The USGS StreamStats Web Application for California

Presented to the California Water Quality Monitoring Collaboration Network, April 12, 2012
What is StreamStats?

- A map-based Web application that provides information that can be used by engineers, hydrologists, managers, planners, and others to make informed decisions on water-related activities

- Primary products are basin delineations, basin characteristics, and estimates of streamflow statistics

- Provides information for gaged and user-selected ungaged sites on streams
Development Team

- John Guthrie, RMMC, programmer
- Al Rea, ID WSC, GIS specialist
- Kernell Ries, OSW, hydrologist, coordinator
- Pete Steeves, MA WSC, GIS specialist
- Dave Stewart, OSW, GIS specialist

Consultants
- ESRI – StreamStats application programming
- Aqua Terra – StreamStatsDB and NSS
Agenda

- Description of web pages and base functionality
- GIS data preparation for StreamStats
- Statistical underpinnings
- Stream network navigation in StreamStats
- Batch process and web services
- Future plans for StreamStats
- Summary of related activities being done by the CA WSC
  – Tony Gotvald Nancy Barth
Welcome to StreamStats

StreamStats is a Web-based tool that allows users to obtain streamflow statistics, drainage-basin characteristics, and other information for user-selected sites on streams. StreamStats users can choose locations of interest from an interactive map and obtain information for these locations. If a user selects the location of a U.S. Geological Survey (USGS) data-collection station, the user will get previously published information for the station from a database. If a user selects a location where no data are available (an ungauged site), a Geographic Information System (GIS) program will estimate information for the site. The GIS program determines the boundary of the drainage basin above the site, measures the physical characteristics of the drainage basin, and solves the appropriate regression equations to estimate streamflow statistics for the site. The results are presented in a table and a map showing the basin outline. The estimates assume natural flow conditions at the site. In the past, it could take an experienced person more than a day to estimate this information for an ungauged site. StreamStats reduces the effort to only a few minutes.

Separate applications have been established for each state that has implemented StreamStats. The state applications provide access to all of the functionality that is available for the state. The State Applications link at the left provides access to the individual applications. In addition to the state applications, a separate application has been established for serving information for USGS data-collection stations throughout the Nation. The USGS Station Statistics link to the left provides access to this application.

Some StreamStats options will not work in Netscape. The application continues to be improved and expanded. Please continue to come back to this page to see future enhancements. Contact us if you have any questions.

Users should familiarize themselves with StreamStats Description, Instructions, and Limitations (using the links on the left) before utilizing the application.

The StreamStats Web application provides access to automated procedures and very large, complex data sets. These data sets are known to contain occasional errors. Users are hereby advised to carefully check all results for accuracy and to exercise their own professional judgment in evaluating the appropriateness of the results for their application. Basin delineations in particular frequently have been found to be erroneous. The Web site provides tools and base maps useful for verifying the accuracy of the basin delineations.
National Station Statistics Site
Base Layers

StreamStats National Data-Collection Station Information

Zoom in to at least 1:5,000,000 to see gages. Click on a gage to get additional information.

Explanation:
- Gaging Stations
  - Continuous Streamgage
  - Lowflow Streamgage
  - Peak Flow Streamgage
  - Peak, Low, and Partial Record
  - Miscellaneous Record
- Unknown
- HUC 8
- HUC 12

Scale: 1:200,000

Imagery
### Streamgage Reports

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
<th>Citation</th>
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<td>Maximum daily flow</td>
<td>180000</td>
<td>cubic feet per second</td>
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<td>Minimum daily flow</td>
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<td>cubic feet per second</td>
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<td>Std of daily flows</td>
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<td>Average BFI value</td>
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<td>dimensionless</td>
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<td>years</td>
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<td>Std of annual BFI values</td>
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<td>Climate Characteristics</td>
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<td>Mean Annual Lake Evaporation</td>
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<td>inches</td>
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<td>Temperature Statistics</td>
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<tr>
<td>Mean Max July Temperature</td>
<td>79.9</td>
<td>degrees F</td>
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<tr>
<td>Mean Maximum January Temperature</td>
<td>51.9</td>
<td>degrees F</td>
<td>44</td>
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<tr>
<td>Mean Min January Temperature</td>
<td>38.000</td>
<td>degrees F</td>
<td>31</td>
</tr>
<tr>
<td>Mean Minimum July Temperature</td>
<td>47.4</td>
<td>degrees F</td>
<td>44</td>
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</tbody>
</table>

### Citations

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State Applications

Welcome to StreamStats

State Applications

StreamStats Application Status

Efforts are underway to make StreamStats operational for many states, with a long-term goal of national coverage. Work needed to implement StreamStats is generally done by the USGS in cooperation with various state and local agencies. The map below indicates states where StreamStats has been implemented, and where work on implementation is currently underway. Green states have fully implemented StreamStats applications, orange states have been completed and are in testing internally, and blue states are undergoing implementation. Users may access the implemented state applications by selecting the state of interest on the map below, or by selecting the name of the state from the list above.

- Fully implemented (Clickable)
- Delineation and basin characteristics implemented (Clickable)
- Implemented and testing internally
- Undergoing implementation
Users are cautioned that peak-flow estimates provided by StreamStats may be unreliable because the equations in Waananen and Crynen (1977) are based on analytical methods and data only through 1974, while the equations in Thomas and others are based on analytical methods and data only through 1986. The California Water Science Center is currently working on a study to update flood-frequency data and estimation methods throughout California.

Users are also cautioned that basin-characteristics data used in StreamStats to solve the regression equations were determined from national and regional Geographic Information Systems (GIS) data bases and may not exactly match basin characteristics measured manually from maps and other data sources in use at the time the equations were developed. In particular, estimation equations developed by Waananen and Crynen (1977) for several regions in California use a basin characteristic termed Altitude Index (I). This characteristic was determined to be equivalent to the Mean Basin Elevation provided by StreamStats multiplied by 0.00083. Users should familiarize themselves with the above reports and be aware of the data limitations before using StreamStats to obtain estimates of flood-frequency statistics for ungauged sites.

Attention!

Please help us conserve our server system resources and close the Interactive Map window when you are finished using it. Doing so will help ensure system availability for all users. Thank you.

Note that the User Instructions for this application include discussions of some tools for network navigation and estimating flows based on similar streamgages that are not yet implemented for California. It is planned to add these tools in the future.

Also, please bookmark this page, rather than the Interactive Map page, since the URL for the interactive map may change in the future.

We want your feedback! Please send any comments or questions that you have on StreamStats to the StreamStats development team at GS-W.StreamStats@usgs.gov.

StreamStats for California was developed in cooperation with the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, and the U.S. Forest Service.

Contact Us if you experience any problems with this application.
California User Interface
Help

For StreamStats user instructions (click here)

- A screen resolution greater than 1024 is required to see the 4 buttons on the right side the toolbar. These buttons include refresh, download, print, and help.

- If you are using IE8 and having difficulty with the interactive map, try turning the compatibility view on.
- Also see: Things_to_check_if_the_StreamStats_Application_is_not_working_for_you.pdf

General Instructions on the viewer

Getting started
Quick tour

Find
- Identify features on the map
- Search for features
- Measure distance and area
- Using Results

Explore the map
- Using the mouse
- Using the keyboard
- Using the Overview and Magnifier
- Using the Toolbar

Personalize
- Working with layers and map contents

More information
- System requirements
- Frequently asked questions and troubleshooting
- Getting more help and information
Working With Panels

Click on triangle to expand panel
Click on plus (+) sign to expand list
Display Streamgages
Navigation Panel

Click on points of compass to move map center
Overview Map
Results Panel / Identify Tool
Select Ungaged Site

Click on Watershed Delineation from a Point

Scale must indicate 1:24,000 or greater

Note canal is not included in stream network used for delineation
Delineated Basin
GIS Data for Watershed Delineations

- Data preparation is done by local offices using ArcHydro Data Model and Tools

- Data for boundary delineations
  - NHDPlus ([http://www.horizon-systems.com/nhdplus/index.php](http://www.horizon-systems.com/nhdplus/index.php)) was used for CA, OR, and WA
StreamStats Integrates NHD Streams, WBD Boundaries and NED Elevation in ArcHydro
Burning and Walling of DEM

Forces DEM to agree with stream network and WBD or locally digitized drainage boundaries
NHDPlus

NHDPLUS Version 2 IS COMING!!

NHDPlus Version 2 (NHDPlusV2) will soon begin its public debut on this website. The data will be released by hydrologic region beginning in late April/early May. An announcement will be sent to those who have signed up for the NHDPlus email list. To sign up for the email list, please send an email with your contact information to NHDPlus@hscnet.com.

The NHDPlus Team can be reached at NHDPlus@hscnet.com.

Horizon Systems and NHD Plus

As a member of the NHDPlus team, Horizon Systems is pleased to host the NHDPlus WEB site. NHDPlus is a project envisioned by the US Environmental Protection Agency. The EPA Office of Water, assisted by the US Geological Survey, has supported the development of NHDPlus to enhance the EPA WATERS application. NHDPlus is an integrated suite of application-ready geospatial data sets that incorporate many of the best features of the National Hydrography Dataset (NHD), the National Elevation Dataset (NED), the National Land Cover Dataset (NLCD), and the Watershed Boundary Dataset (WBD).

First released in 2006, the NHDPlus consists of nine components:

- Greatly improved 1:100K National Hydrography Dataset (NHD)
- A set of value added attributes to enhance stream network navigation, analysis and display
- An elevation-based catchment for each flowline in the stream network
- Catchment characteristics
- Headwater node areas
- Cumulative drainage area characteristics
- Flow direction, flow accumulation and elevation grids
- Flowline min/max elevations and slopes
- Flow volume & velocity estimates for each flowline in the stream network

In addition to working on the construction of the NHDPlus, Horizon Systems conducts NHDPlus training and technical support and develops tools for use with the NHDPlus data.
Bad Delineation from NHDPlus v1

- Best Slough near Wheatland,
  latitude 39.0236, longitude -121.5094
- Always carefully check boundaries before doing anything else
- Trace Flow Path in Watershed and Show Profile tool shows erroneous flow-direction grid in NHDPlus
- Please report any problems found by emailing GS-W_Streamstats_help@usgs.gov
Flow Statistics from Regression Equations

- Regression equation estimates assume natural flow conditions at the selected site
- Availability of equations varies among states
Example Regression Equation

Regression equations take the form:

\[ Q_{100} = 15.7A^{0.77}P^{1.02}H^{-0.43} \]

where:

- \( Q_{100} \) is the 100-year flood flow, cubic feet per second
- \( A \) is drainage area, in square miles
- \( P \) is a mean annual precipitation, in inches
- \( H \) is an altitude index, in 1000 feet

This equation is for the California Sierra Region from Waananen and Crippen, 1977
Get Basin Characteristics

**California StreamStats**

**Basin Characteristics Report**

- Date: Mon Apr 9 2012 12:56:06 Mountain Daylight Time
- NAD27 Latitude: 36.3254 (36 19 31)
- NAD27 Longitude: -119.0791 (-119 04 45)
- NAD83 Latitude: 36.3253 (36 19 31)
- NAD83 Longitude: -119.0800 (-119 04 48)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area, in square miles</td>
<td>72.3</td>
</tr>
<tr>
<td>Mean annual precipitation, in inches</td>
<td>22.5</td>
</tr>
<tr>
<td>Average maximum January temperature, in degrees F</td>
<td>55.4</td>
</tr>
<tr>
<td>Average minimum January temperature, in degrees F</td>
<td>36.5</td>
</tr>
<tr>
<td>Maximum elevation, in feet</td>
<td>5741</td>
</tr>
<tr>
<td>Minimum elevation, in feet</td>
<td>462</td>
</tr>
<tr>
<td>Relief, in feet</td>
<td>5278</td>
</tr>
<tr>
<td>Elevation at outlet, in feet</td>
<td>462</td>
</tr>
<tr>
<td>Average basin elevation, in feet</td>
<td>1728</td>
</tr>
<tr>
<td>Relative relief - Basin relief divided by basin perimeter, in feet per mile</td>
<td>79.2</td>
</tr>
<tr>
<td>High Elevation Index - Percent of area above 6000 feet</td>
<td>8</td>
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<tr>
<td>Altitude Index, in thousands of feet. Estimated as 0.00083 times mean basin elevation.</td>
<td>1.43</td>
</tr>
<tr>
<td>Mean basin slope computed from 30 m DEM, in percent</td>
<td>25.9</td>
</tr>
<tr>
<td>Percentage of basin covered by forest</td>
<td>10.4</td>
</tr>
</tbody>
</table>
Download Shapefile
Printing the Map
Other Tools for Use With Delineated Basins Not Yet Available for CA

- **Edit a Delineated Basin**
  - Add or remove areas

- **Edit Parameters and Recompute Flows**
  - Allows testing of scenarios

- **Estimate Flows Based on Similar Streamgaging Stations**
  - Estimates flows using nearby streamgages and drainage-area ratio method
  - Relies on stream network navigation
StreamStats provides reach addresses for user-selected sites, consisting of reach number and percentage distance from downstream end of reach.
Flow Estimation Based on Similar Gages

Flow Estimation Based on Similar Gages

Estimated flows for the user-selected site determined by weighting of regression equation-based estimates and nearby streamgaging station estimates.

<table>
<thead>
<tr>
<th>Flow</th>
<th>Flow Description</th>
<th>Regression Estimates</th>
<th>Drainage-Area Ratio Estimates</th>
<th>Weighted Estimates</th>
<th>Weighted Equivalent Years of Record</th>
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<tbody>
<tr>
<td>M7D10Y</td>
<td>7-Day 10-Year Low Flow</td>
<td>2.5</td>
<td>3.5</td>
<td>3.39</td>
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<tr>
<td>N7D02Y</td>
<td>7-Day 2-Year Low Flow</td>
<td>4.23999977</td>
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Flow-Duration Statistics

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<tbody>
<tr>
<td>D99</td>
<td>99 Percent Duration</td>
<td>D98</td>
<td>98 Percent Duration</td>
<td>D95</td>
<td>95 Percent Duration</td>
<td>D93</td>
<td>93 Percent Duration</td>
<td>D90</td>
<td>90 Percent Duration</td>
<td>D85</td>
<td>85 Percent Duration</td>
<td>D80</td>
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<td>D75</td>
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<td>D70</td>
<td>70 Percent Duration</td>
<td>D65</td>
<td>65 Percent Duration</td>
<td>D60</td>
<td>60 Percent Duration</td>
<td>D50</td>
<td>50 Percent Duration</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

See Ries, 2006, USGS Techniques and Methods Book 4-A6, p 9 for weighting equations

provided if RATIO >= 0.5 and <= 1.5
Network Tracing in StreamStats

- Configure trace
  - Specify layer used (NHD, NHDPlus, etc.)
  - Direction of tracing (upstream, downstream, both)
  - Participating event layers (gages, dams, etc.)
  - Load event layer

- Trace from delineated or ad-hoc point
  - Display identified reaches
  - Identify point events

- Raindrop trace to network
  - Display path from point to network, and downstream
  - Compute reach address at point on network
Network Profile Plots

- Trace flow path within a delineated watershed
- Show network path and profile
- Show main channel flow path and profile
Terrain Profile Tool

Plot of distance vs elevation HUC:01080204 63 points.

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<th>Z</th>
<th>X</th>
<th>Y</th>
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<td>112.69</td>
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<td>130972.83</td>
<td>893290.69</td>
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Maryland Water-Use Summaries

Net = Σ Discharges – Σ Withdrawals
Detailed Site Report

[values are in million gallons per day; FA-DV is a surface-water withdrawal, FA-OF is a surface-water discharge, GW is a ground-water withdrawal]

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>WATUSECD</th>
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<th>PERMITCODE</th>
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<td>SW Intake-Deer Creek at Street, MD</td>
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</table>

Available only for users with login privileges (mostly gov’t agencies)
StreamStats Web Services

Available for:

- Basin delineation
- Gaging station statistics
- Ungaged site statistics
- Compute NHD reach and measure
- More coming

See Available Web Services link from StreamStats home page for more information
StreamStats Results in Google Earth

Basin: UT Demo

For more information see:
StreamStats Web Services

- OD = 3083
- HydroID = 4575
- DrainID = 4575
- Name = UT Demo
- Description = WI 4060009
- GlobalWash = 1
- HUCID = 14060099
- DRAINAREA = 119.47
- ELEV = 9211.858
- BSLDEM100M = 39.924
- PRECIP = 25.616
- HERBNAT = 7.945
- PK2 = 293
- PK5 = 574
- PK10 = 866
- PK25 = 1340
- PK50 = 1780
- PK100 = 2420
- PK200 = 2840
- PK500 = 3720
Batch Processing


- Input: a point shapefile snapped to the stream grid

- Uses Web Services to perform the computations

- Emails the user when the output is available
National Implementation Status

- 27 states fully implemented
- 1 state partly implemented
- 10 states in implementation process
Planned StreamStats Enhancements

- Migration from ArcGIS Server 9.2 to 10, with web services for all functionality
- A single user interface for seamless access to all state and regional applications
- Estimation of daily flows for Connecticut R. and Delaware R. Basins, MA, PA, NY, IA, probably others
- Automated annual update of non-interpretive streamflow statistics
- Enhanced descriptive information and indicators of errors of computed statistics for streamgages
- Improved and expanded tracking of water use
- Improved documentation
Proposed new user interface
Proposed new user interface

- Displays all regional studies and state applications near the point that was clicked.
Questions or Suggestions?

- **URL**

- **Team email**
  - GS-W StreamStats@usgs.gov