U.S. Fish & Wildlife Service

Technical Procedures for Conducting Status and Trends of the Nation's Wetlands (version 2)

Revised August 2017

U.S. Fish and Wildlife Service

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Contents

TECHNICAL PROCEDURES FOR CONDUCTING STATUS AND TRENDS OF THE NATION'S WETLANDS

PREFACE

These guidelines serve as a reference for conducting the data collection, and validation associated with monitoring wetland and deepwater habitat area, type, and change in support of the U.S. Fish and Wildlife Service Wetlands Status and Trends reporting process. It is impractical to include all of the technical aspects of data handling and analysis within this document or anticipate all resource monitoring needs. Users are advised that other written conventions may be useful in describing image interpretation and monitoring protocols and should be referenced as appropriate. More detailed wetland 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. For additional information contact:

National Standards and Support Team
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This document is intended to be comprehensive; however situations may develop that require modifications or additions.

I. Introduction

The mission of the U.S. Fish and Wildlife Service (Service) is to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The Service supports active programs relating to migratory birds, endangered species, certain marine mammals, inland sport fisheries, and wildlife refuges. The Service communicates information essential for public awareness and understanding of the importance of fish and wildlife resources, their habitats and changes reflecting environmental conditions that ultimately will affect the welfare of human beings. To this end, the Service maintains an active federal role in the inventory and monitoring of U.S. wetland habitats.

The Service is the principal federal agency tasked with providing information to the American public on the status (i.e., extent) and trends of the Nation's wetlands. The Service's Wetlands Status and Trends effort has a history of success in providing actionable scientific information to resource managers and decision makers about wetland resource trends. The Wetlands Status and Trends project uses a rigorous, peer-reviewed scientific methodology that results in the most accurate and contemporary effort to track U.S. wetland resources on a national scale.

The Service's efforts to monitor wetland status and trends have been enhanced by multi-agency involvement in the study's design, data collection, verification, and peer review of findings. The Service is continuing to develop additional data applications that will facilitate even broader use of the Status and Trends dataset and enhance relevancy for integrated natural resource management and decision making. In 2011, the Service, working in collaboration with the National Oceanic and Atmospheric Administration (NOAA), released a report based on further analysis of the national Wetlands Status and Trends dataset in the coastal watersheds of the Atlantic, Pacific, Gulf of Mexico and Great Lakes. The results of that effort stimulated subsequent federal inter-agency policy and management actions focused on wetland conservation and restoration efforts in these coastal areas. In similar fashion, the Service has worked closely with the Environmental Protection Agency (EPA) to develop the National Wetland Condition Assessment study (NWCA). Wetlands Status and Trends protocols provided the foundation for the NWCA sampling effort, and current and future Status and Trends data greatly enhance the interpretation of NWCA findings.

Advances in information technology and geographic information systems have influenced public expectations for greater utility and functionality from government data sources. There is an ever growing importance placed on data quality and integrity. The Service strives to present information on wetlands, deepwater, and related habitats in an accurate, clear, complete, and unbiased manner. To ensure the effectiveness and reliability of Wetlands Status and Trends data, the Service has established the procedural guidelines contained herein and adheres to the various quality assurance and quality control measures described. The goal of these guidelines and protocols is to help ensure that the data collection, analysis, verification, and reporting methods used produce information that is suitable to support decisions for which the data were intended. The technical procedures described herein have been developed to provide the guidelines needed to produce accurate wetland acreage and change estimates for the Nation.

II. The Service's Wetlands Status and Trends Effort

The Wetlands Status and Trends effort provides comprehensive information regarding long-term trends and overall status of U.S. wetlands to government policy makers and the American public.

The historical data base that the Service has developed through Status and Trends provides photographic evidence of land use, as well as wetland and deepwater extent dating back to the 1950s. The Service has rigorously documented the historic downward trend in wetland losses since the 1950s. At that time average annual net wetland loss was 458,000 acres. During the mid-1970s to mid-1980s annual average net loss had declined to 290,000 acres. It declined to about 59,000 wetland acres annually from 1985 to 1997, and from 1998 to 2004 gains in wetland acreage exceeded losses by an average of about 32,000 acres annually. Net average wetland losses increased between 2004 and 2009 to 13,500 acres per year, reversing the long-term trend in wetland loss reduction. The Service has documented these trends and produced six national reports. They are used by federal and state agencies, the scientific community, and conservation groups for planning, decision making and wetland policy formulation and assessment.

Contemporary scientific information is the bedrock of good wetland policy and management. The Service’s strategic plan for wetlands is focused on the development and dissemination of wetlands information to resource managers within the Service and other governmental and non-governmental groups, as well as the public. The Service’s wetland expertise positions the Agency to assume an even greater future role in aquatic habitat policy development. Resource managers increasingly need robust, contemporary information on aquatic habitats to address increasingly complex issues.

Goal Statement

The goal of Wetlands Status and Trends is to provide current scientifically valid information on the status (extent) of U.S. wetlands and related aquatic resources, and monitor trends in these resources over time.

III. Mandate and Authorizations

In 1986, the Emergency Wetlands Resources Act (Public Law 99-645) was enacted to promote the conservation of our Nation’s wetlands. Congress recognized that wetlands are nationally significant resources and that these resources have been affected by human activities. Under the provisions of this Act, Section 401 requires the U.S. Fish and Wildlife Service to conduct Wetlands Status and Trends studies of the Nation’s wetlands at periodic intervals. National reports on the status and trends of wetland area were produced by the Service in 1983/84, 1990, 1991, 2000, 2006, and 2011 (Frayer *et al*. 1983; Tiner 1984; Dahl 1990; Dahl and Johnson 1991; Dahl 2000; Dahl 2006; Dahl 2011). These National reports are supplemented by eight regional and state reports (Tiner and Finn 1986, Hall et al. 1994, Moulton et al. 1997, Dahl 1999, Dahl 2005, Stedman and Dahl 2008, Dahl and Stedman 2013, Dahl 2014)

IV. Operational Terms and Definitions

The national study was designed to quantitatively measure the areal extent of all wetlands, regardless of ownership, in the conterminous United States. The Service’s Wetlands Status and Trends study design, training, and operations are aimed specifically at monitoring wetlands at the national, and to the degree possible, regional scale. The Service is well positioned to carry-out this effort because it has specialized knowledge of wetland habitats, classification, and cover type changes.

Wetland Definition and Classification

The Service uses the Cowardin *et al*. wetland definition (Federal Geographic Data Committee 2013). This definition is the standard for the Agency, and is the national standard for wetland mapping, monitoring, and data reporting as determined by the Federal Geographic Data Committee. This definition is as follows:

> *Wetlands are 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. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.*
>
> *As noted in this definition, plant community composition, soil morphology, and site wetness (hydrology) are the principal indicators of whether a site is a wetland for ecological purposes. Site wetness, i.e., the presence of water, while central to the concept of wetland, is often the most difficult indicator to assess accurately because it is more dynamic (temporally variable) than plant community composition or soil properties. Plants and soil tend to reflect the prevailing degree of wetness at a site over time. For this reason, they frequently are excellent indicators of relative wetness, and this is why they are listed first as indicators of wetlands.*
>
> *Three (3) indicators – hydrophytic vegetation, undrained hydric soil, and wetland hydrology; two (2) indicators—hydrophytic vegetation and wetland hydrology or undrained hydric soil and wetland hydrology; and one (1) indicator— wetland hydrology, respectively, would be used to make the identification, based on the features available at the particular site.*

Ephemeral waters, which are not recognized as wetlands, and certain types of "farmed wetlands," as defined by the Food Security Act and do not coincide with Cowardin *et al*. definition, were not included in this study. The definition and classification of wetland types are consistent between every Status and Trends study conducted by the Service. Habitat category definitions are given in synoptic form in Table 1. The reader is encouraged to review Appendix A, which provides complete definitions of wetland types and land use categories used in this study.

Wetland Classification Applications

The Service has made adaptations to the Cowardin classification system to accommodate the use of remotely sensed imagery as the primary data source. Image analysts must rely primarily on physical or spectral characteristics evident on imagery, in conjunction with collateral data, to make decisions regarding wetland classification and deepwater determinations. Water chemistry, including halinity, water depth, particle size and type and even some differences in vegetative species cannot always be reliably ascertained from imagery. For this reason, those distinctions are not made within Status and Trends data.

Deepwater Habitats

Wetlands and deepwater habitats are defined separately by Cowardin *et al.* (Federal Geographic Data Committee 2013) because the term wetland does not include deep, permanent water bodies. Deepwater habitats are permanently inundated land lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium in which the dominant organisms live, whether or not they are attached to the substrate. For the purposes of conducting Wetlands Status and Trends work **all lacustrine and riverine waters** are deepwater habitats.

Upland Habitats

The Wetlands Status and Trends study uses an abbreviated upland classification system with five generalized categories as seen in Table 1. Some habitat monitoring projects may require more specialized upland classification. For these projects, the Service uses the U.S. Geological Survey (USGS) land classification scheme described by Anderson *et al.* (1976). More detailed Level 1 or Level 2 descriptors found in Anderson *et al*. (1976) or other schemes may be used to satisfy specific study applications.

Table 1-Wetland, deepwater, and upland categories used to conduct Wetlands Status and Trends studies. The definitions for each category appear in Appendix A.

Code	Salt Water Habitats	Common Description
M1	Marine Subtidal*	Open Ocean
M2	Marine Intertidal	Near shore
E1UB	Estuarine Subtidal*	Open water/bay
E2EM	Estuarine Intertidal Emergents	Salt marsh
E2SS	Estuarine Intertidal Forested/Shrub	Mangroves or other estuarine shrubs
E2US	Estuarine Intertidal Unconsolidated Shore	Beaches, bars, flats
RIV	Riverine* (tidal and non-tidal)	Perennial river systems

Code	Freshwater Habitats	Common Description
PFO	Palustrine Forested	Swamps, wetlands with woody plants greater than 6 meters tall
PSS	Palustrine Shrub	Wetlands with woody plants less than 6 meters tall
PEM	Palustrine Emergents	Inland marsh or wet meadow
Pf	Palustrine Farmed	Farmed wetlands
	Palustrine Unconsolidated Bottom (ponds)	Open water ponds/aquatic beds
PUBn	Pond-natural characteristics	Bog lakes, vernal pools, kettles, beaver ponds, alligator holes
PUBi	Pond-Industrial	Mine pits or drainage ponds, highway borrow pits, sewage lagoons, industrial holding ponds

PUBu	Pond-Urban use	Aesthetic or recreational ponds, golf course ponds, residential lakes, ornamental ponds, water retention ponds
PUBf	Pond-Agricultural use	Ponds in close proximity to agricultural, farming, or silviculture operations, such as farm ponds, dug outs for livestock, agricultural waste ponds, irrigation or drainage water retention ponds
PUBa	Pond-Aquaculture	Ponds singly or in series used for aquaculture, including fish rearing
LAC	Lacustrine*	Lakes and reservoirs
	Uplands	
UA	Agriculture	Cropland, pasture, managed rangeland
UB	Urban	Cities and incorporated developments
UFP	Forested Plantation	Planted or otherwise intensively managed forests, silviculture
URD	Rural Development	Non-urban developed areas and infrastructure
UO	Other Uplands	Barren uplands or uplands that do not fall into any other category, including non-intensively managed forests and grasslands

**Deepwater habitat*

V. Limitations

Certain habitats were excluded from this study because of the limitations of imagery as the primary data source to detect wetlands. These limitations included the inability to accurately monitor certain types of wetlands, such as sea grasses found in the intertidal and subtidal zones of estuaries and nearshore coastal waters (Orth *et al*. 1990), submerged aquatic vegetation, or submerged reefs (Dahl 2006). Seagrasses are not delineated as part of Wetlands Status and Trends studies. Additionally, ephemeral waters not recognized as a wetland type by Cowardin *et al*. (Federal Geographic Data Committee 2013), are not included in this study.

VI. Technical Aspects and Project Specifications

Sampling Design

A stratified random sampling approach is used to distribute Wetlands Status and Trends plots across the Nation, regardless of land ownership, and data are collected within four mile square plots. Additional plots have been added through the random selection process overtime, but once selected, plot locations remain constant. Plot areas are examined, with the use of remotely sensed data in combination with field work to determine wetland acreage, type, and change. The design was developed by an interagency group of spatial sampling experts specifically to monitor wetland changes. It can be used to monitor conversions between ecologically different wetland types, as well as, measure wetland gains and losses.

To monitor changes in wetland area, the 48 conterminous U.S. states are stratified or divided by state boundaries and 37 physiographical subdivisions described by Hammond (1970). Zone 36 was added by the Service to include coastal wetlands and nearshore features (Figure 1). In 2008, Zone 37 was added to include the coastal wetlands along the Pacific coast of the conterminous U.S. A list of the physiographic regions by name, abbreviation code and map number is provided in APPENDIX B: Physiographic Subdivisions and Code Abbreviations as used to determine Wetlands Status and Trends in the U.S. (adapted from Hammond 1970). To permit even spatial coverage of the sample and to allow results to be computed easily by sets of states, the 37 physiographic regions formed by the Hammond subdivisions and the coastal zone stratum are intersected with state boundaries to form 222 subdivisions or strata. An example of this stratification approach and the way it relates to sampling frequency is shown for Georgia (Figure 2).

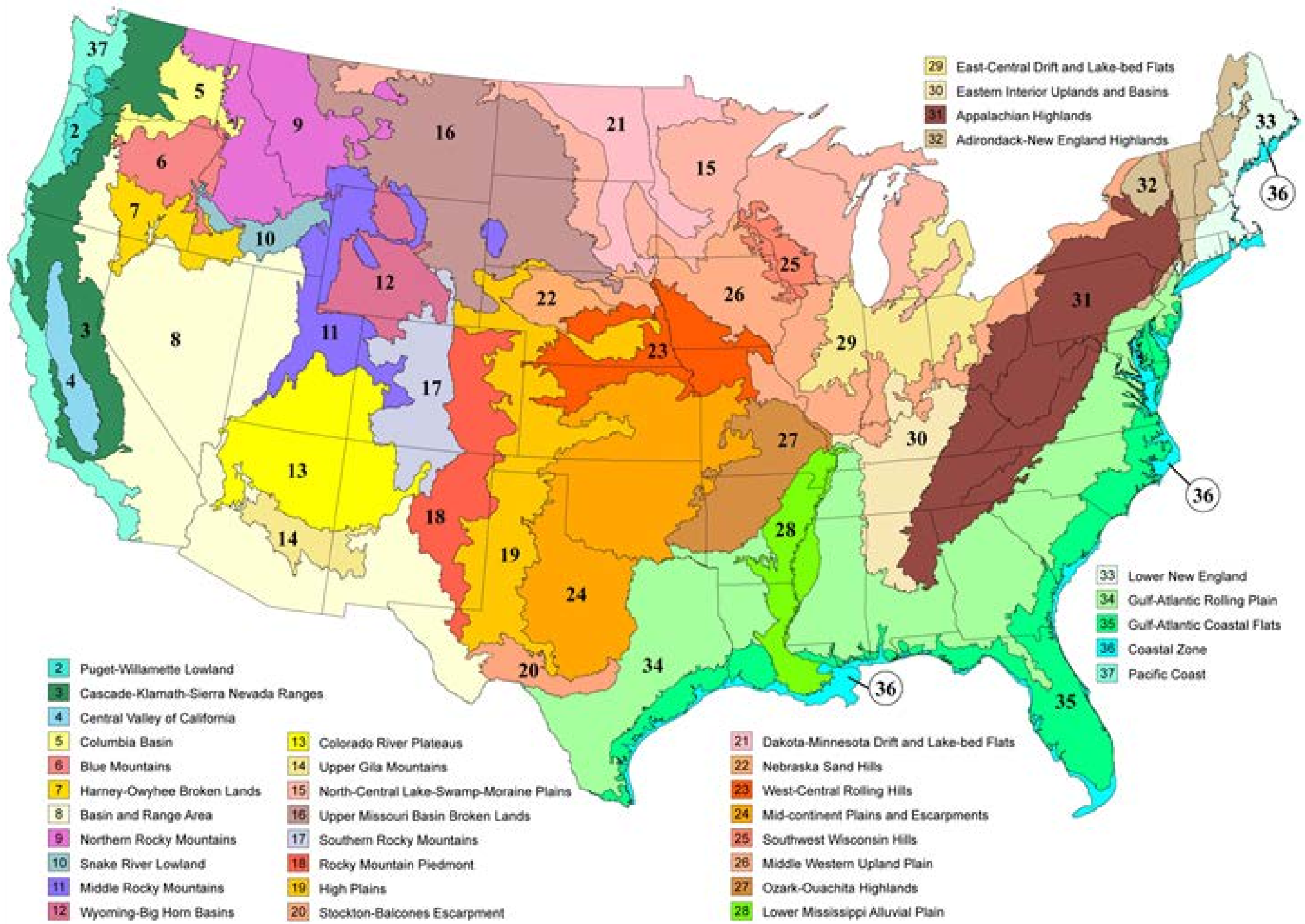


Figure 1-Physiographic regions of the conterminous United States as used for stratification in the Wetlands Status and Trends study (adapted from Hammond 1970)

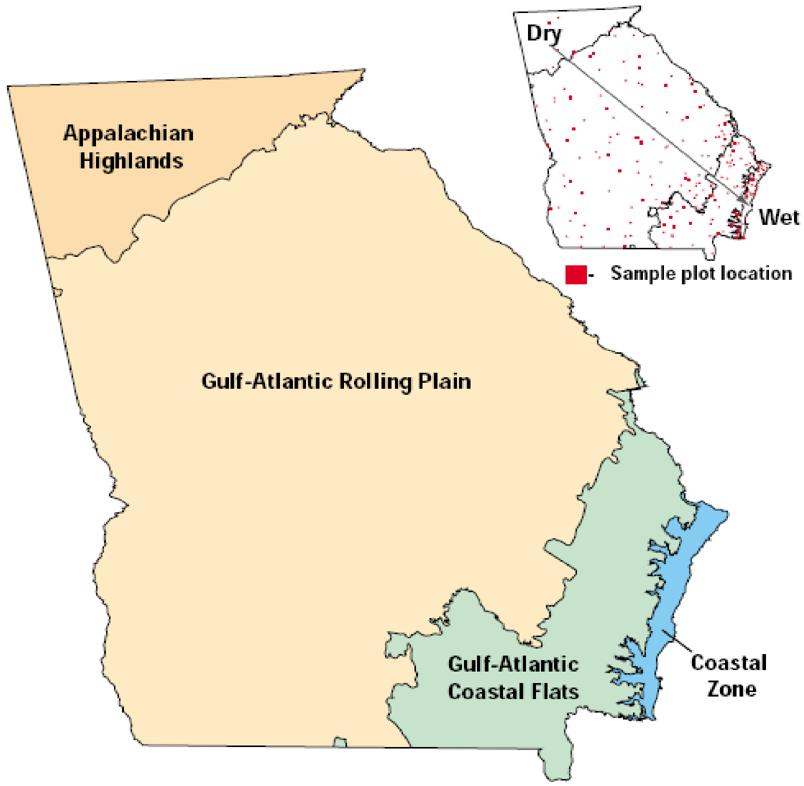


Figure 2 -Physiographic strata in Georgia

Within the physiographic strata described above, weighted, stratified sample plots were randomly allocated in proportion to the amount of wetland acreage expected to occur within each stratum. Each sample area is a surface plot 2 miles (~3.2 km) on a side equaling 4 square miles or 2,560 acres (~1,036 ha).

For each sample plot, two dates of imagery (time one [T1] and time two [T2]) are used to estimate the total area of the sample plot in each wetland type and the changes in wetland area between dates. The changes between T1 and T2 are recorded in categories that can be considered the result of either natural change, such as the natural succession of emergent wetlands to shrub wetlands, human induced change, or a combination of the two wetland change driver types. Areas of the sample plot that have been identified in previous eras as wetlands but are no longer wetlands, are placed into five land use categories, including agriculture, upland forested plantations, upland areas of rural development, upland urban landscapes and other miscellaneous uplands, which includes non-intensively managed forests and grasslands. The outputs from this analysis are change matrices that provide estimates of wetland area by type and observed changes over time. Rigorous quality control inspections are built into the interpretation, data collection, and analysis processes.

Suitable Imagery

Only good quality images are used to support the Status and Trends effort. Fine spatial scale satellite imagery and aerial photography that display information collected discretely in multiple portions of the electromagnetic spectrum, including the near infrared (e.g., false color near-infrared aerial photography) are the preferred data sources. Traditionally, wetland interpreters have found color infrared imagery to be superior to other image types for recognition and classification of wetland types (Figure 5 and Figure 6). However, true color imagery has been proven to be an important data source as well.

An effort is made by the Service to acquire imagery at optimal times relative to phenology, water level, and other dynamic conditions. Leaf-off imagery collected without snow on the ground (early spring or late fall) is preferred (Figure 3). A number of studies have found that imagery obtained during leaf-off conditions allow for better identification of wetland boundaries, areas covered by water, drainage patterns, separation of coniferous from deciduous forest, and classification of some understory vegetation (U.S. Environmental Protection Agency 1991). There are distinct advantages to using leaf-off imagery to detect the extent of forested wetlands. Visual evidence of hydrologic conditions, such as saturation, flooding, or ponding combined with collateral data sources, including soil surveys, topographic maps, and historical wetland maps are used to identify and delineate the areal extent of forested wetlands.

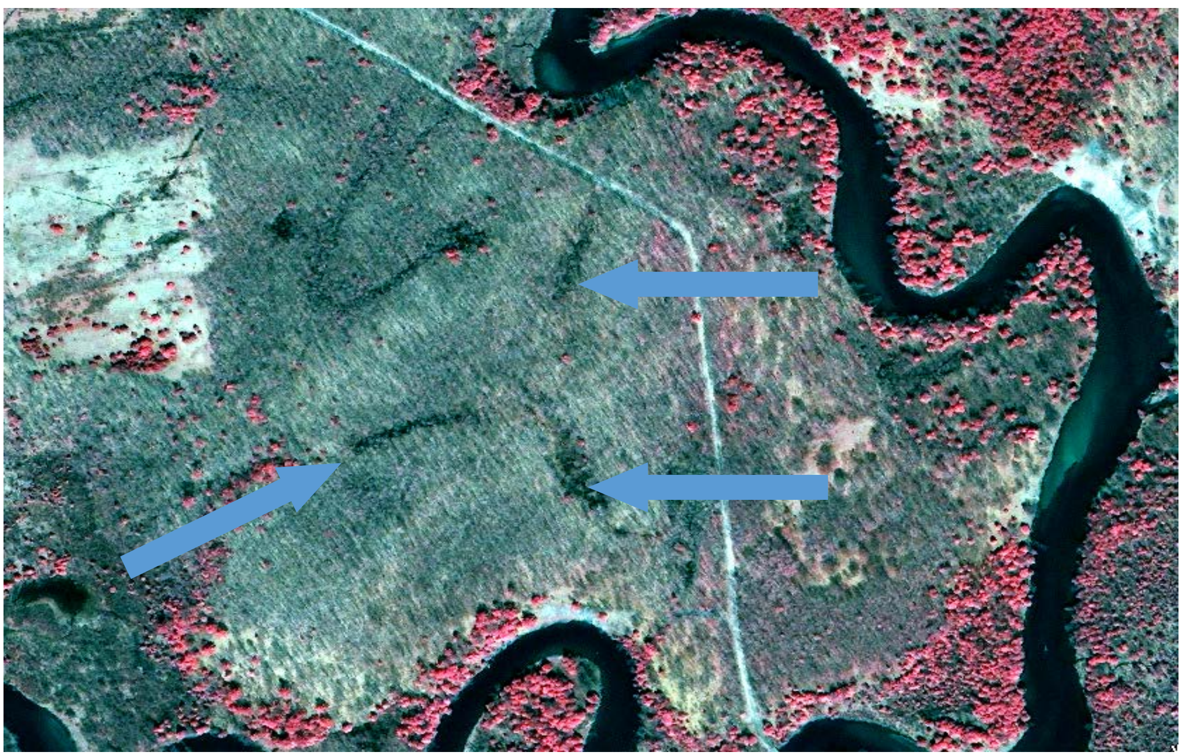


Figure 3 -Early spring 2005 IKONOS satellite image of an area within Michigan. Leaf-off condition makes recognition of wetland features easier. These old oxbows or swales (indicated by blue arrows) can be masked by heavy tree canopy later in the growing season.

VII. Methods of Data Collection and Image Analysis

The mapping of wetlands and deepwater habitats 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 image interpretation. The Service makes no attempt to adapt or apply the products of these techniques to regulatory or legal authorities regarding wetland boundary determinations, jurisdiction, or land ownership, but rather uses the information to assist in making wetland habitat trend estimates. As such, wetland boundaries produced through the techniques described herein are not provided for use in regulatory or legal activities.

Image Interpretation of Wetlands - General Concepts

There are basic image elements that can aid in identification of wetland habitats from aerial or satellite imagery. The image analyst uses these basic elements to make decisions about ecological habitat boundaries. These same elements, listed below, are used in the quality control review of wetland boundaries to check for accuracy and completeness.

> **Tone** (also called Hue or Color) -- Tone refers to the relative brightness or color of elements in an image. 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 an image. The scale will help you determine if an object is a stock pond or large lake.
>
> **Shape** -- Refers to the general morphology 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 in tone within 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 aid analysts in determining the height of objects on aerial imagery; however, they also may obscure objects lying within them.
>
> **Geographic Location** -- This characteristic of imagery is especially important in identifying vegetation types and land forms. For example, large oval depressions are likely to be a type of wetland often called a Carolina bay when viewed in the Coastal Plain of South Carolina.
>
> **Association** -- Some objects are almost always found in association with other objects. The context of an object can provide insight into what it is. For instance, golf courses generally contain open water ponds (wetlands) that are used as water traps.

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

Avery, T.E. 1985. Interpretation of Aerial Photographs 4th edition. Burgess Publishing Co., Minneapolis, MN. 554 p.

Lillesand, T.M., R.W. Kiefer and J. Chapman. 2015. Remote Sensing and Image Interpretation 7th edition. John Wiley and Sons, Inc., New York, NY. 736 p.

W. Philipson (editor) 1996. Manual of Photographic Interpretation (Second edition). American Society for Photogrammetry and Remote Sensing. Bethesda, MD. 600 p.

On-Screen Method. The accepted technique used to interpret and map wetlands for Status and Trends is the on-screen method using digital, rectified imagery. This method involves viewing digital vector map data that overlays digital imagery on a personal computer screen. Changes to the data are made on-screen, checked and saved or exported. The on screen method, as described here, was primarily developed for updating wetland features. It employs geodatabase formats for viewing, editing, and storing the Status and Trends digital data. This greatly improves the administration, access, management, and integration of spatial data. This method has several distinct advantages:

- It uses digital imagery within a GIS interface which allows for faster data computation relative to use of hardcopy imagery.
- Ancillary geospatial data, including topographic information, can be easily referenced to support image interpretation and quality control.
- Automated verification routines can incorporate GIS capability.

There are also several disadvantages associated with this method:

- The process is cursor driven. This requires an ArcGIS literate operator.
- The process relies on the expertise of the image interpreter.

This process relies on the image interpreter's ability to recognize, accurately map and classify wetlands, perform edits and verify the digital data. Attribute domains were created to allow quicker attribution of Status and Trends features using wetland, deepwater, and upland codes. A custom verification toolset was also developed to provide quality control and logic checks of the digital data.

Editing and updating wetland digital data as part of the Status and Trends process implies the following:

- Digital imagery will be used as the base imagery to update wetlands information.
- Existing Status and Trends digital data will overlay and be spatially well aligned with a USGS topographic base map or digital ortho-rectified imagery.
- ArcGIS software will be used in a Windows environment to edit existing Status and Trends digital data.
- The Service's customized geoprocessing models and attribute domains will be used to assist the updating, editing, and data verification processes.

Minimum Hardware and Software Requirements

Desktop Work Stations: The customized Data Verification Toolset is an ESRI model created in ModelBuilder 10.4. To run the tool, the user's workstation must be capable of running the ArcGIS suite, including ArcMap and ArcCatalog. ESRI has published system requirements for ArcGIS on their website: www.esri.com. Workflows using other versions of ArcGIS or ArcPRO do not exist at the time of publication of this document, but may be developed in the future.

Hardware specifications change with technological developments. It is recommended that a high-end GIS workstation and associated computer hardware be used to conduct the Wetland Status and Trends data collection process.

Personnel Qualifications

Using the on-screen method, 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 is done within the digital data file requiring analysts to understand wetland ecology and the Wetlands Status and Trends classification system, as well as be able to operate in a computerized mapping environment. For this reason, image analysts using this method should be experienced with Arc Desktop (10.4 or later versions) software, and have some familiarity with geodatabases and editing spatial data. Image analysts must have an understanding of surface water hydrology and wetland ecology. The analyst 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 analyst must thoroughly understand and be able to accurately apply the Wetlands Status and Trends classification system (Federal Geographic Data Committee 2013) based on the aforementioned conditions.

VIII. Working with the Digital Imagery and Geodatabase Files Provided

Status and Trends plots to be updated are provided to the image analysts via email, ftp, or hard drive. Plots are grouped by state and may include all or a portion of the plots per state. Digital wetlands data are provided in file geodatabase format. These data are in a uniform projection (Albers Equal-Area Conic Projection). The horizontal planar units are meters. The horizontal planar datum is the North American Datum of 1983, also called NAD83. The data provided will include the following information:

1. The 2019 era (T2) digital imagery (all imagery is ortho-rectified)
2. A file geodatabase containing the plot boundaries and digital wetlands data
3. The customized Status and Trends verification toolset
4. Instructions for tool installation and user information
5. Access to field site, field photo, and validation point data templates on ArcGIS Online.

Analysts must review and update (delineate) all wetland, deepwater, and upland features within the plot boundary. ***All work is to be done in ArcGIS 10.4. The verification toolset is designed to work in Arc 10.4.***

Updated plots must be verified through a two part quality review consisting of:

1. Verification of data using the automated quality control tool

2. Plot review by a qualified photo interpreter that did not provide the initial change analysis

When this review is completed the data will be returned to NSST for additional ecological and technical quality control and quality assurance reviews.

Configuring ArcCatalog to connect to NAIP Imagery

The 2019 era (T2) digital imagery will be provided via the services that NAIP creates. To access this imagery:

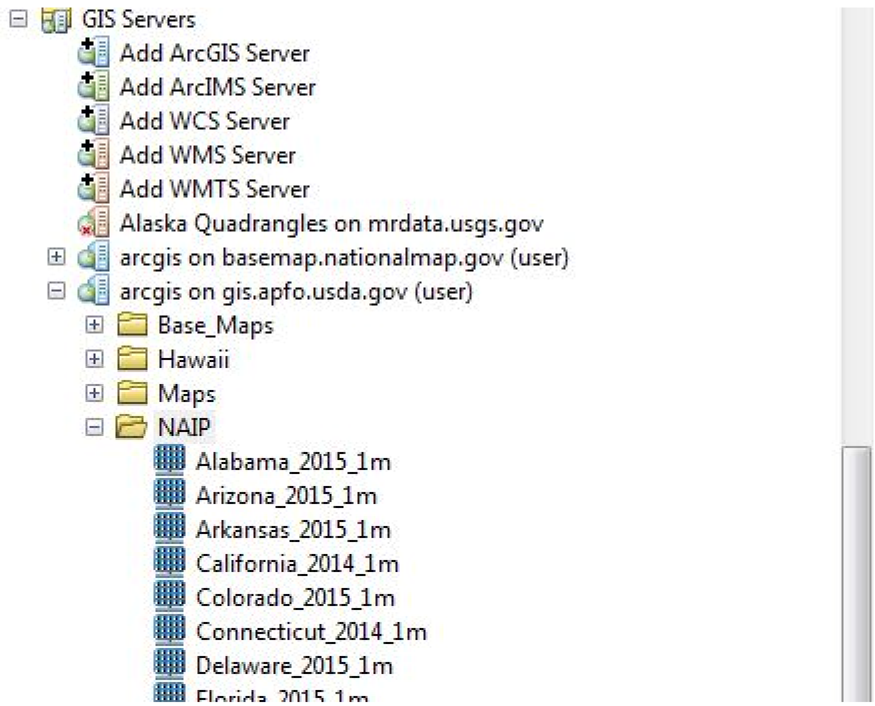
a) Expand the GIS Servers folder in your ArcCatalog table of contents

b) Double-click 'Add ArcGIS Server'

c) Select 'Use GIS services' and click 'Next'

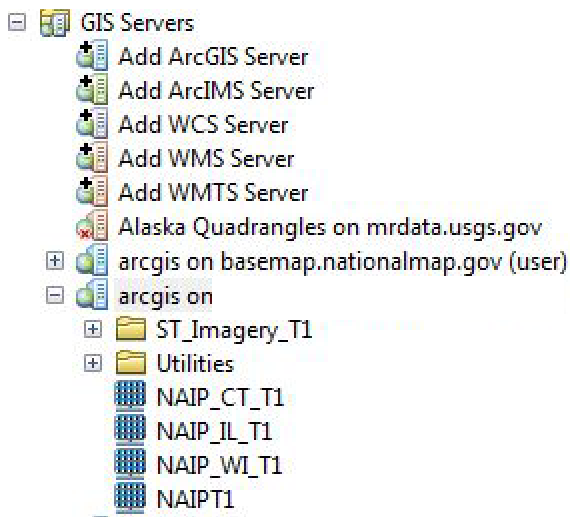
d) Enter the following URL into the top 'Server URL:' text box: https://gis.apfo.usda.gov/arcgis/rest/services

e) Click 'Finish'.



The 2009 era (T1) digital imagery will be provided via image services that NSST has created. The exact address for this imagery will be provided in an email. To access this imagery:

a) Expand the GIS Servers folder in your ArcCatalog table of contents
b) Double-click ‘Add ArcGIS Server’
c) Select ‘Use GIS services’ and click ‘Next’
d) Enter the provided URL into the top ‘Server URL:’ text box.
e) Click ’Finish’.



Acquiring and Incorporating Collateral Digital Data

Minimal data requirements for updating Status and Trends plots include recent digital imagery (T2), plot digital data files (T1), and topographic base maps. Optional collateral data may include digital soils data, hydrography (NHD), coastal navigation chart data, supplemental imagery, previous studies' field reports and photos, and more.

Imagery, USGS topographic maps, NHD hydrography data, soils data, or other collateral data are currently available by accessing ***The National Map*** at: https://nationalmap.gov/index.html. Other collateral data are available through agency web sites including the following:

NRCS soils data at: https://sdmdataaccess.nrcs.usda.gov

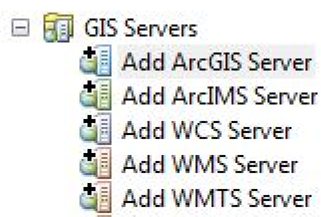
NOAA coastal navigation charts at: http://nauticalcharts.noaa.gov/mcd/enc/index.htm

Viewing Reference DRG's in ArcMap

When reviewing digital plot data it is invaluable to have ancillary imagery, topographic maps and other collateral data to use as additional sources of information. This can be achieved without having the data stored locally, but through the use of ArcGIS Image Services and Web Mapping Services (WMS). Internet access is required along with some simple customization of ArcCatalog to connect to the services, which serve USGS DRGs, DOQQs and Urban Areas Ortho-Imagery.

Configuring ArcCatalog to connect to USGS National Map Server

a) Expand the GIS Servers folder in your ArcCatalog table of contents



b) Double-click 'Add ArcGIS Server'

c) Select 'Use GIS services' and click 'Next'

d) Enter the following URL into the top 'Server URL:' text box: https://basemap.nationalmap.gov/arcgis/services

e) Click 'Finish'.

f) The ArcGIS Server connection is now visible in the table of contents in ArcCatalog. Individual components can be added to an ArcMap session. (Figure 4)

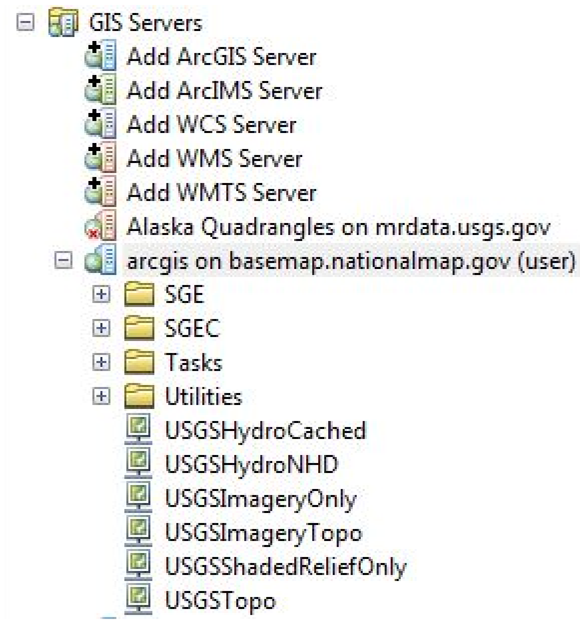


Figure 4 - National map connected as an ArcGIS server shown here in ArcCatalog. Ancillary layers of hydrography, imagery, topography, and shaded relief are visible.

Configuring ArcCatalog to connect to ESRI ArcGIS Online

a) Expand the GIS Servers folder in your ArcCatalog table of contents

b) Double-click 'Add ArcGIS Server'

c) Select 'Use GIS services' and click 'Next'

d) Enter the following URL into the top 'Server URL:' text box: http://server.arcgisonline.com/ArcGIS/rest/services/USA_Topo_Maps/MapServer

e) Click 'Finish'.

The ArcGIS Server connection is now visible in the table of contents in ArcCatalog. Individual components can be added to an ArcMap session. USA_Topo_Maps are seamless, scanned images of USGS topographic maps.

Viewing Imagery through DigitalGlobe's EnhancedView

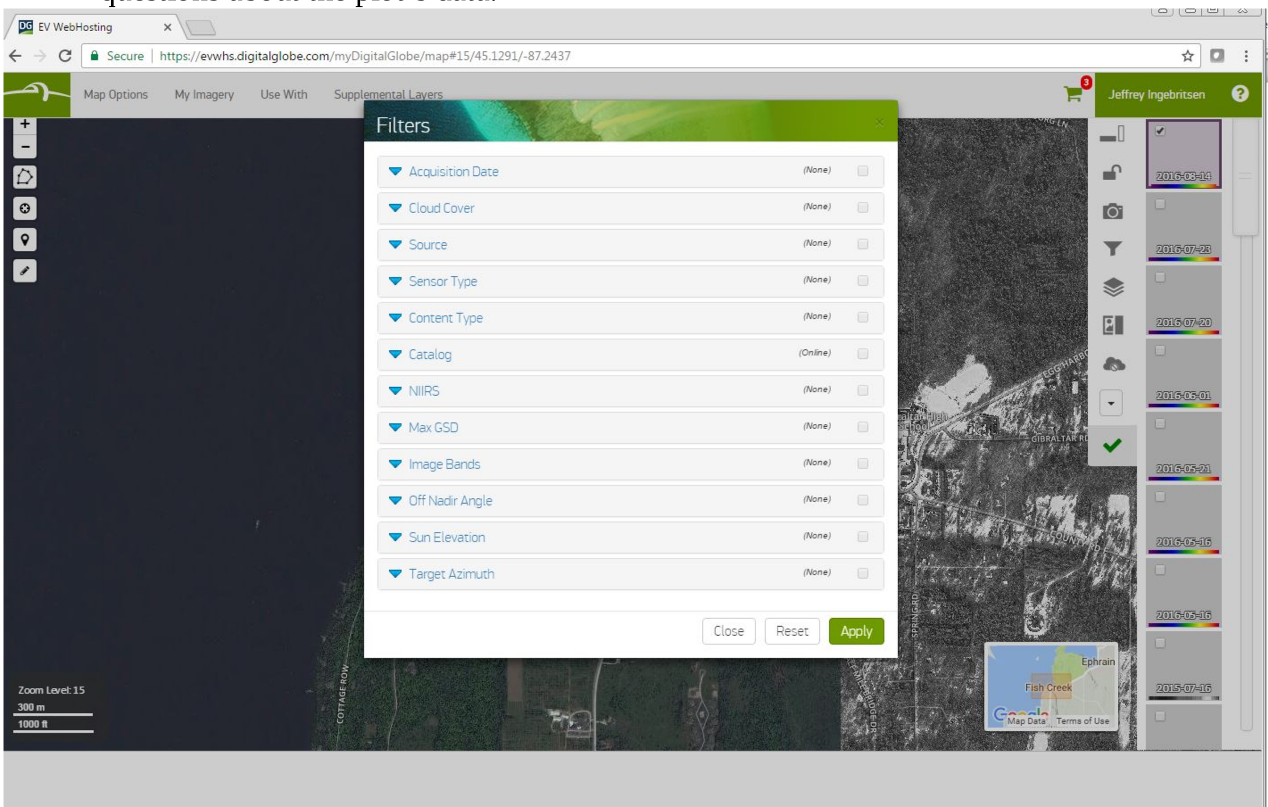
Digital Globe's EnhancedView is an alternate source of ancillary imagery. There are many user guides and instructions for using the EnhancedView resource at evwhs.digitalglobe.com. Once you have gotten an account approved, the imagery can be viewed through two different methods:

Browser-based access:

a) Direct your web browser to evwhs.digitalglobe.com.

b) Log in and zoom to your area of interest.

c) Using the web interfaces, select and view any imagery that may help answer specific questions about the plot's data.

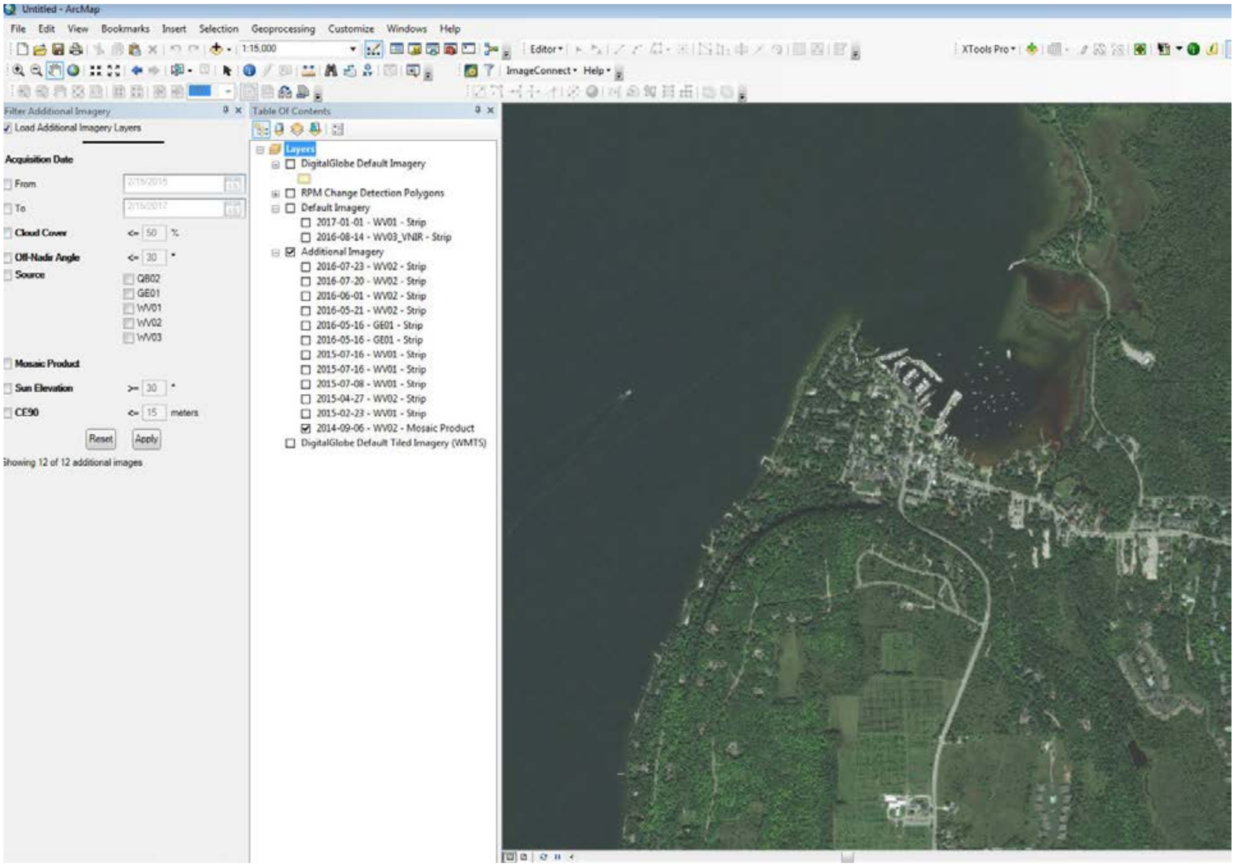


ArcMap ImageConnect Plugin:

a) Follow the instructions at evwhs.digitalglobe.com to download and install the ImageConnect plugin for ArcMap.

b) Log in and zoom to your area of interest.

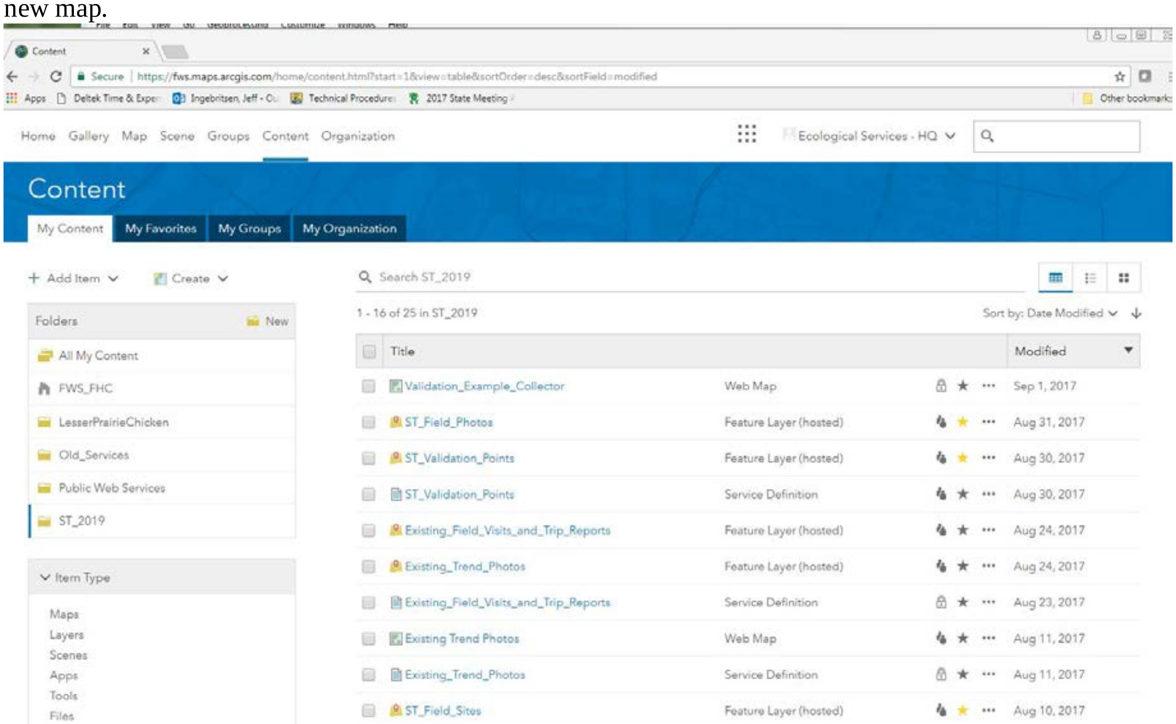
c) Using the Table of Contents and the ImageConnect filter window, select and view any imagery that may help answer specific questions about the plot's data.



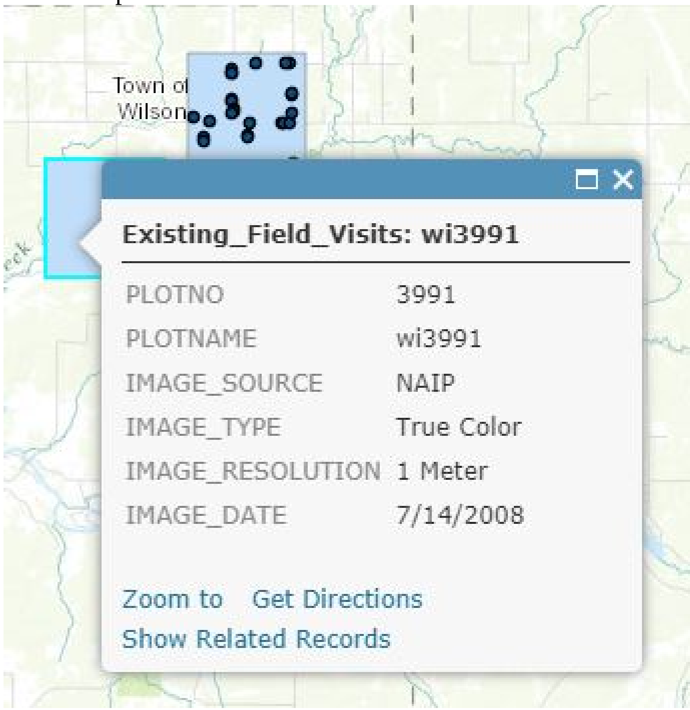
Viewing Previous Studies' Field Trip Data

Field Visits, Trip Reports, and Photographs from previous Status and Trends Studies are available to view through ArcGIS Online.

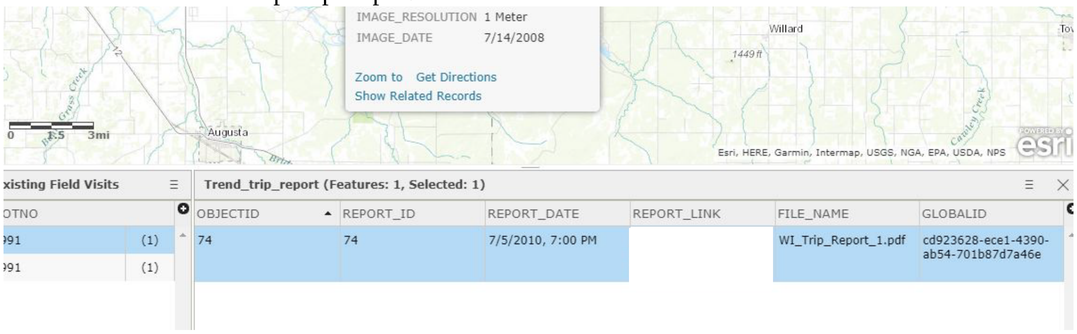
a) In ArcGIS Online, add the Existing_Field_Visits_and_Trip_Reports and Existing_Trend_Photos layers to a new map.



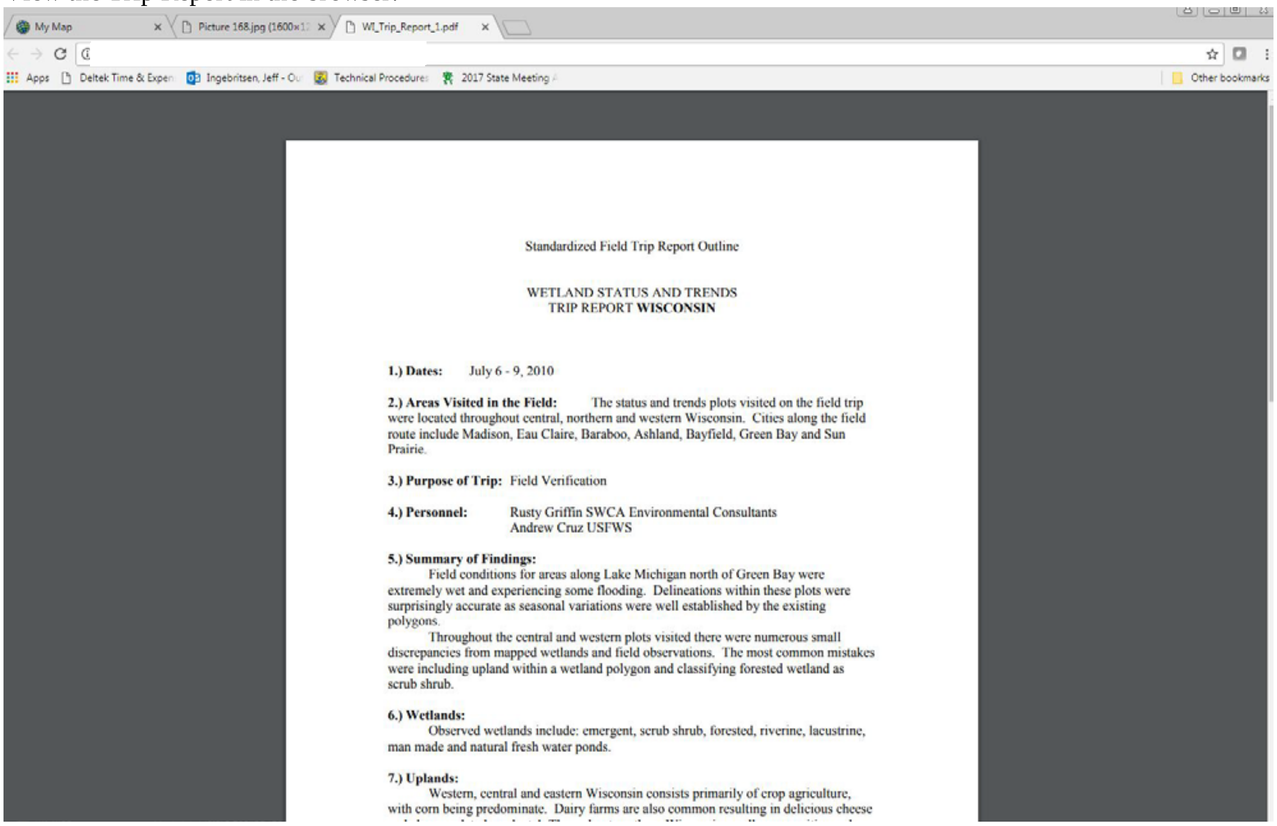
b) Select the plot of interest and select 'Show Related Records'.



c) Follow the link to the Trip Report pdf.



d) View the Trip Report in the browser.



Standardized Field Trip Report Outline

WETLAND STATUS AND TRENDS
TRIP REPORT **WISCONSIN**

1.) Dates: July 6 - 9, 2010

2.) Areas Visited in the Field: The status and trends plots visited on the field trip were located throughout central, northern and western Wisconsin. Cities along the field route include Madison, Eau Claire, Baraboo, Ashland, Bayfield, Green Bay and Sun Prairie.

3.) Purpose of Trip: Field Verification

4.) Personnel: Rusty Griffin SWCA Environmental Consultants
Andrew Cruz USFWS

5.) Summary of Findings:
Field conditions for areas along Lake Michigan north of Green Bay were extremely wet and experiencing some flooding. Delineations within these plots were surprisingly accurate as seasonal variations were well established by the existing polygons.

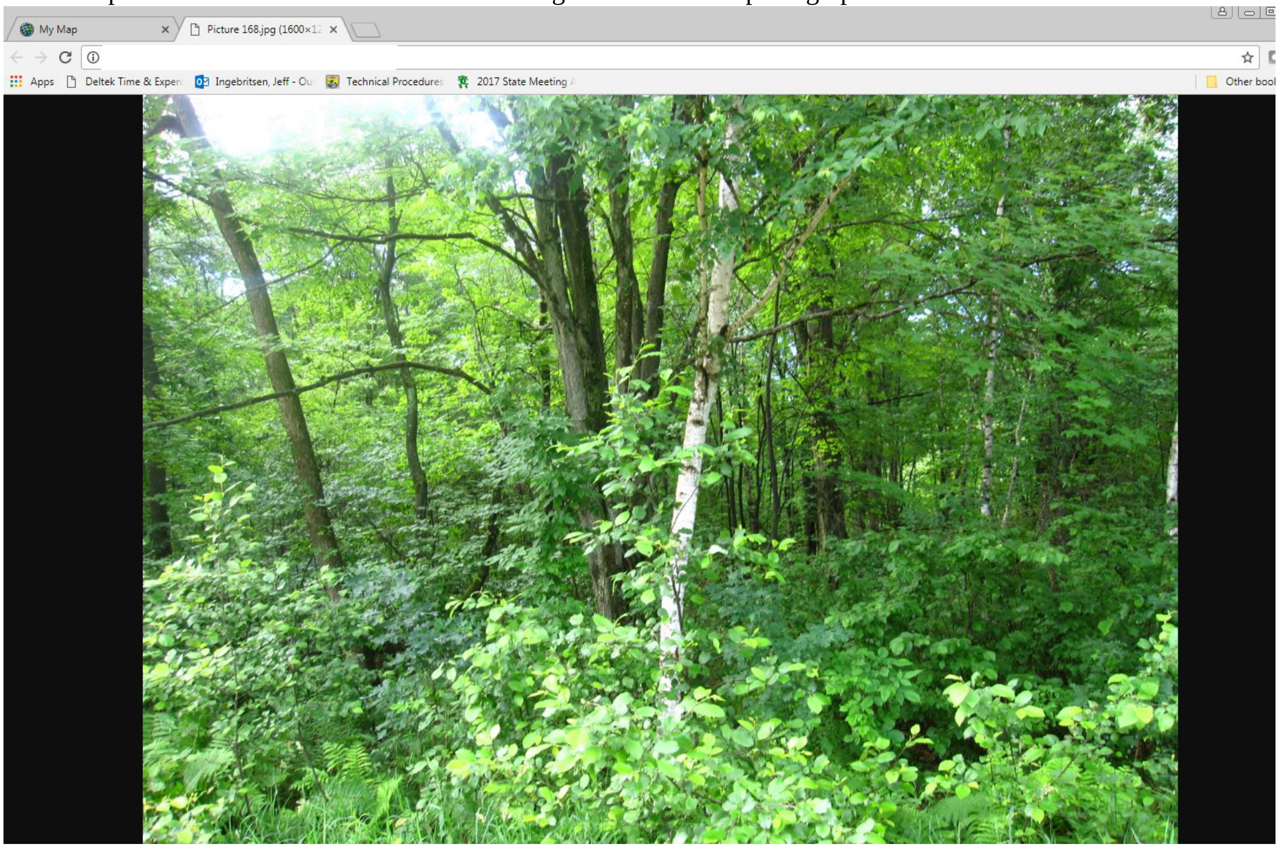
Throughout the central and western plots visited there were numerous small discrepancies from mapped wetlands and field observations. The most common mistakes were including upland within a wetland polygon and classifying forested wetland as scrub shrub.

6.) Wetlands:
Observed wetlands include: emergent, scrub shrub, forested, riverine, lacustrine, man made and natural fresh water ponds.

7.) Uplands:
Western, central and eastern Wisconsin consists primarily of crop agriculture, with corn being predominate. Dairy farms are also common resulting in delicious cheese

e) To view photos, select an Existing Trend Photo point.

f) Click the photo within ArcGIS Online to view a larger version of the photograph in the browser.



IX. Collection of Status and Trends Plot Data

The Service identifies wetlands and deepwater habitats primarily through the analysis of fine spatial resolution satellite and aerial images. Wetlands are identified based on a number of characteristics, including vegetation, visible hydrology, and geography. There is a margin of error inherent in the use of imagery; thus detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis. The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of field verification work conducted. General delineation and classification guidelines are as follows:

- Wetlands, deepwater and upland habitats will be labeled using the letter and number code (alphanumeric) that corresponds with attribute codes and classification descriptors in Table 1.
- Classification of each delineated unit shall include the appropriate system, subsystem, and class.
- Split-class attributes are not allowed and no point nor linear features are included in the Status and Trends data set. Features that are too small to be delineated as polygons will not be included. However, based on existing data, features as small as 0.1 acre have been included as polygons in the database and are tracked as part of this study.
- 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.).
- Imagery in combination with field reconnaissance will prevail as the principle data source for monitoring change. Changes which have taken place since T2 image capture (wetland gains or losses) should not be included as part of the mapping effort (Figure 5 and Figure 6).
- Maximum vegetative summer growth in an average year and at the average low water level shall be the basis for assigning the classification code.

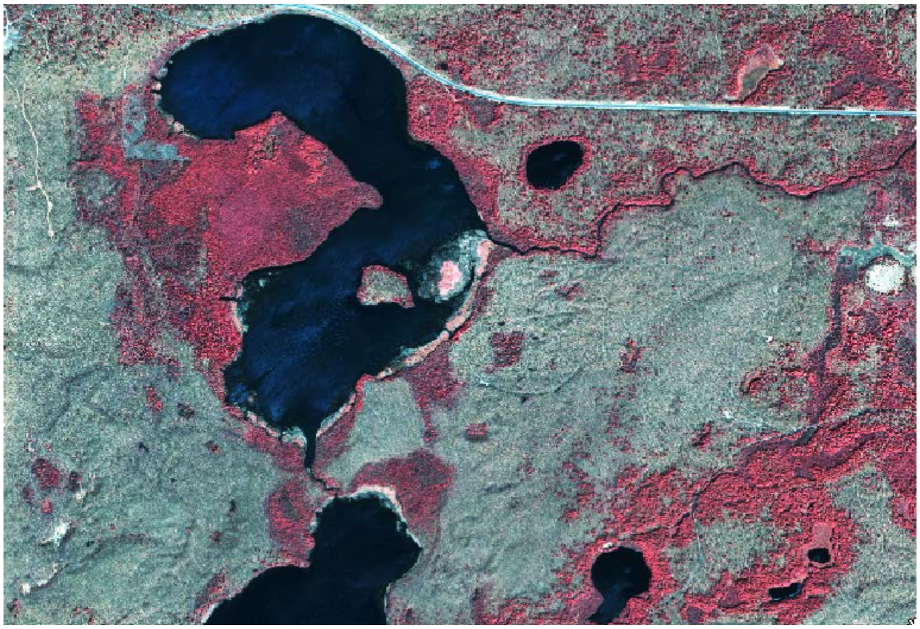


Figure 5 - Fine resolution imagery is the principle data source for determining wetland change. This example shows a false color infrared ≤1 m resolution satellite image [Ikonos, 2005].

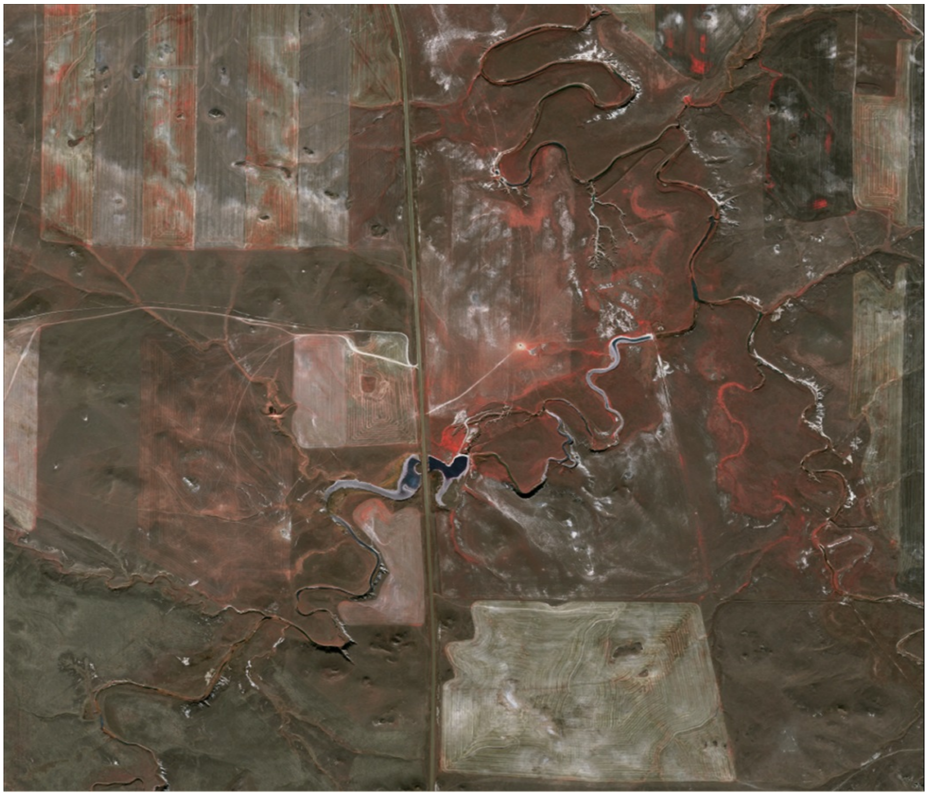


Figure 6 - Fine resolution imagery is the principle data source for determining wetland change. This example shows a false color infrared ≤1 meter resolution satellite image [GeoEye, 2008].

X. Image Analysis Specifications and Guidelines

Wetlands Status and Trends employs remote sensing techniques to locate, identify, and classify wetland and deepwater habitats, and upland land use. Currently, a combination of digital high altitude photography and fine spatial resolution satellite imagery is used. Image analysis to identify and map wetland and deepwater habitats, and upland land use 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 initial image interpretation process.

Minimum Delineation Unit for Wetlands

The targeted mapping unit for wetlands identified is one acre (0.40 ha). Results of past Status and Trends studies indicate the actual minimum feature size to be about 0.1 acre (0.04 ha); however not all features less than the target size were detected (Figure 7). Small wetlands less than the minimum target size should be included when detected. The minimum size for wetland delineations should not be defined using sample plot boundaries, but by the total size of the feature regardless of the acreage within the Status and Trends sample plot area. All features delineated must be polygons.

There is no minimum unit applicable to wetland change delineation provided it can be identified and classified accurately within the working scales of the project (~1:5,000 maximum).

Figure 7 - This wetland is a fraction of an acre, but is apparent on the source imagery. Small wetlands less than the minimum target size should be included when detected.

Level of Accuracy for Wetland Classification

Minimal classification accuracy is 95 % when all quality assurance measures have been completed. This level of accuracy can be reached through a combination of automated and non-automated digital QA/QC and field reconnaissance. Wetlands Status and Trends requires accurate delineation and classification to the "Class" level as described by Cowardin *et al*. (Federal Geographic Data Committee 2013).

Minimum Delineation Unit for Uplands

Wetland Status and Trends uses a modified version of the Anderson, *et al.* (1976) upland land use categories. The minimum delineation unit for identifying uplands is five acres (2 ha). In some instances it may be important to delineate smaller units (e.g., small upland islands created in waterways), but areas smaller than five acres of one upland land use type surrounded by another upland land use type should not be delineated. The minimum mapping size for upland delineations should not be defined using sample plot boundaries, but by the total size of the feature regardless of the acreage within the Status and Trends sample plot area.

Level of Accuracy for Upland Classification

Minimal classification accuracy shall be 95 %. Additionally, the following guidelines apply:

- Roads within urbanized settings should be classified as upland-urban.
- Major (4-lane or greater) highways in rural areas should be classified as upland-rural development. Smaller roads in rural settings should not be delineated.
- Narrow (less than two or three crown widths) lines of trees (e.g., shelterbelts) should not be delineated. These should be classified with the surrounding upland land use.

Edge Matching Adjacent Sample Plots

Adjacent plots should be identified and where possible, these sample plots should be interpreted together through the change analysis phase. Features that cross plot boundaries should be interpreted as one unit, edge matched, but not merged. The image analyst is required to take steps to ensure accurate feature edge-matching of all finalized interpretation.

Collateral Data as an Aid to Image Analysis

The analyst is required to use all available and approved imagery, topographic maps, soils information, or any other available and beneficial sources of collateral data during image interpretation. Review of these materials is helpful in interpreting aerial photographs or satellite images. Sources of collateral data may include the following:

U.S. Geological Survey (USGS) Topographic Maps: Areas indicated on USGS 1:24,000 scale topographic maps by swamp symbology should be closely inspected on the source imagery. These features are often an excellent indicator of wetlands and unless strong evidence indicates otherwise, should be included as wetlands within plot boundaries. Due to the nature of USGS topographic mapping, wetlands marked on USGS quadrangles tend to be at least seasonally flooded (U.S. Geological Survey 2001). All permanent water bodies are also mapped by USGS and can be accessed through the National Hydrography Dataset.

USGS maps also provide excellent information regarding slope, land use, and some cultural features. Close attention should be paid to the topographic contour lines on the USGS maps. Many interpretation errors can be avoided if the degree of slope is taken into consideration. The location, shape, drainage pattern, and surrounding physical and cultural features are all important clues when delineating wetlands.

Natural Resource Conservation Service County Soil Surveys or Digital Soils Information: Soil survey maps are useful collateral data, providing the description, classification, and mapping of soils within a county. Soil maps are a representation of various soil patterns within a landscape. The complexity of the soil patterns, scale of the base photography, field techniques employed, date compiled, and the minimum mapping unit for soil classification all play a role in how the soils information was produced and their utility as collateral data for mapping wetlands. When used by an experienced image analyst as collateral data, soils maps are useful in assisting in separating upland from wetland (hydric) soils.

The soil survey geographic (SSURGO) data base duplicates the original soil survey maps and presents them in digital form. SSURGO data represent the most detailed level of digital soil information.

National Oceanic and Atmospheric Administration (NOAA) Navigational Charts: A NOAA navigational, or nautical chart, is a graphic representation of the estuarine, marine, and near shore environment. They are primarily used to plot routes for sea-going vessels. All nautical charts depict coastline features, configuration of the sea bottom, tidal ranges, location of man-made and natural hazards to navigation, and the properties of the Earth's magnetism. Nautical charts are especially useful in determining the subtidal and intertidal subsystem breaks in the marine and estuarine wetland classification systems. They are also useful in determining the location and extent of mangroves, coastal shoals, flats, or bars.

National Wetlands Inventory (NWI) Data and Ancillary Project Information: The analyst will use current NWI data as collateral information to determine the location and extent of wetlands based on an earlier time period. Using NWI wetland data will provide important information on the presence or absence of wetlands. This information is useful to the analyst using more current imagery, or imagery of a different scale or emulsion.

Local or Regional Studies or Maps: The analyst is also encouraged to consult appropriate internal and external resources (regional experts, on-site resource managers, etc.) to assist in the interpretation process. Examples of this type of information include: Water management or district maps, vegetation maps or surveys, and local habitat studies or characterizations. The Service's Regional Wetland Coordinators, state agencies, or regional authorities are often good sources for such information. The interpretation and delineation of wetlands and deepwater habitats is expected to meet the Service's standards for accuracy and consistency. Communication and problem resolution procedures to ensure product acceptance should be maintained throughout the project.

XI. Plot Editing Guidelines

The following guidelines have been established to further ensure that project objectives are met:

Scale - The Service's Wetlands Status and Trends plots are most accurately viewed at a scale of 1:12,000. Over-delineation of features is possible given the quality of some of the digital imagery being used. This should be avoided to realize project efficiencies, and has led to establishing specific project scale thresholds.

> **Edit scale –** This scale ranges between 1:7,000 and 1:10,000. This is the scale in which most edits and quality control reviews should be performed.

Maximum zoom - This is the maximum magnification an analyst should use for wetland mapping and classification purposes. This scale is established at 1:5,000. Delineations performed below this maximum zoom threshold greatly exceed the project's desired scale, and may misrepresent the data as being more precise than can be supported by the techniques and objectives established by the Service. Delineations performed at scales finer (more detailed) than this threshold lead to project inefficiencies.

Analyst corrections - Corrections to the existing digital data should be made to fix past mistakes. Corrections include such things as missed wetlands, areas incorrectly delineated as wetland, repositioning, or rectification of old line work, and corrections to the wetland or upland classification. Status and Trends does not generate maps for public distribution. For this reason ***the exact geo-position of polygons or line work is of secondary importance to proper identification and accurate delineation of the wetland feature to ensure accurate estimation of area*** (Figure 8).

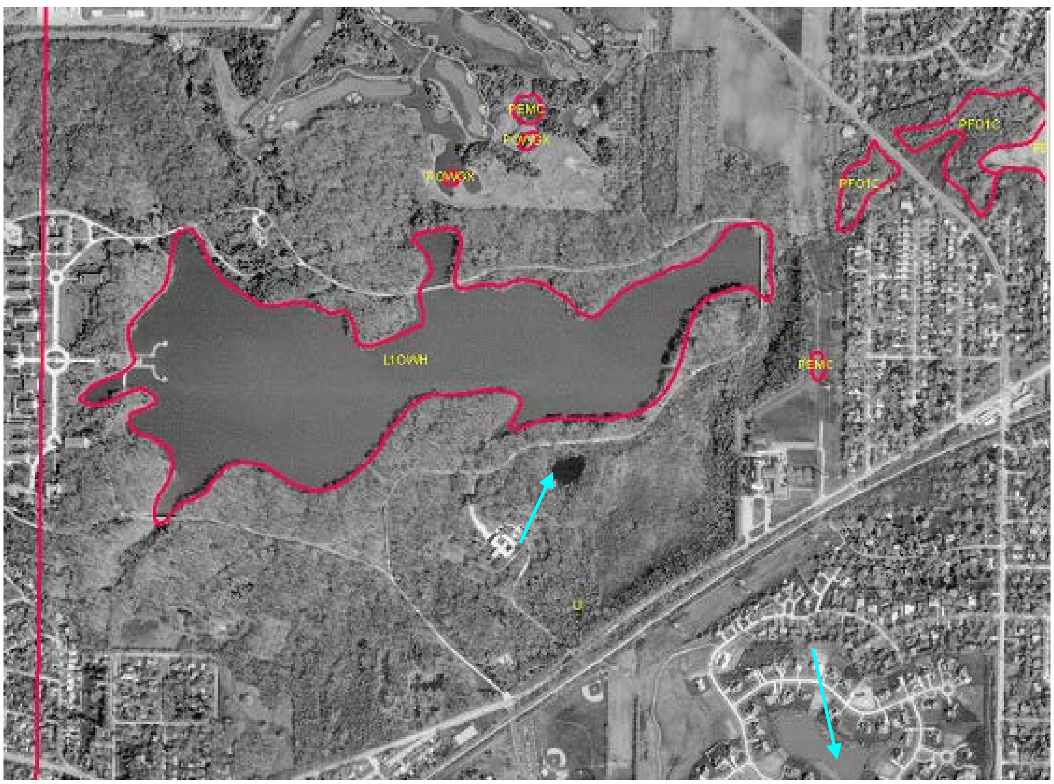


Figure 8 - In this example, some of the line work around the lake does not fit the basin exactly. However, the size, shape, general location, and classification of the lake have not changed over time. There has been no visible ecological change since the last update. In this instance, image analysts shall add the new ponds that have been created (blue arrows) rather than adjust the lake boundary to be more precise.

Change Detection

Change detection and analysis involves identifying wetland gains and/or losses, cover type changes as well as upland land use changes. To determine changes between eras the analyst is required to compare the existing plot information from the past era to more recent imagery of the same area (Figure 10). All changes should represent realistic and logical analysis, avoiding any false or unlikely changes. An example of an unlikely change might involve upland urban (UB) being converted to palustrine forested wetland (PFO) over the course of a ten year time span. This type of change will be carefully scrutinized and verified, if possible, by field examination or collateral data.

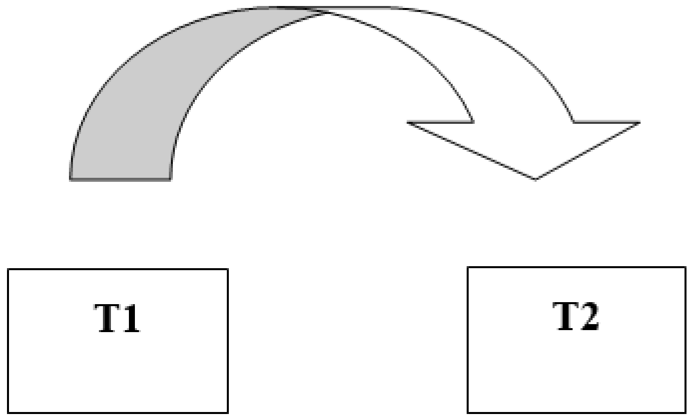


Figure 9- Change detection involves a comparison of two different eras (T1 and T2) over time.

Analyst updates or changes - to the wetland delineations are based on actual change over time. Updates include the 'deletion' of lost wetlands (Figure 10), addition of new wetlands, reshaping of wetland boundaries based on changes that have occurred over time, and re-classification of wetlands that have changed cover-type. Changes in upland land use that have occurred over time are not made unless it involves a wetland feature change. Thus while upland land use classification is updated when a wetland changes to an upland or vice versa, upland land use classification is not updated when the type of upland land cover changes (i.e., agriculture to urban).

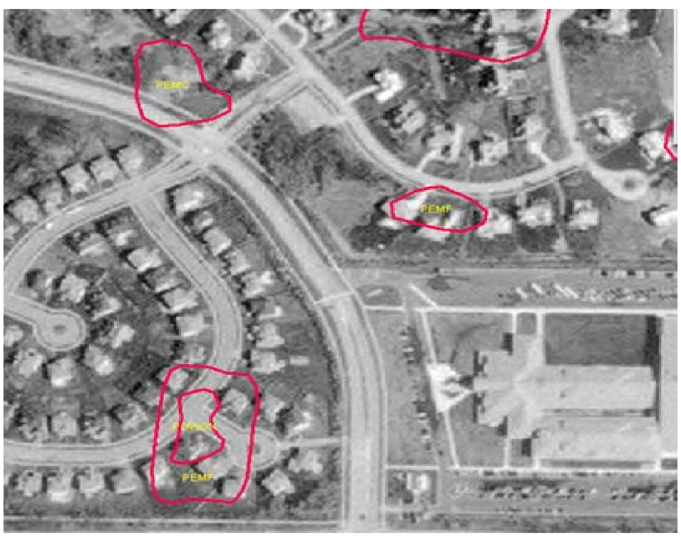


Figure 10-Some changes are obvious on the imagery. In this example, historical wetlands indicated by red polygons have been lost to urban development.

The goals of updating Wetlands Status and Trends plots are to produce data that match existing on the ground wetland and deepwater conditions as represented by the imagery, and to use resources efficiently and cost effectively. Extraneous effort to "over map" or make previously mapped features conform to criteria greatly exceeding the project objectives should be avoided (U.S. Geological Survey 2001). Editing shall conform to the principles listed below:

1. The resulting data set must support clear, unambiguous interpretation and readability of the wetland features that conform to the project's objectives.
2. The classification accuracy of the mapped features must meet current standards (Federal Geographic Data Committee 2013), and the plot data overall must represent the scientific precision that underlies the Service's habitat monitoring objectives.
3. Wetlands Status and Trends plots should reflect ecological change or changes in land use that influence the size, distribution, or classification of wetland habitats. Enhancements to refine cartographic precision should be undertaken only to the extent they bring products into conformance with the project objectives and quality requirements.

Wetland and deepwater feature delineation and attribution provide the distinguishing characteristics needed to differentiate between features that have some ecological distinction or uniqueness relevant to the Status and Trends effort. The decision to retain or change the existing map features or attributes is based on several factors considered to be revision guidelines.

Plot Revision Guidelines:

Retain all lakes, ponds, rivers, bays, sounds, estuaries, perennial streams (polygons), and other water bodies regardless of size, unless a feature has obviously changed or no longer exists.

Revise coastal shorelines only if there are obvious manmade changes or substantial (1 acre or larger) natural changes. The length of change area parallel to the coast should be considered when determining whether or not shoreline changes are substantial. Changes that persist over a greater length are more substantial than changes that occur over a more limited distance. Tide stages do not reflect ecological change in shoreline delineations. However, if change is determined to be notable (e.g., EM to UB) and not just due to tidal influence it should be captured.

Revise existing wetland and deepwater habitat delineations and attributes only where imagery indicates a change or there is positive visual evidence of a change.

Do not revise classifications based on apparent draw down or temporary drought conditions.

Do not revise bathymetric information unless new information is available or where shorelines have obviously been modified.

Revise classification of vegetative surface cover only when one of the following minimum change criteria is met:

- The total area of the feature to be re-delineated or re-classified is greater than 1.0 acre.
- The hierarchy of the re-classification is Cowardin class level or higher.

Avoid False Precision and Misrepresentation of Data

Technological advances in the acquisition of remotely sensed imagery and computerized mapping techniques often provide the ability to capture more detailed information about Earth objects. The use of such technologies can be a tremendous advantage in terms of producing better quality natural resource information in a more timely fashion and often at a reduced cost. However, appropriate use of these capabilities requires specific knowledge of project objectives, limitations, and the proper application of the end products.

When mapping wetlands and deepwater habitats, image analysts will address the following criteria in priority order:

1. Mapping of wetland and deepwater habitats to closely resemble size and shape.
2. Appropriate classification to the Cowardin class level.
3. Approximation of geographical position within 10 m as determined by the imagery.
4. Revisions to reflect more precise geographical location or boundary determination as can be determined by the imagery.

Unrealistic attempts to characterize habitats in greater detail should be avoided unless specifically instructed by the Service Project Manager. Detail beyond project requirements should not be confused with quality.

Within a wetland boundary, the delineation of ecologically unsubstantiated internal breaks should be avoided. Intricate sub-delineation of cover-type changes (less than 0.5 acre) within a wetland is often not warranted. In areas of undulating terrain (i.e., ridge and swale) or complexes of wetland classes (i.e., small shrub islands within emergent meadow), it is best to identify and characterize the wetland by a single classification rather than attempt to delineate and classify internal features.

If wetland sub-units are too small in area based on the minimum delineation unit to allow separate delineation of each cover type, the polygon should be classified to represent the cover type encompassing the greatest acreage (Figure 11). Polygons that may contain a mosaic of cover types or ecosystem components and cannot be delineated separately will be classified using the dominant component (Figures 11 and 12).

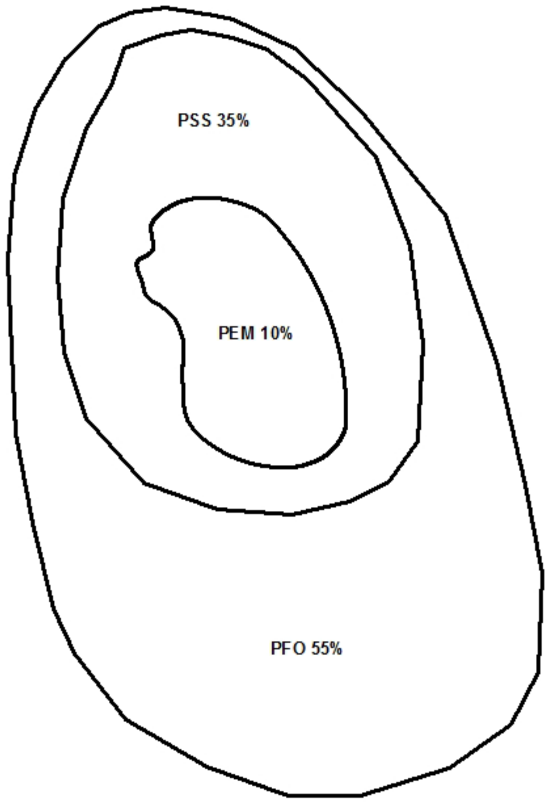


Figure 11 - In this example, a wetland with a total area less than one acre is correctly classified as PFO.

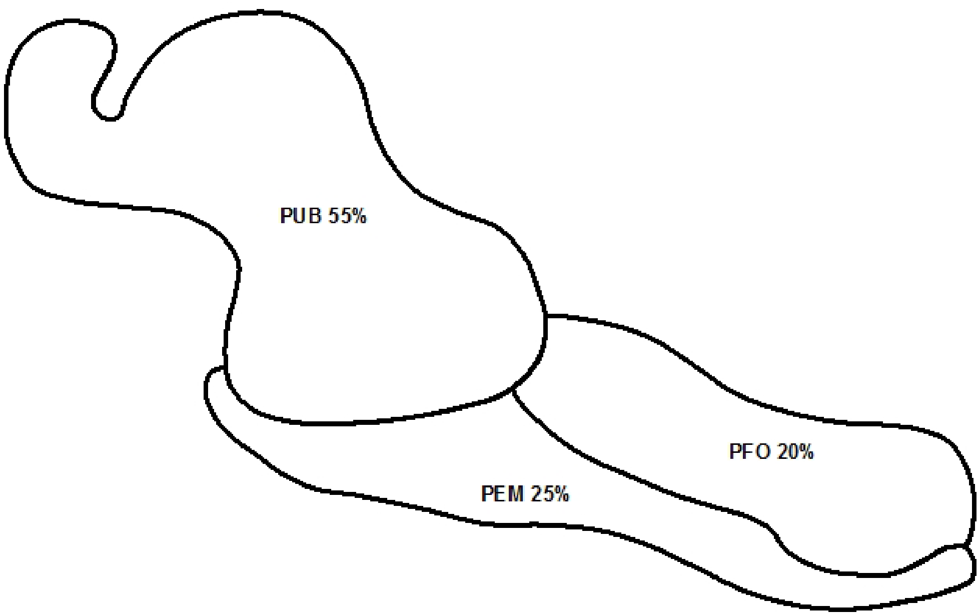


Figure 12 - If a mosaic of cover types cannot be separated, the area should be classified using the dominant component. This wetland complex is correctly classified as PUB.

False Change

False changes are areas where the image analyst is fooled by the appearance of change to the wetland or upland. Common examples of false changes include:

- Palustrine farmed wetlands during dry cycles
- Temporary water draw down
- Drought conditions
- Excess surface water or ephemeral water
- Flooding
- Forested areas harvested without impacting hydrology (this may result in wetland type change but not wetland loss)

Avoid making false changes to the data. In general, false changes can be avoided by observing ***positive visual evidence of a change in land use***. This may include the presence of new drainage ditches (Figure 13, Figure 14, and Figure 15), canals, or other man-made water courses, evidence of dredging, spoil deposition or fills, impoundments or excavations, structures, or pavement or hardened surfaces.

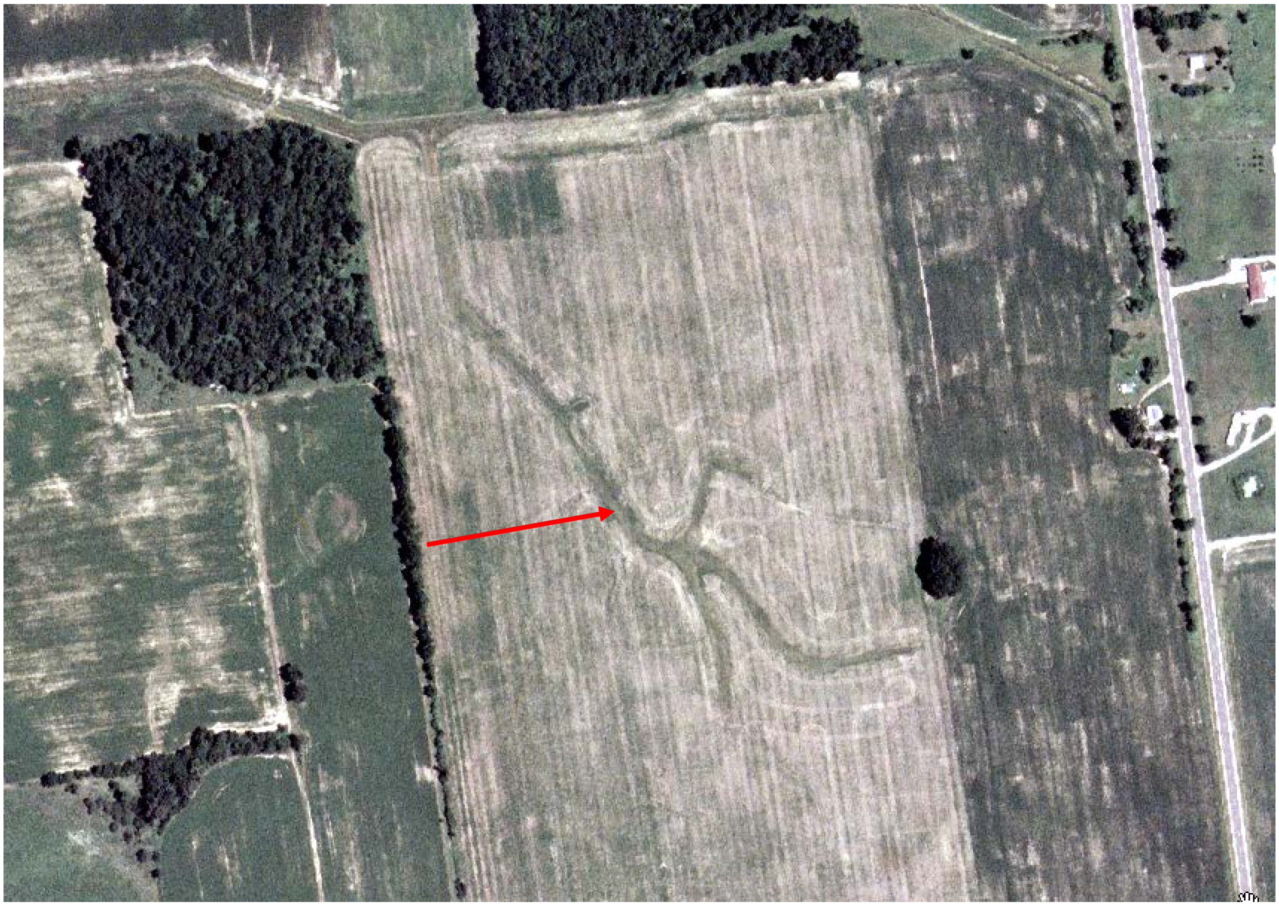


Figure 13 - A true color aerial photograph shows a new drainage network (indicated by red arrow) and provides visual evidence of wetland loss. Lack of wetland vegetation, surface water, or soil saturation further indicates that this wetland had been effectively drained.

Figure 14 - Positive visual evidence of change includes drainage ditches, like the one in this photograph.

Figure 15 - The basin outlined in this photograph has been effectively drained by subsurface tile. The tile head is indicated by the red pointer

Descriptive Categories for Open Water Ponds

The Service's Wetlands Status and Trends Study is a scientific approach to monitor the Nation's wetlands using a consistent, biological definition. Cowardin *et al.* (1979) recognized ponds as an important component of the aquatic ecosystem, and included them within a larger system of freshwater wetlands. The Service has included open water ponds in every Wetland Status and Trends report.

Water features excluded from the Status and Trends study as non-wetland include the following:

- Stock watering tanks
- Swimming pools
- Industrial waste pits
- Stormwater drains (non-retention features)
- Garden ponds or fountains (koi ponds)
- Water treatment facilities
- Municipal or industrial water storage tanks
- Sewage treatment facilities (other than wetlands)
- Water cooling towers or tanks
- Road culverts or ditches
- Other "ephemeral" waters

Because of the proliferation of created open water ponds in recent years, the Service in conjunction with the Environmental Protection Agency has added additional descriptive categories for open water pond areas. The goal is to provide users of Status and Trends data additional information about what types and how many ponds are being created over time.

Subdivision of the pond category (palustrine unconsolidated bottom) considered the statistical design and sampling integrity of the Wetlands Status and Trends study. Sub-categorization of ponds will allow re-aggregation of data to the original classification unit (all ponds). Additionally, the descriptive categories for ponds can be reliably determined using remotely sensed data. There are five descriptive categories of freshwater open water ponds that have been developed. These are listed below along with a brief description of characteristics and remote sensing indicators that may be used to identify and classify these areas.

Freshwater Pond Categories: Descriptive Types

1) ***Ponds with natural features or characteristics*** as indicated by lack of human modification or development. These may include naturally occurring ponds, bog lakes, vernal pools, potholes, kettles, beaver ponds, alligator holes, muskrat "eat outs," etc.

2) ***Ponds used for industrial purposes,*** such as mine reclamation sites, excavated pits or mine drainage ponds, highway borrow pits (Figure 16), sewage lagoons, and industrial wastewater holding ponds.

3) ***Urban ponds*** used for aesthetics or recreational purposes, such as golf course ponds, small (<20 acre) residential lakes, ornamental water bodies, and water retention basins (Figure 17).

Figure 16 - Borrow pits (indicated by the blue arrows) found in association with a highway interchange. The shape and proximity of these ponds to the highway interchange provide good indicators for descriptive categorization.

Figure 17 - Numerous ponds and small residential lakes (red arrows), including golf course ponds (blue arrows) have been created in this suburban development.

4) ***Ponds found in conjunction to agricultural, farming or silvicultural operations,*** such as farm ponds, dug outs for livestock, agricultural waste ponds, irrigation or drainage retention ponds.

5) ***Aquaculture ponds*** occur singly or in series (Figure 18) and are used for aquaculture (fish rearing.)

Figure 18 - A false color infrared aerial photograph of artificially created ponds used for catfish farming (blue rectangles). Ponds in series often provide indicators of aquaculture.

Lands with Special Characteristics

Palustrine Farmed Wetland (Pf): Farmed wetlands are wetlands that meet the Cowardin *et al*. (Federal Geographic Data Committee 2013) definition where the soil surface has been mechanically or physically altered for production of crops, but hydrophytes will become re-established if farming is discontinued.

Status and Trends plots will include all types of farmed wetlands. Typically these include, farmed prairie pothole type depressions, farmed playa lakes and diked former tidelands in California. Other examples of farmed wetlands that should be included: cranberry bogs, rice fields, farmed alluvial depressions, farmed floodplain wetlands, and some types of flooded cultivated grassland (Figure 19 and Figure 20.)

Figure 19 - An example of a farmed floodplain. The wet swale areas in this photograph are still considered wetland because they are not artificially drained.

Figure 20 - A farmed wetland occupies this depression.

Transitional Lands: Transitional areas include those lands that are changing from one land use to another. They generally occur in larger acreage blocks of 40 acres or more. They are characterized by the lack of any image based information which would enable the interpreter to reliably predict future use (Figure 21). This transitional phase occurs when wetlands have been drained, ditched, filled, leveled, or the vegetation has been removed and the area is temporarily bare. Agricultural lands may be differentiated by surrounding land use, patterned system of irrigation or access roads, etc. Forested Plantations may appear more irregularly shaped with fewer access points. If surrounding land use patterns do not give any indication to the likely future use of the transition area, and the area is determined to be upland, the category Upland Other should be applied.

Figure 21 - Lands in transition from one land use to another are characterized by the lack of any remotely sensed information that can reliably determine their future use.

Figure 22 - An example of the "other upland" category as one of five generalized categories of uplands used in the Wetlands Status and Trends study.

Upland Forested Plantation: Upland forested plantations include, but are not limited to, upland pine plantations, such as those found in the Southeastern United States (Figure 23) and upland hardwood plantations as found in selected areas (i.e., Arkansas). Forested plantations, which include both uplands and wetlands, can be identified by remotely sensed indicators, including:

1) Trees planted in rows or blocks

2) Forested blocks growing with uniform crown heights

3) Image patterns that indicate logging activity and use, including access roads or trails, and loading and skidding pads.

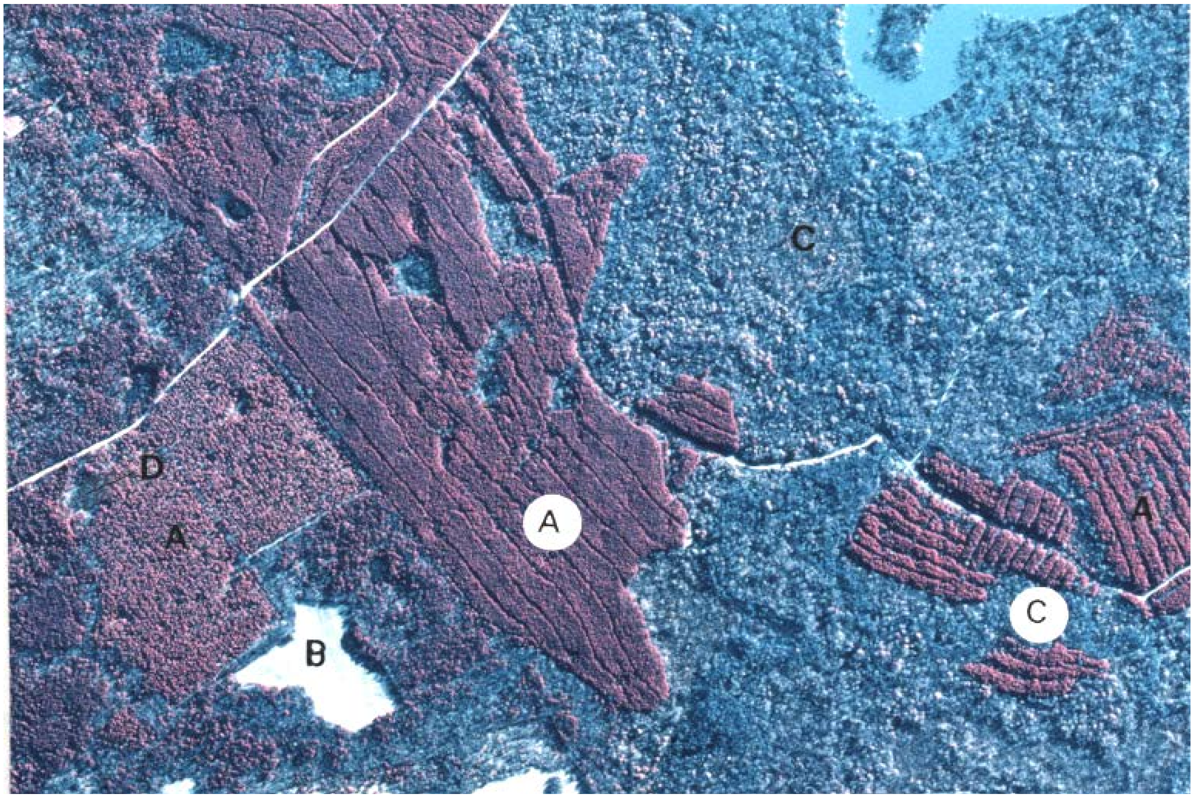


Figure 23 - This false color infrared aerial photograph shows many of the remotely sensed indicators used to identify forested plantations. Trees with uniform crown height (A); block or patch cutting/planting (B); trees planted in rows (C); and evidence of logging activity and use patterns such as skids and haul roads (D).

Areas where trees are being cultivated can be classified as wetland or upland forested plantation. The practice of cultivating trees does not determine wetland status within the Status and Trends dataset. For example, hardwood plantations (e.g., St. Francis National Forest in Arkansas) are managed forest stands and can occur in both uplands and wetlands. Both upland and bottomland hardwood wetlands are managed by clear cutting on an 80-100 year cycle. Reforestation is accomplished by natural regeneration and planting. Wetland/upland determinations remain unchanged for this type of plantation.

Alteration of vegetation commonly associated with forested plantations (e.g., harvest and planting) should not be used to indicate a wetland loss. For example, in the southeast U.S. pockets of wetlands are often found within planted tracts of pine. Field observations indicate that some planted trees in these wetlands may eventually die off and reveal emergent vegetation or wet shrubs on the photography. These identifiable areas should be delineated and classified by the appropriate wetland class descriptor (PEM, PSS, etc). Furthermore, certain tree species planted on undrained or incompletely drained hydric soils may thrive. These may occur in floodplains, bays, or pocosins and should be classified as wetland (PFO). Where the image signature indicates continued wetland presence and/or an area was considered a wetland in T1 and there is no positive visual evidence of wetland drainage or fill, a wetland class should be used. Wetland type should reflect the current dominant vegetation type.

On the other hand, when a wetland signature is not present (e.g., inundation, water strained leaves, break in canopy cover, cover type change, stressed vegetation, etc.) when one might be expected (e.g., after timber harvest), and there is positive evidence of wetland drainage or fill (e.g., ditching), it will be assumed that the wetland has been drained or otherwise destroyed and recorded as a loss (Figure 24).

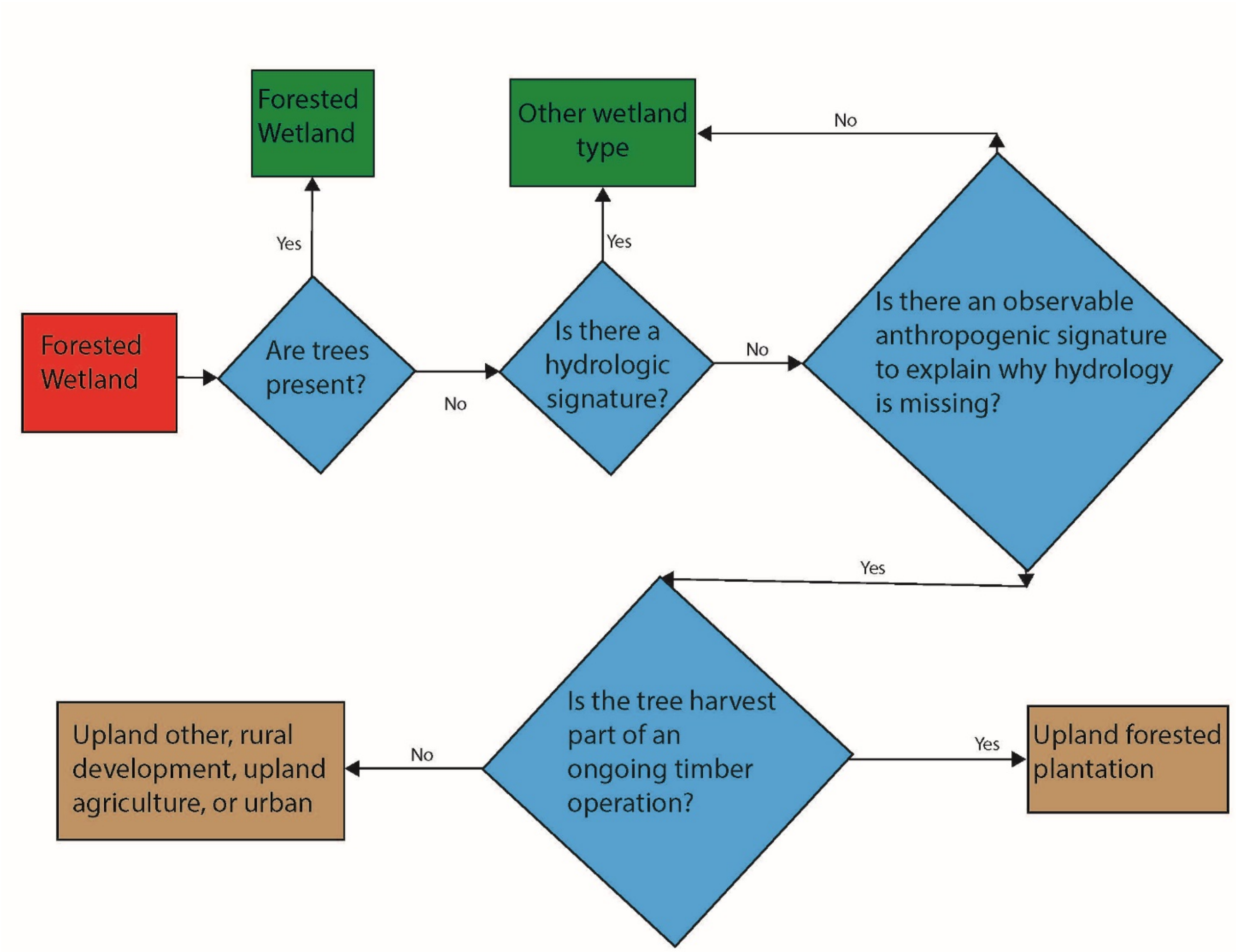


Figure 24 - This flow chart illustrates the conceptual process associated with assignment of T2 class when T1 is PFO.

Upland Christmas tree farms are included in the upland forested plantation category, but upland groves and orchards are categorized as upland agriculture.

XII. Editing Status and Trends Geodatabase Files

ArcMap Editing - Image Analysis

In an open ArcMap session, there are several digital map parameters that need to be set prior to editing. These include:

Optimal polygon color, fill and line width - It is necessary to set optimal parameters for working with existing digital wetland map data in an ArcMap edit session. Optimum polygon outline color must provide the image analyst good contrast between the line work and source imagery. Thus, polygon color is based on imagery type. Bright yellow or red colors display well against the gray scales of black and white imagery. Other colors may be more appropriate if the imagery is true color or false color infrared, or if the line work is displayed directly on the DRG backdrop. Black, white, and low contrast colors should not be used. A solid polygon fill color should not be used during the wetland interpretation process. Doing so prevents the image analyst from clearly viewing the underlying image and may adversely influence wetland cover type classification. Color fills may be useful in searching and identifying particular polygons or habitat types from the attribute table or for other quality control measures. In these instances, fill color should be determined by the analyst.

Polygon outline width (line weight) in ArcMap should not be so heavy as to mask the boundaries of wetlands on the imagery or so thin that they are difficult to detect or give a false sense of boundary precision. Settings for polygon outline width shall not be less than 0.4 or exceed 2.5. Line widths of 0.75 to 1.25 are considered optimum.

Polygon labels - should be displayed for most of the edit session. This enables the image analyst to determine the accuracy of existing feature classifications. Labels may be toggled on and off to better view landscape features or details during an edit session. Label color and font size are determined by the image analyst, but should provide high contrast for easy viewing without masking important image characteristics.

DRG and other collateral layers - may be toggled on and off to facilitate viewing the imagery and delineating features. Collateral data layers may be viewed separately or in various combinations at the discretion of the image analyst.

Editing Status and Trends Plots in ArcMap

Status and Trends data are unique from the NWI geospatial dataset (i.e., NWI maps) and the same editing routines that can be used successfully to update the geospatial dataset may not apply to this project. For example, the entire land area of the sample plot is classified based on land cover / land use for a specific timeframe. This creates challenges when making certain corrections or update changes to the geodatabase.

The following are recommendations for editing the Status and Trends data in ArcMap. Following these steps will reduce errors and problems in habitat classification.

Adding the Topology Layer

When adding data to an ArcMap session, add only the topology layer from the geodatabase. A message will pop-up asking if you want to add all feature classes that participate in the topology to the map (Figure 25). Click Yes.

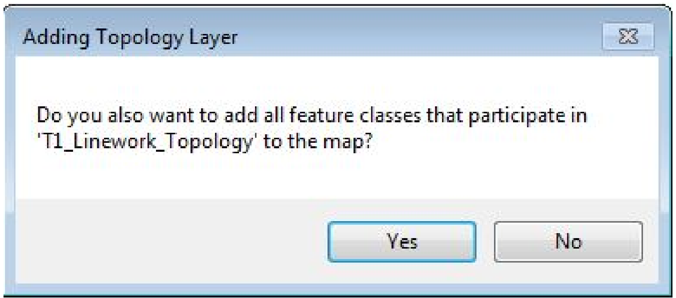


Figure 25 - Pop-up message for topology layers.

This will add all the associated feature classes that participate in the topology and everything you need to delineate the Status and Trends plots, except the imagery.

Adding the Topology Toolbar

To use some of the topological tools in ArcMap adding the topology toolbar is required. To view this toolbar in ArcMap, click Customize > Toolbars > Topology. The topology toolbar will appear and can be anchored to various locations in the ArcMap window. It will not become active until you start an editing session in ArcMap.

Setting the Sticky Move Tolerance

To ensure that accidental feature moves do not occur during an edit session the sticky move tolerance should be set in ArcMap (Figure 26). This requires a user to move the mouse a certain distance before the software recognizes the intent to adjust the location of a feature.

1. Click ‘Options’ in the ‘Editor’ pulldown menu in ArcMap.
2. On the ‘General’ tab of the pop-up window enter ‘25’ in the ‘Sticky move tolerance’ text box. The default units are pixels. This requires the mouse to be moved 25 pixels of screen resolution before the feature is moved.

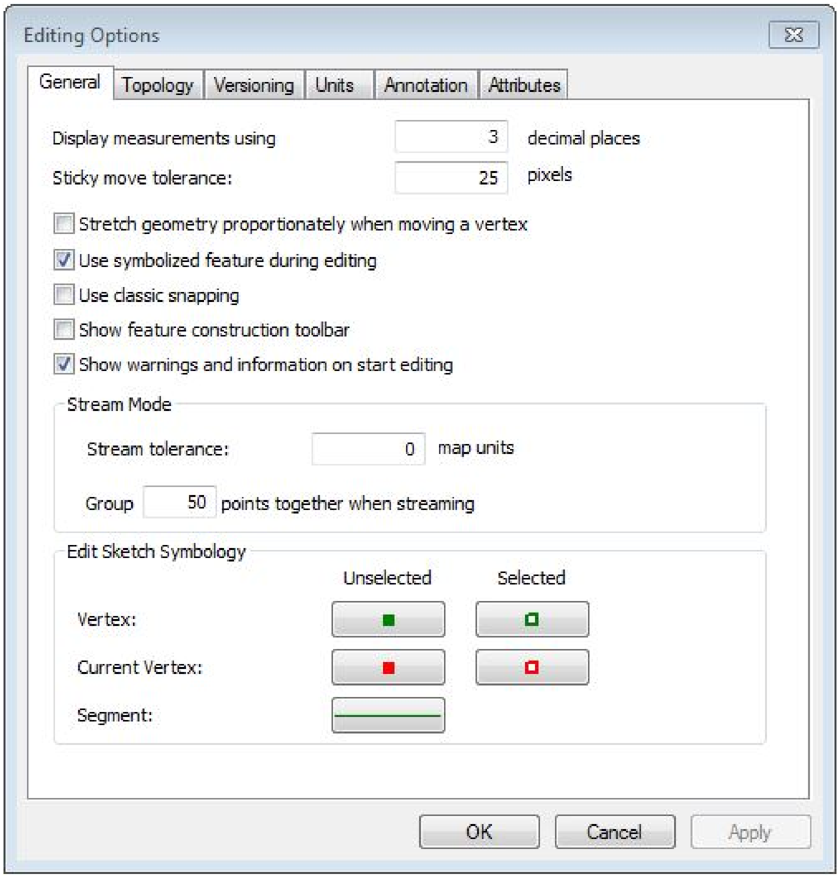
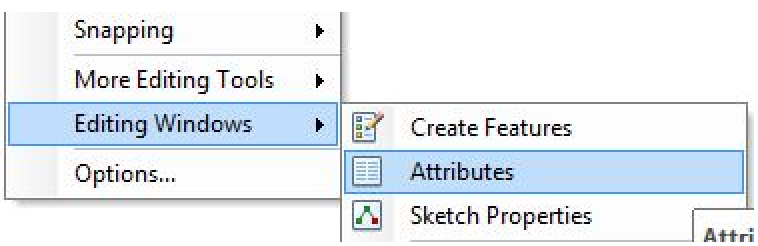


Figure 26 - Sticky move tolerance.

Attributing Polygons

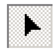
In this study, land use/land cover for both T1 and T2 are captured for each polygon in the ERA_19_Trend feature class. The ERA_09_ATT field holds the habitat type for time one (~2009) and ERA_19_ATT field holds the habitat type for time two (~2019). Initially the ERA_19_ATT field has been calculated to equal the ERA_09_ATT field, which assumes no change has occurred within the study period. When change is observed, the ERA_19_ATT field needs to be changed to represent the habitat for that polygon at T2 (~2019). This can be done utilizing the attribute domain of habitat codes that appears as a pull-down menu in the ERA_19_ATT field, when editing, in either the attribute table or the "Attributes Tool" on the Editing Windows section of the Editor Toolbar.

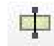


There may be some instances where the time one (~2009) habitat was incorrectly identified. To make these corrections select the proper habitat code from the attribute domain pull-down menu for the ERA_09_ATT field.

Cutting and Creating Polygons

Cutting current polygons into multiple polygons is the preferred way to delineate change in the Status and Trends plots. This preserves the historic attribution and line work of the previous era. To cut a polygon:

Select the polygon of interest with the edit tool  on the Editor Toolbar.

Select “Cut Polygon Tool” on the Editor Toolbar 

Ensure the default Straight Segment  is selected on the Editor Toolbar.

Click outside the selected polygon, then click (digitize) along the intended border of the new polygon (Figure 27), and double-click outside the polygon to cut the polygon into two pieces (Figure 28).

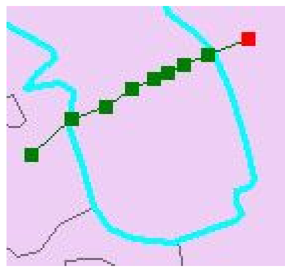
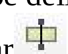


Figure 27 – Step one of the polygon cut and create process.

Figure 28 – Step two of the polygon cut and create process.

Be sure to change the attribution in the latest era to the correct code.

If a new isolated polygon needs to be delineated in the middle of a current polygon, use the “Cut Polygon Tool” on the Editor Toolbar .

Ensure the default Straight Segment  is selected on the Editor Toolbar.

Click inside the selected polygon, then click (digitize) along the intended border of the new polygon (Figure 29), cross your initial digitizing path, and double-click to cut the polygon into two pieces (Figure 30).

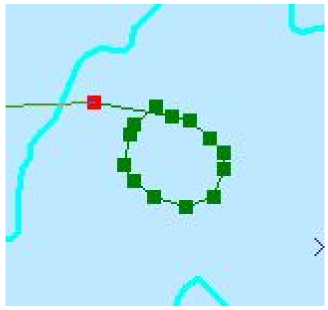


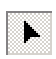
Figure 29 – Step one of the isolated polygon addition process.

Figure 30 – Step two of the isolated polygon addition process

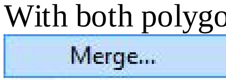
Deleting Polygons

Deleting polygons is **NOT** recommended as it leaves a hole in the seamless layer and removes all historic attribution for that area. A polygon should not be deleted but rather attributed to its new code. The historic line work must be left intact.

There may be situations where a mistake was made during delineation of a new polygon and it needs to be removed. If this occurs instead of deleting the polygon **merge** it with polygon adjacent to it with the appropriate code.

Select both polygons with the edit tool  .

With both polygons selected, select the Merge option in the Editor pull-down menu 



.

In the Merge pop-up window (Figure 31) select the polygon with the appropriate code to merge to. To highlight the associated polygon in the ArcMap window click on the feature record in the pop-up window.

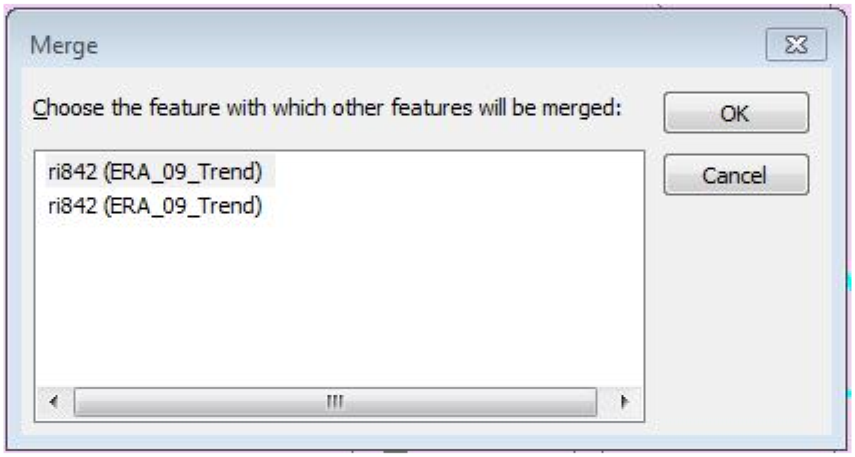


Figure 31- Merge pop-up window.

Validating Topology

The topological rules created for the Status and Trends study do not allow polygons to overlap within either layer, and all Status and Trends polygons (ERA_19_Trend) and plot boundaries (Plot_2019_Tracking) must completely cover each other. In other words, no two trend polygons or plot polygons can occupy the same space and all trend polygons must be within the boundaries of the plots. To validate topology:

1. Select one of the validation options from the topology toolbar.
   a.  Validate Current Extent
   b.  Validate a Specified Area
2. When the topology layer is visible (checked in the ArcMap table of contents) any topological errors should be highlighted in red.
3. If delineations were conducted properly there should be no topological errors.
4. Errors can also be viewed by clicking the Error Inspector  on the Topology toolbar.
   a. The Error Inspector pop-up window appears in the ArcMap window.
   b. Select 'Search Now' in this window to view topological errors.
5. Overlapping topological errors can be remedied by clipping one of the polygons and discarding the area that intersects.
   Note: To ensure a hole is not clipped into the trend plot, the 'Plot-Tracking' layer should be turned off before performing the clip operation.
6. The topological errors caused by polygons extending beyond the plot boundary can be remedied using the 'Cut Polygons' tool, with the snapping set to Edge Snapping, and then deleting polygons outside the plot boundary.

Reshaping Polygons

Reshaping polygons using the 'Reshape feature' tool should **NOT** be done for normal delineation of Status and Trends polygons. Reshaping a polygon changes the historic line work and thus the historic acreage of previous era delineations.

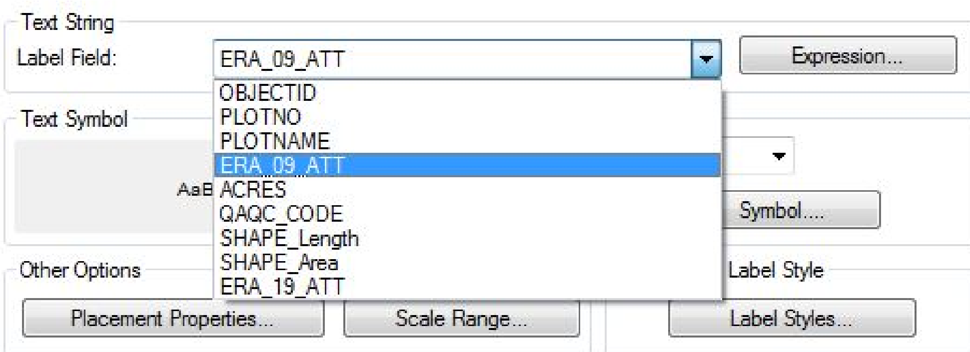
If the decision is made that the polygon delineation is historically incorrect, it may be reshaped.

This needs to be done using the Topology Edit Tool  on the Topology Toolbar and the 'Reshape Edge' topology tool on the Topology Toolbar. This reshapes both polygons on each side of the line, which prevents gaps or overlaps from being created.

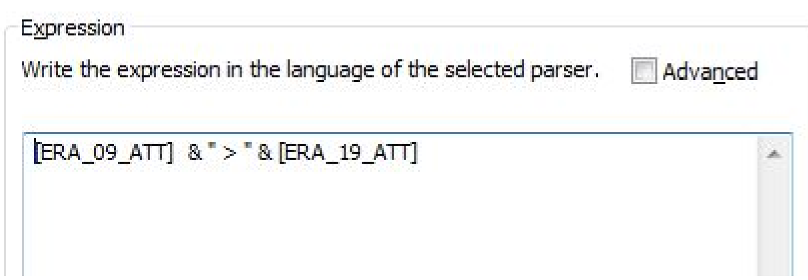
Labeling Polygons

To view the labels for both Eras of the Status and Trends polygons, you may want to try the following option.

1. Right click the ERA_19_Trend layer in the table of contents in ArcMap.
2. Click Properties.
3. Select the Labels tab.
4. Select 'ERA_09_ATT' from the pull-down list in the 'Label Field' window.



5. Click the 'Expression…' button next to the 'Label Field' window.
6. In the Expression window click 'ERA_19_ATT' and the 'Append' button.
7. In the Expression text box click between double quotes and type a single space, followed by an arrow character (>), so that there are spaces surrounding the '>' inside the double quotes.



8. Click OK.

9. The color can be changed in the ‘Labels’ tab and the labels may be turned on by checking the ☑ Label features in this layer box in the upper left hand corner.
10. Click OK.
11. Labeling can also be done by right clicking the ERA_19_Trend layer in the Table of Contents and selecting ‘Label Features.’

Status and Trends Verification Toolset

The Wetlands Status and Trends Data Verification Toolset is designed to automate the geospatial quality control functions necessary to ensure that data in the Status and Trends geodatabase are accurate. This toolset was created using Esri ModelBuilder and is compatible with Esri’s ArcDesktop software suite. Data verification is required for all Status and Trends geospatial data files.

The Data Verification Toolset was developed for use in ArcGIS specifically for Status and Trends work. It has been designed to address geopositional errors, digital anomalies, and provide logic checking. Some logic checking functions include identifying improbable changes that may represent errors in image interpretation. Such improbable changes consider the length of time between update cycles and identify certain unrealistic cover-type changes, such as open water ponds changing to forested wetland. When these features are identified, the image analyst must determine if the data accurately reflect the change in condition.

The verification toolset also checks for other types of errors in the digital data. Listed below are several important features of the trend verification tool:

- Identifies improbable changes
- Identifies unattributed or null polygons
- Finds adjacent polygons with the same attribute in both eras
- Locates potential digital slivers < 0.01 acres

Some functions the verification toolset performs will flag potential problems but provide the image analyst the option of editing or ignoring the feature. This is to accommodate the image analyst’s ability to ultimately determine the best ecological portrayal of the data.

The Verification Toolset and associated files are stored in a ‘ST_QAQC_Tool’ folder. This folder can be stored in any location on your machine and contains a Readme.txt, the Data Verification Toolset Installation and User Information.pdf, a Scratch folder, a ST_QAQC.mxd, the Status&Trends.tbx, and several component calculation expressions saved as .cal files. The Readme.txt provides a general description of the contents and purpose of the folder. The Data Verification Toolset Installation and User Information document provides descriptions of and procedures for the use of the Verification models. The Scratch folder is used for writing intermediate data from the models and contains a file geodatabase named Scratch.gdb that is required for the models to run correctly. The ST_QAQC.mxd is an ArcMap document that can be utilized to identify and locate specific verification errors. The Status&Trends.tbx is the ArcToolbox that contains the Status and Trends QAQC models.

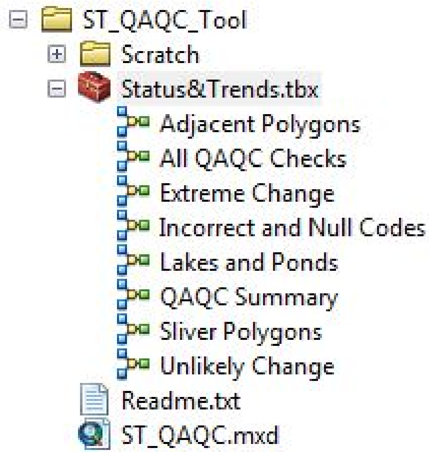


Figure 32 - ST_QAQC_Tool view in ArcCatalog.

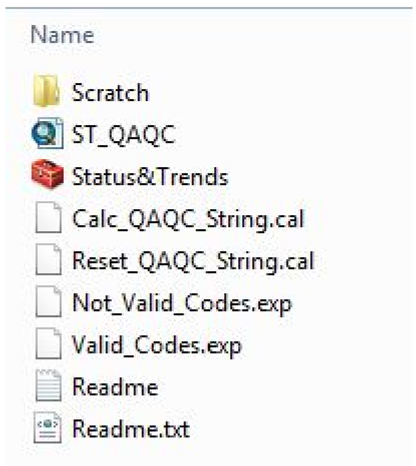
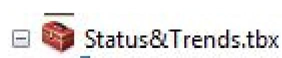
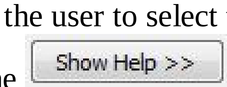


Figure 33 - ST_QAQC_Tool view in Windows Explorer.

Status and Trends Verification Models

To run any of the QAQC models simply navigate to the 

toolbox in ArcCatalog, which is in the ST_QAQC_Tool folder and double-click on any of the models. A window will appear similar to the shown in Figure 34, which will allow the user to select the input geodatabase and provides a description of the tool on the right pane if the 

button is selected. Click the browse button  next to the Geodatabase text box and browse to the geodatabase that the user intends to run verification on and press ‘OK.’ Each model can be run individually to address specific types of errors or all the verification checks can be run at once using the All_QAQC_Checks model.

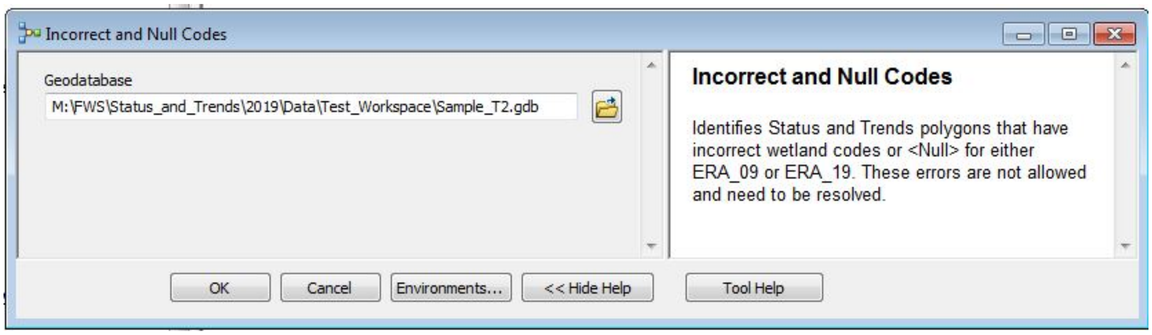


Figure 34 - Model interface example.

Function of the Individual Verification Models

All QAQC Checks - This model performs complete data verification. It includes the Incorrect and Null Codes, Unlikely Change(s), Sliver Polygons, Lakes and Ponds size differentiation, Adjacent Polygons and Extreme Change verification checks (detailed descriptions of these data verification components appear below). The QAQC Summary tool (also explained below) can be run after employing this tool to summarize all potential verification errors**.**

Incorrect or Null Codes - This model converts the first letter of the QAQC code to a 'C' for those records that have an incorrect or Null value in either the ERA_09_ATT field or the ERA_19_ATT field. A valid codes domain has been implemented for both of these fields to ease data entry, but errors can still be introduced by using some edit procedures. See Table 1 "Wetland, deepwater, and upland categories used in the national status and trends update study" for information on wetland codes.

Unlikely Change - This model converts the second letter of the QAQC code to a 'U' for those records that have an improbable change from ERA_09 to ERA_19 based on the length of time between eras and the unlikelihood that those types of land use or ecological processes reflect real conditions. Polygons with these types of changes should be reviewed by the data analyst to ensure they are correct. Improbable changes are listed below.

UA	to	PFO
UB	to	PFO
LAC	to	PFO
UB	to	LAC
Any Upland	to	RIV
Any Estuarine	to	Any Palustrine
Any Estuarine	to	RIV
Any Estuarine	to	LAC

This model also identifies marine or estuarine polygons that have been coded in non-coastal states.

Sliver Polygons - This model converts the third letter of the QAQC code to a 'S' for those records that have an area of less than 0.01 acres. These polygons are very small and are likely errors in delineation and not true Status and Trends polygons. Polygons of this type should be reviewed by the data analyst to ensure they are correct.

Lake and Pond Size Determination - This model converts the fourth letter of the QAQC code to an ‘L’ for those records that have a lake that is less than 20 acres in size at ERA_19. It also converts the fifth letter of the QAQC code to a ‘P’ for those records that have a pond that is equal to or greater than 20 acres at ERA_19. Polygons of these types do not follow classification protocols and should be reviewed by the data analyst to ensure they are correct. Many of the lake errors are typically portions of a larger lake on the edge of a plot.

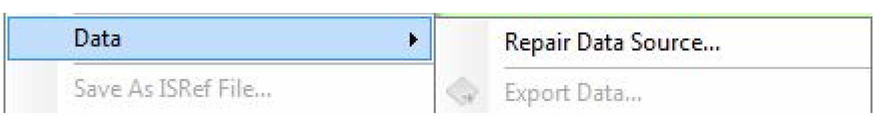
Adjacent Polygons - This model converts the sixth letter of the QAQC code to an ‘A’ for those polygons that are adjacent to another polygon with the same classification label in both the ERA_09_ATT field and the ERA_19_ATT field. These errors are not allowed and need to be resolved.

Extreme Change - This model converts the last letter of the QAQC code to an ‘E’ for those records that are 50 acres or greater and have changed habitat categories from ERA_09_ATT to ERA_19_ATT. Polygons of this type should be reviewed by the data analyst to ensure they are correct.

QAQC Summary - This model summarizes errors into a table by conducting a frequency on the QAQC_CODE field (Figure 24). It should be used after all other individual models have been run to summarize all potential verification errors. The user needs to direct the model to the geodatabase that contains the appropriate ERA_19_Trend feature class. The summary table will be created in the same file geodatabase as the data. A new table will be created each time the tool is run, with a date stamp appended to the table name. This model is not required to complete verification, but assists in the identification and summary of potential errors in the dataset.

ST_QAQC Map Document

There is an ArcMap document in the ST_QAQC_Tool folder that can be used to assist in the identification and location of verification errors. The polygons are symbolized and labeled based on the QAQC_CODE to identify different types of errors. Note that the labels are not visible at scales smaller than 1:24,000. To use this map document either double-click on ST_QAQC.mxd in ArcCatalog or open it from ArcMap using File > Open and navigate to the file. When the map document opens in ArcMap the data links will be broken. To repair the links to the data, right-click any of the layers and select Data > Repair Data Source.



In the pop-up window navigate to the dataset to be reviewed and select the layer with the same name as the one that was right-clicked. This will repair all data links for the map document. To zoom to the data click the  button on the navigation tool bar or hold down the Alt key and click the ERA_09_Trend layer. This will zoom to the extent of the data. Polygons flagged by the QAQC Tool can also be viewed in a non-tabular form by symbolizing polygons using the QAQC_Code column (Figure 35).

NOTE: To find specific instances of an error sort the attribute table by QAQC_CODE and double-click the gray box associated with a given record on the far left side of the table.

270758	5055	ri5055	LAC	PFO	6.351824	Polygon	NUNLNNN
270816	5055	ri5055	PUBn	PFO	1.039195	Polygon	NUNNNNN

This will zoom the ArcMap display to that polygon. The 'Select by Attribute' function in ArcMap can also be used to select all records of a defined QAQC_CODE value.

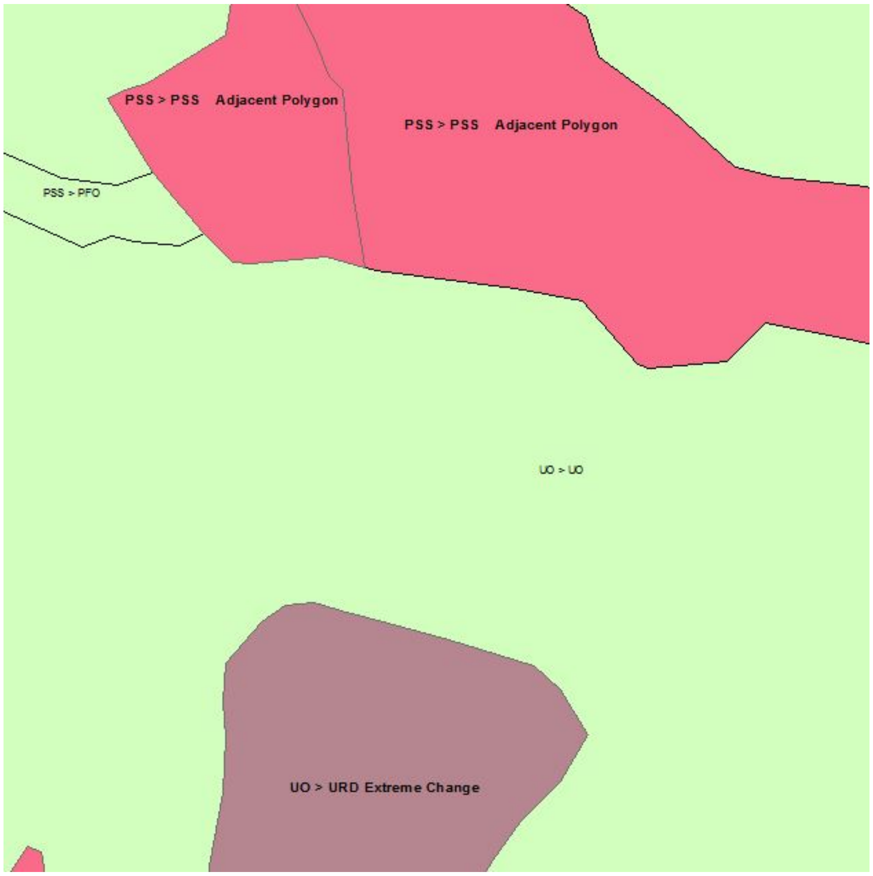


Figure 35 - Example of map document with color shaded and labeled errors.

To refresh the cartographic representation of the errors while fixing them, be sure to change the QAQC_CODE to 'NNNNNN' otherwise those polygons will remain shaded as an error until the tool is rerun.

Plot Tracking Fields

The 2019_Plot_Tracking feature class has a few other fields that should be populated by the analyst. Information on the imagery used to determine the habitat category for the ERA_19_ATT field needs to be complete. The **Image_Source** field identifies the imagery source (e.g., GeoEye, NAIP, etc). The **Image_Type** field identifies the type of imagery used (e.g., CIR, True color, Black and White, etc.). The **Image_Resolution** field identifies the scale of the imagery used (e.g., 1:40,000, 1 meter, 2 foot). The **Image_Date** field identifies the date of the imagery (e.g., 1/1/2019). These fields may already be populated when the data are received, but may be modified as needed. If any of these fields are left blank they will be flagged in the ST_QAQC.mxd.

Finally the **Comments**, **Date_Completed**, **Image_Analyst**, and **Update_Status** fields are to assist the user in tracking plot specific information and work progress. **Comments** can include anything specific to that plot about imagery, line work, adjustments, changes, or no change observed. **Date_Completed** should be filled with the date that the plot was finished. **Image_Analyst** is to record the name of the analyst who performed the work. The **Update_Status** field is to track the status of the plot update. This field contains an attribute domain and will have a default value of 'Not Reviewed'. This should be changed to one of the other two attributes, 'Change' and 'No Change', depending on the outcome of the plot update.

XIII. Field Reconnaissance

Field reconnaissance can address questions regarding image interpretation, land use practices, and classification of wetlands. Field work is also done as a quality control measure to verify information is correct, and to revise methods to improve future information accuracy.

Information gained from field studies in combination with the analyst's skills and experience in image interpretation and use of collateral data should result in successful wetland delineation and classification. Field work shall involve visits to a cross section of wetland types and geographical settings, as well as to sites that may be updated using different image types, scales, and dates.

Preparation for Field Reconnaissance

To ensure accurate and consistent interpretation of photography, analysts need to spend time in the field correlating image signatures with wetland and upland types. The actual number of person-days required in the field is determined by not only the goals of the effort, but also access to field sites, weather, travel logistics, etc.

Preplanning of the field trip should include identification of hydric soils or hydric soil characteristics likely to be encountered, information about common wetland plants and their distribution, dominant land use, drainage practices, agricultural crops, and preliminary image analysis of sites to be field inspected.

Timing of field work inevitably influences results, particularly due to temporal variations in phenology and water regime. Work conducted in early spring will highlight different components of an ecosystem than work conducted late in fall when different water conditions and plant species may dominate on the same site. An effort should be made to schedule field visits for times when wetlands in a region are most likely to be accurately classified on the ground.

Field sites should be chosen based on such things as commonly occurring image signatures or habitats characterizing an area; representation of regional habitats within the sample, unusual but important imagery signatures (some which may be difficult to identify); borderline signatures (those features that might be wetland or upland); and specific signature problems based on the date of photography (recent burning, extreme high or low water conditions). All sites should be accessible.

Field Sites and Data Collection

Field trip reports and field data sheets provide documentation of the field verification efforts including, general descriptions of wetlands and uplands in an area, descriptions of surface water conditions both on the imagery and at the time of field work, and details about the quality of the source materials used. They must be completed. While in the field, representative photographs of land use and wetland types should be obtained. The exact location of the field photographs, site location referred to in notes and other information must be provided. Wherever possible, digital cameras, data recorders, laptops, and global positioning systems (GPS) should be used to provide more accurate information.

Digital field notes regarding changes observed are preferred, and any handwritten notes should be clear and understandable. Notations might include: 'extend or add this wetland'; 'delete wetland'; or 'refine delineation.'

Time spent in the field is invaluable. To realize the maximum, it is often necessary to reassess some potential field sites based on work already completed versus time, access to sites and priorities.

Aids to Field Determinations:

Plant Species That Occur in Wetlands

The presence of wetland plant species often provide important collateral information to help biologists determine if a site is a wetland or to gain insight into length and periodicity of flooding. Many plant species, however, seemingly grow equally well in wetlands and upland conditions. To clarify what plants may be found in wetlands, the Service has prepared a list of wetland plant species, "*National List of Plant Species That Occur in Wetlands*" (Reed 1988). In the listing, wetland plants are divided into four indicator categories based on a frequency of occurrence in wetland. These categories include:

- Obligate wetland - almost always occur in wetlands
- Facultative wet - Usually occur in wetlands, but may occur in non-wetlands
- Facultative - Occur in wetlands and non-wetlands
- Facultative upland - Usually occur in non-wetlands, but may occur in wetlands

A list of plant species with the wetland indicator status found at a particular site can provide useful information about the site. This information, taken from the field data form, will be entered into a database for future reference and use. Review of common wetland and upland plant species and their wetland status is strongly encouraged before field trips. Reference material should be consulted as needed. The most up to date information can be referenced on the National Wetland Plant List website:

http://wetland-plants.usace.army.mil/nwpl_static/index.html

Hydric Soil Lists and Indicators

Hydric soils are defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, July 13, 1994).

Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation and/or inundation for more than a few days. Saturation or inundation when combined with anaerobic microbiological activity in the soil causes a depletion of oxygen. This anaerobic environment promotes biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, and/or accumulation of iron and other reducible elements. These processes result in characteristic morphologies which persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils (U.S. Department of Agriculture, Natural Resources Conservation Service, Wetland Science Institute and Soils Division 1996). *Field Indicators of Hydric Soils in the United States* (United States Department of Agriculture, Natural Resource Conservation Service, 2010) is a guide to help identify and delineate hydric soils in the field.

A list of the Nation's soils with actual or high potential for hydric conditions has been prepared by the Natural Resources Conservation Service. "Hydric Soils of the United States" includes a list of soils with at least one phase in the listing that meets the hydric soil criteria. The list does not include soils that are classified at categories higher than the series level in Soil Taxonomy (Soil Survey Staff 1999) nor does it include map units that may contain these series. The list is useful in identifying map units that may contain hydric soils. There is a national list of hydric soils as well as state and county lists. While the state and county lists may provide more regionally specific information, analysts should be aware that they may not be comprehensive in their presentation of all soil series with hydric characteristics. Hydric soils lists and maps reflect only the soil series or map unit considered hydric. Soil map units may contain inclusions of smaller features with hydric characteristics.

Soils that are artificially drained or protected (for instance, by levees) may be listed as hydric even though an area no longer meets the Cowardin definition of wetland. Hydric characteristics and thus status can persist for years, even decades, after wetland conversion to upland.

Field Forms and Reporting Requirements

A field trip report is required for all Status and Trends field trips. A standard field trip report outline is included as Appendix C.

Field trip reports shall discuss the details of field reconnaissance efforts (including participants, dates, and location), general descriptions of wetlands and uplands in the area, description of water conditions, details about the quality and interpretation of the imagery, dominant wetland, deepwater, and upland trends and related drivers, as well as any special problems or findings.

During each field trip, participants are encouraged to complete Field Data Forms at a variety of different check sites which are well distributed throughout the trip area. The exact number of check sites may be determined by the project specifications, weather conditions, access to sites, trip objectives, etc. Good quality digital photographs should be provided for field sites for which a Field Data Form is completed (Field Data Form is included in Appendix D).

Private Land Access Protocol

The Service respects private property and land owner rights. Personnel should contact landowners in advance to obtain permission to access private lands to conduct field verification or evaluations. Site visits will not be made where this is not possible, or landowners cannot be contacted. At no time should Service personnel or contractors cross fences, gates, barriers, or traverse posted property without permission of the landowner.

IVX. Quality Control and Quality Assurance

A quality assurance program is essential for ensuring the validity of analytical data. The Service has developed and implemented quality assurance measures that provide appropriate methods to take field measurements, ensure sample integrity, and provide oversight of analyses which included reporting of procedural and statistical confidence levels.

Because of the sample based approach, various quality control and quality assurance measures were built into the data collection, review, analysis, and reporting stages. Some of the major quality control steps include:

Plot Location and Positional Accuracy. Status and Trends sample plots are permanently fixed georeferenced areas that are revisited periodically to monitor land use and cover type changes. Plot outlines are computer generated for the correct spatial coordinates, size, and projection.

Imagery, Base Maps, and Collateral Data. Imagery is the primary data source, but it is used with reliable collateral data, such as topographic maps, coastal navigation charts, published soil surveys, published wetland maps, and State, local, or regional studies. All imagery and collateral data should comply with Federal Geographic Data Committee (FGDC) geospatial accuracy standards.

Internal reviews and checking. Quality control of interpreted map products is performed on 100 % of the project area by a qualified image analyst other than the person performing the original work. To accomplish this, the review analyst will perform an incremental screen by screen (working west to east or north to south) qualitative review of the project area at between 1:10,000 – 1:12,000 scale. Following completion of row or column of screen views edits should be saved.

Internal quality control review of interpreted images should include a comparison of contours, hydrographic symbols, or cultural features from the base image or ancillary data to wetland delineations and vegetation signatures. There is considerable latitude allowed in conducting qualitative reviews; however, a complete review of the project area must be completed. All work shall adhere to quality requirements and technical specifications.

A customized data verification toolset has been constructed to automate (to the extent possible) the quality control functions necessary to ensure that the geodatabase is accurate. This suite of functions has been designed to address geopositional errors, digital anomalies, and some logic checks within an automated framework. These tools are extensions to the Esri ArcMap desktop geographic information system (GIS) product.

The geospatial analysis capability built into this study provides a complete digital database to better assist analysis of wetland change information.

Minimizing Procedural Error

Procedural or measurement errors occur in the data collection phase of any study and must be considered. Procedural error is related to the ability to accurately recognize and classify wetlands both from multiple sources of imagery and on-the-ground evaluations. Types of procedural errors include missed wetlands, inclusion of upland as wetland, misclassification of wetlands or misinterpretation of data collection protocols. The amount of introduced procedural error is usually a function of the quality of the data collection conventions; the number, variability, training and experience of data collection personnel; and the rigor of any quality control or quality assurance measures. The image analyst must take the appropriate steps to ensure that procedural error is minimal.

Rigorous quality control reviews and redundant inspections are incorporated into the data collection and data entry processes to help reduce the level of procedural error.

XV. Materials Handling and Tracking – Safeguarding Information

The Service's Wetlands Status and Trends plot locations and content, in any format, are considered ***proprietary information***. Their location and content shall not be disclosed to anyone who does not have a need to review such information in order to directly produce Status and Trends data and/or is not legally bound by the confidentiality agreement that is signed by all contractors and cooperators expressly charged with Status and Trends data production. This aforementioned disclosure includes the transfer of information by any mechanism, including display, publication, transfer of hardcopy or digital information between parties, discussion, or any other type of distribution. Service contractors and cooperators are bound by a strict confidentiality agreement, which should be consulted by all involved personnel. The storage and labeling of Status and Trends data is addressed within the agreement, as well as restrictions on data distribution and display.

The location of these sample plots is not made public in an effort to avoid deliberate land use actions that would bias the Status and Trends statistical sample or compromise any privacy issues regarding private lands.

There may also be copyright or use restrictions on the imagery used to update the plot information. Do not copy, duplicate, or distribute this imagery.

When receiving or transferring Status and Trends plots or data within an organization as required to directly support the Status and Trends project, keep good records of both incoming and outgoing work materials.

XVI. Mandatory Submissions

A completed Status and Trends Plot Tracking feature class with the DATE_COMPLETED, IMAGE_ANALYST, and UPDATE_STATUS fields completed must be returned with the updated digital plot data.

Submission of completed field site and field photographs feature classes are required (through ArcGIS Online). Photographs must be submitted as attachments to the ST_Field_Photos point feature class. Each photograph will be associated with a unique point. Photographs shall be good quality. Poor quality photos that are out-of-focus, blurred or that otherwise do no clearly depict useful information about a site will not be accepted into the database. Photographs that contain private property information, such as street addresses, telephone numbers, advertisements, vehicle license plates, or recognizable profiles of individuals should be avoided. Copyrighted photographs will not be accepted.

Digital Data Requirements and Delivery

Digital data must conform to the following criteria:

- Digital wetlands data must be provided in file 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).
- Internal to the project area, data should be seamless.

Metadata

Because the Wetlands Status and Trends project does not distribute map products directly to the public, there are no specific metadata forms to be completed. Metadata for the project are stored to comply with the Service's Metadata Documentation and Record system. These data address the informational content of the trend plot materials. Submittal of complete and correct information on the updated plot transmittal sheet is important to keep these metadata records current. Information regarding the date, content and source of the update submissions must be completed on the transmittal sheet prior to submission to the Service.

XVII. Achieving Quality Requirements for Wetland Status and Trends

Quality requirements for Status and Trends digital files are defined in this document. They include quality goals for wetland identification, delineation, and classification accuracy. Additional requirements for digital data accuracy and metadata ensure data are complete and accurate.

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 Wetland Status and Trends data are based on a three step quality assurance process. The data must pass these quality control procedures to ensure the information is accurate. The steps include: 1) review by technical specialist(s), 2) automated verification routines, and 3) final verification and data integrity inspection as provided the National Standards and Support Team. These three processes are described below:

A) Review by Technical Specialist(s) - This quality control 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 images will be performed by a qualified image analyst other than the person performing the original work. The reviewing analyst will adhere to all 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 of and performance monitoring by a government official through an extramural agreement.

Internal quality control review of interpreted images should include a comparison of relevant ancillary data to wetland 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.

Service Quality Assurance Review - This is considered to be exclusively a Service function that must be performed by responsible Service personnel. Final quality assurance of Status and Trends plots entails highly qualified and experienced personnel checking the entire project area for quality. Any qualified Service personnel may conduct final quality assurance reviews. These reviews may entail using various technical means or field verification to check the work. Final quality control reviewers must coordinate closely with project Manager regarding revisions or modification to the work products.

B) Data Verification

All digital data files will be subjected to rigorous quality control inspections. Digital data verification includes quality control checks that address the geospatial correctness, digital integrity, and some cartographic aspects of the data. These steps take 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.

C) Oversight, Data Integrity, and Database Management

The National Standards and Support Team (NSST) has primary responsibility for the operation of 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. The NSST is key to the processes used to verify, assimilate, distribute, and archive geo-spatial wetland data. The NSST plays a substantial role in the quality assurance of the digital data files. This includes the following responsibilities:

- Final Data Verification - The NSST performs the final verification checks of the digital data before it is approved and entered into the wetlands 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 including submission of the Photo form, Field Trip Report(s), and Field Data Form(s) are required. These will be used as project specific metadata information.
    - Updated digital data must be returned to the Service’s NSST using the Service’s ftp site provided. Only data in file geodatabase format will be accepted. Data must have passed verification and quality control reviews.
    - Submission of field photographs is also required with geopositional location recorded in a point feature class. These should be clearly labeled and become the property of the Government.

Finally, when the data pass these quality assurance steps, any information disseminated for any reason must be authorized by the National Standards and Support Team.

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APPENDIX A. Definitions of Habitat Categories Used by Status and Trends

Wetlands[1]

In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of substrate development and the types of plant and animal communities living in the substrate and on its surface. The single feature that most wetlands share is a substrate that is at least periodically saturated with or covered by water. The water creates severe physiological problems for all plants and animals except those that are specially adapted for such conditions.

WETLANDS are 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. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes1; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year. As noted in this definition, plant community composition, soil morphology, and site wetness (hydrology) are the principal indicators of whether a site is a wetland for ecological purposes. Site wetness, i.e., the presence of water, while central to the concept of wetland, is often the most difficult indicator to assess accurately because it is more dynamic (temporally variable) than plant community composition or soil properties. Plants and soil tend to reflect the prevailing degree of wetness at a site over time. For this reason, they frequently are excellent indicators of relative wetness, and this is why they are listed first as indicators of wetlands. Cowardin et al. (FGDC 2013) intended that all available information should be used in making a wetland identification, as follows:

If plants and soil are present at a site, then both a predominance of hydrophytes and a predominance of undrained hydric soil, as well as wetland hydrology, should be required for positive wetland identification. If plants are present but soil is absent (e.g., Algal Aquatic Beds on rock substrates), then a predominance of hydrophytic vegetation, as well as wetland hydrology, should be required for a positive wetland identification. If plants are absent but soil is present, then a predominance of undrained hydric soil, as well as wetland hydrology, should be required for positive wetland identification.

If neither plants nor soil is present, then the wetland identification must be made strictly on the basis of hydrology. In this case, the substrate should be “saturated with water or covered by shallow water at some time during the growing season of each year.” Cowardin et al. (FGDC 2013) fully realized how vague this hydrologic definition was but, given the lack of detailed hydrologic data from the diversity of wetland types, geologic regions, and climatic regions of the U.S., there was no way they could have been more specific. In these examples, three (3) indicators – hydrophytic vegetation, undrained hydric soil, and wetland hydrology; two (2) indicators—

[1]Adapted from FGDC (2013).

hydrophytic vegetation and wetland hydrology or undrained hydric soil and wetland hydrology; and one (1) indicator— wetland hydrology, respectively, would be used to make the identification, based on the features available at the particular site.

The term wetland includes a variety of areas that fall into one of five categories: (1) areas with hydrophytes and hydric soils, such as those commonly known as marshes, swamps, and bogs;(2) areas without hydrophytes but with hydric soils—for example, flats where drastic fluctuation in water level, wave action, turbidity, or high concentration of salts may prevent the growth of hydrophytes; (3) areas with hydrophytes but non-hydric soils, such as margins of impoundments or excavations where hydrophytes have become established but hydric soils have not yet developed; (4) areas without soils but with hydrophytes such as the seaweed covered portions of rocky shores; and (5) wetlands without soil and without hydrophytes, such as gravel beaches or rocky shores without vegetation.

Marine System The marine system consists of the open ocean overlying the continental shelf and its associated high energy coastline. Marine habitats are exposed to the waves and currents of the open ocean. Salinity exceeds 30 parts per thousand, with little or no dilution except outside the mouths of estuaries. Shallow coastal indentations or bays without appreciable freshwater inflow and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the Marine System because they generally support a typical marine biota.

Estuarine System The estuarine system consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The salinity may be periodically increased above that of the open ocean by evaporation. Along some low energy coastlines there is appreciable dilution of sea water. Offshore areas with typical estuarine plants and animals, such as red mangroves (*Rhizophora mangle*) and eastern oysters (*Crassostrea virginica*), are also included in the Estuarine System.

Marine and Estuarine Subsystems

Subtidal - The substrate is continuously submerged by marine or estuarine waters.

Intertidal - The substrate is exposed and flooded by tides. Intertidal includes the splash zone of coastal waters.

Palustrine System The palustrine (freshwater) system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, farmed wetlands, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 parts per thousand. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 20 acres (8 ha); (2) an active wave formed or bedrock shoreline features are lacking; (3) water depth in the deepest part of a basin less than 2.5 meters at low water; and (4) salinity due to ocean derived salts less than 0.5 parts per thousand.

Classes

Unconsolidated Bottom: Unconsolidated bottom includes all wetlands with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent. Examples of unconsolidated substrates are: sand, mud, organic material, cobble gravel. Fresh water ponds (unconsolidated bottom) are further described by sub-categories in this document.

Emergent Wetland Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

Shrub Wetland Shrub Wetlands include areas dominated by woody vegetation less than 6 meters tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

Forested Wetland Forested Wetlands are characterized by woody vegetation that is 6 meters tall or taller.

Farmed Wetland: Farmed wetlands are wetlands that meet the Cowardin *et al.* definition where the soil surface has been mechanically or physically altered for production of crops, but where hydrophytes will become reestablished if farming is discontinued.

Deepwater Habitats:

Wetlands and deepwater habitats were defined separately because the term wetland does not include deep, permanent water bodies. For conducting status and trends studies, Riverine and Lacustrine were considered deepwater habitats. Elements of Marine or Estuarine systems can be wetland or deepwater. Palustrine includes only wetland habitats.

The 2.5-m lower limit for inland wetlands was selected because it approximates the maximum depth to which emergent plants normally grow (Welch 1952, Zhadin and Gerd 1963, Sculthorpe 1967) and the depth beyond which soil does not occur, according to the USDA Natural Resources Conservation Service (Soil Survey Staff 1999). As Daubenmire (1968:138) stated, emergents are not true aquatic plants, but are “amphibious,” growing in both permanently flooded and wet, nonflooded soils.

Riverine System: The Riverine system includes deepwater habitats contained in a channel, with the exception of habitats with water containing ocean derived salts in excess of 0.5 parts per thousand. A channel is "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Langbein and Iseri 1960).

Lacustrine System : The lacustrine system includes deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent coverage; (3) total area exceeds 20 acres (8 ha).

Uplands

Agriculture[1]: Agricultural land may be defined broadly as land used primarily for production of food and fiber. Agricultural activity is evidenced by distinctive geometric field and road patterns

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[1] Adapted from Anderson *et al.* 1976.

on the landscape and the traces produced by livestock or mechanized equipment. Examples of agricultural land use include cropland and pasture; orchards, groves, vineyards, nurseries, cultivated lands, and ornamental horticultural areas including sod farms; confined feeding operations; and other agricultural land including livestock feed lots, farmsteads including houses, support structures (silos) and adjacent yards, barns, poultry sheds, etc.

Urban: Urban land is comprised of areas of intensive use in which much of the land is covered by structures (high building density). Urbanized areas are cities and towns that provide the goods and services needed to survive by modern day standards through a central business district. Services such as banking, medical and legal office buildings, supermarkets, and department stores make up the business center of a city. Commercial strip developments along main transportation routes, shopping centers, contiguous dense residential areas, industrial and commercial complexes, transportation, power and communication facilities, city parks, ball fields, and golf courses can also be included in the urban category.

Forested Plantation: Forested plantations include areas of planted and managed forest stands. Planted pines, Christmas tree farms, clear cuts, and other managed forest stands, such as hardwood forestry are included in this category. Forested plantations can be identified by observing the following remote sensing indicators: 1) trees planted in rows or blocks; 2) forested blocks growing with uniform crown heights; and 3) logging activity and use patterns.

Rural Development: Rural developments occur in sparse rural and suburban settings outside distinct urban cities and towns. They are characterized by non-intensive land use and sparse building density. Typically, a rural development is a cross-roads community that has a corner gas station and a convenience store which are surrounded by sparse residential housing and agriculture. Scattered suburban communities located outside of a major urban center can also be included in this category as well as some industrial and commercial complexes; isolated transportation, power, and communication facilities; strip mines; quarries; and recreational areas such as golf courses, etc. Major highways through rural development areas are included in the rural development category.

Other Land Use: Other Land Use is composed of uplands not characterized by the previous categories. Typically these lands would include unmanaged or non-patterned upland forests and scrub lands, native prairie, and barren land. Lands in transition may also fit into this category. Transitional lands are lands in transition from one land use to another. They generally occur in large acreage blocks of 40 acres (16 ha) or more and are characterized by the lack of any remote sensor information that would enable the interpreter to reliably predict future use. The transitional phase occurs when wetlands are drained, ditched, filled, leveled, or the vegetation has been removed and the area is temporarily bare.

APPENDIX B: Physiographic Subdivisions and Code Abbreviations as used to determine the Wetlands Status and Trends in the U.S. (adapted from Hammond 1970).

	PHYSICAL SUBDIVISION	ABBREVIATION and NUMERIC CODE
1	Adirondack - New England Highlands	ANEH (1)
2	Appalachian Highlands	AH (2)
3	Basin and Range Area	B+RA (3)
4	Blue Mountains	BM (4)
5	Cascade-Klamath-Sierra Nevada Ranges	CKSNR (5)
6	Central Valley of California	CVC (6)
7	Coast Ranges	CR (7)
8	Colorado River Plateau	CRP (8)
9	Columbia Basin	CB (9)
10	Dakota-Minnesota Drift and Lake-bed Flats	DMDLBF (10)
11	East-Central Drift and Lake-bed Flats	ECDLBF (11)
12	Eastern Interior Uplands and Basins	EIUB (12)
13	Gulf-Atlantic Coastal Flats	GACF (13)
14	Gulf-Atlantic Coastal Rolling Plains	GARP (14)
15	Harney-Owyhee Broken Lands	HOBL (15)
16	High Plains	HP (16)
17	Lower Mississippi Alluvial Plain	LMAP (17)
18	Lower New England	LNE (18)
19	Mid-Continent Plains and Escarpments	MCPE (19)
20	Middle Rocky Mountains	MRM (20)
21	Middle Western Upland	MWU (21)
22	Nebraska Sand Hills	NSH (22)

23	North Central Lakes-Swamp-Moraine Plains	NCLSMP (23)
24	Northern Rocky Mountains	NRM (24)
25	Ozark-Ouachita Highlands	OOH (25)
26	Puget-Willamette Lowland	PWL (26)
27	Rocky Mountain Piedmont	RMP (27)
28	Snake River Lowland	SRL (28)
29	Southern Rocky Mountains	SRM (29)
30	Southern Wisconsin Hills	SWH (30)
31	Stockton-Balcones Escarpment	SBE (31)
32	Upper Gila Mountains	UGM (32)
33	Upper Missouri Basin and Broken Lands	UMBBL (33)
34	West-Central Rolling Hills	WCRH (34)
35	Wyoming-Big Horn Basin	WBHB (35)
36	Coastal Zone	CZ (36)
37	Coastal Zone - Pacific	CZP (37)

APPENDIX C: Field Trip Report Outline

Standardized Field Trip Report Outline

WETLAND STATUS AND TRENDS TRIP REPORT

1. Location:

2. **Dates:** Field trip dates and dates of imagery used to create data being assessed (clearly distinguish these two date types).

3. **Antecedent Weather Conditions:** General weather for past week (e.g., precipitation and temperature), as well as long-term conditions (e.g., drought, flood, average).

4. **Areas Visited in the Field:** Location information (Physiographic region(s), nearest cities, and counties) and types of wetlands visited.

5. **Plot List:** List by Quad Name, Plot Number, and sites field inspected.

6. **Personnel:** List people on the trip, their affiliations, and the dates personnel were in the field (include everyone involved – even local personnel).

7. **Dominant image trends:** Generally describe the level of change present in image based data produced for the relevant plots and the types of wetlands and deepwater habitats affected.

8. **Dominant Land Cover / Land Use**: Describe the dominant land cover (e.g., forest) and/or land use (e.g., forest plantation) for the area visited.

9. **Wetlands:** Synopsis of wetland change/conditions and drivers/controls on these parameters in the study area – as determined on the ground. This may be broken out into inland and coastal discussion, etc.

10. **Uplands:** Same as for wetlands section. Mention predominate vegetation type – including crops and natural plant communities, as well as dominant trends within upland areas (e.g., conversion of cropland to suburban development).

11. **Summary of Findings:** List common classification errors and image characteristics that may help to reduce future errors, as well as dominant trends and trend drivers/controls that may be relevant at a national scale.

12. **Vegetation List:** List the dominant wetland species within each Status and Trends class visited.

13. **Other Notes:** Include any other relevant findings including information that may be beneficial for future QA/QC. List ancillary data that were important for the formulation of findings.

APPENDIX D: WETLAND STATUS AND TRENDS FIELD DATA FORM

Plot number: ____________________ **State:______________**

Date and time of field visit:_____________________________________

Study: 2019 era Update________________________________

Field personnel:____

Coordinates or site location:____

Ownership:____

Wetland/upland field classification:____

Vegetation:____

____

____

Soil Name:____

Survey date:___________________________________

Listed as hydric: Yes________ **No_________**

List used: **National_______** **State_______** **County________**

Remarks:

APPENDIX E. STATUS AND TRENDS TRACKING FORM

Status and Trends Tracking Form

State ______ **Date_________________**

Project Area___________________

Analyst Name____

Organization____

Address/Contact Information _______________________________________

____

____

Plot #s Included (list by plot number)

No Change Plot #s (list by plot number)

U.S. Department of the Interior

Fish and Wildlife Service

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