USGS
science for a changing world

nationalatlas.gov
Where We Are

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

Robin H. Gary and Zachary D. Wilson
USGS Texas Water Science Center-Austin

U.S. Department of the Interior
U.S. Geological Survey

¿Our Challenge?

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

USGS

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: http://www.iscgm.org/

USGS

Project Approach

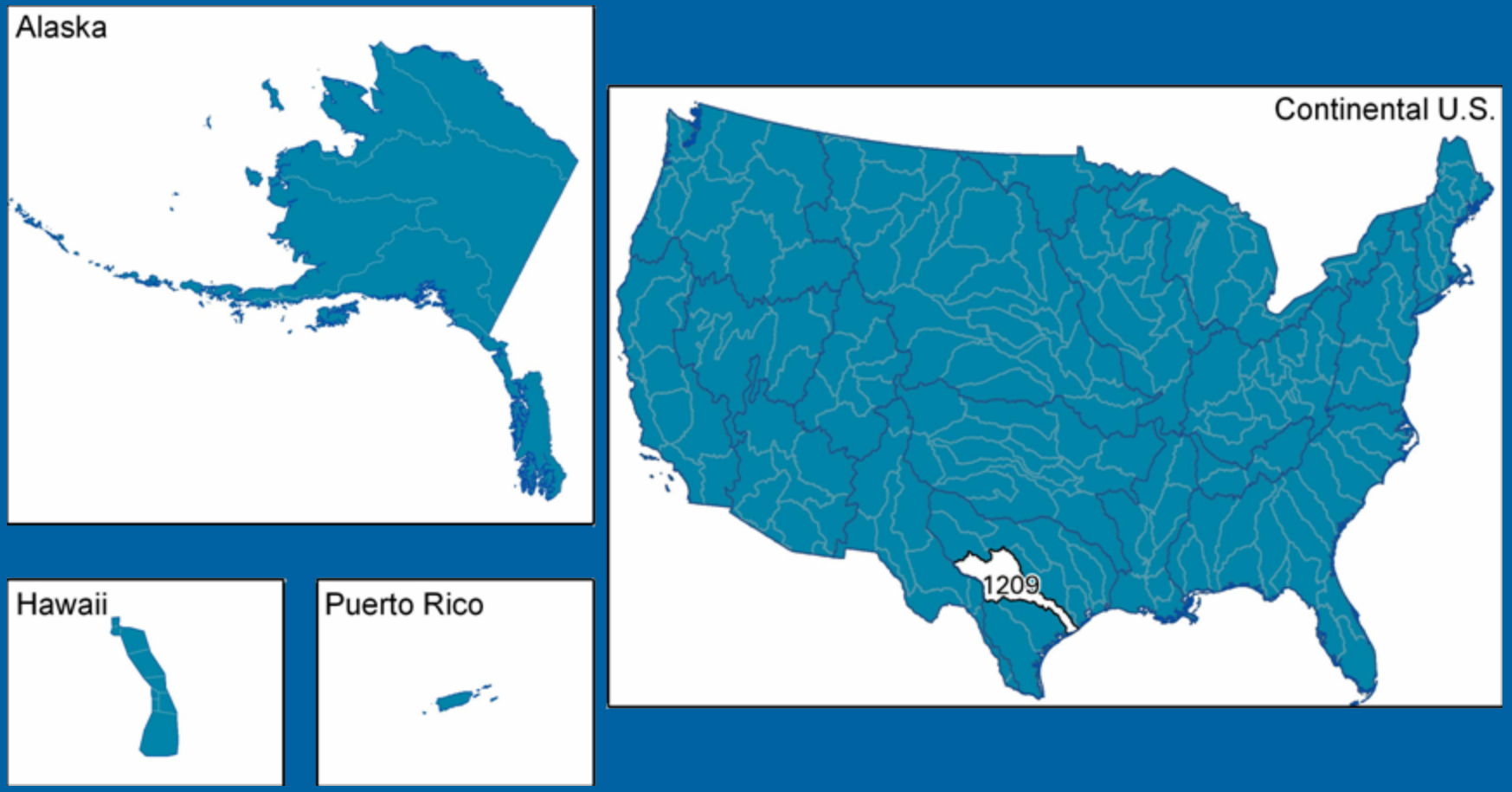
Use ancillary data to identify reaches in the National Hydrography Dataset (NHD) that should be included in the 1:1,000,000-scale (1:1M) dataset.

Base Data:
NHD (1:100K)

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

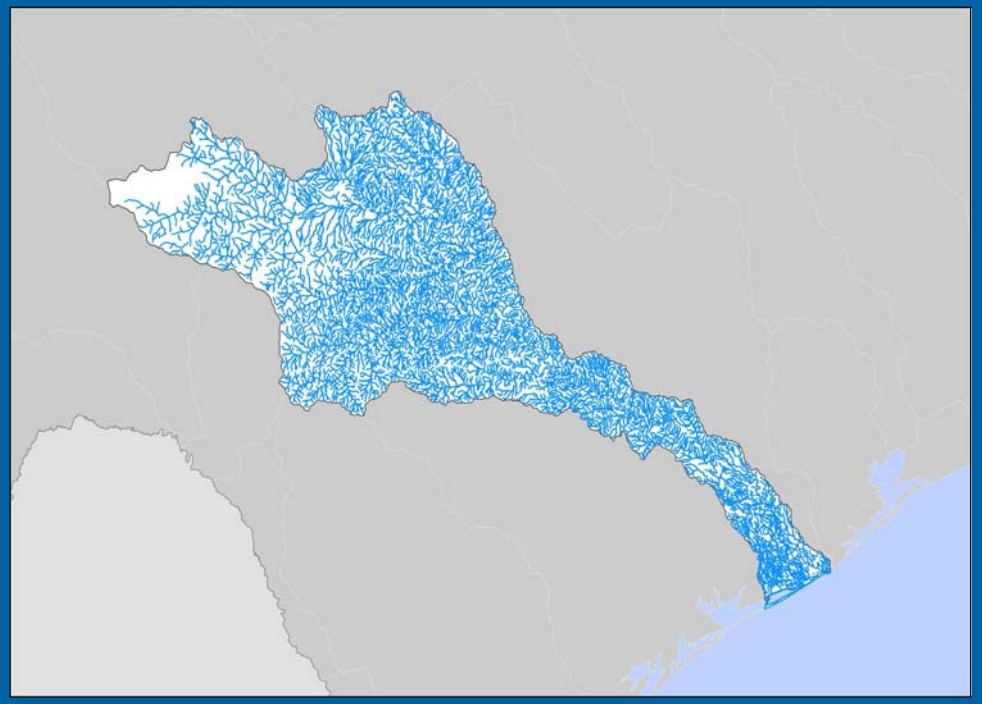
USGS

NHD Hydrologic Regions and Subregions



USGS

Existing Data: National Hydrography Dataset (NHD)

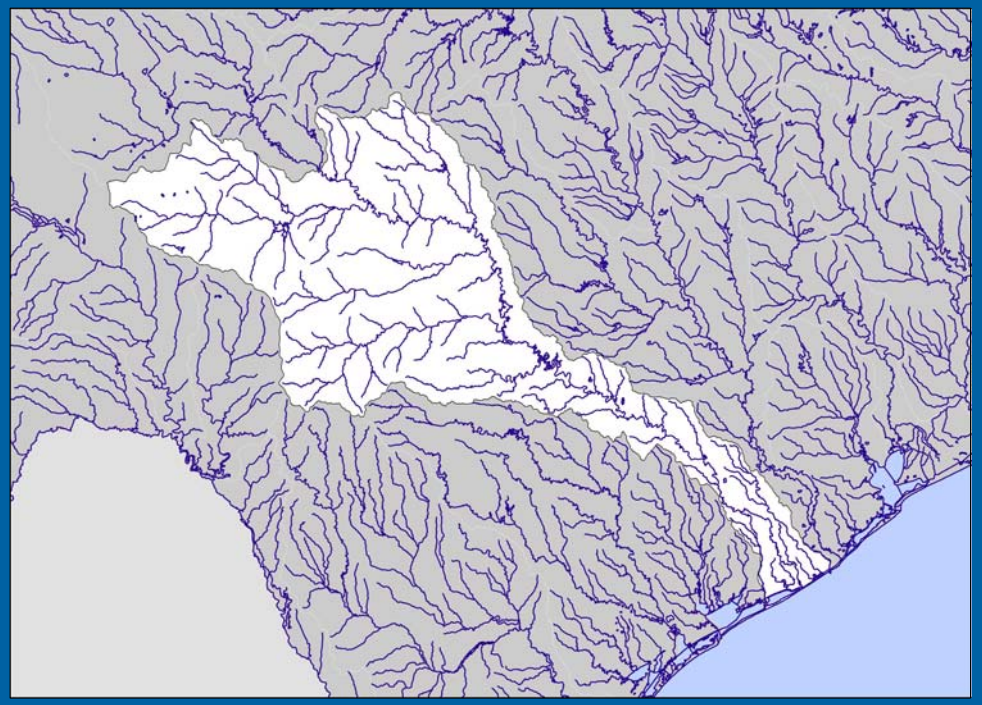


- 1:100,000 (1:100K)
- Preserves a traceable network where segments have a flow direction
- Classifies flowlines as streams, canals, shorelines, connectors, or artificial paths
- Contains Geographic Names Information System (GNIS) names

USGS

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

Existing Data: National Atlas Streams

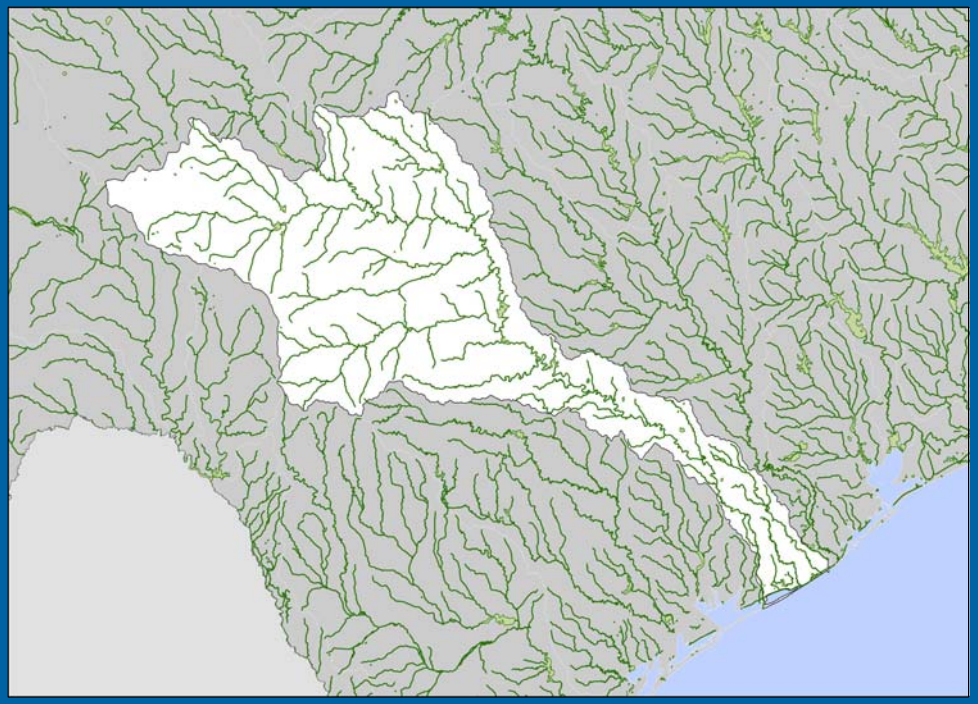


- 1:2,000,000 (1:2M)
- Compiled by the National Atlas of the United States of America
- Designed specifically for cartographic purposes

USGS

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

Existing Data: VMAP0

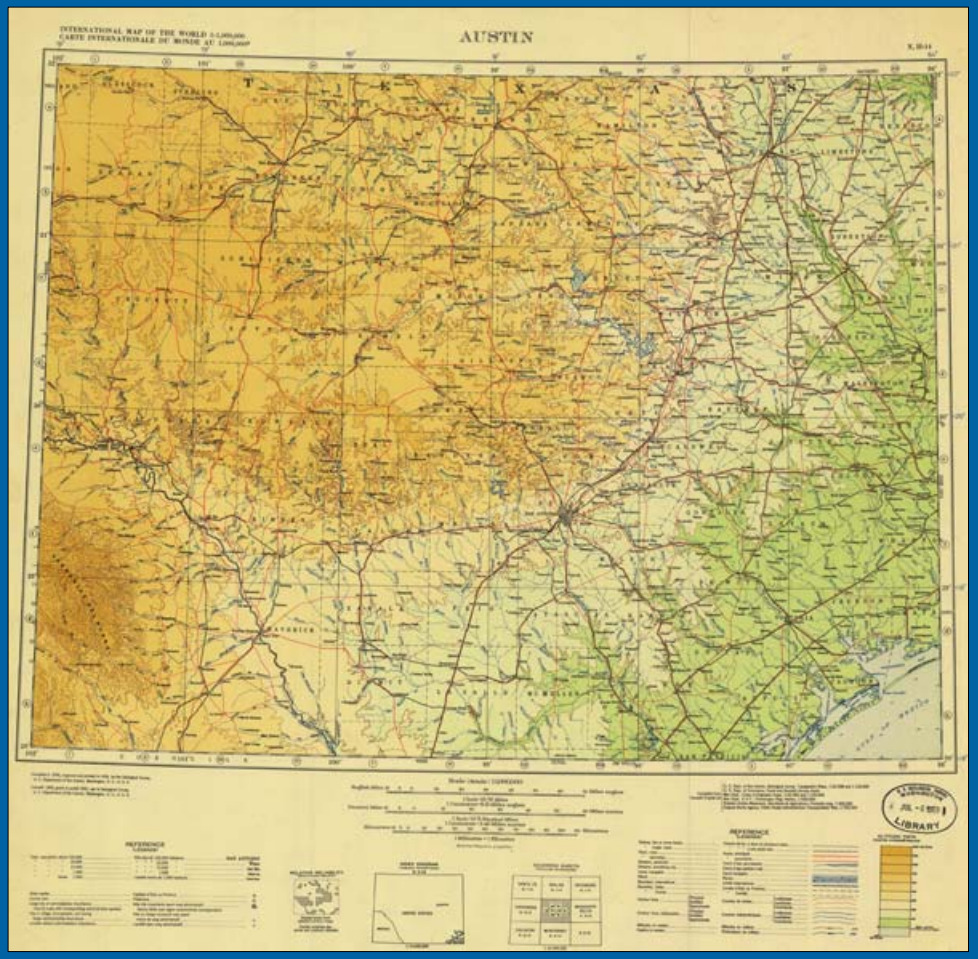


- 1:1,000,000 (1:1M)
- Compiled by the National Imagery and Mapping Agency (NIMA), now known as the National Geospatial-Intelligence Agency (NGA)
- Used data collected from 1972 to 1992

USGS

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

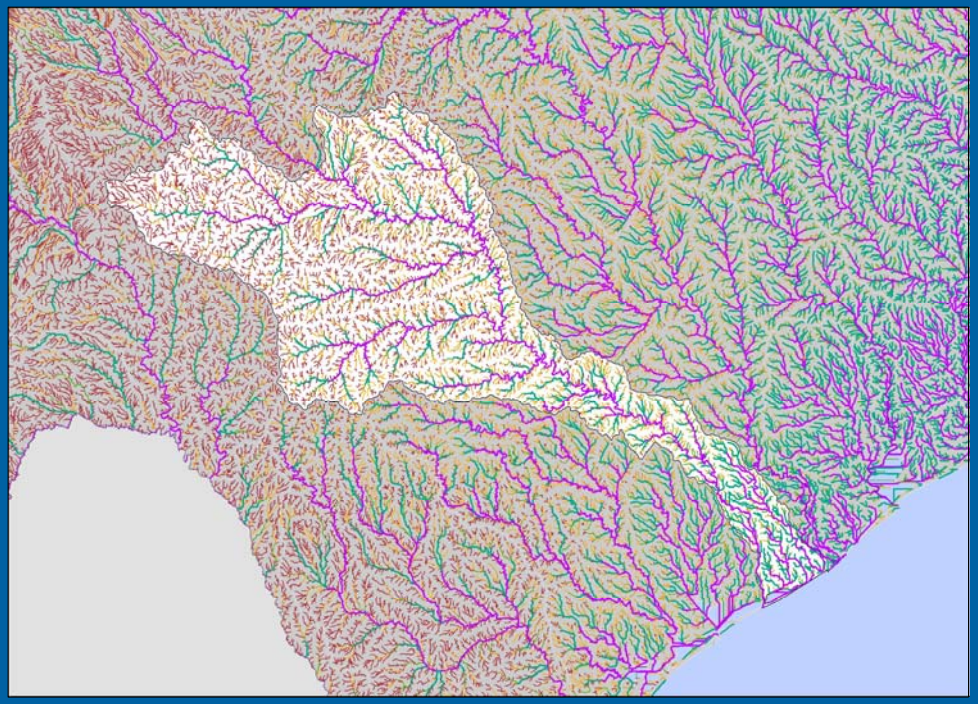
Existing Data: International Map of the World (IMW)



- 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

USGS

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

USGS

USGS EDNA Data: http://edna.usgs.gov/Edna/datalayers/flow_accum.asp

Methods testing

(trial and error)

1. Utility Network Analyst
2. GNIS Names Hierarchy
3. Hydrologic Derivatives

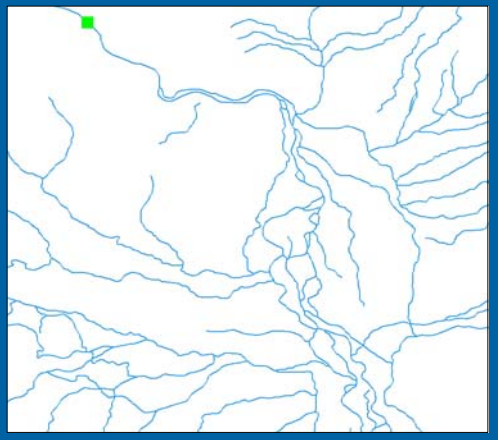
4. Final Method

USGS

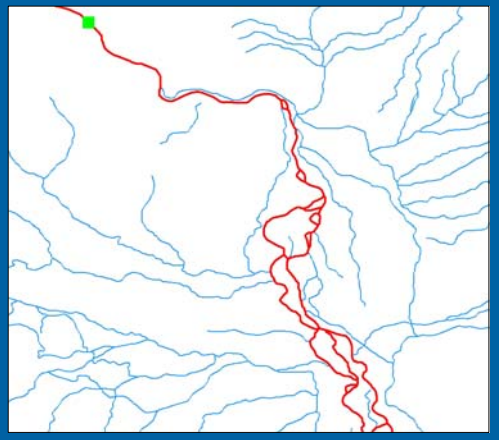
Utility Network Analyst

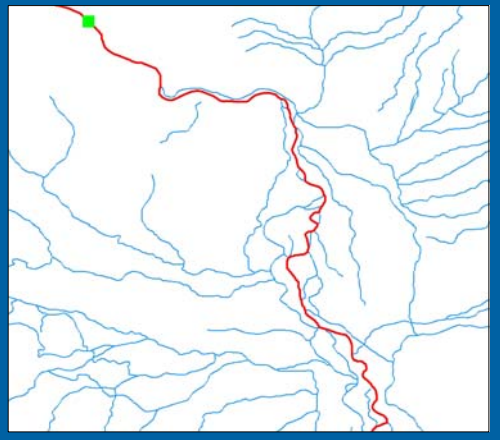
- Allows the user to trace downstream on any dataset which contains a geometric network.
- The geometric network stores the directionality of each line feature with the feature class.
- By placing a flag on a headwater reach, one can trace flow downstream to the outlet of the network.

Set Flag



Trace Downstream





Final Method

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

USGS

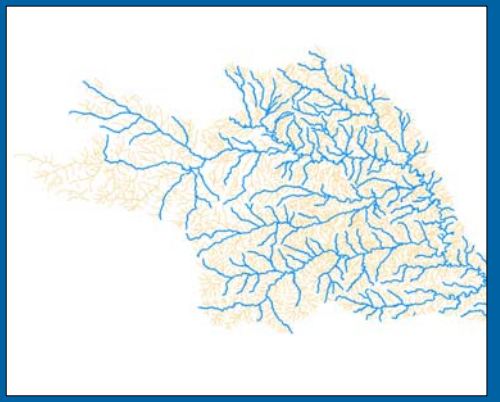
GNIS Names Hierarchy

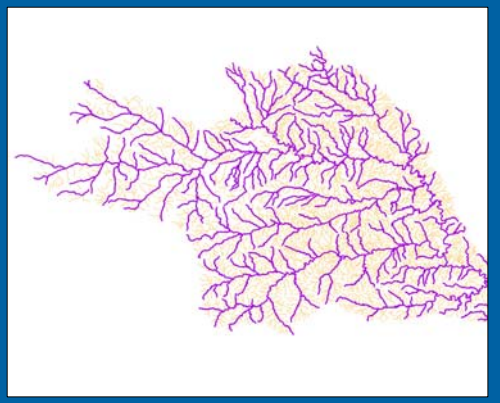
- Counts the number of stream segments with the same name, as indicated by the Geographic Names Information System (GNIS) attribute
- Aims to establish a hierarchy such that small streams with only one or two named segments are not selected
- A relative threshold value for the stream segment GNIS count 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.

All Named Segments

Name Hierarchy





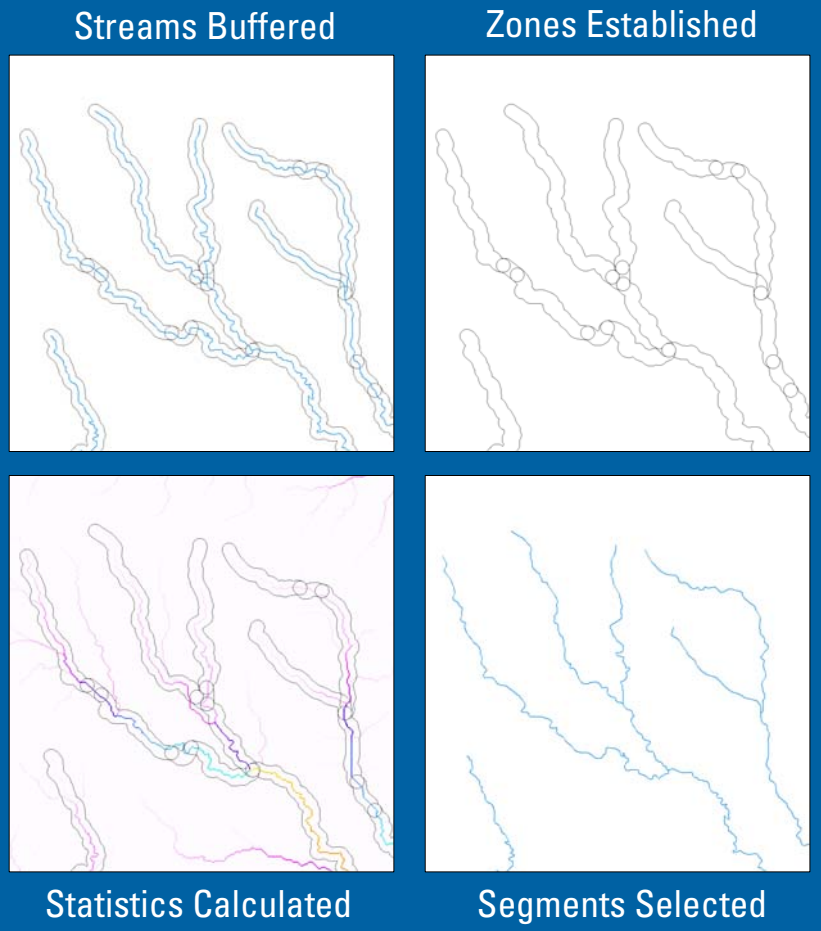
Final Method

USGS

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

Method Results: 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.



USGS

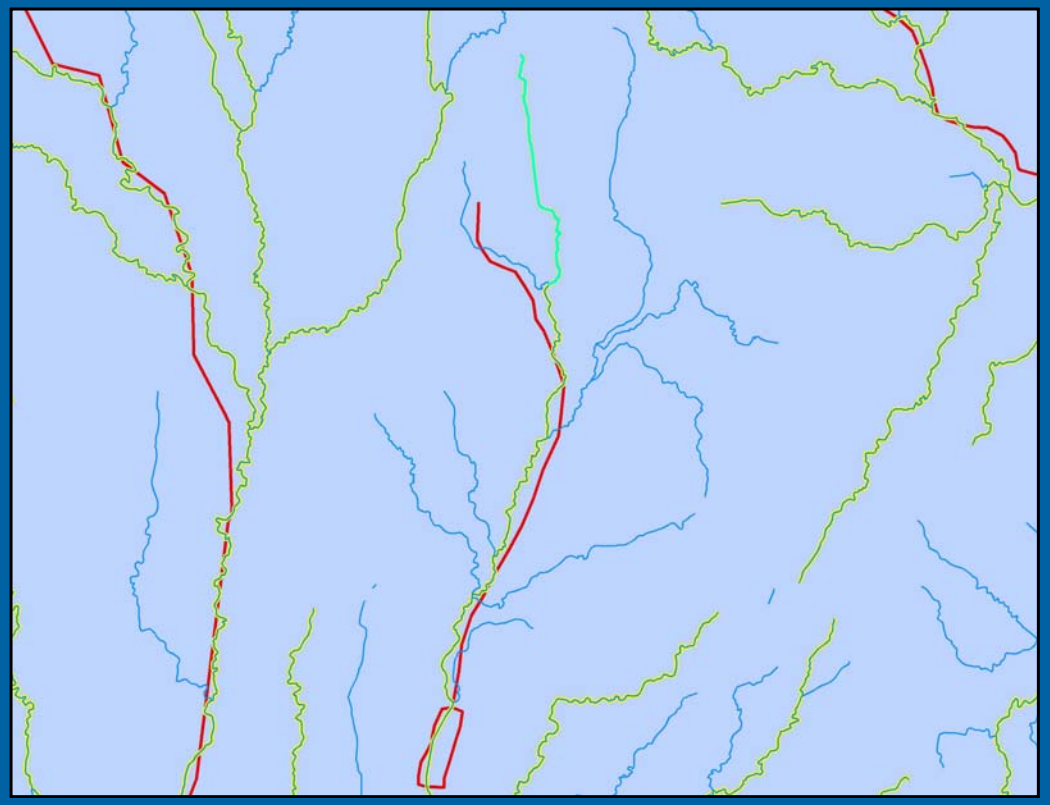
Final Method

- **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)

USGS

Attribute headwater reaches

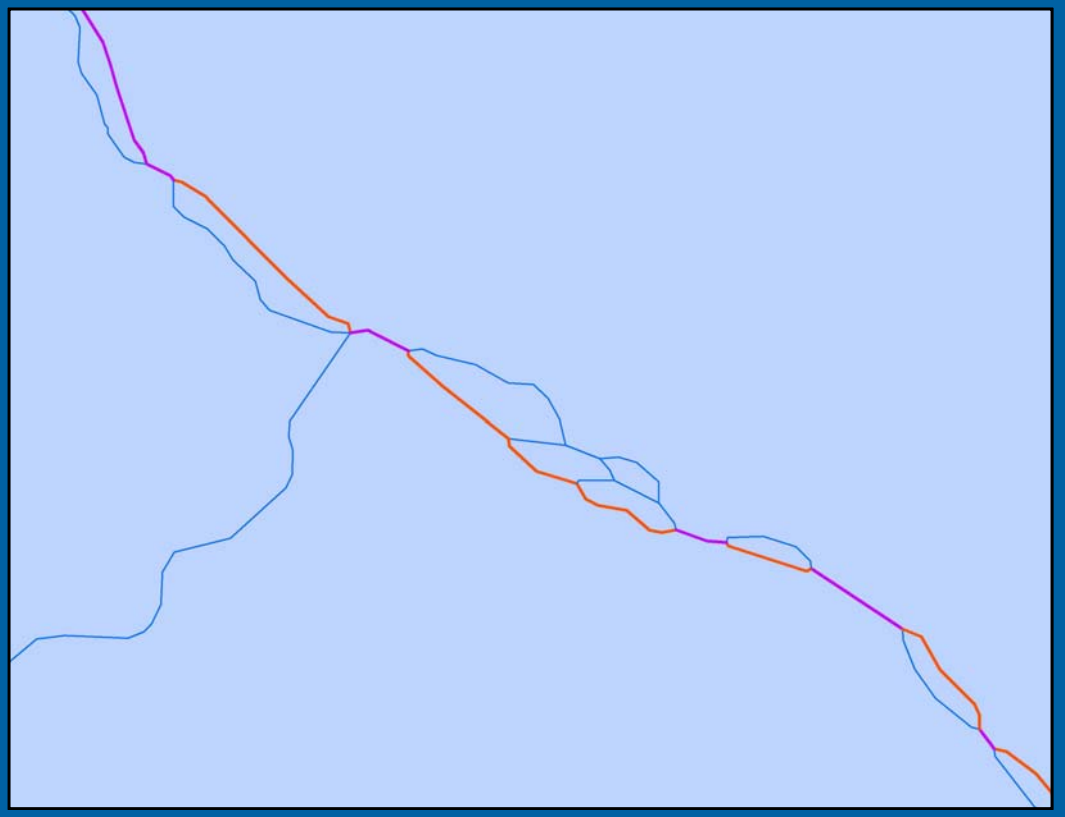
- GNIS names are important
- Include streams indicated by National Atlas, VMAP0, and IMW
- EDNA – if ambiguous



USGS

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

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



USGS

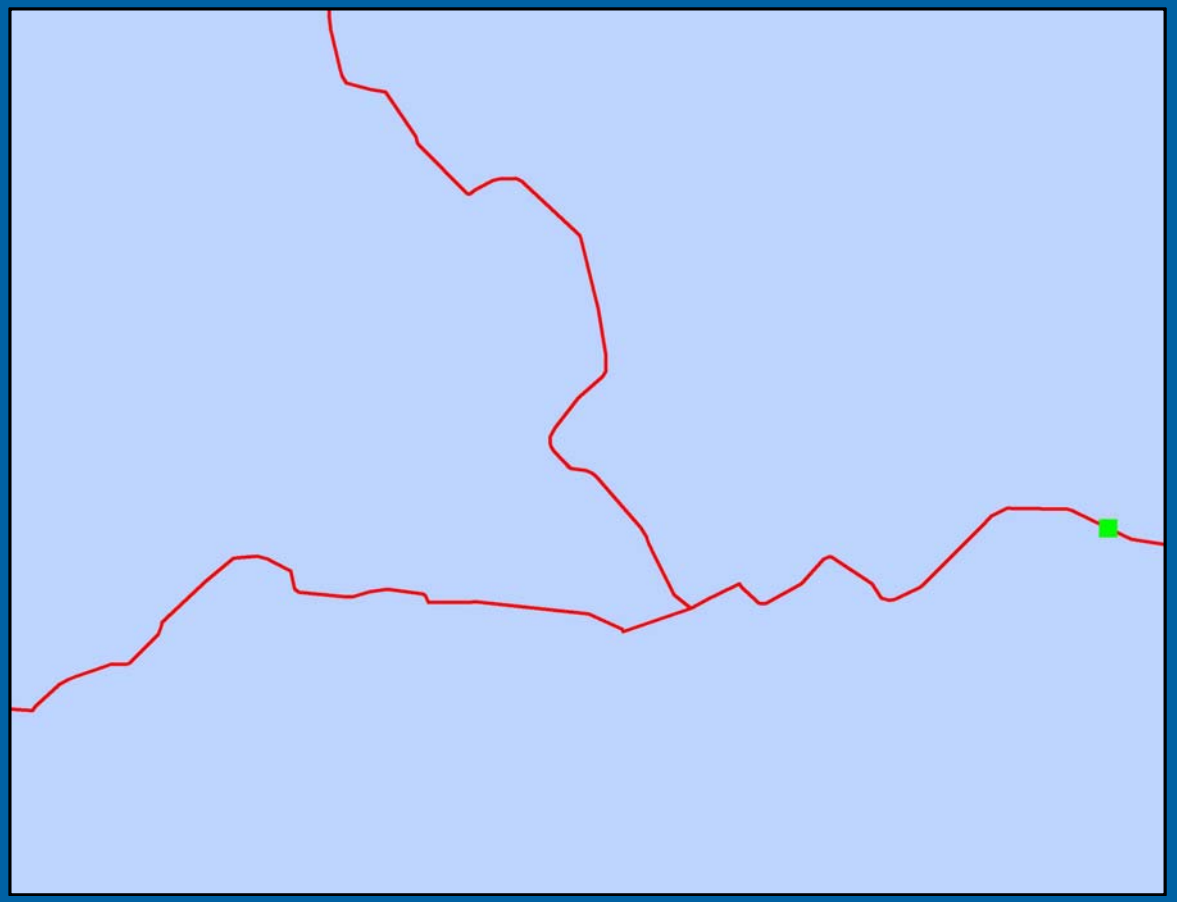
Handle other cases

- Digital orthoimagery
- EDNA
- Digital Raster Graphics

USGS

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



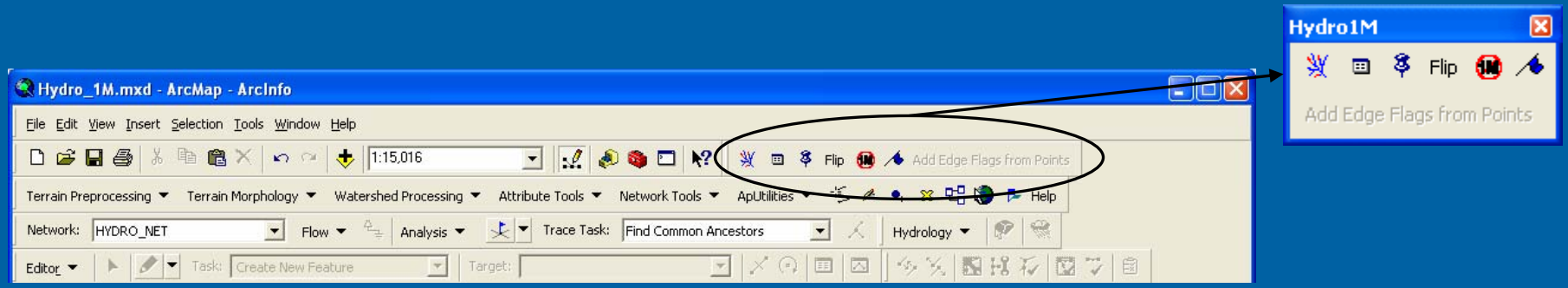
USGS

Final Method Summary

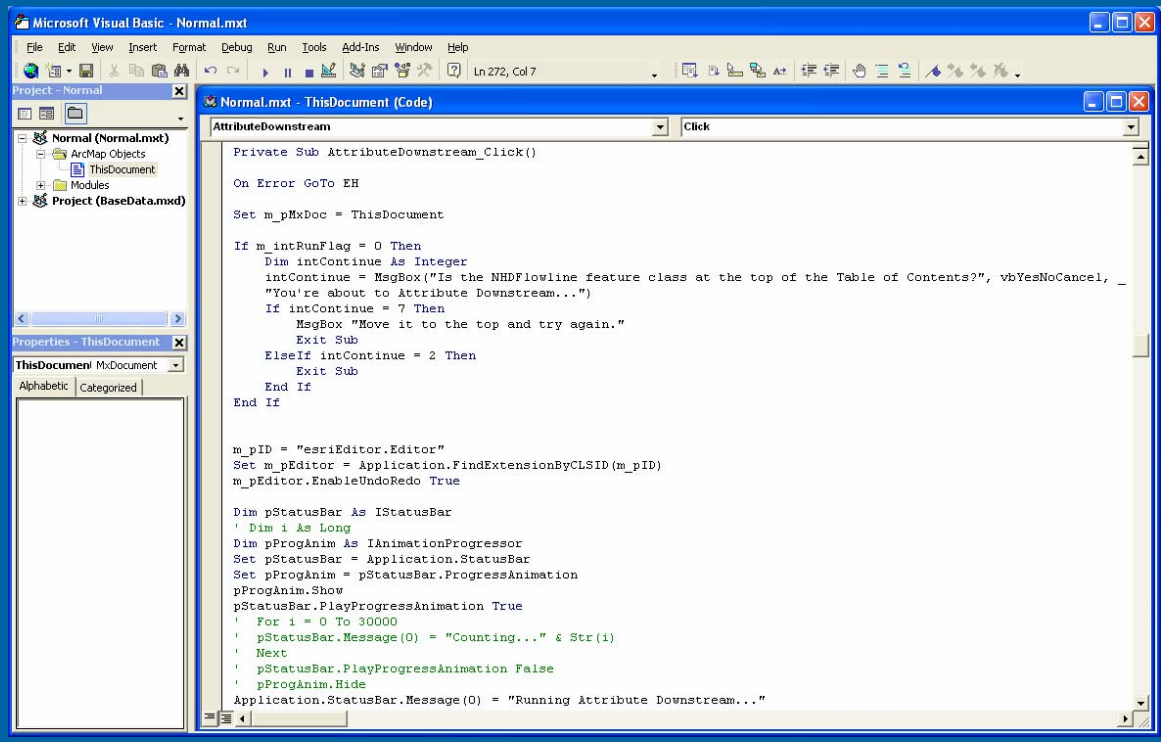
- Attribute headwater reaches
- Trace downstream algorithm
- Handle other cases
- Generalize streams

USGS

Custom VBA/ArcObjects tools

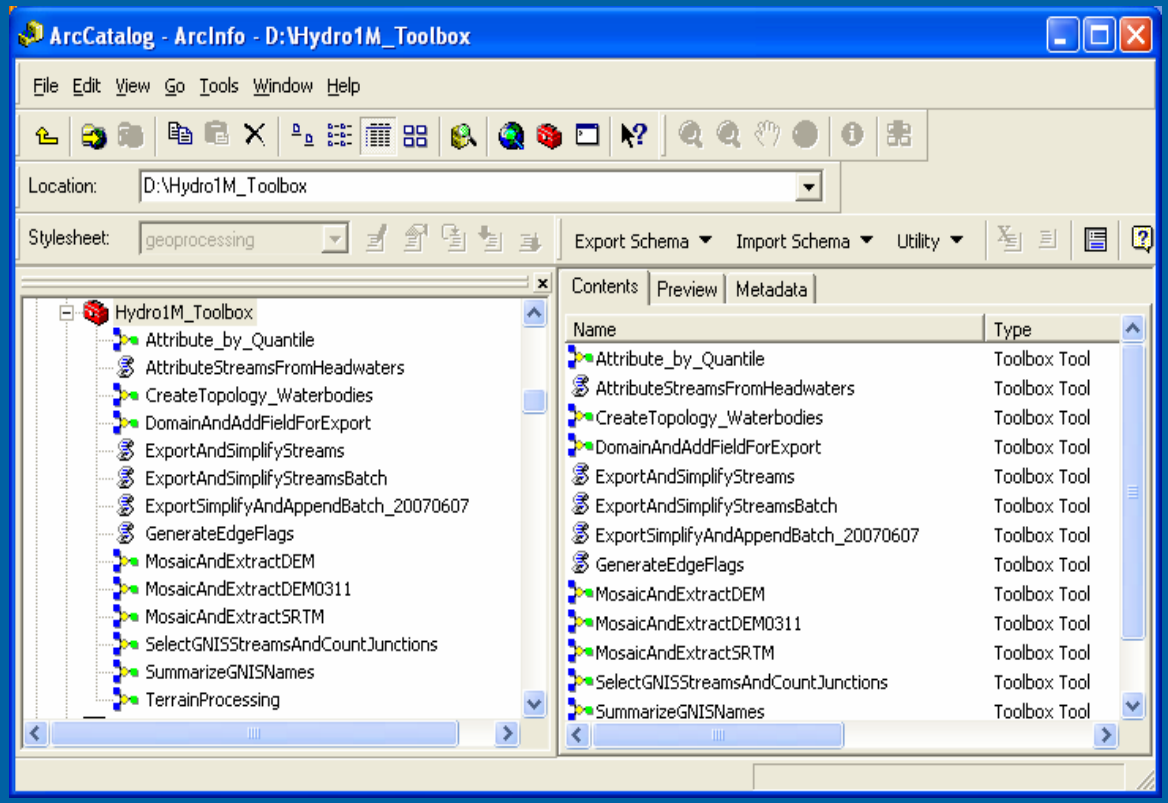


- CheckFields
- AttributeDownstream
- Flip
- SelectNon1M
- ResetRunFlag
- Help



USGS

Custom Python scripts



- 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

USGS

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	IMW
15	DRG
16	Canada
17	Mexico
18	Shortest segment
99	Manually excluded

USGS

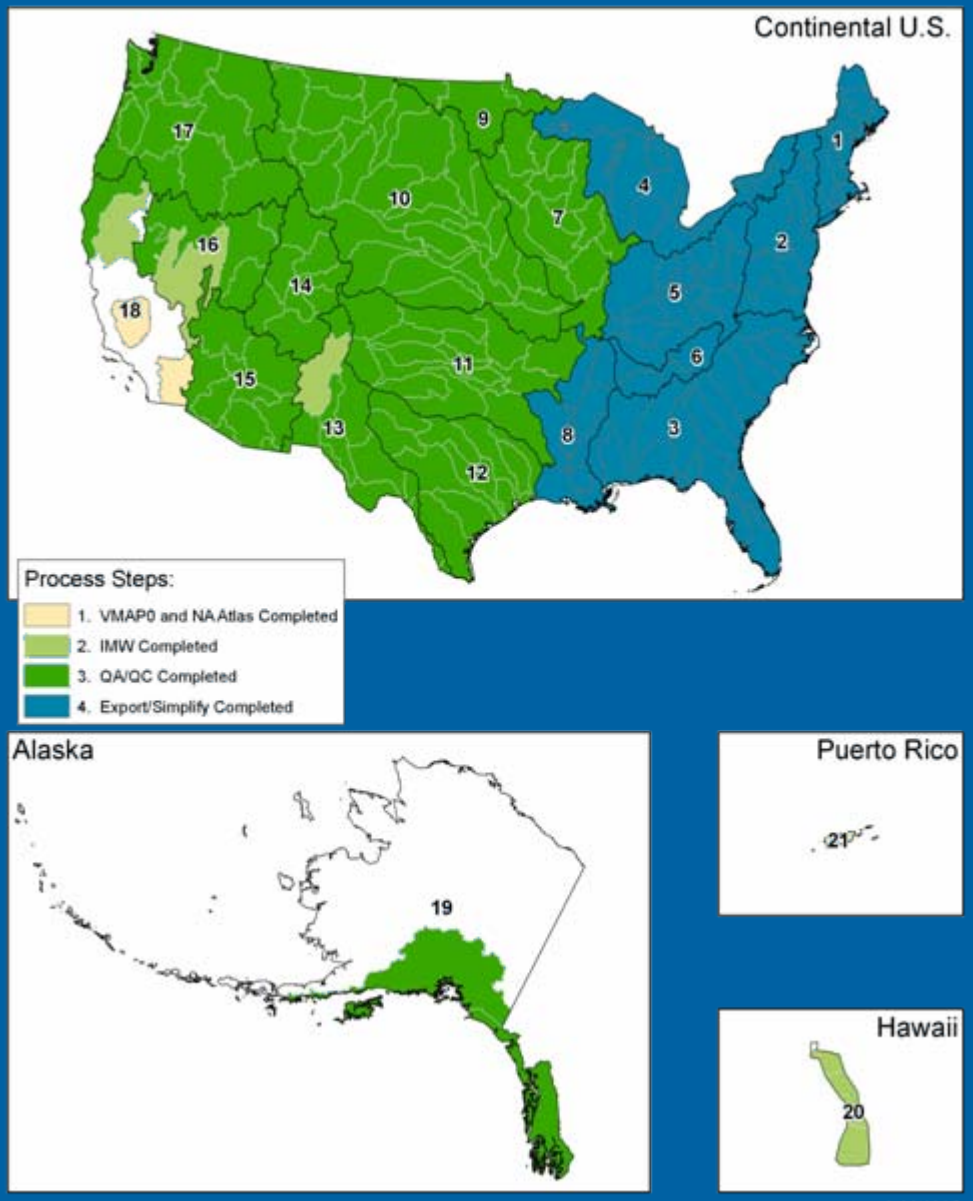
Conclusion

- 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

USGS

Water Courses Status Graphic



USGS

Acknowledgments

- **Jay Donnelly** – National Atlas of the United States
- **John Hutchison** – USGS, Sioux Falls, S.D.
- **Anna Regan** and **Andrew Murray** – Natural Resources Canada, Ottawa, Canada
- **Jose Luis Ornelas** – INEGI, Aguacalientes, Mexico
- **Sue Greenlee** and **Kris Verdin** – USGS, Sioux Falls, S.D.
- **Christy-Ann Archuleta, Christina Bowden, Case Watkins, Jean Parcher, Brian Reece, Daniel Pearson, William Asquith**, and **Peter Bush** – USGS, Austin, Tex.

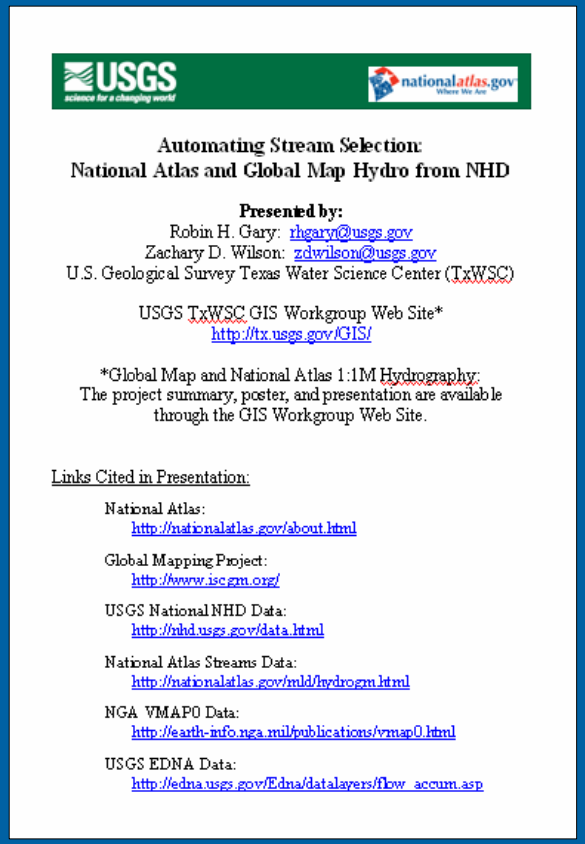
USGS

Thanks! Questions?

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

Robin H. Gary
rhgary@usgs.gov

Zachary D. Wilson
zdwilson@usgs.gov



USGS science for a changing world

nationalatlas.gov Where We Are

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

Presented by:
Robin H. Gary: rhgary@usgs.gov
Zachary D. Wilson: zdwilson@usgs.gov
U.S. Geological Survey Texas Water Science Center (TxWSC)

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.iscgm.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

USGS