain SSURGO soil spatial data and attribute data contact your State or local USDA-NRCS office or:

National Cartography and Geospatial Center
USDA-Natural Resources Conservation Service
P.O. Box 6567
Fort Worth, TX 78115
Telephone: 1-800-672-5559
FAX: (817) 509-5469

Soils data can be very confusion for those unfamiliar with the data sets or do not use it often. The FWS GIS website: *fws.gov/data/gisconv/soiltool.html* has tips for interpreting soils data and descriptions of the MUIR database. Additional information on soil surveys, lists of surveys, and USDA-NRCS contacts can be obtained through the USDA-NRCS website: *nrcs.usda.gov.*

5. BOUNDARIES

During the process of developing the Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP), it is essential that the refuge have accurate refuge boundary data. The refuge boundary data layer needs to consist of the current and approved acquisition boundary along with inholdings. The Realty Division of US Fish and Wildlife Service is working on creating boundary layers for every refuge and this should be done by 2003. For those already done, regions may be able to obtain these directly from the Regional Realty Office free of charge. They can also be downloaded from the FWS GIS website: *fws.gov/data/datafws.html.*

USFWS Region	Refuge Boundary Availability
1	All refuges, except Hawaii and the Pacific Islands, are complete and available on the FWS website.
2	Older general boundaries for all refuges are available. They are in the process of updating to current boundaries.
3	Approximately 25% are complete, many of the refuges do not have the boundary metadata.
4	Approximately 85% complete and available on FWS website.
5	100% complete and available on FWS website.
6	Approximately 80% done, only available through the Regional Reality Office, they do not have the boundary metadata.
7	Almost 100% complete, only available through the Regional Reality Office.

Along with the refuge proposed and current boundaries, the surrounding landownership boundaries are a necessary data layer for the CCP and HMP process as well. Land ownership along with other political boundaries such as, towns, counties, Indian reservations, parks, zoning, local planning, etc. can often be found at State GIS clearinghouse websites.

The Public Land Survey System (PLSS) is a legal reference system designed to ease the description, inventory and transfer of real property primarily in the western half of the US. It is a grid of 6 mile x 6 mile squares, which are townships, and within the townships is a grid of smaller squares which are numbered and ownership is indexed accordingly. This data is available for all except the following states: Connecticut, Delaware, Georgia, Hawaii, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Vermont, and West Virginia. The Public Land Survey System data can be downloaded, free of charge, from the USFWS GIS website: *fws.gov/data/giscinv/dlgtools.html.*

The Bureau of Land Management (BLM) is developing a Geographic Coordinate Data Base (GCDB) as the framework for its Land Information System and is mandated as the base land lines theme for all federal agency mapping and GIS efforts. The Geographic Coordinate Data Base will be a common reference to the Public Land Survey System and is intended to facilitate the integration to separate GIS systems. The GCDB contains latitude and longitude coordinate values and other descriptive information for corner positions and monuments recorded in the PLSS. These coordinates are easily converted to Universal Transverse Mercator (UTMs) or state plane values. BLM is designing a data layer to automatically display data from the national land and mineral records which includes information on land ownership status and use authorizations such as oil and gas leases, mining claims, rights-of-way, and more. The GCDB data is available for Arizona, Arkansas, California, Colorado, Michigan, Montana, Nevada, New Mexico, North Dakota, Oregon, Utah and Wyoming at the BLM website: *blm.gov/gcdb.*

6. MAN-MADE FEATURES

Man-made features that occur on and near the refuge are important features to be mapped for management and planning purposes. The man-made features generally mapped on refuges include roads, culverts, dams, water structures, buildings, power lines, and geodetic benchmarks. Many of these features are displayed on 1:24000 USGS topographic paper maps, however, the maps may not reflect the current status of these features and they often do not include refuge specific features such as water control structures. The current status and location of man-made features need to be included in the refuge=s baseline inventory. During a recent Real Property Inventory, each refuge was asked to submit the GPS location of the real property that exists on the refuge. This data should be available from the Regional Offices, if a copy was not kept at the refuge.

Man-made features need to be a separate data layer to allow for GIS manipulation. The more current USGS topographic paper maps may accurately display man-made features and, therefore, the corresponding digital raster graphics will be accurate as well (see Section 1.Topography). However, digital raster graphics (DRGs) are scanned images of topographic maps and component features cannot be separately manipulated in a GIS. Existing data such as roads, state and county boundaries can be easily incorporated as separate data layers, and the refuge specific data can be collected with a global positioning system (GPS).

Most of the existing man-made feature data have been created as digital line graphics (DLGs) by USGS. There is wide variation in data specifications and availability of data sets. The EROS Data Center is the major Internet source for DGL data (*edcwww.cr.usgs.gov/glis/hyper/guide*). The 1:24000 data are in Spatial Data Transfer Standard (SDTS) format and the instructions on how to transfer these data into a GIS are found at the FWS GIS website: *fws.gov/data/gisconv/dlgtools.html* as well as the documentation and tools needed to use USGS DLG data.

7. VEGETATION

A. Vegetation Mapping

To assist in the effective assessment, management, and inventory of the nation's plant communities, the National Vegetation Classification (NVC) was developed (Federal Geographic Data Committee [FGDC] 1997). The NVCS, which has been adopted as the federal standard, serves to support the use of a consistent national vegetation classification system to produce uniform statistics in vegetation resources from vegetation cover data at the national level. For vegetation mapping, we recommend that the FGDC standard be applied to all refuges at the Alliance level and at a scale appropriate to the refuge. Many forest alliances are roughly equivalent to the Acover types@ developed by the Society of American Foresters and should be helpful for the development of a Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP).

The 1997 FGDC standard introduced two floristic categories of the classification hierarchy, Alliance and Association, but provided no details about nomenclature or methods for defining and describing the units within them. Furthermore, no list of floristic types was provided. In 1998, a list of floristic types was published in cooperation with the Natural Heritage Network and maintained by NatureServe as a first approximation of Alliance and Association types, with the expectation that the list would be enhanced and revised with adherence to the philosophy that Athe data used to describe Alliance and Association types must be collected using uniform standard and documented sampling methods.@ However, the FGDC standard only provides a brief overview of what those methods are.

Although the 1997 FGDC standard provided no specific guidance on methodology for the floristic levels, it did lay out some principles for its overall development (FGDC 1997, Section 5.3). These principles, particularly the final one, shed some light on the nature of the floristic units that the FGDC Vegetation Subcommittee envisioned: AThe lower levels of the NVCS are based on actual floristic (vegetation) composition. The data used to describe Alliance and Association types must be collected in the field using standard and documented sampling methods. The Alliance and Association units are derived from these field data. These floristically-based classes will be nested under the physiognomic classes of the hierarchy.@

Although the standards have been published and adopted, important components such as widely accepted standards for terminology, documentation of many vegetation types (particularly below the Alliance level), and field data acquisition were lacking. To remedy this, the Ecological Society of America (ESA), joined with cooperating organizations (The Nature Conservancy, U.S. Geological Survey, U.S. Federal Geographic Data Committee) to refine the classification system. In 2003, they completed the document, "Guidelines for Describing Associations and Alliances of the U.S. National Vegetation Classification" (Version 2.0; March 2003) that affirms standards for floristic units of vegetation. In the future, Alliances and Associations accepted into the list of NVCS floristic units are expected to meet these standards for sampling definition and description. It is important to note that the classification guidelines are relatively fixed but do allow for refinement as additional information becomes available. The ESA initiative provides standards in four main areas: (1) plot records, (2) type description, (3) peer review, and (4) data management. These standards and other pertinent information are available on the ESA's Panel on Vegetation Classification website: esa.org/vegweb. More information regarding the FGDC Vegetation Subcommittee can be obtained from their website: biology.usgs.gov/fgdc.veg/.

The Alliance level represents the minimum standard for NWRS. Based on the size of a refuge, associated scale issues, and the questions that are being asked, it may be appropriate to pursue a more detailed floristic level. For mapping agricultural or other highly manipulated lands, a flexible approach is recommended depending on refuge objectives. Such categories might include pasture, orchards, and agriculture by crops. Vegetation maps at the Alliance level using the NVCS (or systems that would allow cross walking to NVC) are available as GAP (Geographic Approach to Planning for Biological Diversity) products in some states, but in most cases refuges will need to produce these vegetation maps. This will require aerial photographs and/or digital images, photo interpretation, vegetation classification, ground reference data, and GIS interface. Information on methods is available in a variety of texts such as in Küchler, A.W. 1967. Vegetation mapping. Roland Press; and Küchler, AW, & Zonneveld, IS (eds.) 1988. Vegetation Mapping. Handbook of Vegetation Science, Vol. 10. Dordecht, the Netherlands: Kluwer Academic. Mapping costs will vary depending on refuge staff skills, the size of the refuge, and vegetation complexity.

B. Plant Community Description

Vegetation classification is of central importance to biological conservation for planning and inventory, to resource management for monitoring and planning, and to basic scientific research as a tool for organizing and interpreting ecological information. All of these activities require that ecological units be defined and that their distributions on the landscape be known and understood. Vegetation classification contributes significantly to analysis of ecological problems that vary in scale from persistence of tiny populations of endangered species to global projections of the impact of climate change. Technological advances have made practical large-scale analyses that cross agency jurisdictions or geographic regions and address applied ecological issues as diverse as global change, ecosystem management, and conservation planning. However, all such efforts depend on having available a common set of well defined and broadly accepted classification units.

A basic premise underlying the standards for defining Alliance units is that they are best described and analyzed using plot data collected in the field using standard methods. The standards for floristic vegetation classification in "Guidelines for Describing Associations and Alliances of the U.S. National Vegetation Classification" (Version 2.0; March 2003) (see above) provides a means to describe the floristic composition and structure of plant communities, describe the spatial and temporal variation within plant communities, determine the environmental and biotic characteristics of plant communities, and establish the geographical and elevation range of the plant communities recognized. These data may be used to describe and classify the plant communities of a refuge, region, and the nation as well as provide ground reference data for vegetation mapping.

As a minimum standard, each Alliance portrayed on a national wildlife refuge vegetation map shall be represented by a single plot using the methods described in "Guidelines for Describing Associations and Alliances of the U.S. National Vegetation Classification" (Version 2.0; March 2003). A stand selected for sampling is considered typical of the Alliance of which it is a part and each plot sampled therein is expected to yield a more or less typical description in terms of both floristic composition and structure. Each plot should represent one entity of vegetation; that is, a plot should be relatively homogeneous in both vegetation and habitat and large enough to represent the stand=s floristic composition and structure. This representative plant community is in essence a living voucher of an Alliance. Because quantitative plot data constitute the primary descriptor of the floristic units, further plot sampling within Alliances is encouraged. This will permit the classification of individual plant communities into types such as Associations and Alliances. For a classification effort to be effective, samples of types should be collected from as wide an area as possible. Although only a few plots may be sufficient to determine that a distinct type is warranted, more widespread sampling will ensure that the type is adequately characterized and understood in comparison to others that may be conceptually similar. Not all field sampling can be done this comprehensively, however, and we recognize that much work will be accomplished in smaller stages and by different investigators.

The fundamental unit of vegetation observation is the plot. At a minimum, a plot contains information on location, spatial extent, and the species present with cover values as a measure of importance. A vegetation plot database is used to store, preserve and distribute plot data that meet recognized minimum standards. Plots are used to classify vegetation. Eventually, each vegetation type will be documented in a vegetation classification database, which will refer to the plots used to develop the types. A vegetation classification database that is part of the national strategy is available, VegBank (http://vegbank.org/vegbank/index.html), which is the database developed by the Ecological Society of America's Panel on Vegetation Classification. VegBank consists of three linked databases that contain (1) the actual plot records, (2) vegetation types recognized in the U.S. National Vegetation Classification and other vegetation types submitted by users, and (3) all plant taxa recognized by ITIS/USDA as well as all other plant taxa recorded in plot records. Vegetation records, community types and plant taxa may be submitted to VegBank and may be subsequently searched, viewed, annotated, revised, interpreted, downloaded, and cited. VegBank is being developed in collaboration with The National Center for Ecological Analysis and Synthesis, USGS Biological Resources Discipline, NBII, and NatureServe.

8. NATIONAL WETLANDS INVENTORY MAP

The majority of the refuges have wetland habitat. The mapping of aquatic habitats is essential to these refuges. The National Wetlands Inventory Center (NWIC) of the USFWS has been producing information on the characteristics, extent and status of wetlands and deepwater habitats. Classification is based on the 1979 USFWS publication by Cowardin, Carter, Golet and LaRoe entitled >Classification of wetlands and deepwater habitats of the United States=. The NWI and NVCS differ in their fundamental approaches. NWI produces a habitat classification, while NVCS classifies the vegetation. In addition, NVCS encompasses both upland and lowland vegetation, while NWI is limited to wetlands. The NWIC has mapped 90 percent of the lower 48 states and 34 percent of Alaska. About 44 percent of the lower 48 states and 13 percent of Alaska has been digitized. A map depicting the current status of NWI maps for the US, information to obtain maps and the Cowardin publication can be found at the NWI website: *wetlands.fws.gov*

Digital maps can be downloaded from the NWI website download page, free of charge. The data is organized by USGS 250k map name. It is advisable to have a USGS index book for the state in which your desired quads are located in order to find which 250k directory to access.

Paper maps can be obtained from a number of sources. The USFWS, NWI and Earth Science Information Center (ESIC) of the USGS have a cooperative agreement for the sale and distribution of NWI maps. ESIC offices accept orders and payment for NWI products:

USGS/ESIC
National Headquarters

507 National Center
Reston, VA 20192
(703) 648-5920

Overlays are NWI delineation=s only, no base information. Composites are NWI delineation=s and a USGS topographic base map combined. Maps are priced as follows:

Mylar Maps (overlay or composite)	$14.00 each
Paper Maps (overlay or composite)	8.00
USGS handling charge	5.00

NWI maps can also be purchased through various State Distribution Centers. There are 34 Centers covering 47 States. Each Center establishes its own pricing structure, product types and order procedures. A list of State Distribution Centers is available at the NWI website.

9. VERTEBRATE FAUNA AND VASCULAR FLORA

As a minimum standard, refuges should document the occurrence of all birds, mammals, reptiles, amphibians, fish, and vascular plants. Additional information is recommended for some vertebrates and vascular plants and in some cases invertebrates and non-vascular plants should be included in minimum inventories (see below). Obviously refuges may need to go well beyond the minimum inventory recommendations for some taxa that are key conservation targets on the particular refuge.

A. Data Collection

Some refuges already have baseline inventory information on wildlife that exceeds minimum standards, but most will need to collect some additional data if only to update dated information. Furthermore, new refuges will need the full suite of information. An obvious initial step is a literature review including specimen data from museums and Natural Heritage databases. For field data collection, rapid assessment methods may suffice. A matrix which outlines the pros and cons for a number of rapid inventory methods is included in Appendix A to assist refuges with determining the best method for them.

B. Species Lists and Checklists

A distinction was made between species lists (which should have abundance derived from objective population sampling that the refuge will define to fit their needs) and checklists for visitors (where subjective relative abundance symbols are assigned based on probability of observing a species). Species lists, which normally would be stored as a database, could have very specific population estimates, estimated densities from index plots, or best guesses of experts about abundance (e.g., hundreds, thousands, etc.) and these would be updated as new information is derived. Species lists are for use in habitat

management planning and for designing monitoring programs. In contrast, checklists would meet public use objectives, and information in species lists could be used to help develop checklists.

C. Nomenclature

To standardized genus and species names used in the species list database, refer to the U.S. Department of Agriculture=s Integrated Taxonomic Information System (ITIS). The ITIS has partnered with others in Mexico and Canada to develop Species2000, a source for standard taxonomic names, which can be accessed via the internet. (*sp2000.org/Annualchecklist.html*). For plant species use the U.S. Department of Agriculture=s Natural Resources Conservation Service=s PLANTS Database which can be accessed via the internet (*plants.usda.gov*). The names in PLANTS are the most current and are ultimately fed into ITIS.

D. Species Lists for Vertebrates

Besides simple lists with abundance indicators, status (e.g., breeder, migrant, wintering, resident, vagrant) and seasonal occurrence should be included for species groups where seasonal change is important (e.g., birds). Definitions of seasons will vary among areas (e.g., the timing of spring varies with latitude), so clear descriptions of timing of seasons needs to be included on species lists. Additionally databases need to include sources for information (see examples of species lists formats below).

All the data in the species lists except relative abundance (which will not have standard definitions among refuges) may be collated at regional and national levels for planning and reporting.

Birds

National Database				Refuge Database	
Species	Status	Seasonal Occurrence Sp Su Fa Wi	Source	Relative Abundance	Comments
USDA-ITIS (Integrated Taxonomic Information System).	*breeding, migrant, resident, vagrant*	*Present/not detected data displayed for spring (Sp), summer (Su), fall (Fa), and winter (Wi).*	*source of the data - literature citation, refuge survey, reports from visitors, voucher specimens*	*this is refuge defined to meet the needs of the refuge biologist and determined upon the level of data collected - census data v.s. index data.*	*could include information on general locations*

Mammals

National Database			Refuge Database	
Species	Status	Source	Relative Abundance	Comments
USDA-ITIS (Integrated Taxonomic Information System).	*migratory, resident*	*source of the data - literature citation, refuge survey, reports from visitors, voucher specimens*	*this is refuge defined to meet the needs of the refuge biologist and determined upon the level of data collected - census data v.s. index data.*	*could include information on general locations*

Amphibians / Reptiles

National Database		Refuge Database	
Species	Source	Relative Abundance	Comments
USDA-ITIS (Integrated Taxonomic Information System).	*source of the data - literature citation, refuge survey, reports from visitors, voucher specimens*	*this is refuge defined to meet the needs of the refuge biologist and determined upon the level of data collected - census data v.s. index data.*	*could include information on general locations*

Fish

National Database			Refuge Database	
Species	Status	Source	Relative Abundance	Comments
USDA-ITIS (Integrated Taxonomic Information System).	*anadromous, resident*	*source of the data - literature citation, refuge survey, reports from visitors, voucher specimens*	*this is refuge defined to meet the needs of the refuge biologist and determined upon the level of data collected - census data v.s. index data.*	

E. Species Lists for Vascular Plants

Similar to Vertebrates, plant species lists include the names of all species known, but instead of status, a commonness class and assignment to a particular National Vegetation Classification System alliance is included. All this information can be aggregated at regional and national levels for planning and reporting. Additionally, refuges should add

a data field that specifies the habitat (using nomenclature in for the ecosystem where the refuge occurs) where the species is the most common.

While collecting vascular plant data, it is important to obtain a voucher specimen to allow for the confirmation of species identification, establish a historical record, and will assist with the development of species range maps. Each botanical specimen needs to be prepared and housed in a herbarium either at the refuge or elsewhere with a label that gives the pertinent information concerning the source of the specimen, whether collected from nature or cultivated. If cultivated, the source of the culture should be given.

Refuge specific data that can be housed in the refuge database should include a Refuge-defined habitat to assist with the general identification of where the plant can be located on the Refuge.

Vascular Flora

National Database				Refuge Database	
Species	Commonness Class[a]	NVCS Alliance	Source	User-defined Habitat	Comments
USDA-ITIS (Integrated Taxonomic Information System) for individual species, and the NVCS (National Vegetation Classification System) for plant communities.	*Abundant Common Uncommon Rare*	*the National Vegetation Classification System=s Alliance level in which this species was found.*	*identify the source of the data - historical record, literature citation, refuge survey, volunteer information, voucher specimen, etc.*	*this is refuge defined to meet the needs of the refuge biologist and refuge management.*	*could include information on general locations*

[a] >Commonness Classes= as modified from Duncan and Meacham (Duncan, T., and C. A. Meacham. 1986. MEKA manual (Version 1.3). University Herbarium, University of California, Berkeley, California. 49 pp.) A species relative abundance is based on how often it occurs within the NVCS Alliance it is found:

1) Abundant = very likely to be encountered; nearly always found in appropriate Alliance, sometimes forming dense stands;

2) Common = likely to be encountered in appropriate Alliance;

3) Uncommon = unlikely to be encountered, sometimes not present in appropriate Alliance;

4) Rare = extremely unlikely to be encountered, often not present in appropriate Alliance, and often restricted to a small number of sites.

F. Invertebrates and Non-vascular Plants

The cost of inventorying invertebrates and non-vascular plants does not warrant including these groups of taxa in the minimum inventory. However, species which are threatened and endangered, major foodbase taxa for species of concern, environmental quality indicators, or are pests, invasive or disease vectors, need to have baseline data collected. These are addressed in Section 10 Resources of Special Interest.

G. Voucher Specimens

Voucher specimens serve to verify identification and provide archive material for future use. Scientists can make errors in field identification, particularly with plants and small animals. Furthermore specimens make future changes in taxonomy less confusing to rectify with historical information. Vouchers also can provide locality data important for follow up work in the future.

Voucher specimens of plants and animals should be documented in a database such as ABiota@. More information on Biota and purchasing instructions can be found at the Biota website: *viceroy.eeb.uconn.edu/Biota*. The benefit of having all national wildlife refuges use the same database is that the information can be pooled for regional and national perspectives.

10. RESOURCES OF SPECIAL INTEREST

Resources of Special Interest are those species, species groups or habitats selected during the CCP process or during other planning efforts as particularly important on a refuge (*e.g.* T&E species, invasive species, establishing legislation species, priority species in national or regional conservation plans). Included here might be invertebrates or non-vascular plants of special interest because they are major food base taxa for other key conservation targets, environmental quality indicators (*e.g.*, lichens for air quality, aquatic insects for water quality), or problems species like invasive species or disease vectors (*e.g.*, fire ants, bark beetles). Every species or area identified as a Resource of Special Interest should be evaluated during the formulation or review of the refuge Inventory and Monitoring Plan.

Resources of Special Interest that can be delineated and mapped, such as a rare plant community, colonial bird rookery, riparian communities, shorebird concentration areas, etc. are referred to as AFocal Areas@. As part of the baseline inventory, the Focal Areas of a refuge need to be mapped.

Resources of Special Interest that are population based, (an individual species or species groups) such as the Dakota Skipper butterfly, piping plover, Plymouth Red-bellied turtle, breeding waterfowl, migrating shorebirds, etc. require a more intensive effort than the species lists. Quantitative data need to be collected at least once as a means to evaluate the species or species group in determining whether or not it should be included as a target species for monitoring in the Refuge=s Inventory and Monitoring Plan. For

selected species, quantitative surveys using appropriate protocols should be used to collect baseline data. These data would then be used for comparisons either in management assessment monitoring or for long-term trends monitoring. In addition, the current distribution should be determined and mapped as a GIS data layer. Each focal area or species map should be a GIS data layer.

Resources of Special Interest

Resource of Special Interest	***Distribution***	***Quantitative Abundance***	***Comments / Other***
species name or group of species or Focal Area	*where the species is found, description of environment, mapping of Focal Area*	*results of inventory survey*	*reference to data source, name of surveyor, date of survey, etc.*
For Example:			
Dakota Skipper	Tall Grass Prairie	9	Butterfly Survey 2001
Tall Grass Prairie	Well drained, nutrient rich, sandy soil.....	1,7000 acres	GAP Land Use Data

III. Implementation Strategies for Recommended Baseline Inventories

The following are specific approaches that could be used to implement the recommended biotic and abiotic baseline inventories, followed by a table outlining possible strategies with existing resources and new/reallocated funds.

1. Assimilation of Existing Abiotic GIS Data:

Topography, aerial photography, hydrography, soils, political boundaries, and the National Wetlands Inventory maps for each refuge are currently available for free or relatively negligible cost. However, the consolidation of these data into an operational GIS can be complicated, involving georeferencing and converting data into a standard datum. The use of these standard data require the development of accurate refuge boundary data, which are currently being developed by all Regions. Real property, manmade structures and resources of special interest (*e.g.*, important wildlife areas, rare plant communities, distribution of threatened or endangered species) will need to be identified and located via GPS or other accurate means by refuge staff.

Recommendation 1: Employ a contractor(s) to work directly with Regional GIS coordinators, Regional realty offices, and individual refuges, to acquire, process, and package these data layers on recordable compact disk (CD-R) for turnkey delivery to field stations. A standard contract should be developed and coordinated nationally by Regional and Washington GIS staff. Contractors could be drawn from the private sector, USGS, or academia.

2. Acquisition of Biotic Inventory Information (Fauna and Flora):

A. Species Lists (vertebrates and vascular plants): Basic inventories, including archiving of voucher specimens, are not complete or poorly documented on most refuges, yet they are critical to planning efforts and to understanding the full impacts of management actions. Compilation of these lists will require that intensive, though not exhaustive, inventories be completed for each refuge. To be reasonably complete, they need to occur over all seasons and be performed by persons with taxonomic expertise. Proper archiving and preservation of specimens is best done by museums with experience and facilities, so the Service would want agreements with selected universities and institutions (*e.g.*, National Museum of Natural History - Smithsonian Institution, Chicago Field Museum, American Museum of Natural History) for this purpose.

Recommendation 2A: A standard "rapid ecological assessment" process that would allow refuges to accumulate extensive information on their taxa in a one-year period needs to be developed by a small national team. The process can draw heavily on existing rapid assessment protocols already documented

and employed in the Neotropics and elsewhere. The refuge protocol would specify the composition of each refuge's assessment team, which might consist of BRD scientists, university personnel, representatives of State Natural Heritage programs, and local experts as well as refuge staff. It would also specify a standard reporting format, based on an electronic species list developed by the WH-9 Database Team. Individual refuges could then be funded and become responsible for implementing the assessment based on the existing CCP schedule for field stations. Those stations which already have significant data would adapt the approach to target existing data gaps by gathering information on specific species or groups.

B. Vegetation: Baseline vegetation mapping using the federal/Service standard, which will provide consistency among refuges as well as other Interior agencies and NGOs, is lacking on most refuges. Collection of biological data on vegetative communities, which sustain our Trust Resources, has not been done to the level of the Service's standard. Increasing the diversity of our 'biological skills' by incorporating botanists into the workforce will assist in meeting these two needs, as well as properly address the botanical needs of the NWRS.

Recommendation 2B.1 - Mapping: Baseline inventory of plant communities (*i.e.,* habitats) requires the development of digitized vegetation maps for each NWR to the Alliance level of the National Vegetation Classification System (NVCS). Costs will vary widely depending on availability of existing data, minimum mapping unit, and the contractual arrangement between the refuge and the cooperator assisting with mapping. A standard Scope of Work needs to be developed by a team of Regional and national GIS staff and subject-matter experts. This would ensure standardization, a minimally acceptable level of accuracy across all stations, and completion of all stations on a predictable schedule. Stations should be scheduled for mapping following the existing schedule for CCP completion. Because of the cost involved, Regions and field stations should develop funding proposals in RONS (see Recommendation 3). Refuges should explore partnerships with universities, NGOs and other agencies to bring expertise and cost-sharing to projects, which may allow expanding projects beyond the minimum (e.g., mapping at finer classification to the Association level). Because of the variation in size, terrain, existing data, and needed ground-truthing among refuges, the cost will have to be individually calculated for each refuge.

Recommendation 2B.2 - Living Vouchers: On each refuge, permanent representative (*i.e.*, "living voucher") plots need to be established and maintained within each Alliance. A national botanical team representing each Region should develop a standard protocol for identifying, mapping, and maintaining the "voucher plots" and determining the number appropriate for each Alliance. Identification of these plots would be done concurrently with the vegetative mapping. The botanical team will decide how best to choose

the expertise (e.g., contractor, cooperator, Service botanists, refuge personnel, etc), to identify the plots.

Recommendation 2B.3 - Regional Botanists: Each Regional Office should establish a dedicated Regional Refuge Botanist position to recognize the System's responsibility to these resources under the Refuge Improvement Act and related policies. These positions could be co-funded with other Service programs that share responsibility for plant resources.

3. Staff, Training and Equipment:

Implementing these recommendations will require additional staff, training and equipment, primarily at field stations. Refuges need additional biologists as well as personnel versed in botany and spatial information. Equipment needs will primarily center around more advanced computers to process, display and print spatial data; advanced GPS recorders, and software. Training needs will center around use of this equipment. Requirements will vary greatly across stations, depending on current capabilities.

Recommendation 3: Biological personnel and spatial information needs should be incorporated into RONS at every refuge. The RONS projects will identify the unique needs of each refuge which can then be addressed at the regional or Washington level. A basic RONS biological and spatial information needs project description should be developed to assist refuges with developing their own project tailored to their needs. The funding proposal should cover the costs for developing data, staffing/contracting, and equipment and software. Training needs should be addressed through routine opportunities for professional development and in staff Individual Development Plans. NCTC offers numerous relevant courses (e.g., TEC7112 - GIS Introduction for Conservation Professionals, TEC7114 - GIS Design for Refuge Lands Management, TEC7134 - GIS Vegetative Cover Mapping).

4. Incorporation Into Policy:

Institutionalizing these standards within the NWRS requires amendment of 701 FW 2 (*Inventory and Monitoring of Populations).*

Recommendation 4: The Division of Planning and Policy should be tasked with assuring completion of this amendment when all Promises Teams addressing inventory or monitoring issues have completed their work. The amendment should include a handbook on inventory and monitoring to accompany the revised policy. Individuals would be drawn from the various teams to contribute to the policy revision and handbook development.

WH-8-1 Baseline Inventory Team – Implementation Strategies

Recommendation	Existing Resource Strategy	New or Reallocated Funds Strategy
1. Assimilation of Existing Abiotic GIS Data	A national GIS Team has been tasked with addressing this need, and will provide recommendations.	
2. Acquisition of Biotic Inventory Information A. Species List	The Division of Wildlife and Habitat Management establishes a team of refuge/regional/national biological personnel and species specialists with expertise in sampling design to develop a standard protocol of rapid sampling methods for all taxa.	The Division of Wildlife and Habitat Management contracts the development of a rapid sampling protocol with sampling and species specialists outside the Service (i.e. USGS).
		USFWS partners with the National Park Service to cost-share in the development of inventory and monitoring protocols. (the Database Team is recommending assessing NPS's database; NPS is in the process of developing protocols.)
B. 1. Vegetation Mapping	The Division of Wildlife and Habitat Management establishes a team of regional/national GIS staff with subject-matter expertise to develop a standard Scope of Work (SoW) for mapping. - Refuges use the SoW to obtain cost estimates for their refuges to develop a mapping RONs project. - Refuges use SoW to explore partnerships with Universities, NGOs and other agencies to cost-share project.	Each region is provided $100,000/ year dedicated to the mapping of refuges in accordance with the schedule of CCP completion. $700,000 annually until completed.

B. 2. Living Vouchers	Team member (Steve Talbot, botanist) has agreed to develop a standard Living Voucher protocol for refuges. - Refuge staff implement protocol.	Contract plant ecologists to collect data in concert with mapping projects.
B. 3. Regional Plant Ecologists	Fill existing refuge biologist vacancies with plant ecologists who perform regional responsibilities a portion of their time and coordinate with the Regional Division of Wildlife and Habitat Management. 1-2 refuge positions per region.	Hire 7 GS11/12 regional plant ecologists who coordinate with the WO Division of Wildlife and Habitat Management. 7x $ 50,000 = $ 350,000 initial start-up cost 7x $120,000 = $ 840,000 recurring staff cost
3. Staff, Training and Equipment	The WO Division of Wildlife and Habitat Management establishes a small team of refuge/regional/national staff to develop a basic RONs biological and spatial information needs project description to assist refuges with developing their own project tailored to the refuge needs. - Refuges develop and submit a biological RONs project.	The WO pursues a national funding effort similar to the National Park Service which enabled their Inventory and Monitoring Program.
4. Incorporation Into Policy	Establish a team drawn from the various Promise's Teams to revise the policy and develop a handbook for refuge personnel based on the revised policy, encompassing all aspects of inventory and monitoring (including the I&M database).	The WO Division of Wildlife and Habitat Management revises policy 701 FW 2 and oversees a contact to an outside source to develop a handbook for refuge personnel based on the revised policy, encompassing all aspects of inventory and monitoring (including the I&M database).

Appendix A.

COMPARATIVE ATTRIBUTES OF RAPID METHODS FOR ASSESSING TERRESTRIAL BIODIVERSITY

	Desired Attributes	BioBlitz [1]	Rapid Ecological Assessment (TNC) [2]	GAP Analysis [3]	Gradsect (NCR) [4]	Rapid Biodiversity Assessment [5]	Rapid Assessment Programme [6]
Expense	low	low	medium depends on design	high	medium	low depends on design	high
Time	rapid	rapid	rapid but depends on design	must develop GIS layers	medium	medium	medium
Personnel	minimal	lots but only for 24 hrs	small team	small team	small team	small team	small team
Repeatability	not necessary	no	no	no, but improves w/ species-habitat data	yes	depends on design	depends on design
Uniform Effort	not necessary	no	no, although it could be	no	not likely	depends on design	not likely
Requires GIS	not necessary	no	not necessarily	yes	no	no	no
Measures Occurrence	yes	yes	yes	predicted	yes	yes but limited to inverts	yes but limited to higher orders
Measures Distribution	ideally	no	could if linked to GIS	predicted	yes	no	no
Measures Relative Abundance	not necessary	no	no	could, but theoretical	could (CPUE)	no	could
Measures Density	not desireable	no	no	no	no	no	no

Assessment of biological diversity and methodologies for future assessments, UNEP, 6 Aug 1996, (http://www.iisd.ca/linkages/diodiv/sbstta/sb202.html)
Nature in Focus: Rapid Ecological Assessment, Sayre *et al.* (2000), Island Press, Wash., D.C.
BioBlitz (http://www.mpl-pwrc.usgs.gov/blitz.html)

Points to consider:

- Rapid inventories are generally about generating a simple list of species. By definition, rapid inventories are short-term projects which employ limited sampling techniques over a limited amount of time.

- Depending on the field methods used, a fairly comprehensive species list (*i.e.*, species richness); a list of species within selected taxa (*e.g.*, birds, woody flora, and/or invertebrates); or a list known to be grossly incomplete (*e.g.*, BioBlitz), can be generated.

- These species lists (whether complete or incomplete) can be generated within map polygons or at sampling points (distributed randomly, stratified-randomly, or systematically). Taking this extra step and complemented with GIS, maps showing distribution and, in some instances, estimates of relative occurrence can be generated. Several methods that are used internationally (GAP Analysis, Conservation Biodiversity Workshops [CBWs], and Biodiversity Information Management System [BIMS]) do not necessarily require empirical field data; these use *predicted* occurrence data based on a species known habitat/life history requirements.

- Rapid inventory methods that were reviewed are not standardized well. The BioBlitz is a great example. It is a methodological process, not a standardized technique. Even GAP Analysis varies from state to state. An existing rapid inventory approach that will satisfy our needs may need to be developed specifically for Refuges.

[1] The BioBlitz is an initial step toward closing that information gap in inventory. Informal in methodology and organization, it can be molded by the sponsoring group to fit the circumstances and talent pool of the region. Count as many species from as many taxonomic groups as possible in a 24-hour time period. The details of when, where, and how are forged to fit the local situation. Mark-recapture estimators can be used on combinations of simple species lists from the same area to estimate the total species richness for taxonomic groups without having to resort to comprehensive samples. A one day event cannot come near to documenting all the species present. The species pool changes throughout the year, so no matter what day is chosen, species will be missed. Repeating a Blitz on the same day each year should not be thought of as a means of tracking change over time. The loose nature of participants, the vagaries of species detection, weather, observer skill, and many other factors all conspire to limit the usefulness of among year comparisons. However, repeated blitzes will add to the accumulated species inventory and are a good means for identifying groups that would benefit from a more formal monitoring program.

[2] By definition, TNC's Rapid Ecological Assessments (REAs) are short-term projects employing limited sampling techniques over a limited amount of time. REAs consist of a series of increasingly refined analyses: satellite imagery to produce land use/cover maps, airborne remote sensing/aerial reconnaissance to produce vegetation cover/community maps, and stratified field inventory to ground truth remotely-generated data sets. The UNEP's appraisal: "In effect, REA uses the same GIS datasets as a GAP Analysis, and then supports the analysis with subsequent ground-truthing". Floral surveys are mandatory, faunal surveys are discretionary. Faunal surveys are generally

stratified by vegetation community/cover polygon. An REA is not a complete floristic inventory. However, an REA should include: (1) species for characterizing vegetation types (canopy species, dominant/codominant species, indicator species); (2) species of conservation concern (endemic, rare/endangered);, and (3) species of management concern (exotics, economic). Allows for using vegetation sampling methods of choice (Dallmeier's square plots, Gentry's rectangular plots). Faunal surveys may target selected taxa or target species; again, a suite of published sampling methods can be employed at the discretion of the REA Team. Page 103 in Nature in Focus: REA suggests that faunal survey design will ultimately be based on the goal of the REA; TNC suggests six possible goals: (1) associate animal communities with the vegetation type they inhabitat (e.g., GAP analysis); (2) determine as completely as possible the diversity of target taxa within site; (3) compare diversity among subregions of a site; (4) characterize communities of various animal taxa in the different veg types at a site, emphasizing the most common types; (5) map the distribution of target species; and (6) perform a survey to initiate a monitoring program. NOTE: In the table above, I've ignored the GIS component of the REA.

[3] GAP Analysis is essentially the superimposing of three digital layers in a GIS: vegetation type, species distribution (actual and/or predicted), and land use. For example, the Mid-Atlantic GAP Analysis Program (http://fwie.fw.vt.edu/mdgap) is using eleven Landsat Thematic Mapper scenes (30-m resolution) to generate digital land cover/land use maps (including a vegetation map typed to the Alliance level in the NVCS), a species-habitat association matrix that is refined using additional ecological filters such as hydrography, soils, or habitat patch size, and a land stewardship classification.

[4] Gradsect (Gradient-directed transect): The National Conservation Review (Sri Lanka Forest Department) identifies sites on a 1:500,000 topographic map, positioning of transects along environmental gradients (generally assumed to be elevational contours, although precipitation, temperature, and latitude may be other gradients over a landscape scale), and surveyed for presence/absence of selected taxa (woody plants, mammals, birds, reptiles, amphibians, butterflies, mollusks, mound-building termites; fish identified opportunistically). This is similar to the botanical surveys that Stephen Talbot described in AK.

[5] Rapid Biodiversity Assessment (RBA) is based on the premise that certain aspects of biodiversity can be quantified without knowing the scientific names of the species involved. Two methods to characterize diversity without formal taxonomic content: (1) "ordinal" RBA = taxa keyed to a level needed for the goals of an assessment; e.g., in environmental quality monitoring, family or genus may be adequate if it indicates disturbance or pollution; (2) "basic" RBA = rather than key to species level, create locally-functional schemes for classification and ID based on easily-distinguished morphological criteria; e.g., butterflies might be distinguished on the basis of wing color, pattern, and size. RBAs focus on invertebrate groups, particularly butterflies, ants, termites, certain beetle families, grasshoppers, spiders. The approach is useful for comparing the diversity between different sites as long as the same *operational taxonomic units* are used.

[6] Rapid Assessment Programme (RAP) uses teams of experts to conduct preliminary assessments of the biological value of poorly known areas. Usually focuses on higher vertebrates and vascular plants. Field trips last 2 - 8 weeks and sites are targeted based on satellite and remote imagery.