U.S. Fish & Wildlife Service

A System for Mapping Riparian Areas In The Western United States

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PREFACE

These technical procedures serve as a reference for conducting the image analysis work normally associated with mapping riparian and associated habitats. This document is intended to be comprehensive, however situations may develop that require modifications or additions.
It is impractical to include all of the technical aspects of data handling and analysis within this document or anticipate all resource inventory needs. Users are advised that other written conventions or formal training may be useful in recognizing and describing riparian habitats, image interpretation and/or mapping protocols. More detailed field guides, regional information, plant lists and soils descriptions are also available.

This information is intended to provide general guidelines for work performance, but should not be substituted for direct communication with the appropriate Program, Project or Technical Specialist(s) regarding procedural questions.

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General Disclaimer

The use of trade, product, industry or firm names or products in this report is for informative purposes only and does not constitute an endorsement by the U.S. Government or the Fish and Wildlife Service.

INTRODUCTION

The U.S. Fish and Wildlife Service (Service), through the National Wetlands Inventory (NWI), is congressionally mandated to identify, classify and digitize all wetlands and deepwater habitats in the United States. The NWI has extensive mapping expertise and knowledge involving wetland identification and classification, image interpretation, and digital data capabilities. Reflecting this expertise, the NWI is regularly asked to provide resource mapping guidance, and with increasing frequency, is requested to map riparian areas of the western United States.

Riparian habitats are among the most important vegetative communities for western wildlife species. Chaney, et al. (1990) observed that greater than 75 percent of terrestrial wildlife species in the Great Basin region of eastern Oregon, as well as in southeastern Wyoming, are dependent on riparian habitats. In Arizona and New Mexico, 80 percent of all vertebrates use riparian areas for at least half their life cycles; more than half of these are totally dependent on riparian areas. Similarly, the Arizona Riparian Council (Fact Sheet No. 1, 1995) has indicated that 60 - 75 percent of Arizona's resident wildlife species depend on riparian areas to sustain their populations, yet these areas occupy less than 0.5 percent of the state's land area. Aquatic and fish productivity are directly related to a properly functioning and healthy riparian habitat (Washington Dept. Fish and Wildlife 1995).

Arid and semi-arid areas of the U.S. may be highly susceptible to the potential effects of climate change. Projected changes in precipitation patterns and frequency, especially with mountain snowpack, combined with higher temperatures, could lead to winter flooding and reduced summer flows, adversely affecting these important riparian habitats (State of New Mexico, 2005).

The Fish and Wildlife Act of 1956 authorizes the Service to map habitats used by fish and wildlife resources. However, the Service has developed this document to guide the classification and mapping of riparian areas in the western U.S. Others have developed assessment and management techniques for riparian areas. (Bureau of Land Management 1998; USDA 1981). Also, many western states, including California, Montana, and Colorado have developed their own standards and systems for identifying local riparian habitats.

CONCEPT OF RIPARIAN

Riparian is viewed from many perspectives. Gregory, et al. (1991) indicates riparian areas are transitional interfaces between terrestrial and aquatic ecosystems. More classical riparian interpretations identify primarily woody vegetation associated only with lotic systems. Recent interpretations include a broader view involving both lotic and lentic systems, surface and subsurface water influences, and natural forces and human-induced activities that affect the woody and emergent vegetation. Riparian areas are closely associated with water and topographic relief; they are distinct from either wetland or upland. Riparian areas lack the amount or duration of water usually present in wetlands, yet their connection to surface or subsurface water distinguishes them from adjacent uplands.

Lists of plants and soils associated with riparian areas have not been developed across the area of applicability by the Service, although localized riparian community descriptions may exist. Since riparian areas are transitional between wetlands and uplands, some wetland (or upland) plant species may occupy riparian areas.

AREA DESCRIPTION

The definition and conventions that follow apply primarily to areas of the western United States where mean annual evaporation exceeds mean annual precipitation by 10 inches or more (Figure 1). Lotic and Lentic vegetative communities in this zone exhibit more semi-arid characteristics where riparian habitats can be more easily distinguished from bottomland/wetland habitats. Parts of Alaska do meet these climatic definitions, but geomorphological differences and the ability to define these areas through remote sensing limit the ability to accurately map them.

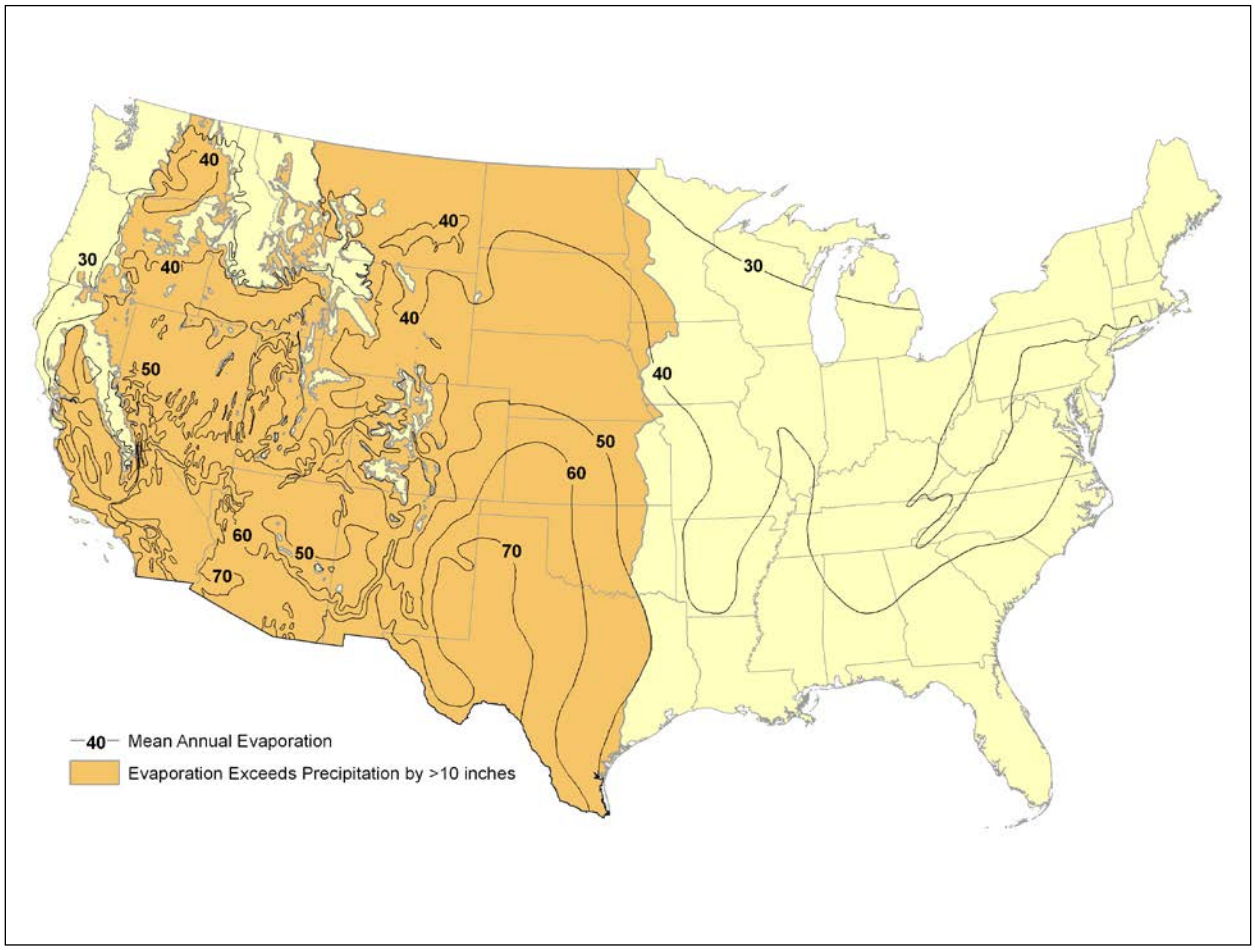

Figure 1. The area of applicability (shaded area) for the Fish & Wildlife Service's riparian definition and mapping conventions. In this area, mean annual evaporation exceeds mean annual precipitation by 10 inches or more. Note that there are some higher elevation areas in the Rockies and Sierra Nevada's where precipitation exceeds evaporation. The Mean Annual Evaporation attribute on the arc data set contains the annual evaporation rate in inches. This is free water surface evaporation, the rate of evaporation from a shallow lake for a year.

RIPARIAN DEFINITION

There are many riparian definitions used by government agencies and the private sector. Riparian initiatives often concentrate on either functionality or land use applications where an exact definition is not required. However, a riparian definition is essential for consistent and uniform identification, classification, and mapping. For these purposes in the area of applicability:

Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland.

DATA AND MAPPING STANDARDS

On June 26, 2006, the original document ***A System for Mapping Riparian Areas in the Western United States (USFWS 1997)*** was adopted as a Data Layer Standard by the U.S. Fish & Wildlife Service. This document is a revision to meet current mapping and technological standards of the Service. This document should be used in conjunction with the USFWS document; ***Data Collection Requirements and Procedures for Mapping Wetland, Deepwater and Related Habitats of the United States (USFWS, 2009)*** and contains more comprehensive information on the proper techniques for collecting digital data.

LIMITATIONS

Riparian habitats are primarily identified with data collected from aerial imagery, and are subject to errors of omission and commission consistent with data collected through remotely sensed technologies. Time of year, climatic or meteorological conditions, and other factors may influence what is identified, classified and mapped as riparian.

This document was developed to identify, classify, and map riparian areas at a national level across a broad spectrum of semi-arid landscapes. It does not supersede any local inventory efforts developed by other entities, including states, counties, or watershed management groups.

This document is not a primer on wetland/riparian ecology, interpretation, resource analysis using remotely sensed imagery, or skills needed to operate GIS software. Wetland/riparian image analysts need to be fully trained before attempting to apply these data collection standards.

RIPARIAN MAPPING SYSTEM

Conventions are necessary to ensure consistency in riparian mapping efforts throughout the western U.S. The present conventions were developed by the Service to be used for the preparation of riparian data. These conventions provide specific instructions for the application of the riparian mapping system and are in concert with the Cowardin et al. (1979) classification

system for mapping wetlands. Wetlands mapping, based on the Cowardin et al. system, uses detailed image interpretation techniques and digital cartographic conventions. This can be referenced in the ***DATA COLLECTION REQUIREMENTS AND PROCEDURES FOR MAPPING WETLAND, DEEPWATER AND RELATED HABITATS OF THE UNITED STATES (USFWS, 2009).***

Riparian data, as developed by the Service, are intended to provide stand-alone riparian products. It may be helpful to use riparian data in conjunction with wetland map data and accommodations have been made in the structure and functionality of the Service's Geodatabase systems, to facilitate this.

Woody riparian areas associated with lotic systems (perennial or intermittent) are the predominant features of the mapping effort. This is consistent with the classical concept of riparian areas, ensures a high degree of data accuracy, and identifies a large percentage of the riparian areas in the western U.S. However, emergent cover and/or lentic riparian areas may be identified if the imagery allows identification of these features.

Aerial photographs and/or digital imagery are the primary data source for riparian mapping, and are supported by field reviews, soil surveys/digital soils data, digital topographic maps, and local inventories. The riparian mapping system (Figure 2) is hierarchical, open ended, and uses System, Subsystem, Class, Subclass and Dominance Types. The level of mapping detail is determined by user needs.

* **System** is a single unit category - riparian vegetation (Rp).

* **Subsystem** defines two categories reflecting the water source for the riparian area - lotic (1) and lentic (2).

* **Class** describes the dominant life form of riparian vegetation. For these conventions, classes are: forested (FO), woody vegetation usually greater than 6 m. in height; scrub/shrub (SS), woody vegetation usually less than 6 m. in height; and emergent (EM), erect, rooted vegetation with herbaceous stems.

* **Subclass** further describes the Class as either dead (5), deciduous (6), evergreen (7), or mixed deciduous/evergreen (8).

* **Dominance Type** refers to vegetative species within the mapping unit, e.g. cottonwood (CW), alder (AL). Dominance types vary throughout the western U.S.

For instance, **Rp1FO6CW** is interpreted as:

System:	**Rp** - Riparian
Subsystem:	**1** - Lotic
Class:	**FO** - Forested
Subclass:	**6** - Deciduous
Dominance Types:	**CW** - Cottonwood

Although specific vegetation types are identified (Figure 2), these species are presented only as examples. A single dominant type (e.g., cottonwood) often infers or may be interpreted as representing a plant community of several species such as an indicator species does for a guild.

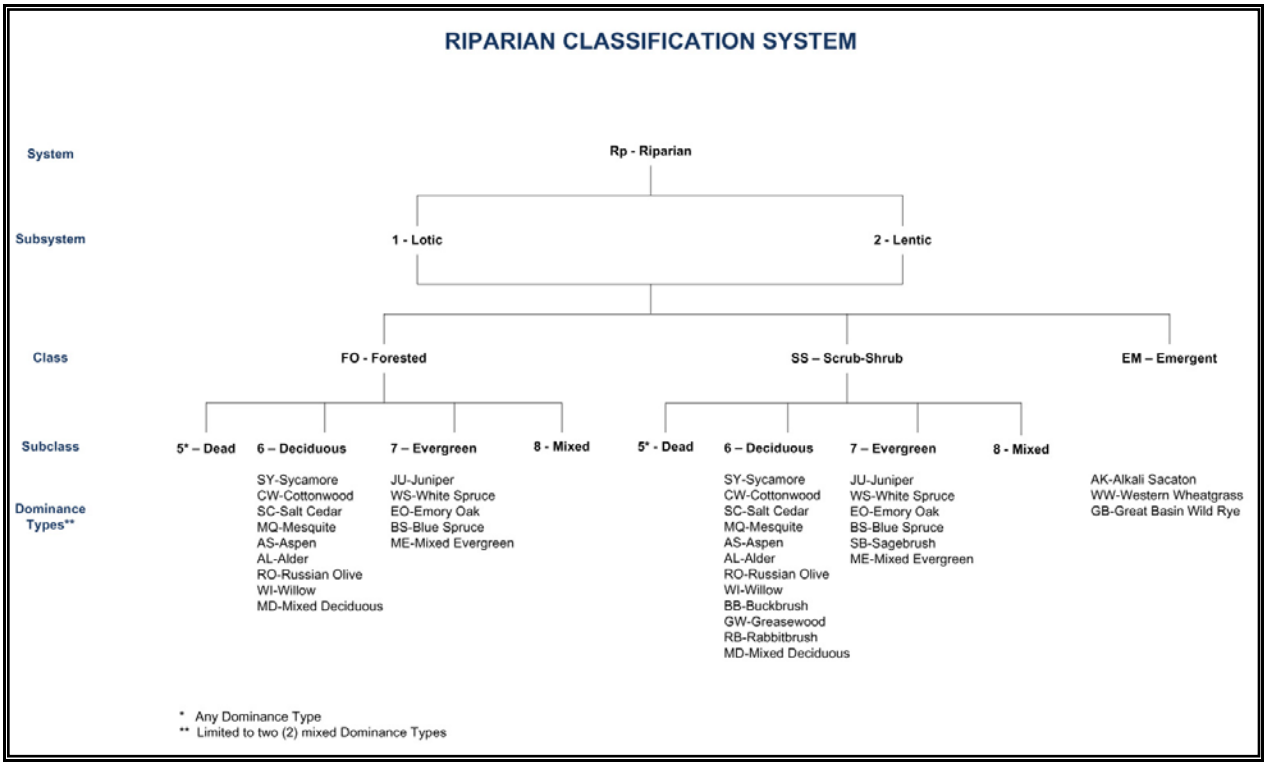

Figure 2. Schematic of hierarchal riparian mapping and classification system.

TECHNICAL PROCEDURES FOR MAPPING RIPARIAN HABITATS

The delineation of riparian features through image analysis forms the foundation for deriving all subsequent products and data results. Consequently, the Service places a great deal of emphasis on the quality of the image interpretation. The Service makes no attempt to adapt or apply the products of these techniques to regulatory or legal authorities regarding habitat boundary determinations, jurisdiction or land ownership, but rather uses the information to assist in resource mapping and habitat characterization. Coordination and consultation with the Service's Regional Wetlands Coordinator is very important to understand classification application concepts, wetland delineations, and national project objectives.

Detailed procedures for mapping riparian habitats align with pre-existing NWI procedures for mapping wetlands. The USFWS document; ***DATA COLLECTION REQUIREMENTS AND PROCEDURES FOR MAPPING WETLAND, DEEPWATER AND RELATED HABITATS OF THE UNITED STATES (USFWS, 2009)*** provides guidance for creating digital data for inclusion into the Service's wetlands Master Geodatabase. This document can be viewed/downloaded from the NWI website: http://www.fws.gov/Wetlands/

The following sections will briefly discuss topics related to mapping riparian habitats. Though this document can be used as a stand-alone guideline for collection riparian digital data, it is highly recommended that the above-mentioned wetlands data collection document also serve as a reference. That document contains complete information for all aspects of collecting NWI-related data.

Collecting Digital Riparian Data – General Concepts

As with wetlands data, all riparian data must be collected in Environmental Systems Research, Incorporated's (ESRI) digital Geodatabase format. Though riparian data can be collected as stand-alone features, it may be helpful to collect it in conjunction with wetlands data for that same area. Collecting the wetland and riparian data together will provide;

- A better description of the ecological design of the area being mapped
- Wetland and riparian digital datasets that topologically "fit" (do not overlap or have gaps between data features) together in a GIS, but can still be mutually exclusive if needed.

This is best achieved by creating wetland and riparian data in the same Feature Class (a subset of the Geodatabase). They can be separated prior to submission into the Wetlands Master Geodatabase.

Image Interpretation of Riparian Habitats - General Concepts

There are "basic elements" that can aid in identification of wetland habitats from aerial photographs or digital imagery. The image analyst uses these to make decisions about ecological habitat boundaries to map wetlands. These same elements are used in the quality control review of delineated information to check for accuracy and completeness.

Tone (also called Hue or Color) -- Tone refers to the relative brightness or color of elements on a photograph. It is, perhaps, the most basic of the interpretive elements because without tonal differences none of the other elements could be discerned.

Size -- The size of objects must be considered in the context of the scale of a photograph. The scale will help you determine if an object is a stock pond or large lake or reservoir.

Shape -- Refers to the general outline of objects. Regular geometric shapes are usually indicators of human presence and use.

Texture -- The impression of "smoothness" or "roughness" of image features is caused by the frequency of change of tone in images. It is produced by a set of features too small to identify individually. Grass, cement, and water generally appear "smooth", while a forest canopy may appear "rough".

Pattern (spatial arrangement) -- The patterns formed by objects in an image can be diagnostic. Consider the difference between (1) the random pattern formed by a natural grove of trees and (2) the evenly spaced rows formed by an orchard or planted forest.

Shadow -- Shadows may aid interpreters in determining the height of objects on aerial imagery. However, they can also obscure objects within them.

Geographic Location -- This characteristic of imagery is especially important in identifying vegetation types and land forms. For example, large oval depressions in the ground are readily identified as Playa Lakes in the Southern Plains.

Association -- Some objects are always found in association with other objects. The context of an object can provide insight into what it is. For instance, a nuclear power plant is not (generally) going to be found in the midst of single-family housing.

Image Interpretation of Riparian Habitats – Specific Guidelines

The conventions that follow are designed specifically for riparian mapping done in conjunction with standardized Service wetland and deepwater mapping.

- The tallest life form, making up at least 30% cover, defines the class.
- The mixed subclass (8) is a mix of woody evergreen and deciduous vegetation. Each must comprise at least 30% of the vegetative cover.
- Polygons are used to capture larger habitats, linears can be used, if necessary, to capture narrow features.
- Mixed Classes and Subclasses are permitted, though every attempt should be made to interpret the unique Class or Subclass. Example of a mixed class riparian habitat; Rp1FO6CW/SS6SC (habitat contains forested deciduous cottonwood and scrub-shrub deciduous salt cedar). Example of a mixed Subclass riparian habitat; Rp1SS6RB/SS7JU (habitat contains scrub-shrub deciduous rabbitbrush and scrub-shrub evergreen juniper).
- Mixed Dominance Types are permitted. Example of a mixed Dominance Type riparian habitat; Rp1SS6SC/WI (habitat contains scrub-shrub deciduous salt cedar and willow).
- Tilled fields used for grain production will not be mapped as riparian.
- Riparian and wetland polygonal and linear features should not overlap.

Working with Older-Era Hardcopy Maps

Older-era hardcopy maps are inherently different in their cartographic construction and

symbolism than current digital data. If using hardcopy wetland/riparian maps, please refer to the original document, ***A System for Mapping Riparian Areas in the Western United States (USFWS 1997),*** for cartographic conventions; http://www.fws.gov/Wetlands/_documents/gOther/SystemMappingRiparianAreasWesternUS.pdf

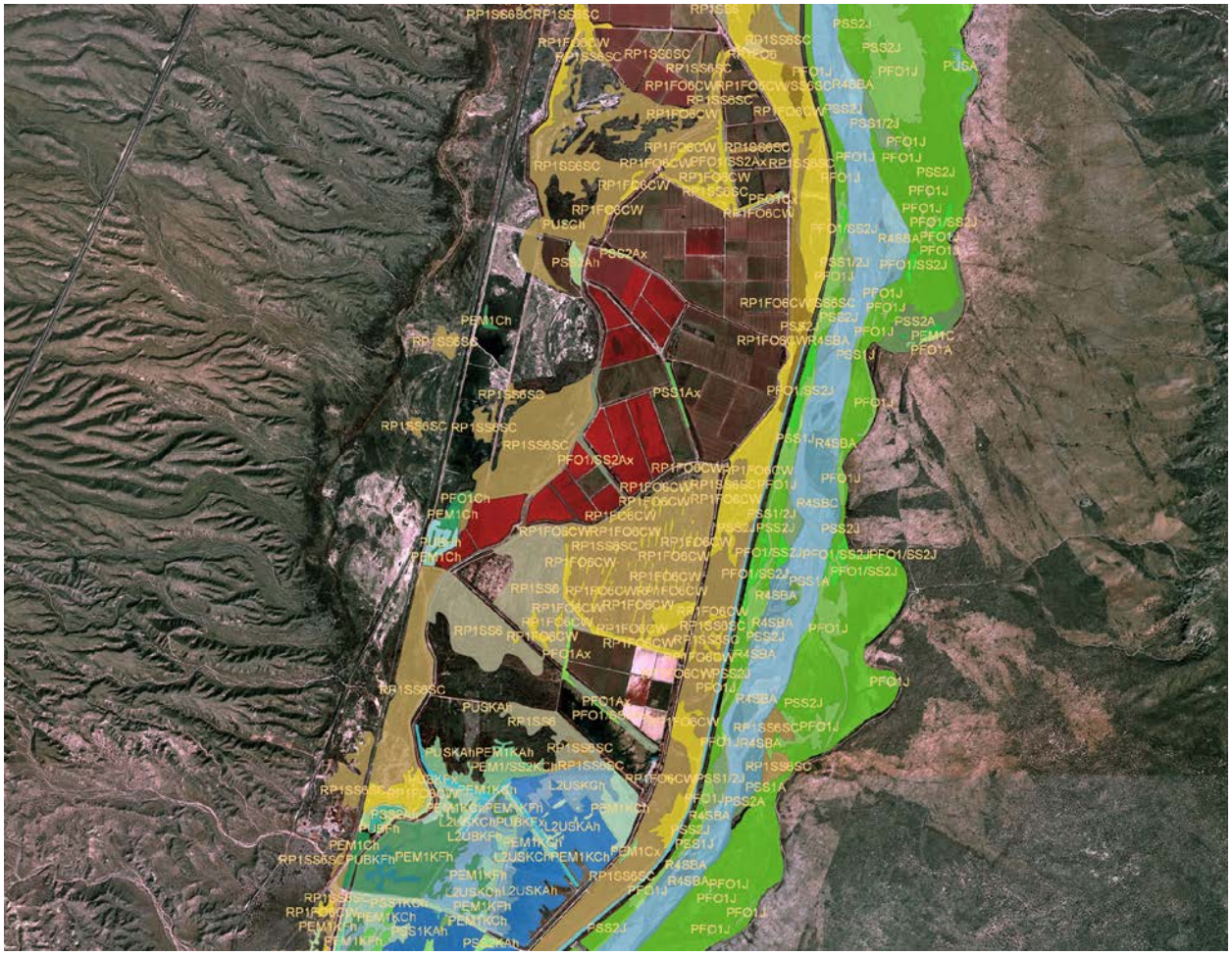

Figure 3. Example of interpreted wetland (green/blue shading) and riparian (tan shading) habitats on top of a Color Infrared Digital Ortho Quarter Quad, Location; Bosque del Apache National Wildlife Refuge, New Mexico.

For general information on photo interpretation and photo interpretation techniques, users are referred to the following publications:

Avery, T.E. 1970. *Interpretation of Aerial Photographs* 4th edition. Burgess Publishing Co., Minneapolis, MN. 324 p.

Lillesand, T.M. and R.W. Kiefer. 1987. *Remote Sensing and Image Interpretation* 2nd edition. John Wiley and Sons, Inc., New York, NY. 721 p.

W. Philipson (editor) 1996. *Manual of Photographic Interpretation* (Second

edition). American Society for Photogrammetry and Remote Sensing. Bethesda, MD

Ustin, S. 2004. *Manual of Remote Sensing, Volume 4, Remote Sensing for Natural Resource Management and Environmental Monitoring,* (3rd Edition). Wiley Publishing, Inc., Indianapolis, IN. 768 p.

Also see: http://www.asprs.org/ for additional information on remote sensing techniques.

Technical Methodologies

Currently there are various accepted techniques used to interpret, delineate and map riparian areas. The technologies change with time and this section does not contain a comprehensive discussion of all possible data capture methods. One of the predominant approaches currently being employed by the Service is presented below. Information on other riparian (habitat) interpretation techniques is included in Appendix A.

On-Screen (Heads-up) Method

The Heads-up process is the current method most feasible for identifying and delineating wetlands using digital imagery and supporting tools.

The on-screen or heads-up method involves viewing digital map data that overlays digital imagery on a personal computer screen (monitor). Changes to the map data to make it current with the digital imagery can be made on-screen and the digital data file checked and saved or exported.

The heads-up method was primarily developed for updating existing wetland maps, although it can be used to do original habitat mapping. Three-dimensional viewing which can be incorporated into a heads-up process provides a useful method to delineate wetland and deepwater habitats. ArcMap (latest version) employs geodatabase formats for viewing, editing and storing map data. This greatly improves the administration, access, management and integration of spatial data. The ArcMap system also provides access to a suite of editing tools available in ArcGIS, it creates smaller more efficient files and to permit map editors to “drag and drop” polygons which proved to be a very important capability in updating habitat map files.
The heads-up method has several distinct advantages:

- Uses digital imagery (DOQs or other digital data)
- Eliminates manual cartographic transfer work
- Provides seamless coverage of work areas
- Easily transportable to ArcSDE or other platforms
- Digital Raster Graphics (DRGs), or other digital data layers provide a direct backdrop for image interpretation and checking
- Linear features files can be greatly reduced or eliminated
- Automated verification routines can incorporate GIS capability

There are also several limitations associated with this method:

- The process is machine/cursor driven. This requires an Arc-literate operator
- On-screen viewing generally does not include stereo capabilities (although these capabilities can be incorporated through heads-up stereoscopic analysis or by viewing imagery through a manual stereoscopic process.)
- Electronic media requires different preparation, storage, distribution and archiving skills

The heads-up process developed for updating maps relies on the image interpreter's ability to recognize, accurately delineate and classify targeted habitat types, perform data edits, and verify the digital file. It eliminates all of the manual transfer and rectification stages of the traditional (older) photo interpretation method. Customized ARC tools were created to allow quicker attribution of map features using wetland and deepwater codes as well as other descriptive codes or information. A custom verification tool was also developed to provide quality control or logic checks of the digital data. This tool can be accessed at: http://www.fws.gov/Wetlands/Data/Tools.html.

Editing and updating wetland/riparian digital map data using the heads - up process implies the following:

- Digital imagery will be used as the base imagery to update the wetland/riparian information
- The existing wetland/riparian map digital data will overlay and register to a USGS DRG topographic base map or rectified imagery where available
- ArcGIS software will be used in a Windows environment to edit existing digital data
- The Service's customized software tools will be used to assist the updating and editing and data verification processes

The Target Mapping Unit (TMU) is an estimate of the size class of the smallest habitat that can be consistently mapped and classified at a particular scale of imagery, and that the image-interpreter attempts to map consistently. The size of a TMU is based on a simple square or a circle shape (a polygon with significant interior area relative to its perimeter) and not a long, narrow rectangle (i.e., a linear feature with little or no discernable interior area at the scale of interest). Therefore, riparian habitats which appear long and narrow (less than 15 feet wide at a scale of 1:12,000), such as those following drainage-ways and stream corridors, are excluded from consideration when establishing the TMU, and such areas may or may not be mapped, depending on project objectives.

Linear Data - Riparian linear data and wetland linear data will be created in the

same Geodatabase Feature Class (or layer) to assure digital accuracy. Note: some linear data are being buffered to very narrow polygonal data. Linear data are currently not displayed on the Wetlands Mapper, though the data is available from the Service.

Edge matching - Edge-matching of the interpretation is required for a seamless wetland database. There are two types of edge-matching: 1) internal ties along the borders of source images and 2) external ties to pre-existing data immediately adjacent to the project area.

The Service requires that in all cases, internal edge-matching shall be performed. Mapping units lying along the outer borders of source images within a project area, whenever practical shall be edge-matched with interpretations on all adjacent images within the project area. All linear and polygon features shall be edited to ensure an identical or coincident transition across images in the entire project area. At a minimum, features located on the outer edge of the project area will be closed exactly at the border of the project area. Because some maps have been updated, there may be some temporal differences in the data.

Edge matching of data adjacent to the project area can be facilitated by referencing on-line data available at: http://www.fws.gov/Wetlands/Data/Mapper.html or by establishing a web mapping service (WMS) connection to the existing wetland data.

Ancillary Data - Other datasets, such as Digital Elevation Models (DEM) or Digital Raster Graphs (DRG) can also be used to evaluate differences in elevation relative to the associated stream, river or wetland feature.

ACHIEVING QUALITY REQUIREMENTS FOR RIPARIAN DATA

Quality requirements for wetland data are defined as "level of accuracy" benchmarks in the National Standards and Quality Requirements. This information can be found at; http://www.fws.gov/stand/standards/dl_wetlands and is applicable to riparian data as well. They include quality goals for identification, delineation and classification accuracy[1]. Additional requirements for digital data accuracy and metadata ensure data are complete and accurate. Riparian data will be required to meet the same standards as the wetlands data.

The Service has produced step-down Information Quality Guidelines for information disseminated by the agency. These guidelines are applicable to all Service offices that disseminate information to the public to ensure the information complies with the basic standards of ***quality*** to ensure and maximize its ***objectivity***, ***utility*** and ***integrity***.

The quality and integrity of the Service's habitat map products is based on a process involving

[1] Currently, the Federal Geographic Data Committee Work Group has completed the wetland map standards to be applied to all federally funded wetlands mapping projects.

various levels of quality oversight (Figure 5).

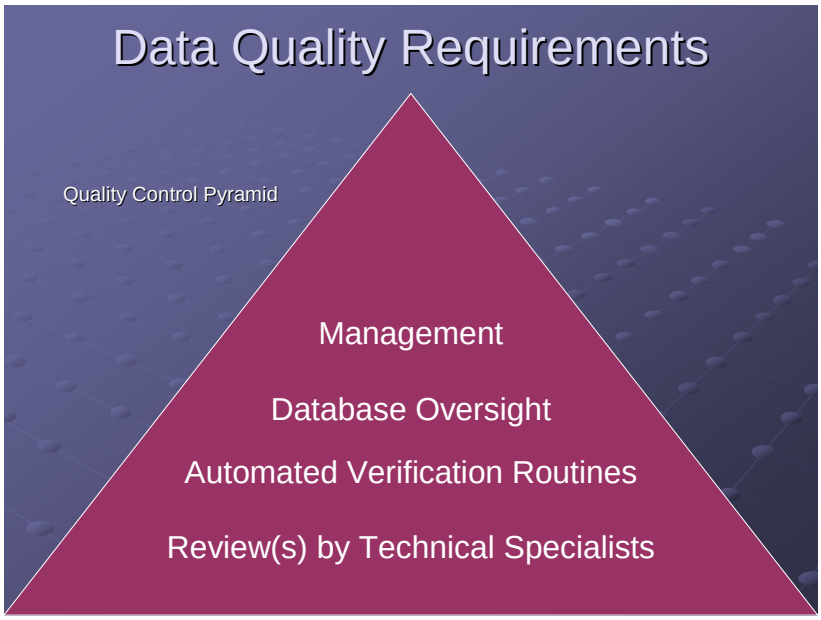

Figure 5. The Service's quality control schema provides various levels of quality oversight and data review.

As part of this process, digital map data must pass these quality control procedures to ensure the information is accurate. The steps include: 1) review by technical specialist(s) 2) pass automated verification routines, and 3) pass final verification and data integrity inspection as provided by a database manager. Each step and components are described below:

1. Review by Technical Specialist(s)
This quality assurance step defines the responsibilities of the image analyst(s) for data quality and completeness. There are two mandatory sub-steps:

- **Internal Inspections of Data Quality** - Quality control of interpreted map products will be performed by a qualified image analyst other than the person performing the original work. The reviewing analyst will adhere to all National Standards, Quality Requirements and Technical Specifications and will perform a 100% review of the work. This internal inspection may be completed by non-Service personnel under the specific technical direction and performance monitoring by a Government official through an extramural agreement.

  Internal quality control review of interpreted images (regardless of methodology used) should include a comparison of contours, hydrographic symbols or cultural features from the USGS base map to delineations and vegetation signatures. All available collateral data should be used during this quality control review. The responsible reviewer must record the pertinent

information regarding the review process to accompany the appropriate metadata for the project area.

If internal review is conducted by the Service Region it does not substitute for a Regional quality control review as described below.

- **Regional Quality Control -** This is considered to be exclusively a Service function that must be performed by responsible Service personnel. Regional quality control of map products entails spot checking of not less than 20% of the project area by qualified personnel. The Region has the discretion of how these quality controls are completed (i.e. using different technical means, field verification, etc.) Upon completion of the Regional quality control review, the Region should be prepared to certify that work products meet all applicable standards, quality requirements and technical specifications. If the products do not meet these standards, the Region has two options: Correct the work to bring it into compliance with quality standards, or return the work to the originating entity citing deficiencies and requesting additional work be completed to meet the standard(s).[2]

  Regions may choose to use other qualified Service personnel to perform quality control reviews. Work backlogs, level of expertise and experience in mapping particular wetland types may be factors in soliciting quality control review from other qualified Service personnel to ensure the work is accurate and completed in a timely fashion. Not less than 20% of the project area must be reviewed to ensure the work is complete and meets the quality requirements and specifications.

- **Final Quality Control Review -** This is considered to be exclusively a Service function that must be performed by responsible Service personnel. Final quality control of map products entails spot checking of not less than 10% of the project area by qualified personnel. Any qualified Service personnel may conduct final quality control reviews. These reviews may entail using various technical means or field verification to check the work. Final quality control reviewers must coordinate closely with Regional quality control personnel regarding revisions or modification to the work products. Ultimately, the Regional certification of data integrity and quality to the Service's Geodatabase Manager will conclude the data collection phase of the project.

2. Automated Verification

All digital data files will be subjected to rigorous quality control inspections.

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[2]There may be contractual considerations regarding review time lines and obligations under any extramural agreement.

Data verification includes quality control checks that address the geospatial correctness, digital integrity and some cartographic aspects of the digital data. This step takes place after the ecological data collection phase of the project has been completed, reviewed and approved as qualitatively acceptable. Implementation of quality checks ensures that the data conform to the specified criteria, thus achieving the project objectives.

The Service, in conjunction with USGS has developed customized Attribution and Verification Tools for performing data checks on wetland and riparian map data. These tools can be found at; http://www.fws.gov/Wetlands/Data/Tools.html. Tools to address riparian data are being developed, and will be available from the web link above. These suites of tools are extensions to Environmental Systems Research, Incorporated's (ESRI) ArcMap desktop geographic information system product. The latest version of the verification tools has been constructed to automate (to the extent possible) the quality control functions necessary to ensure the geodatabase is accurate. Various functions have been designed to address geopositional errors, digital anomalies, and some logic checks that make use of the power of the geographic information system. Additional quality assurance issues not readily apparent on the verification tools may be handled by the geodatabase architecture itself.

In lieu of using riparian-specific automated tools for quality assurance, contact the Service's appropriate Regional Coordinator or the National Standards Support Team for guidance.

Attribute Validity

This standard requires that all polygons have a valid attribute code to depict habitat type. To avoid attribute errors, all data submissions must be run through the attribute verification checks prior to submission to the Service for inclusion in the geospatial data layer.

The Service's Attribution Tools have been constructed to attribute map features that may depict wetlands, riparian areas, uplands or other natural features. These tools can also serve as a reference for uncommon or rarely used codes or to assist users who are not familiar with the alphanumeric wetland mapping codes. The main Attribution Tool contains the entire hierarchical scheme for classifying wetlands, deepwater, and riparian habitats (Cowardin *et al*, 1979, A System for Mapping Riparian Areas in the Western United States (USFWS 2009).

3. Oversight, Data Integrity and Database Management

The Service's National Standards and Support Team (NSST) has primary responsibility for the Service's wetlands geodatabase configuration and systems. This includes responsibility for the integrity and distribution of the digital geo-spatial data developed by the Service as part of the wetland, deepwater, and riparian habitat mapping effort. The Geodatabase Manager is key to the processes used to verify, assimilate, distribute and archive geo-spatial wetland data. The Geodatabase Manager plays a substantial role in the quality assurance of the digital data files. This includes the following responsibilities:

- **Final Data Verification -** The Geodatabase Manager performs the final verification checks of the digital data before it is approved and entered into the geodatabase. This final check involves some geospatial analysis, logic checking, and ensuring the necessary supporting documentation has been provided in proper format.

- **Records and Documentation -** Additional reporting requirements applicable to all mapping projects include submission of a Supplemental Map Report (User Report) included as Appendix E. This will be used as project specific metadata information.

Submission of completed field data forms and/or field photographs are optional. These are supplemental information to the data and should be clearly labeled if included (format(s) provided). Information on where to store these images and how to send them will be provided by the Service's Geodatabase Manager (Wetlands_Team@fws.gov). A completed Regional Transmittal Form (Appendix F) must be included and is the responsibility of the Regional Wetlands Coordinator.

New or updated digital map data must be returned to the Service's Geodatabase Manager on a CD or DVD with the contents and date marked. Only data in geodatabase format will be accepted. For work produced by Service Regions the 'check-in' revisions or updates to the Master SDE geodatabase, must be returned to conform with the 'checked-out' geodatabase (with revisions) initially provided by the NSST. Data must have passed verification and Regional review(s).

DIGITAL DATA REQUIREMENTS AND DELIVERY

The digital data must conform to the following criteria:

- Digital data must be submitted and pass FWS Regional reviews prior to submission to the wetlands geodatabase

- Digital data must be provided in personal geodatabase format

- Data will be in a uniform projection (Albers Equal-Area Conic Projection). The horizontal planar datum is the North American Datum of 1983, also called NAD83

- Data must have passed verification and all quality control review(s). All polygons must have a valid attribute code to depict wetland habitat type. To avoid attribute errors, all data submissions must be run through attribute verification checks prior to submission.

- No point data are to be submitted.

- The inclusion of linear delineations is not required. If linears are delineated

they should be created and edited in the 'RipLinears' feature class of the personal geodatabase. Linear features will be maintained as a separate feature class. Linear water features can be displayed by accessing the National Hydrography Dataset (http://nhd.usgs.gov) or by buffering linears to polygons.

- Internal to the project area, data should be seamless

METADATA

Metadata are stored in the Wetlands Geodatabase in Federal Geographic Data Committee (FGDC) compliant format. Metadata at the National level is provided to comply with the Service's Metadata Documentation and Record form. Additional supplemental information which serves as project level metadata is included as well. Metadata layers contained in the Services Geodatabase are shown in Figure 4.

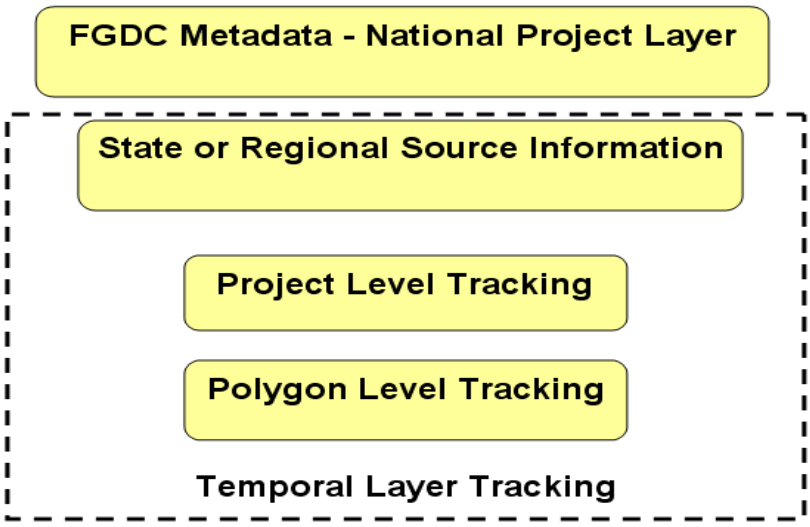

Figure 4. Metadata layers contained within the Wetlands Geodatabase

Project Level Metadata

Project level metadata are assembled for each project area checked-out from the Service's Wetlands Master Geodatabase and modified/updated. This will provide the needed tracking and reference information to the geodatabase users.

Mandatory Submissions - A completed Supplemental Map Information Report (supplemental metadata) must be included and an electronic copy is to accompany the digital data when submitted. This information becomes the "project level metadata" or intra-data specific to the updated version of the geodatabase. An electronic copy of a completed Regional Transmittal Form must also be included. These forms can be accessed at; http://www.fws.gov/Wetlands/Data/Tools/Forms.html.

Optional Submissions - Submission of completed field data forms and/or field

photographs are optional. These are supplemental information to the data and should be clearly labeled if included. Each photograph submitted must be linked to subject matter discussed on the field data form and be provided at 72 dpi in j-peg or tiff format.

The Supplemental Map Report, Field Data Form and Region Transmittal Form are standardized report forms designed specifically for the Service's geodatabase and are available in electronic format at; http://www.fws.gov/Wetlands/Data/Tools/Forms.html.

CONTRIBUTED DATA

Wetland and riparian data may be developed outside the scope of the Service. These data must adhere to FGDC and/or USFWS-developed data standards prior to acceptance into the Service's geodatabase. For data contributed to the Service's geodatabase, information should follow the flow and quality control processes shown in Figure 6. Further information on contributing data can be found at; http://www.fws.gov/Wetlands/WetlandsLayer/ContributedData.html.

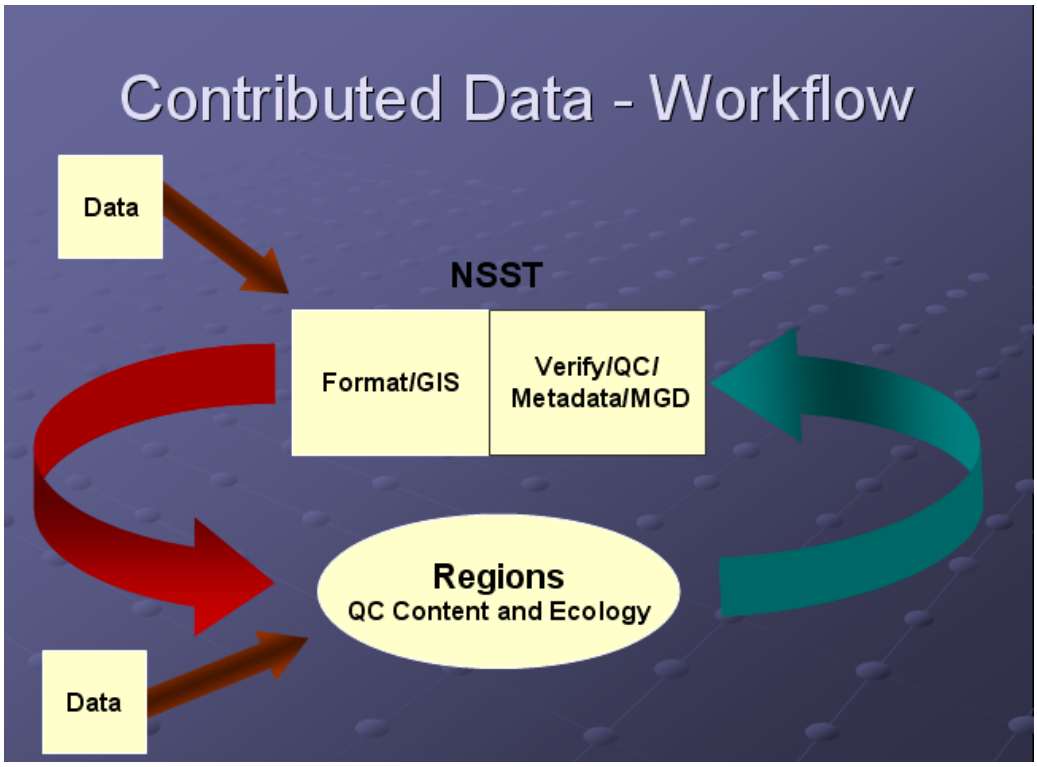

Figure 6. Workflow for incoming data submitted to the Service's geodatabase. Information passes through Regional and national quality control and verification steps.

SCALABLE PRODUCTS

The production of interim products is at the discretion of the Region and/or the Riparian Data Steward. These are considered interim work products and may include map information at different scales, classification level(s), or resolution. In some instances these products can be extremely useful for filling data gaps however, all scalable products should be clearly marked with notations such as "draft" or "interim map". They do need to conform to the specifications established for standard map products or data. Regional specifications will dictate the procedures used to produce and distribute any interim map information.

ACCESSING AND ACQUIRING RIPARIAN DIGITAL DATA

Digital riparian and wetland data can be accessed and acquired through the following means:

On-line; The National Wetlands Inventory Wetlands Mapper (Figure 7.);
http://www.fws.gov/Wetlands/Data/Mapper.html

Special requests and linear data and other riparian information can be acquired through;

A. National Standards Support Team

U.S. Fish & Wildlife Service (Wetlands_Team@fws.gov)
505 Science Drive
Madison, WI 53711-1061
(608) 238-9333
FAX 608-238-9334

B. Regional Wetlands Coordinators (Western U.S. Regions);

Pacific Region 1/8
William Kirchner (Bill_Kirchner@fws.gov)
U. S. Fish & Wildlife Service
Eastside Federal Complex
911 NE 11th Avenue
Portland, OR 97232-4181
Phone: 503/231-2070
Fax: 503/231-2050

Southwest Region 2
Jim Dick (Jim_Dick@fws.gov)
U. S. Fish and Wildlife Service
500 Gold Ave., SW - Rm. 6056
P.O. Box 1306
Albuquerque, NM 87103
Phone: 505/248-6660
Fax: 505/248-6922

Midwest Region 3
Brian Huberty (Brian_Huberty@fws.gov)
U.S. Fish and Wildlife Service
1 Federal Drive, BHW Bldg, Mail Stop 4056
Fort Snelling, MN 55111-4056
Tel. 612/713-5332
Fax 612/713-5292

Mountain Prairie Region 6
Kevin Bon (Kevin_Bon@fws.gov)
U. S. Fish and Wildlife Service
P.O. Box 25486
Denver, CO 80225
Phone: 303/236-4263
Fax: 303/236-0027

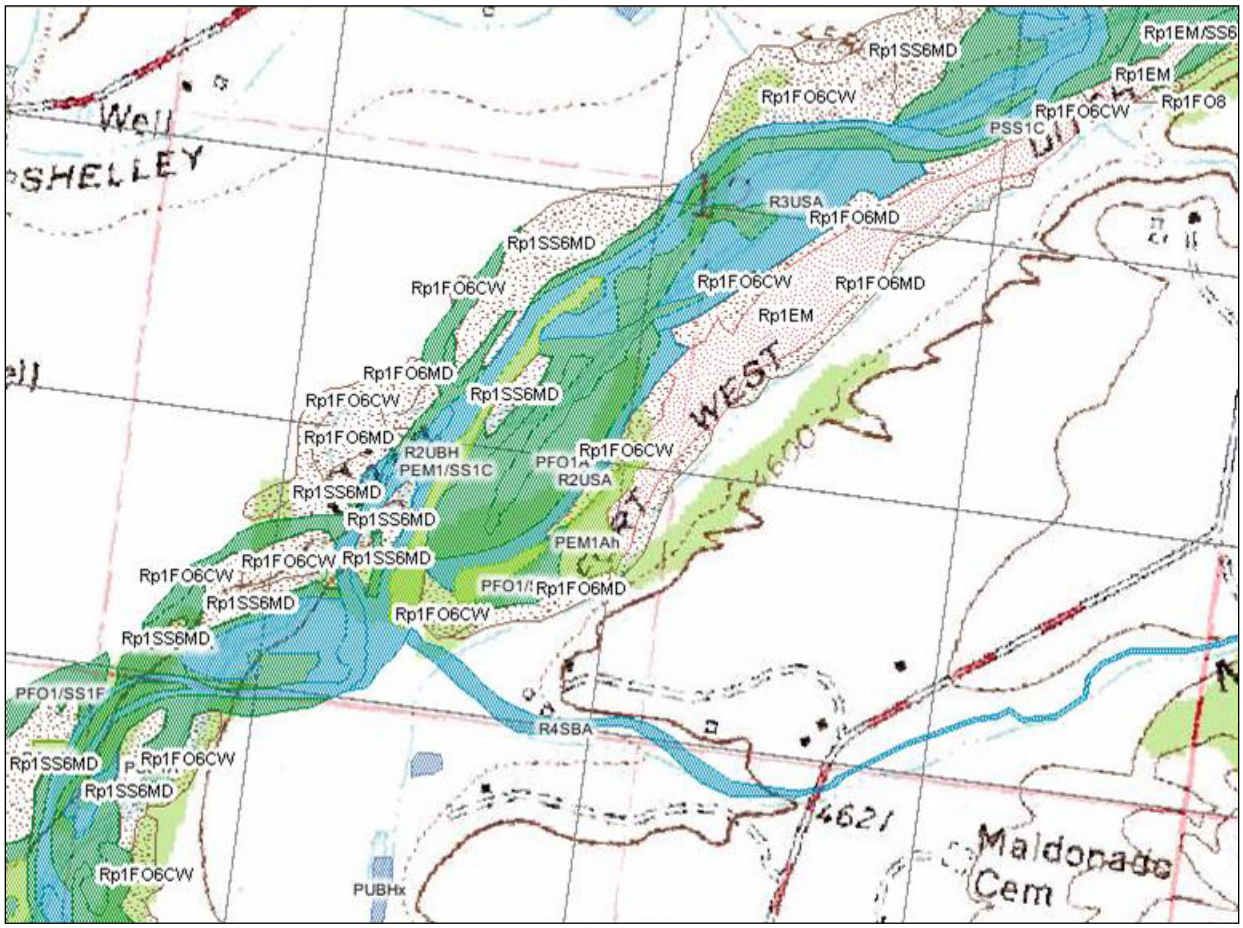

Figure 7. Example of wetland and riparian data that can be accessed from the online Wetlands Mapper.

DEFINITIONS

The following definitions were developed for use specific to these mapping conventions.

Dead No longer living, due to natural or man-made causes. This could include, but is not limited to, extended periods of flood inundation, water table changes, fire, chemical treatment, insect infestation.

Dominant The vegetative species or life form either controlling or most prevalent in the immediate environment. For these conventions considered to be at least 30 percent vegetative cover.

Emergent A species that is erect and rooted with an herbaceous stem.

Forested Woody vegetation greater than 6 meters in height.

Growth form Generally related to vigorous health, compactness, crowding, and / or numbers of individuals.

Intermittent A stream that flows only at certain times of the year or an area where the substrate is usually exposed, but surface water is present for variable periods without a detectable seasonal pattern.

Lentic Related to or living in standing water.

Lotic Related to or living in flowing water.

Perennial A stream that flows continuously or an area where water covers the land surface throughout the year in all years .

Scrub/Shrub Woody vegetation less than 6 meters in height.

Wetland Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.

RELATIONSHIP TO OTHER PROGRAMS

Wetland Regulatory Programs

The procedures described in this document are for mapping riparian areas for resource inventory purposes only, and have no relationship to any wetland (or other) regulatory program. These mapping conventions do not supplant the procedures for identifying wetlands subject to U.S. Army Corps of Engineers regulation under Section 404 of the Clean Water Act, as described in the 1987 Wetland Delineation Manual (Corps of Engineers 1987) and the applicable Supplements (i.e., Arid West Region and Mountain Valleys and Coast) or other Federal, State, or local wetland programs.

Federal, State, and local regulatory agencies with jurisdiction over wetlands and other habitats may define and describe these habitats in a different manner than that used here. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, State, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland or riparian areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

CHRONOLOGY OF DEFINITION AND SYSTEM DEVELOPMENT

The Service completed riparian mapping projects for several agencies in Arizona in the early 1990s. Additional projects were conducted for the National Park Service in Nevada, and Bureau of Land Management in Wyoming. Each project included a variety of definitions, classifications, and mapping conventions. The Service was regularly asked to map riparian areas in the western United States, but lacked a standard definition and conventions to guide the mapping.

Riparian was an important discussion topic at the Service's National Wetlands Inventory Regional Coordinator meeting in Tucson, Arizona, in January 1997. A commitment was made at that meeting to assemble a committee of habitat and cartographic specialists to develop the Service's riparian definition and mapping conventions.

A group of Service employees met in March, 1997, and produced a draft riparian document which contained a definition, a classification system, and mapping conventions. The group included NWI Coordinators and Assistant Coordinators from the western states; Washington Office staff; and a cartographic specialist from the National Wetlands Inventory Center in St. Petersburg, Florida. Service support staff from Regional and Field Offices provided additional input.

A draft document was then reviewed by NWI staff in all of the Regions, in Washington, and the National Wetlands Inventory Center in St. Petersburg, Florida. Following that review, the revision was sent to all Service Divisions and Field Offices with a request for a critical review. During this time, the draft procedures were used by the Service for wetland and riparian mapping in Great Basin National Park, Nevada, as part of an interagency agreement with the National Park Service.

Subsequent to the Service review and further updating of the draft document, Service personnel met in Great Basin National Park, Nevada, during late May, 1997, to field test the definition and conventions and to evaluate their effectiveness in a field situation. As part of the draft map review process, Park Service personnel field-checked over 700 sites mapped as riparian to validate the procedures. Field checking revealed that the draft procedures were used successfully to identify and map riparian areas using aerial photographs. Field checking also revealed that some changes in the draft document should be considered.

Paramount among these was that the microclimatic conditions that are responsible for riparian area formation and identification in Alaska are vastly different compared to those in the lower 48 states. Subsequently, the draft was refocused to apply only to areas of the arid west where mean annual evaporation exceeds mean annual precipitation. The Alaska Regional Wetlands Coordinator concurred with this decision.

Another consideration from the Nevada field work was the necessity to change the focus of the definition from one based on the species make up and physiognomy of woody vegetation on the ground, to one based on the signature of vegetation observable from remotely-sensed data. This issue was addressed in the subsequent revision of the draft.
An Operational Draft document was prepared in July 1997 which considered input from the Service and other subject matter experts in Great Basin National Park. This document was called an Operational Draft to symbolize the fact that the Service was satisfied with what had been produced, and would use the definition and conventions for mapping purposes, but was still receptive to improvement if additional information or experience indicated that changes were needed.

On July, 23, 1997, the Acting Director of the Service transmitted the operational draft to the Director's of 10 Federal agencies having a direct or peripheral interest in riparian areas as well as to the Directors of the State resource agency in each of the 22 states in the riparian definition's "Area of Applicability". A transmittal letter requested that a critical review be conducted by each agency or state before the Service formally adopted the definition and conventions. The Service made it clear in the cover letter that the agency was pleased with the current product, but was willing to consider changes based on the input of others. The Western Regional Offices provided the Acting Director's July 23, 1997 letter and copies of the Operational Draft to additional State and Federal Agencies and non-governmental entities to achieve the most comprehensive review possible. Input from this review was considered by the Service during a final review of the document in early November, 1997. Those agencies that provided input are included in the Acknowledgments section.

In 2000, western Service Regions began widespread implementation of the system, using it in conjunction with the wetlands Cowardin Classification System.

In July, of 2006, The Service officially adopted the Riparian Data Layer Standard. The document was updated to reflect the changes to the system, after years of on-the-ground usage and new digital mapping techniques.

ACKNOWLEDGMENTS

The principal authors of the original document were David Dall, Chuck Elliott, and Dennis Peters; NWI Regional Wetland Coordinators (former) in the Western United States. The 2009 document update was drafted by Jim Dick, Elaine Blok, Kevin Bon, Bill Kirchner, Tom Dahl, Mitch Bergeson, and Justin Miner. Ryan McHale provided some of the photography for Appendix A. Unless otherwise stated, all ground photography in Appendix A. by Jim Dick.

Several early drafts of this document were reviewed by staff of the National Wetlands Inventory

in each of the 7 Service Regions. Subsequent review was provided by Field Offices of the Divisions of Ecological Services and Refuges. Valuable review and criticism of the draft was provided by the following outside agencies and organizations as the draft approached the final version: Arizona Game and Fish Department, California Department of Fish and Game, Iowa Department of Natural Resources, Kansas Department of Wildlife and Parks, Louisiana Department of Wildlife and Fisheries, Nebraska Game and Parks Commission, Nevada Division of Wildlife, Texas Parks and Wildlife Department, Utah Division of Wildlife Resources, Wyoming Game and Fish Department, U.S. Army Corps of Engineers, U.S. Bureau of Land Management, U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Geological Survey, U.S. National Park Service, U.S. Natural Resources Conservation Service, U.S. Office of Surface Mining, University of Montana (School of Forest Resources), Western Working Group - Partners in Flight, Wyoming Game and Fish Department, Wyoming Natural Diversity Database, and Mr. Donn Kesselheim.

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Dahl, T.E., J. Dick, J. Swords, and B.O. Wilen. 2009. Data Collection Requirements and Procedures for Mapping Wetland, Deepwater and Related Habitats of the United States. Division of Habitat and Resource Conservation, National Standards and Support Team, Madison, WI. 85 p.

Gregory, S. V., F. J. Swanson, W. A. McKee and K. W. Cummins. 1991. An Ecosystem Perspective of Riparian Zones. BioScience 41(8): 540-51.

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Reed, P.B. Jr. 1988. National list of plant species that occur in wetlands: 1988 National summary. U.S. Fish and Wildlife Service. Biological Report 88(24). 244 pp.

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U.S. Fish and Wildlife Service. 1994a. Cartographic Conventions for the National Wetlands Inventory. U.S. Fish and Wildlife Service, St. Petersburg, FL. 71 pp.

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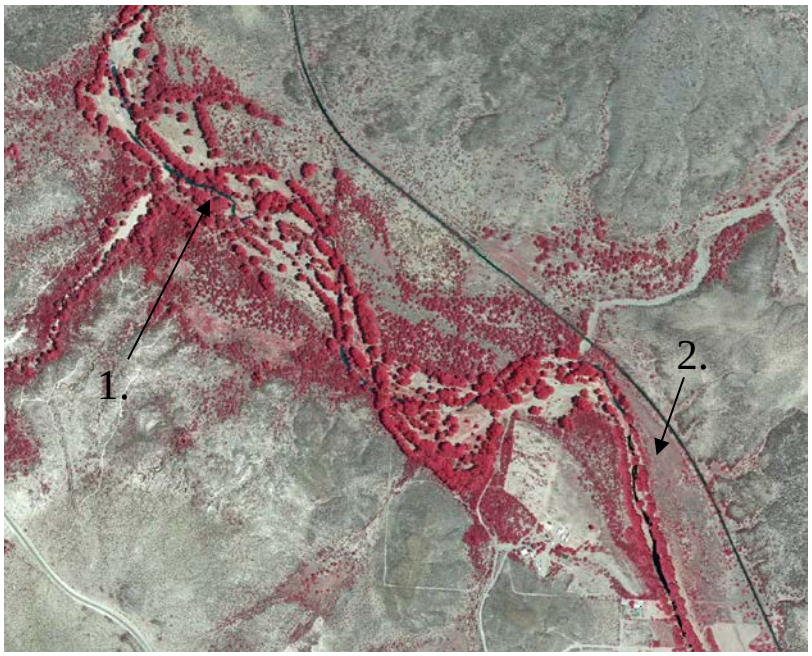
Citation:
  Citation_Information:
    Originator: Earth Data Analysis Center
    Publication_Date: 19910301
    Title: **Evaporation Isopleths**
    Edition: First
    Geospatial_Data_Presentation_Form: map
    Publication_Information:
      Publication_Place: Albuquerque
      Publisher: Earth Data Analysis Center
    Other_Citation_Details:
    Online_Linkage: http://rgis.unm.edu/rgisftp.htm
    Online_Linkage: http://rgisedac.unm.edu/climate/cli2e00.zip
    Online_Linkage: http://rgisedac.unm.edu/climate/cli2shp.zip

Citation:
  Citation_Information:
    Originator: Chris Daly, Spatial Climate Analysis Service
    Originator:
      George Taylor, the Oregon Climate Service at Oregon State University
    Publication_Date: 200009
    Title: **United States Average Annual Precipitation, 1961-1990**

Geospatial_Data_Presentation_Form: Map
Publication_Information:
Publication_Place: Corvallis, OR, USA
Publisher:
Spatial Climate Analysis Service, Oregon State University;
USDA - NRCS National Water and Climate Center, Portland, Oregon;
USDA - NRCS National Cartography and Geospatial Center, Fort Worth, Texas
Online_Linkage: <http://nationalatlas.gov/atlasftp.html>
Online_Linkage: <http://www.ncgc.nrcs.usda.gov/branch/gdb/products/climate/index.html>
Use_Constraints:
None. Acknowledgement of the PRISM model, the Spatial Climate Analysis Service at Oregon State University, the Natural Resources Conservation Service (NRCS) Water and Climate Center, the NRCS National Cartography and Geospatial Center (NCGC), and (or) the National Atlas of the United States would be appreciated in products derived from these data.

Appendix A: Riparian Communities, Photographic Examples



Color Infrared image of the San Pedro River, and its associated riparian vegetation. Pima County, southern Arizona.

1. Forested, deciduous Cottonwood (Rp1FO6CW), up a terrace from the river channel.

2. Emergent, Alkali Sacaton (Rp1EMAK), up on the second terrace from the river channel.

Dead Salt Cedar (Rp1SS5SC) along the Pecos River in southern New Mexico. Result an invasive species control project.

Photo by Ryan McHale

Dense stand of Sagebrush (Rp1SS7SB) associated with dry wash in Gobernador Canyon, northwest New Mexico.

Evergreen forest (Rp1FO7) along the Blackfoot River, Montana. *Photo by Bureau of Land Management.*

Mixed deciduous forest (Rp1FO6MD) associated with the Salinas River, near Bradley, CA. *Photo by Elaine Blok.*

Mixed deciduous shrub (Rp1SS6MD) stands out against the desert background. Professor Creek, near Moab, UT. *Photo by Bureau of Land Management.*

Spruce (forested, evergreen; Rp2FO7) line a lentic system in Utah. *Photo by USFWS.*

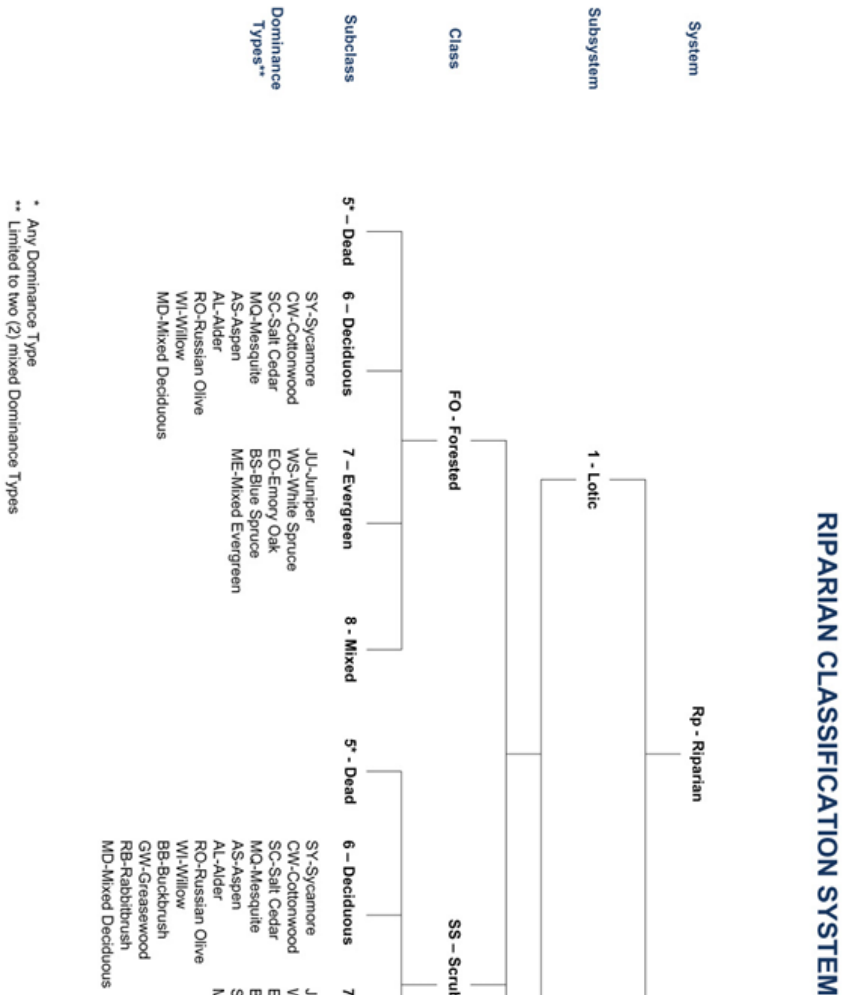
Mixed deciduous/evergreen forest (Rp1FO8) along the Animus River, southwestern Colorado.

Deciduous forest (Rp1FO6) borders the Missouri River, in Montana. *Photo by Bureau of Land Management.*

Deciduous forest (Rp1FO6) showing its fall colors, Chama River, Abiquiu Valley, northern New Mexico. *Photo by Jim Dick & Ryan McHale*

Appendix B: Riparian Map Legend and Coding

For the purposes of applying the riparian classification system for mapping, a series of letter and number codes has been developed by the Service. The following map code diagram shows codes and relationships of riparian systems.



Appendix C: Other Methods of Data Capture (Provided for Informational Purposes)

Manual Stereoscopic Interpretation Methods

Manual Stereoscopic Interpretation Methods (excerpted from Photointerpretation Conventions National Wetlands Inventory U.S. Fish and Wildlife Service, 1995**)**

Air photo interpretation involving three-dimensional viewing of successive air photos that overlap the same geographic area (between flight lines) provides a useful method to delineate wetland and deepwater habitats. In stereo view, topographic relief features become recognizable. Photos are examined stereoscopically by experienced ecologists who delineate (or "classify") habitat boundaries in ink on photo overlays. Supporting information from topographic maps, soil surveys, and other land cover maps can assist in this process. This, combined with the visual appearance of discrete vegetation communities based on color, texture and relative height, permits an experienced wetlands interpreter to accurately identify and delineate wetland habitats. This process has been employed successfully by Service biologists to map wetlands since the mid 1970s. Other Federal agencies including National Aeronautics and Space Administration, U.S. Geological Survey, Environmental Protection Agency, Army Corps of Engineers, Natural Resources Conservation Service, and the National Oceanographic and Atmospheric Administration have all successfully employed stereoscopic air photo interpretation techniques to identify wetlands and related habitats.

Interpretation Equipment Requirements
All stereo photo interpretation should be done using equipment equal to or better than four-power (4X) mirror stereoscopes. Before beginning actual delineation, photointerpreters shall ensure that the work photo overlays (with work areas identified) are correctly aligned to the fiducial or other registration marks on the photograph. The photo overlays shall be properly secured to the photographs.

Personnel Qualifications
Photo interpreters must be able to see in stereo and have an understanding of surface water hydrology and wetland ecology. The interpreter observes the amount of standing water, if any, visible on the photograph and relates it to the date of photography, type of wetland vegetation, local or regional precipitation patterns, length of growing season, soil types, physiographic position, and knowledge of the area gained from supplemental data sources. The examination of aerial photos stereoscopically enables the interpreter to observe the vertical as well as the horizontal spatial relationships of the ground features. These variables are synthesized and applied by the photo interpreter in making delineation and classification determinations. Due to the complexity of the interpretative process and the wealth of data within aerial photos, accurate photo interpretation requires considerable expertise (U. S. EPA 1991).

Delineating Photo Overlays

Photo overlays are made from clear stabilene mylar and are fastened on photos with drafting tape. The fiducial (registration) marks on the photos are precisely transferred to the overlay. The photo interpreters shall ensure that the overlays are correctly aligned to the fiducial before beginning the photo interpretation. Wetlands, deepwater habitats and all other mapped features shall be labeled using the letter and number codes (alpha-numeric) that coincide with the map legend. All labels shall be printed neatly and legibly. All photo interpretation delineations shall be made on the photo overlays in waterproof black ink with pen points no larger than a Castell 000 or a Keuffel and Esser 0000 or 000000 point, depending on wetland complexity and the level of detail deemed necessary by specific project area guidelines. All map feature labels and line work must be drawn neatly on the aerial photography overlays. All labels must be consistent and legible. Labels for polygons should be placed within the polygon, if space permits. If the label is placed outside the polygon, a lead line shall be drawn from the label extending inside the polygon. To complete interpretation and facilitate edge matching of features, photo interpretation will be performed beyond the work area boundary by approximately one-quarter inch on the acetate overlay.

Wetlands and deepwater habitats are identified and classified according to Cowardin *et al.* (1979). Classification of each mapped unit shall include the appropriate system, subsystem, class and water regime. The use of subclasses and special modifiers will be determined by project specifications originating from the Region or Project Officer. The use of split-classes is discouraged. If a wetland is too small in area based on the minimum mapping unit to allow separate delineation of each cover type, the polygon should be classified to represent the cover type encompassing the greatest acreage. Polygons that may contain a mosaic of cover types or ecosystem components and cannot be delineated separately will be classified using the dominant component.

Additionally, wetland delineation line work will follow the border of the wetland boundary. No upland features should be included as part of a wetland feature (i.e. adjacent roads, railroads, etc.).

The aerial photos in combination with field reconnaissance will prevail as the principal data source for mapping. Changes which have taken place since the time of the photography (wetland gains or losses) should not be included as part of the mapping effort. Maximum vegetative summer growth in an average year and at the average low water level shall be basis for classification.

Wetlands will be labeled using the letter and number code (alphanumeric) that correspond to classification descriptors and presented as wetland map legend information.

Linear wetlands features should be considered secondary in priority to larger wetlands that can be enclosed within a polygon. Delineation of linear features is discouraged; however, special projects may warrant the incorporation of some linear features. When this occurs, linears will be captured and maintained as a *separate feature class* within the wetlands geodatabase.

Any classification change along a linear wetland shall be indicated by a short solid line drawn perpendicularly across a dash along the linear. When two separate linears intersect, the dashes must connect at the intersection.

If small sections of a river channel are obscured by an overhanging canopy, the location of the channel should be approximated from the USGS topographic map. Interpreters should attempt to connect disconnected sections of a river channel so that a unified stream system is delineated. The channel of a river should not be approximated upstream beyond the last open stretch of water or streambed visible on the photography.

Feature Edge-matching

To ensure accurate delineation, wetland and deepwater delineations lying along the outer borders of each work area must be edge-matched in stereo with the all adjacent work areas. Where edge ties have been checked, the photo interpreter shall label the photo work overlay to indicate edge-matching is complete. The necessary steps must be taken to ensure accurate feature edge-matching of all delineated work.

Stereoscopic Quality Control Review

The photo interpreter will review the work area for any problems such as missed wetlands, upland included as wetland, miss-classifications, missing labels, incomplete work and agreement with collateral data sources.

Cartographic Transfer Specifications

The use of manual stereoscopic interpretation methods requires a separate cartographic transfer process to align the photographic delineations to a USGS 7.5' topographic quadrangle (rectified base map). The Service developed cartographic conventions (January 1995) that are applicable to this process. Some elements of the transfer process have particular relevance to quality control of map products. These include the following technical steps:

- Photo overlay review and alignment
- Scaling the photographic image on the zoom transfer scope (ZTS)
- Cartographic alignment
- Use of the topographic quadrangle
- ZTS overlay alignment
- Transfer of delineated polygons and classification labels

Digital Data Capture Specifications
The use of manual stereoscopic interpretation methods also requires a separate digital capture step following manual transfer to a rectified base map. The Service developed digitizing conventions (January 1995) that are applicable to this process. Although the Service provides considerable latitude on the method(s) of digital data capture used (i.e. scanning. board digitizing, etc.), there are specific requirements for data delivery formats. These include the following:

- Digital map data must be provided in geodatabase format
- Data should be provided in a uniform Albers Equal-Area Conic Projection
- The horizontal planar datum should be the North American Datum of 1983, also called NAD83
- Point features (if delineated) must be buffered to 11.28 m (0.1 ac.)
- Linear features (if delineated) should be in a separate feature class
- Data must pass the Service's automated verification
- There may be metadata requirements required by the Region or Project manager
- All digital data produced by cooperators, collaborators, or contractors must be delivered to the appropriate Regional Wetlands Coordinator

Digital Transfer Scope (DTS) Method (Transitional ArcView based method or application that is no longer supported by Arc technology.)

The DTS application is an ArcView® 3.x Extension. By interfacing a digital transfer scope with Arc View polygonal and linear Shapefiles can be georeferenced to a base data source (i.e. DRGs, etc). Wetland polygons are created using digitizing tools and editing functions in ArcView 3.x. A recommended technical reference of the digital transfer scope operation is: *Getting Started with the Digital Transfer Scope* (DTS™) *Software Tutorial Accompaniment to the Digital Transfer Scope Reference Manual.*

Interpretation Equipment Requirements
System and hardware information may be found in the *Digital Transfer Scope Reference Manual*, which is provided in hard copy form with the DTS instrument.

Personnel Qualifications
Personnel using the on-screen method need the same experience in the identification and classification of wetlands as cited in the manual stereoscope method. Photo interpreters must be able to see in stereo. Using the DTS, image analysts are responsible for ecological integrity of the mapping process as well as most of the cartographic accuracy. The identification, delineation and attribution of features are done within the digital data file requiring analysts to be able to operate in a computerized mapping environment. For this reason, image analysts using this method should be experienced with ArcView (3.x or later versions) software, and have some familiarity with Shapefiles and editing spatial data.

Operational Techniques

File Structure – Shapefile Creation: Create a folder for Shapefile/base maps on a local or network drive. For creating a new NWI map coverage, begin with a Hydrology DLG or the DRG for the quadrangle and trace the major water bodies. This creates the most accurate data set to match further interpretation work. Append the existing wetland polygons. Alignment of themes to the basemap is done by adjusting the scale in the ArcView view.

Add a digital soils layer, if available. Query out all hydric soils. Use this to append the DLG.

Create a new polygon theme. Set general snap tolerance to 0.001 miles name the new theme (based on the quadrangle, etc.) and direct ArcView to store the new theme in a designated folder.

Create a new line theme. Set snap tolerance for 1.01 miles. Name the new theme and direct ArcView to store the new theme in a designated folder. Modify the data table for new themes, in ArcView and add an "Attribute" field, any other fields needed, and a "comments" field for quickly selecting areas for future field review.

Use the topographic map or contour lines (if available) to gather the best data. Check obvious drainage's (wet vegetated linear features, intermittent streams) and large flat areas in particular. Wetland areas are mapped to the extent of the source imagery.

For editing an existing NWI coverage, or updating an old coverage, the DLG or DRG is still the starting point. Work towards refining the coverage and re-labeling by using the newest photography available.

Attributing Polygons – Reduce the size of the view in ArcView, open the data table and resize so that both fit on the screen. In edit mode, select polygon(s) in the view activate table, and type in the attribute.

Edge Matching – To accurately tie adjacent Shapefiles, match vertices of the new theme with the previous theme. Use the "Snap-to-It" tool.

Backup Shapefiles – It is recommended that at the end of every edit session Shapefiles be copied to a backup folder. It is also advisable to create a CD with all Shapefiles completed and in progress at weekly intervals.

Quality Control Review - To ensure accuracy, the analyst will review the work area for any problems such as missed wetlands, upland included as wetland, mis-classifications, missing labels, incomplete work and agreement with collateral data sources.

After a work has been complete, open the data table along with the "query builder" window. Activate the "Attribute" field to show a list of all attribute labels used. This can be used to find missing labels as well as correct attribution errors.

Once work on the DTS is complete. Convert the Shapefile to a personal geodatabase using ArcGIS. Run the Service's verification routine to ensure the digital data meet the requirements.

Advantages of the DTS Method

- Utilizes existing digital NWI layer during photo interpretation
- Utilizes other digital sources as collateral information (i.e. SSURGO, state digital wetland data, DLG, and DRGs)
- Can create NWI data from scratch
- Allows stereoscopic views of photography and digital layers simultaneously
- Ability to work on ArcGIS
- Eliminates need for acetate paper, ZTS and digitizing steps
- The DTS Extension also provides a freehand drawing tool for tracing features without having to click the mouse for each individual node. This is functionally equivalent to stream mode digitizing on a regular tablet. To bring up the Freehand Drawing Dialog, choose **Freehand Drawing Tools** from the **DTS** menu
- Shapefiles are easily converted to personal geodatabase files

Appendix D. Supplemental Map Information (User Report)

Outline

1. Project Area:

2. Source Imagery: (type, scale and date)

3. Collateral Data: (include any digital data used as collateral)

4. Inventory Method: (original mapping, map update, techniques used)

5. Classification: (Cowardin wetlands, riparian, uplands, hydrogeomorphic, etc.)

6. Data Limitations:

7. General description of the Project Area

- Geography
- Vegetation, soils, land use
- Natural history or important cultural features

8. Description of wetland habitats

- Organize by Cowardin classification type
- Wetland classification codes and corresponding community type(s)

9. Description of other habitats

- Riparian
- Uplands

10. List of wetland plant species with indicator status

11. Regional specialized conventions

12. Other discussion of mapping issues (image quality, water conditions, etc.)

13. References

Appendix E: Regional Transmittal Form

To: Geodatabase Manager

From: _____

Date: _____

Subject: Data Submission to the Wetlands Master Geodatabase

The following work areas have been reviewed and accepted by Regional Quality Control. The attached data file(s) are submitted for final verification and entry into the MGD. The following information has been included:

Project Title or Area _____

Digital Data Format_____

Quadrangles or Study Area:_____

Metadata ____

Supplemental Map Information (User Report)____

Field Data Sheet(s)____ No._____

Photographs____ No._____ Format_____

QC Review Date_____ Reviewed By_____

Comments_____ _____

Request for Entry of Corrected Map Data____

.....

To be completed by Geodatabase Manager

Final Verification Pass____ Fail____

Data Posted on:_____

Data Returned on:_____

Comments:_____

U.S. Department of the Interior
Fish and Wildlife Service

http://www.fws.gov

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