Improvement of the National Hydrography Dataset for US Forest Service Region 3 in Cooperation with the National Forest Service

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Table of Contents

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Executive Summary

The purpose of this project is to perform comprehensive updates to the National Hydrography Dataset (NHD) in multiple national forests in US Forest Service Region 3 (the Southwest, see Figure 4), in compliance with requests from the U.S. Forest Service (USFS). The Center for Geospatial Science and Technology (CGST) at California State University, Northridge (CSUN) receives and organizes NHD work, while training and employing student workers. ArcGIS Geographical Information System (GIS) software with the U.S. Geological Survey's (USGS) unique NHD tools were utilized throughout the project to perform updates. The USFS coordinated for updates to be performed only within designated National Forests. The nature of the updates included geometry additions and corrections, seasonality corrections, and general attribute updates. Hydrologic features improved upon included streams, lakes, washes, reservoirs, and canal ditches. Aerial imagery reference data from multiple sources was utilized, including National Agriculture Imagery Program (NAIP), Esri topographic base maps, and Google imagery in order to determine necessary updates, in coordination with specific business rules. Additionally, local data regarding the presence of springs and riparian vegetation has been utilized to increase seasonality accuracy. After the completion of edits, local name data is integrated to ensure accuracy, in the case that a Geographic Names Information System (GNIS) tag was not already present.

Project Objectives

The purpose of this program was the improvement of the NHD using GIS including geometry, name consistency, and attributes. The features were edited at a scale of 1:10,000 – 1:15,000 in order to ensure effective resolution when viewed up to a scale of 1:24,000. Following geometry updates, seasonality accuracy was improved using local reference data and aerial imagery. Following CGST updates, data was passed to USFS hydrologists local to the updated region, in order to facilitate a highly informed review, by those to whom the accuracy of the data is most relevant. After any recommendations they submit are returned to the CGST to be incorporated, the data is resubmitted to the national database.

The CGST has been contracted to perform updates within several National Forests, within USFS region three, in a series of three work phases. Phase one involves the completion of the Coronado, Tonto, Coconino, Carson, and Kaibab National Forests, while phase two dealt with the completion of Prescott, Apache-Sitgreaves , and Cibola national forests. Lastly, phase three focused on the Lincoln and Santa Fe National Forests. Phase one was completed prior to this internship. My contributions were split between phase two and three work, with phase two being nearly completed at the time my WRPI internship concluded.

Originally, I was interested in this project as a method of expanding my GIS experience and in order to learn to work In a GIS office environment, as part of a large team. I was personally tasked with performing initial NHD updates, and later went on to update provisional name data. Additionally, through this internship I was able to become highly integrated at the CGST, which has allowed me to participate in multiple projects to expand my career knowledge. My long term career goal is to help with efficient land use and sustainability as a GIS analyst. I am nearing the end of the GIS Bachelor's program at California State University, Northridge.

Project Approach

Step One: NHD Training

Prior to performing any actual work on NHD updates, the CGST provided me with extensive training materials partially provided by the USGS and partially created here at the center. These materials provided me with education on how to use the NHD tools, aerial imagery interpretation, the use of topographic maps to determine flow line presence, and familiarized me with the CGST business rules. This was achieved through supplying me with a large amount of project documentation, video tutorials, and practice jobs.

Step Two: Data and Job Preparation

Prior to working on any NHD job provided by the center, various data preparation tasks needed to be completed. An appropriate metadata document had to be prepared based on specifications related to the CGST, along with multiple layers of collateral and reference data needing to be imported to the job. These included the "DoNotEdit" layers (see Figures 1 and 2) which indicated the scope of our work area, riparian vegetation and spring layers which assisted to seasonality arbitration, and various aerial imagery sources. Additionally, an initial quality control (QC) check is performed at this stage, to ensure that the existing data is in a working condition, and to record or correct any errors. These checks include pseudo-nodes, flow direction consistency, and invalid geometry.

Step Three: NHD Editing

Each editor is assigned a watershed which is identified by its Hydrologic Unit Code (HUC), which are defined by elevation boundaries in order to separate self-contained drainage areas. This is all defined prior to reaching the CGST, and existing at increasing levels of specificity. Jobs are assigned at a HUC8 level where the ID has eight digits, and is a relatively large area. This is then subdivided into HUC10 and HUC12 subcategories; all CGST editors work on HUC8 jobs broken into HUC12 areas. Editors tracked their progress in a HUC12 based attribute table.

The majority of all NHD editing fell under two main categories in my experience: geometry addition and seasonality correction. Many smaller streams and waterbodies simply didn't exist in the NHD, and the bulk of all streams have been digitized as intermittent, regardless of terrain. The conversion of streams in arid areas to ephemeral seasonality was important, along with utilizing the aforementioned supplemental data layers to determine higher levels of seasonality. This was often assisted by checking for water presence in multiple aerial imagery sources. In mountainous areas, added flow lines had a minimum length of five hundred meters, but in flatter areas shorter streams could be added. During editing, procedures and best

practices were based on both USGS provided data dictionaries, and CGST developed business rules.

While job data included all water bodies for the relevant HUC, all edits were limited to the boundaries of US National Forests (see Figure 1).

Step Four: Provisional Name Integration

Intermittently, editors who were between jobs could be assigned to provisional name integration. This entailed using local reference data to match names to their respective streams and other features. Given that a stream had no existing GNIS, it could be assigned the one found in local data. This actual name assignment was performed in Excel, and then formatted to be imported into ArcGIS, as the USGS no longer supports any provisional naming tools. If a stream had an existing GNIS, it was marked as a conflict, and generally left as found.

Step Five: Job Submission

After an editor has completed edits on all HUC12s in their job area, they initiated an automated final QC and resolved any produced errors, before submitting the job to the CGST servers. At that point, another employee or intern at the CGST will perform an internal QC that takes roughly ten percent as long as the original job. During that time, the second editor checks for GNIS name continuity, flow consistency, seasonality accuracy, and integration of local reference data. As previously noted, at this point that job was submitted to local USFS hydrologists, and any all feedback they provided was incorporated into the edits. That particular job would be considered officially complete at this point.

Project Outcomes

At this point in time, the Coronado, Coconino, Kaibab, Tonto, and Carson National Forests have been completed and returned to the national database. The updated hydrological data is available online for both public and private use. The Apache-Sitgreaves national forest has completed all major edits and is currently in the process of finalization. The Prescott, Cibola, Lincoln, and Santa Fe forests are all still in need of further edits (see Figure 4 for all national forests). My work primarily entailed a large-scale densification of flow lines, and seasonality corrections (see Figures 1 and 2 for flow line densification examples). Numerous flow lines were categorized as perennial or intermittent (indicating water should be constantly be present, or present a majority of the year), when they lacked any indication of active flow. These were reclassified as ephemeral, indicating that they only have water in response to direct input, generally rain (see Figure 3 for a legend of these NHD items). Other contributions and outcomes include a correction to flow line and waterbody geometry to more closely match their real counter parts.

Conclusions

This project has delivered broad improvements to the NHD within several national forest areas. This updated water surface data will be available to both public and private groups, and will enable more informed research, development, and sustainable land management. I was enabled throughout this project to cultivate and apply skills cooperating in a GIS team environment, follow a structured workflow, and learn new geospatial skills, all of which are important to my career development. The Watershed Management Experiential Learning for USDA Careers internship not only aided in this by encouraging my participation in the project, it also made me aware of several USDA and USFS career paths I previously had no knowledge of. Additionally, thanks to my participation I was able to present our project at the WRI conference, providing me valuable networking and experience.

Appendices

Figure 1: Map showing a before edit HUC12, and flow lines in DoNotEdit areas (Black Boxes)

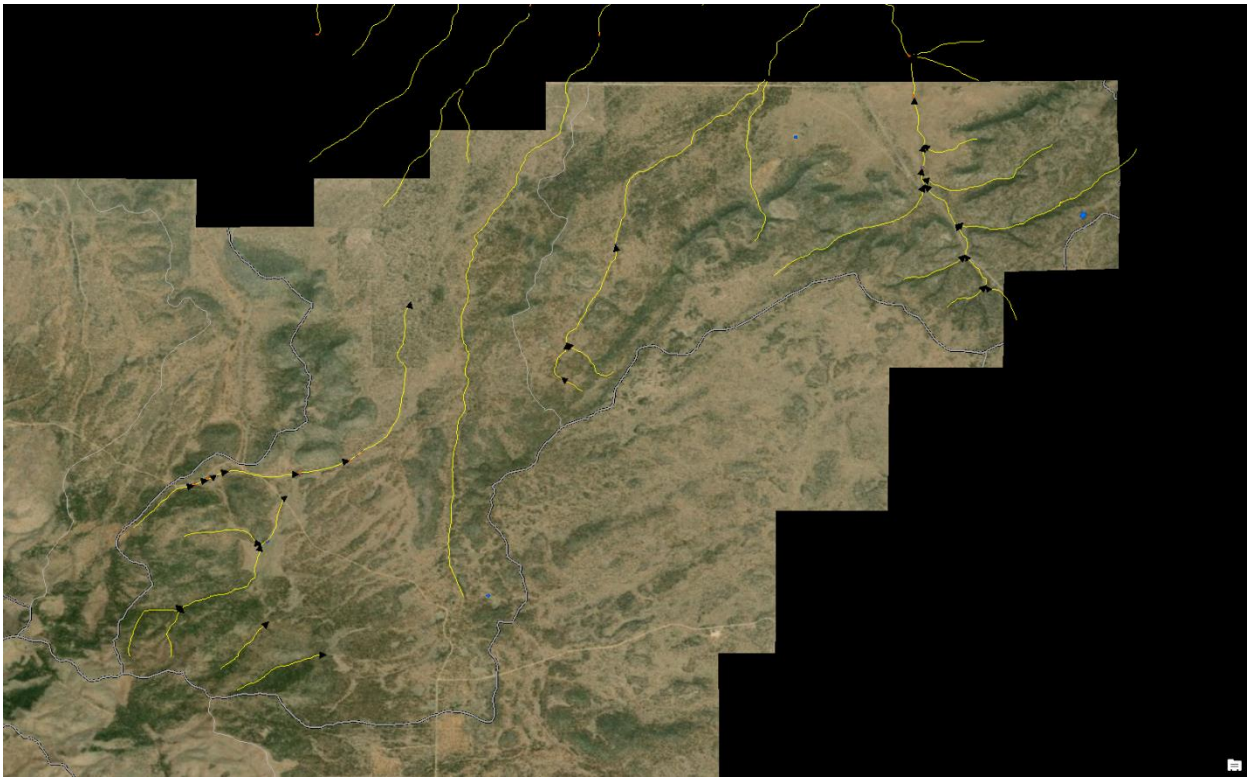

Figure 2: Map showing a post-edit HUC12

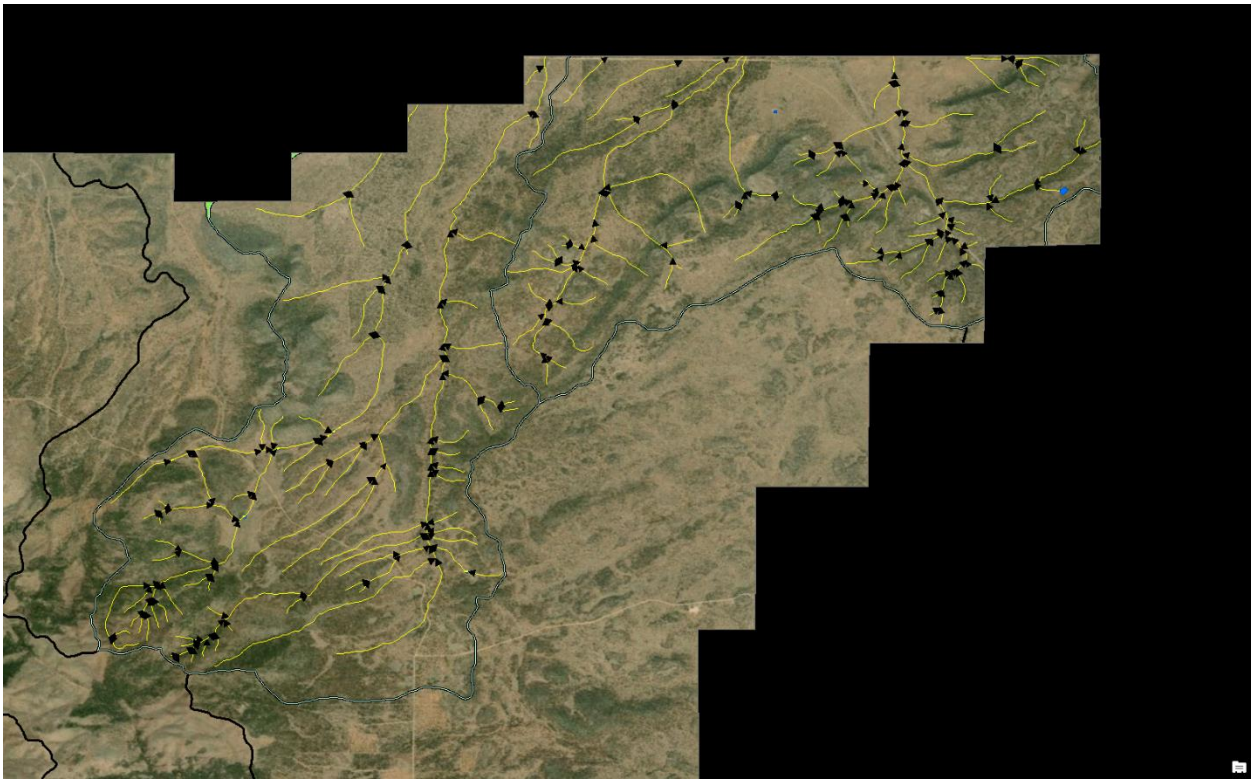

Figure 3: Legend of common NHD items

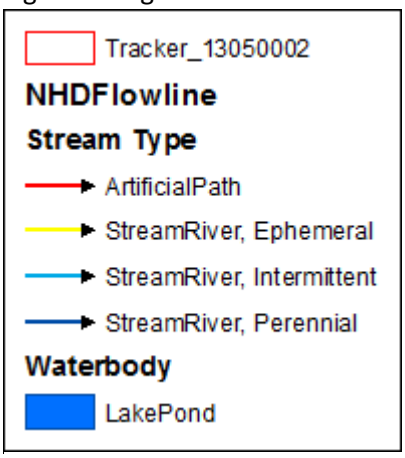

Figure 4: USFS area of interest