



# Automating Stream Selection: National Atlas and Global Map Hydro from NHD

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U.S. Department of the Interior

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# ¿Our Challenge?

To develop and implement a repeatable method for generalizing the 1:100,000-scale National Hydrography Dataset (NHD) to create a 1:1,000,000scale networked hydro dataset for the entire United States that fulfills both National Atlas and Global Map data needs.



# **Project Background**

#### National Atlas

- A cooperative effort by many agencies of the Federal government to provide a National Atlas that is truly national in scope and breadth.
- Data layers include: Agricultural, Commerce, Environmental, Health, Census, Infrastructure, Land Use, Transportation and Hydrography data.
- On-line link: http://nationalatlas.gov/about.html

#### • Global Map

- The Global Mapping Project is an international effort to develop and integrate 1:1,000,000-scale (1:1M) geospatial data that will facilitate environmental research at spatial scales ranging from continental to global.
- Data layers include: Boundaries, Drainage, Transportation, Population Centers, Elevation, Land Cover, Land Use, and Vegetation.
- On-line link: <u>http://www.iscgm.org/</u>



# **Project Approach**

Use ancillary data to identify reaches in the National Hydrography Dataset (NHD) that should be included in the 1:1,000,000-scale (1:1M) dataset.

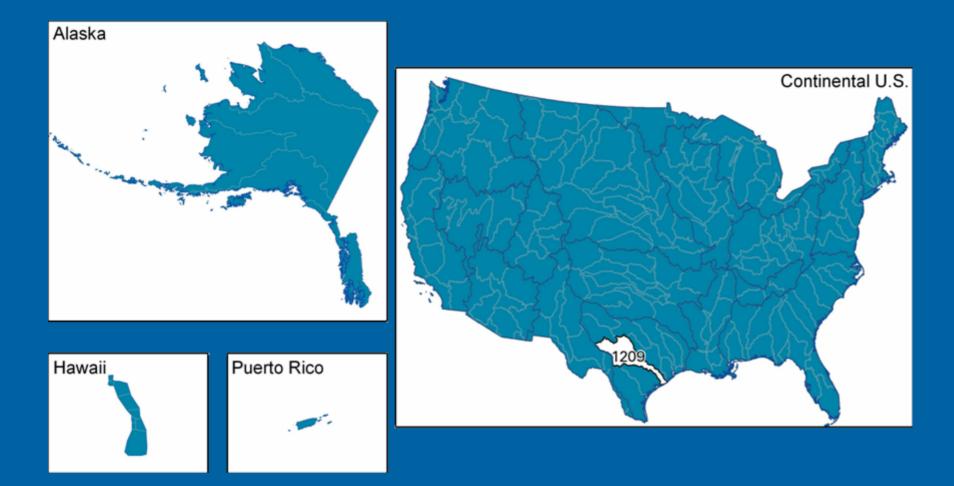
> <u>Base Data:</u> NHD (1:100K)

#### **Ancillary Data:**

National Atlas (1:2M) VMAP0 (1:1M) IMW (1:1M) EDNA (30m resolution)

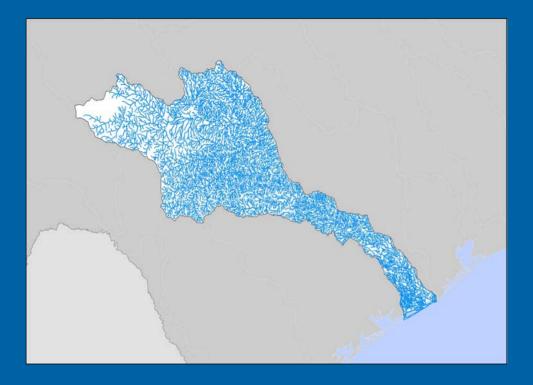


#### NHD Hydrologic Regions and Subregions





### Existing Data: National Hydrography Dataset (NHD)

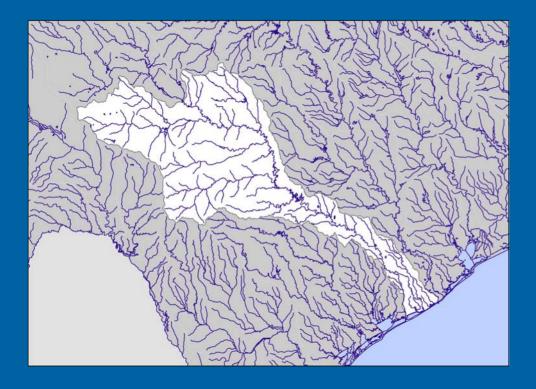


- 1:100,000 (1:100K)
- Preserves a traceable network where segments have a flow direction
- Classifies flowlines as streams, canals, shorelines, connectors, or artificial paths
- Contains Geographic Names Information System (GNIS) names

USGS NHD Data: http://nhd.usgs.gov/data.html



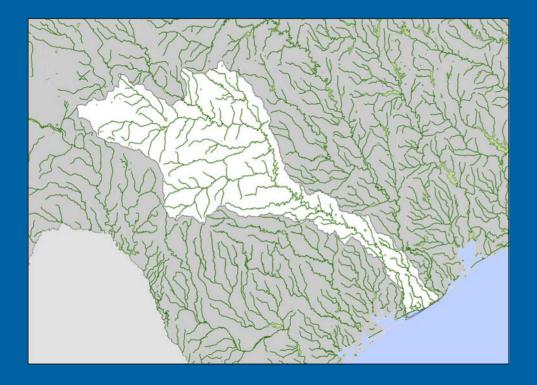
#### **Existing Data: National Atlas Streams**



- 1:2,000,000 (1:2M)
- Compiled by the National Atlas of the United States of America
- Designed specifically for cartographic purposes



#### Existing Data: VMAP0



- 1:1,000,000 (1:1M)
- Compiled by the National Imagery and Mapping Agency (NIMA), now known as the National Geospatial-Intelligence Agency (NGA)
- Used data collected from 1972 to 1992



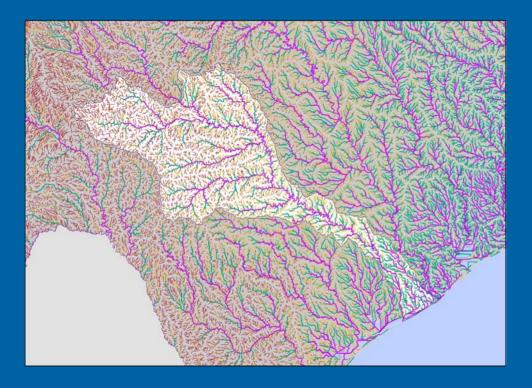
### Existing Data: International Map of the World (IMW)



- 1:1,000,000 (1:1M)
- Compiled by numerous organizations
- Paper maps produced from the 1920s to the 1970s
- Available for all of the United States, Canada, and Mexico



#### Existing Data: Elevation Derivatives for National Applications (EDNA)



- 30-meter resolution
- Provides a synthetic stream network derived from a 30-meter National Elevation Dataset (NED) raster
- Estimates mean annual stream flow from precipitation and flow accumulation data



# **Methods testing**

(trial and error)

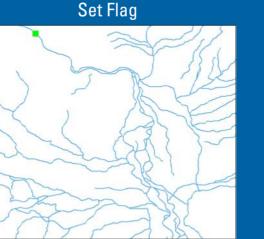
- Utility Network Analyst
   GNIS Names Hierarchy
   Hydrologic Derivatives
- 4. Final Method



### **Utility Network Analyst**

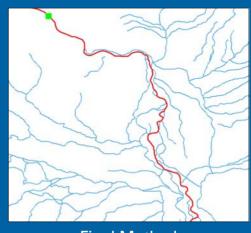
- Allows the user to trace downstream on any dataset which contains a geometric network.
- The geometric network stores the directionality of each line feature with the feature class.
- By placing a flag on a headwater reach, one can trace flow downstream to the outlet of the network.

<u>Method Results:</u> In areas with low relief and areas with braided streams, all stream reaches were selected instead of only the main flow path.



Trace Downstream





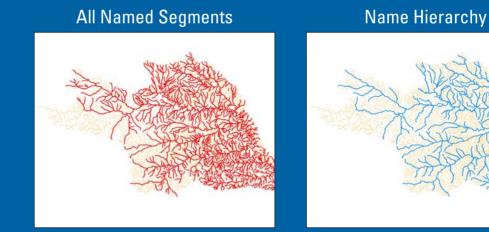
**Final Method** 

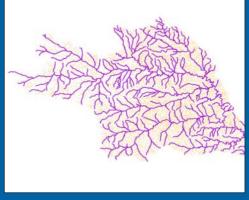


### **GNIS Names Hierarchy**

- Counts the number of stream segments with the same name, as indicated by the Geographic Names Information System (GNIS) attribute
- Aims to establish a hierarchy such that small streams with only one or two named segments are not selected
- A relative threshold value for the stream segment GNIS count is estimated by comparing density to ancillary maps compiled at 1:1M

<u>Method Results:</u> There are occasional breaks in network connectivity and inconsistent stream density.





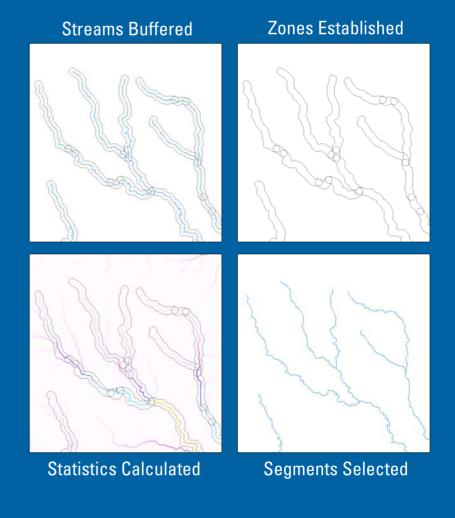
Final Method



### **Hydrologic Derivatives**

- Zonal statistics can be calculated using a polygon feature class and raster data
- Aims to determine the most hydrologically significant reaches by calculating statistics for a buffer for each reach in the 1:100K NHD
- Uses USGS Elevation Derivatives for National Applications (EDNA) flow accumulation data

<u>Method Results:</u> This approach successfully selected reaches that correlated with the 1:1M ancillary datasets in the middle parts of watersheds but had limited success finding the important headwater reaches and reaches in areas with low relief.





## **Final Method**

- Attribute headwater reaches of streams indicated by ancillary datasets (National Atlas, VMAP0, and IMW)
- Use a trace downstream algorithm to automatically attribute streams that belong in the 1:1M dataset (written in VBA using ArcObjects)
- Consult additional ancillary datasets (digital orthoimagery, EDNA, and Digital Raster Graphics) to handle other cases that cannot be decide by algorithm
- **Generalize streams** using "Bend Simplify" and D-P algorithms (Python and the Geoprocessor object)



## Attribute headwater reaches

- GNIS names are important
- Include streams indicated by National Atlas, VMAP0, and IMW
- EDNA if ambiguous





### Trace downstream algorithm (What's it looking for?)

- Only one downstream reach
- GNIS Name
- Stream subtype
- Has flow direction





## Handle other cases

### Digital orthoimagery

#### • EDNA

### • Digital Raster Graphics





### Generalize streams (cartographic)

- Subregions appended to a regional dataset
- Bend Simplify with 500-meter tolerance
- D-P algorithm with 1-meter tolerance
- Check topology and network connectivity





## **Final Method Summary**

• Attribute headwater reaches

• Trace downstream algorithm

• Handle other cases

Generalize streams



### **Custom VBA/ArcObjects tools**

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## Custom Python scripts 🖏

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SummarizeGNISNames	SelectGNISStreamsAndCountJunctions	Toolbox Tool
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- Creation of the directory structure
- Data preprocessing (add necessary fields, from/to nodes, and domains)
- Geodatabase compaction
- Export/simplify/append 1M streams
- Edge flag generation



## **Density and Scale Issues**

Varying density within ancillary datasets - "What does 1:1M-scale stream network density look like?"

- Automated processing makes repeatable decisions
- Feature level metadata document why particular reaches were included

Code_Field	Description
0	Not a 1M stream
1	National Atlas
2	VMAP0
3	National Atlas and VMAP0
4	National Atlas and EDNA
5	VMAP0 and EDNA
6	National Atlas, VMAP0, and EDNA
7	EDNA
8	DOQQ
9	Only downstream reach
10	GNIS_ID equivalent to upstream reach
11	Only downstream reach with GNIS_ID
12	Only downstream reach classified as Stream
13	Only downstream reach with Flow Direction
14	IM/V
15	DRG
16	Canada
17	Mexico
18	Shortest segment
99	Manually excluded

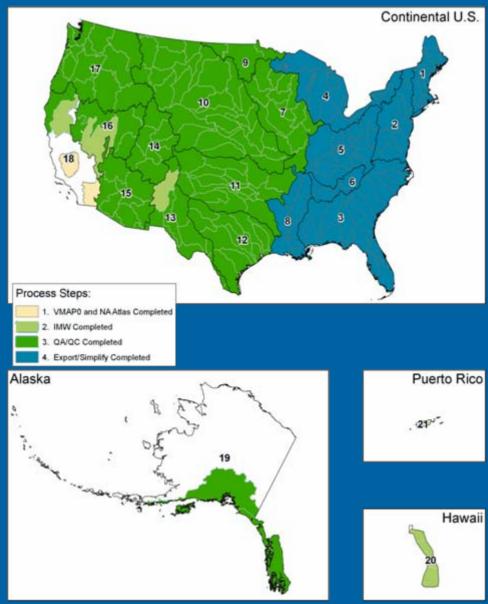


## Conclusion

- Final method fulfills our objective of creating a traceable 1:1M-scale hydro dataset that conforms to National Atlas recompilation and Global Map specifications and has a high degree of repeatability
- The NHD network is making it possible to complete the entire United States in a little over one year



### Water Courses Status Graphic





## Acknowledgments

- Jay Donnelly National Atlas of the United States
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## **Thanks! Questions?**

USGS Texas Water Science Center GIS Workgroup Web Site <u>http://tx.usgs.gov/GIS/</u>

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Automating Stream Selection: National Atlas and Global Map Hydro from NHD

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> USGS TxWSC GIS Workgroup Web Site\* http://tx.usgs.gov/GIS/

\*Global Map and National Atlas 1:1M Hydrography: The project summary, poster, and presentation are available through the GIS Workgroup Web Site.

Links Cited in Presentation:

National Atlas: http://nationalatlas.gov/about.html

Global Mapping Project: http://www.isc.gm.org/

USGS National NHD Data: http://nhd.usgs.gov/data.html

National Atlas Streams Data: http://nationalatlas.gov/mld/hydrogm.html

NGA VMAP0 Data: http://earth-info.nga.mil/publications/vmap0.html

USGS EDNA Data: http://edna.usgs.gov/Edna/datalayers/flow\_accum.asp

