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Perspective

What if… the United States of America were based on watersheds?

Gerald J. Kauffman*

College of Human Services, Education, and Public Policy, Institute for Public Administration, Water Resources Agency, University of Delaware, DGS Annex, Academy Street, Newark, DE 19711, USA

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Abstract

Watersheds know no political boundaries. Except for the borders of a few countries and a few of the United States, this adage is true. Most watersheds include many state, provincial, and local governments and this ''balkanization'' is what makes the policy of watershed management so complex. Employing an historical exercise in counterfactualism, ''what if'' the United States were originally delineated on a watershed basis? ''What if'' each state was originally delineated by watershed, basin, or hydrologic planning unit? What would we learn as watershed managers from this exercise? This article reviews a selected history of watershed management in the USA as it relates to the many laws, regulations, and river basin commissions that were created to manage water resources that cross political boundaries. There are several lessons that watershed managers can learn from this exercise in counterfactualism. Watersheds form the best hydrological planning units for land, water, and ecosystem management. The concept of the river basin commission is a particularly effective way to manage water resources. Opportunities should be sought in the USA and overseas to create and recreate governments based on watersheds. Prospects should be explored to delineate the boundaries of sub-government jurisdictions such as water, sewer, stormwater, or planning districts based on watersheds.

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1. Introduction

Watersheds know no political boundaries. Except for the borders of a few countries and a few of the United States, this adage is true. Most watersheds include many state, provincial county,

*Tel./fax: +1-302-831-4929.
E-mail address: jerryk@udel.edu (G.J. Kauffman).

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and local governments and this "balkanization" is what makes watershed management so complex.

In 1878, recognizing that the link between watersheds and public policy was critical, John Wesley Powell, the great explorer of the Colorado River, proposed that political jurisdictions conform to watersheds in the American west. For this progressive watershed management idea, Mr. Powell lost his job as the head of the US Geological Survey (Powell, 1878).

Bill Sharpe in an August 29, 1999 column in *The Washington Post* put it nicely when he wrote:

> Every student of hydrology quickly learns that the management of water resources only makes sense when it's done on a watershed basis. Governments, however, are organized by city, township and county boundaries, which are irrelevant to the natural scheme of things. Thus the challenge has been to make sensible water resources plans out of the nonsense of political subdivisions.

Most of the United States were not delineated based on watershed boundaries but rather by lines based on compass headings and natural features such as rivers. The borders of many states such as Pennsylvania along the east–west Mason–Dixon Line or polygonal Colorado and Wyoming were surveyed along the linear lines of latitude and longitude. Other states such as New Jersey along its Hudson River boundary with New York or the Vermont/New Hampshire line along the Connecticut River share meandering borders along rivers and waterways. Only the borders of a hand full of states such as West Virginia–Virginia and Idaho–Montana were delineated along watershed lines.

Since watershed and government boundaries usually do not coincide, watershed managers face complex institutional and governance challenges. For example, management of water resources in the 33,300 km^2 (13,000 square mile) Delaware River Basin presents unique inefficiencies because each of its four states (DE, NJ, NY, and PA) and dozens of counties administers its own set of disparate water quality regulations, stormwater ordinances, and politics. A small tributary of the Brandywine Creek is regulated as a cold water trout stream in Delaware whereas a few yards away across the border in Pennsylvania it is regulated as a warm water stream. Each of the four states issues a separate fishing license to fish in the waters of the basin. Every watershed like the Delaware River with more than one state or local jurisdiction faces similar complexities presented by the fragmented fiefdoms called governments.

2. What if?… a counterfactionalism exercise in watershed history

Many historians and scientists play "what if?" by altering events and then speculating on how the outcome would change. The "what-if?" exercise, called counterfactualism by scholars, is touted as a way to learn from the events of history. Perhaps it would be instructive to review a selected history of watershed history in the US and play "what if?" the boundaries of the states were based on watersheds. What would we learn as watershed managers from this exercise?

So "what if" the United States were originally delineated on a watershed basis? Other countries have done it. For instance, the borders of the Swiss Canton Valais are wholly based on the Rhone River watershed.

"What if" each state was originally delineated by watershed, basin, or hydrologic planning unit? Would watershed coordinators experience reduced institutional complexities in managing watersheds? Hypothetically, yes. If the state of Delaware were originally drawn along the boundaries of the Delaware River Basin, then there would be one set of water quality regulations instead of four, one set of stormwater ordinances, one fishing license, and one state political structure. A watershed-based State of Delaware would have a single governance and institutional structure to manage the water resources of this 530-km (330-mile) long river system. Water resources management would become streamlined and more efficient with the one state—one watershed approach.

3. An abbreviated history of watershed management

The word watershed was derived from the German *wasser-scheide* or water parting (Reimold, 1998). The German equivalent *wasser-scheide* has been in use since the 14th century. Also defined as a crucially important factor or event, the watershed is the region draining into a river or water body. As a scientific term, the English word watershed did not become common until about 1800. (Oxford English Dictionary, 1978).

When the original 13 colonies formed their boundaries and became states starting with the first state of Delaware in 1787, the concept of the watershed as a means for setting borders was probably primitive due to lack of a geographic sense of place and fledgling mapping skills. Surely the colonists recognized the concepts of ridges and the difficulties traveling west across the gaps of the Allegheny and Blue Ridge Mountains. But their understanding that these same ridges formed watershed boundaries was limited. In 1776, when George Washington (a general and land surveyor) crossed the Delaware River on Christmas Eve in a pivotal battle of the revolution, the dictionaries of the time did not list "watershed" as a word.

Colonial maps that listed watershed boundaries were primitive. A 1770 map of colonial Maryland, Virginia, and New "Jersey" located waterways such as the North Sea (Atlantic Ocean), Chesapeake Bay, and the Christina River, but except for a few hilltops, the ridges or watershed boundaries were not delineated. The 18th century and 19th century surveyors and mapmakers did not enjoy the modern GIS technology that we have today in accurately delineating watersheds.

Since the modern concept of "watershed" and map making skills were limited, the surveyors of state boundaries relied on more easily surveyed features such as rivers and compass bearings. Rivers and streams were easier to locate and delineate on the map. Along with these natural features, compass headings and latitude/longitudes became a basis for delineating state boundaries.

What if the state founders had GIS technology? Would more of the states have watershed-based boundaries?

4. Watershed-based political boundaries

Over the course of US history, let us explore a few cases where state boundary determinations are related to watershed management.

4.1. Delaware

The history of Delaware's state boundaries is a fine case study in how the historic survey of boundaries based on bearing and distance became problematic for modern watershed managers. Delaware has four major boundaries: the east–west boundary with Maryland, the north–south Mason–Dixon Line boundary with Maryland, the Delaware-Pennsylvania arc boundary, and the boundary with New Jersey along the Delaware River and Bay (Schenck, 2001).

Take the case of the north–south boundary. In 1764, Charles Mason and Jeremiah Dixon surveyed the north–south boundary which is Delaware's boundary with Maryland. This north–south component of the Mason–Dixon Line runs not more than a couple dozen miles west of the continental divide that separates the Delaware River and Chesapeake Bay drainages. If Mason and Dixon understood the concept of watershed management and had more sophisticated mapping and surveying skills, they might have surveyed Delaware's western boundary as the twisting divide between the Delaware and Chesapeake watersheds.

This linear survey became problematic for modern watershed managers as 25% of Delaware occupies the headwaters of rivers that flow to the Chesapeake. Because of the north–south boundary, the Eastern Shore of Maryland separates Delaware from the waters of the Chesapeake Bay. Partly because of this disconnect, Delaware did not choose to become a party to the Chesapeake Bay agreement. Think about how more efficient management of the Chesapeake and the Delaware watersheds would be if Mason and Dixon surveyed their line not on a northerly heading but rather along the meandering ridgeline that separates the drainages of these two estuaries.

4.2. Great Lakes

Two hundred years ago, the British put the border in the middle of the Great Lakes (instead of along the watersheds) to exclude other powers from intruding (Durfee, 2000). Rather than the tradition of setting borders along waterways, this was a conscious policy by the British to demilitarize the Great Lakes. The International Joint Commission was later formed in the 20th century to manage the watersheds of the Great Lakes (Galloway & Clamen, 2001).

4.3. Virginia/West Virginia

In the 1860s, Virginia and West Virginia became two of only a few states that share watershed-based boundaries. Consider the case of how Virginia split into east and west Virginia (George Mason University, 2001). During the Civil War, residents of the western third of Virginia beyond the Blue Ridge voted to back the Union and secede from Virginia which had joined the Confederacy. In June 1863, West Virginia became a separate state with the boundaries fixed more or less along the ridges of the Blue Ridge Mountains. The boundaries of the Greenbrier River watershed in WV constitute a lengthy boundary between east and west Virginia.

With the split of the two states, Virginia was now oriented geographically toward the Chesapeake Bay drainage and West Virginia was oriented to the Ohio River and Mississippi River

drainages. A century—old boundary decision has become a modern-day watershed manager's desire. Imagine that—state boundaries based on watersheds!

4.4. Montana/Idaho

In 1889 Montana and in 1890 Idaho were admitted to the union as the 41st and 43rd states. Both states share a watershed border along the Great Divide of the Rocky Mountains that is the high ground that separates the drainages of the Atlantic from the Pacific and Arctic Oceans (Coffman, 2001). The crest of the Bitterroot Mountain range forms a large section of the Idaho–Montana boundary, which separates the watersheds of the east flowing Mississippi/Missouri rivers from the west flowing Columbia River.

Fortunately for modern watershed managers a portion of the boundary between Montana and Idaho was set along the Continental Divide. Now if only the boundaries of rectangular Wyoming, Colorado, and New Mexico were delineated along the Rocky Mountain ridge instead of along the grid of the township and range system.

In 1878 John Wesley Powell, the great explorer of the southwest and the Colorado River, lost his job as head of USGS for proposing that political jurisdictions conform to watersheds in the west. His idea was to link watersheds and public policy. If Mr. Powell's foresighted idea were taken seriously, these rectangular states of the west like Arizona and Nevada would have looked different and water resources may have been managed more efficiently with borders based on watersheds

5. A chronology of watershed laws and regulations

States boundaries largely do not follow watersheds. However, many laws and regulations have evolved to address interjurisdictional and interstate watershed issues (Dzurik & Theriaque, 1996). The following sentences summarize a brief chronology of water resources legislation that strives to achieve interstate watershed coordination:

Rivers and Harbors Act of 1899: Provided authority for US Army Corps of Engineers to exercise control over all construction in navigable waters of the US.

Reclamation Act of 1902: Congress created the Bureau of Reclamation and authorized the Secretary of Interior to construct irrigation projects, reservoirs, and diversion canals (many that became interbasin and interstate transfers) in the western states and territories.

Boundary Waters Treaty of 1909: Expresses concern over water diversion and pollution in waters that cross the US/Canada Border. The International Joint Commission was created by the US and Great Britain to address water resources problems in these trans-boundary waters (Galloway & Clamen, 2001).

River Basin Study (308 Act) of 1925: Congress authorized the US Army Corps of Engineers to complete comprehensive river basin studies, called 308 reports, throughout the US (Priscoli, 2000). These reports contributed to a series of river basin commissions in later decades.

Federal Water Pollution Control Act of 1948: One of the first pieces of environmental legislation enacted by Congress. Required states to determine which lakes and streams had become polluted.

Water Resources Council of 1965: The WRC was formed at the executive level and consisted of cabinet members to advise the president at the highest level on water resources matters. The WRC was dissolved in 1982.

Wild and Scenic Rivers Act of 1968: Administered by the US National Park Service to preserve the free flowing nature of waterways that possess outstandingly remarkable values. In 2000, the President and Congress signed legislation designating the White Clay Creek in Delaware and Pennsylvania as the first wild and scenic river designated on a watershed-wide basis instead of a river corridor basis.

National Environmental Policy Act of 1969: Requires an environmental impact statement (EIS) for federal actions that affect the quality of the human environment. NEPA also created the Council on Environmental Quality which was put under presidential jurisdiction.

Federal Water Pollution Control Act Amendments of 1972: Spurred by the first Earth Day activities in 1970, these amendments reflected a new approach which prohibited point source discharges of pollutants into waterways without a permit.

Clean Water Act of 1977: The stated intent was to restore the fishable and swimmable status of the nation's waters by 1983. Several notable sections of the CWA which affect interstate waters include:

Section 404—required dredge and fill permits to protect navigable waters and wetlands.

Section 401—created national pollutant discharge elimination system (NPDES).

Section 208—required statewide and areawide pollution control planning, which was the basis for forming many regional watershed management agencies throughout the US such as the Water Resources Agency for New Castle County in Delaware.

Section 303d—requires total maximum daily loads (TMDLS) for watersheds which do not meet state water quality standards.

Water Quality Act of 1987: First serious effort at the federal level to control nonpoint sources of pollution such as stormwater from urban and agriculture uses.

Safe Drinking Water Act Amendments of 1986 and 1996: Set enforceable federal drinking water standards including wellhead protection program in 1986 and Source Water Protection Program in 1996. The source waters of drinking water intakes are typically intrastate and interstate watersheds.

6. Watershed management agencies and entities

Since watersheds generally do not honor political boundaries, regional watershed and river basin management agencies and entities were created at the Federal, local, or nonprofit level to manage water resources. Mr. Sharpe called for "blowing the dust" off the old water resources council and river basin commissions to start meaningful, integrated water resources planning on a watershed-by-watershed basis. The following notable programs were formed during the 20th century as governance and stewardship structures to manage watersheds and associated political jurisdictions:

1922 Colorado River Agreement: Delegates from the seven Colorado River basin states signed an agreement to apportion the river water between the upper and lower river basin states

(Gelt, 2001):

- Upper Basin—Colorado, New Mexico, Utah, and Wyoming.
- Lower Basin—Arizona, California, Nevada.

1933 Tennessee Valley Authority: During the depression, President Roosevelt and Congress passed the TVA act to manage water resources and provide energy in the Alabama, Georgia, North Carolina, Tennessee, and Virginia portions of the Tennessee River watershed. Under the TVA Act of 1933, the Tennessee Valley Authority has statutory authority to manage the multi-state basin of the river and tributaries for flood control, power production, and navigation Feldman, 2001).

1945 Brandywine Valley Association: Thirty people from West Chester, Pennsylvania and Wilmington, Delaware got together to form the first small watershed association in America (Brandywine Valley Association, 2001).

1961 Delaware River Basin Commission: A compact was established between the governors of NY, NJ, PA and DE and Presidential appointee to manage the 33,300 km^2 (13,000 square mile) watershed on the basis of comity (Delaware River Basin Compact, 1961).

1970 Susquehanna River Basin Commission: An intergovernmental compact was established between MD, NY, PA, and Congress to manage the 70,400 km^2 (27,510 square mile) watershed and its rivers.

1972 Florida Water Resources Act: The Florida legislature established regulatory authority to create five water management districts based on hydrologic boundaries rather than political boundaries:

- Northwest Florida Water Management District
- Suwanee River Water Management District
- St. John River Water Management District
- Southwest Florida Water Management District
- South Florida Water Management District.

1983 Chesapeake Bay Agreement: Joint agreement signed between the governors of MD, PA, VA, Mayor of District of Columbia, USEPA, and Chesapeake Bay Commission to restore the waters of this fragile estuary.

1995 State of Delaware Whole Basin Program: The whole basin approach focuses on protecting Delaware's environment by managing the air, fish, wildlife, parks, recreation, and water resources in a coordinated fashion—by drainage basin (Delaware Department of Natural Resources and Environmental Control, 1997). For environmental protection purposes, Delaware is managed by four basins:

- Piedmont Basin
- Chesapeake Bay Basin
- Delaware River/Bay Basin
- Inland Bays/Atlantic Ocean Basin.

7. The United States (Watersheds) of America

So using the principle of counterfactualism, what if the states were based on watersheds or river basins? What if the surveyors and founders of the United States had a modern understanding of watershed management and GIS mapping skills? Well, the United States would look like Fig. 1 where the states would take on the shape of the major river basins.

In a watershed-based USA, preference on redistricting would be given to states that possess a river's name. In the modern watershed manager's ideal, the State of Delaware would include the entire 33,000 km^2 (13,000 square mile) Delaware River Basin instead of a small 2560 km^2 (1000 square mile) portion of it. The State of Colorado would include the land area of the entire Colorado River Basin instead of occupying just the headwaters. Ohio would include the entire Ohio River Basin.

Using the watershed boundary delineation approach, there would be 36 states instead of 50. Headwater states like Indiana, Kentucky and West Virginia would merge with Ohio to become an

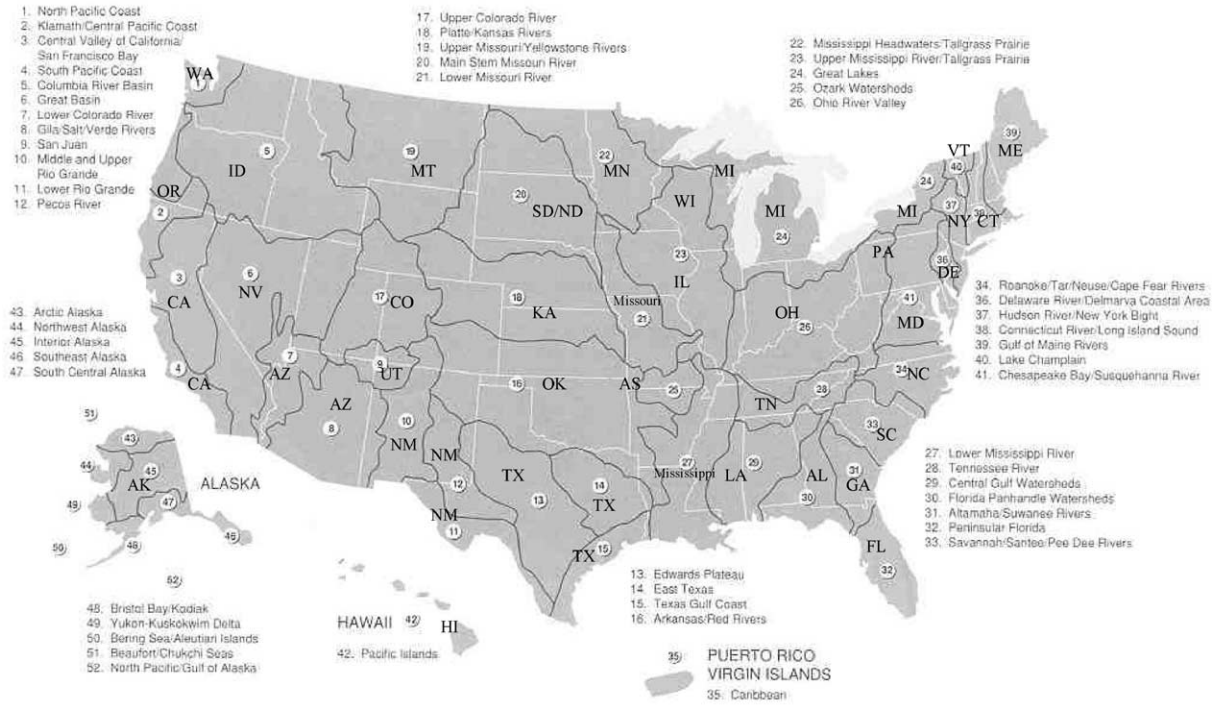

Fig. 1. The United States (Watersheds) of America. This map shows the US under the hypothetical scenario assuming the states were delineated on a watershed basis. The lighter lines are the traditional state boundaries. The darker lines are the boundaries of the major river basins and watersheds in the US While redelineating the states based on watersheds may be impractical, this map provides the basis for forming interstate river basin commissions for watersheds that do not currently have one.

Ohio River Valley based state. Massachusetts, New Hampshire and Rhode Island would become part of the new Connecticut River based state.

Several watershed-based states would become larger and some would become smaller. States like California, Texas and Pennsylvania would lose land. Small states like Delaware and Connecticut would become significantly larger if they took on the shape of the river basin that shares their name.

Yes, from a watershed manager's perspective, would not it be nice if the states were based on watersheds? Table 1 lists the 50 traditional United States and 36 redelineated states if they were based on watersheds.

8. Watershed history lessons

The redefinition of the United States based on basin boundaries may seem like a whimsical "what if…?" dream of a water coordinator. Yet there are several lessons that watershed managers can learn from this exercise in historic counterfactualism.

1. *Watersheds form the best hydrological planning units for land, water, and ecosystem management*: Since most political boundaries do not follow basins, modern watershed planning agencies such as the Brandywine Valley Association, the Delaware River Basin Commission, and the Florida Water Management Districts have evolved as the next best way to meet the governance, institutional, and technical challenges of water resources management. In the National Water Commission report (1973) the National Water Commission concluded "States should consider the use of river basin authorities…in the planning and management of their water resources. States should also consider the use of river basin authorities in combination with an interstate compact commission for rivers flowing between two states." These words were wise in 1973 and remain so today. The map of the US and watersheds in Fig. 1 provides the basis for creating river basin commissions in areas that yet do not have one.
2. *Seek opportunities to create and recreate governments based on watersheds*: As most governments in the US were formed years ago, opportunities for redelineating political boundaries based on watersheds are rare. However, when occasions arise to create or add onto new towns through annexation or incorporation, then consider delineating the expanded town boundaries based on watersheds. The forming of new democracies overseas may provide excellent opportunities to establish the boundaries of new countries or states or provinces based on watershed lines.
3. *Explore opportunities to delineate the boundaries of sub-government jurisdictions such as water, sewer, stormwater, or planning districts based on watersheds*: For instance, in New Castle County, Delaware, two watersheds are protected as overlay zoning districts in the planning code utilizing impervious cover thresholds (Kauffman & Brant, 2000). The Dane County Lakes and Watershed Commission in Wisconsin has positive experiences in dealing with intergovernmental tensions through a substate institutional arrangement in watershed management (Nakamura & Born, 1993). While it may not be practical to redelineate the

Table 1
Hypothetical United States based on watershed boundaries

Traditional state	Watershed-based
1. Alabama	Gulf/Panhandle
2. Alaska	Arctic/Bering Sea
3. Arizona	L. Colorado/Gila R.
4. Arkansas	Ozark River
5. California	Sacramento River
6. Colorado	U. Colorado River
7. Connecticut	Connecticut River
8. Delaware	Delaware River
9. Florida	Peninsular Florida
10. Georgia	Altamaha/Suwanne
11. Hawaii	Pacific Island
12. Idaho	Columbia River
13. Illinois	U. Mississippi/Praire
14. Indiana	(becomes Ohio River)
15. Iowa	(becomes middle Missouri)
16. Kansas	Platte/Kansas Rivers
17. Kentucky	(becomes Ohio River)
18. Louisiana	Central Gulf
19. Maine	Gulf of Maine Rivers
20. Maryland	Chesapeake Bay
21. Massachusetts	(becomes Connecticut R.)
22. Michigan	Lake Michigan
23. Minnesota	Mississippi headwaters
24. Mississippi	L. Mississippi River
25. Missouri	L. Missouri River
26. Montana	U. Missouri/Yellowstone
27. Nebraska	(becomes Platte River)
28. Nevada	Great Basin
29. New Hampshire	(becomes Connecticut R.)
30. New Jersey	(nowHudson/DelawareR.)
31. New Mexico	Rio Grande/Pecos Rivers
32. New York	Hudson River
33. North Carolina	Roanoke/Tar/Neuse R.)
34. North Dakota	Main Stem Missouri R.
35. Ohio	Ohio River Valley
36. Oklahoma	Arkansas/Red River
37. Oregon	Central PacificCoast
38. Pennsylvania	Susquehanna River
39. Rhode Island	(becomes Connecticut R.)
40. South Carolina	(Savannah/Santee Rivers)
41. South Dakota	(now Main stem Missouri
42. Tennessee River	Tennessee River
43. Texas	Edwards/East Texas Gulf)
44. Utah	San Juan River
45. Vermont	Lake Champlain
46. Virginia	(Chesapeake Bay)
47. Washington	Northern Pacific Coast

Table 1 (*continued*)

Traditional state	Watershed-based
48. West Virginia	(Ohio River Valley)
49. Wisconsin	(Upper Mississippi River)
50. Wyoming	(Missouri/Colorado River)

boundaries of state or local governments by watersheds, it remains feasible to redraw the boundaries of public water and sewer and planning districts based on hydrologic boundaries.

In the idealistic world of the water resources manager, watersheds *would* know political boundaries. In reality they mostly do not, but governance mechanisms such as water laws, river basin commissions, water districts and watershed associations are the next best thing.

What if… John Wesley Powell's watershed policy ideas were taken seriously 125 years ago?

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