October 13, 1893. One-armed explorer John Wesley Powell strides onto the stage at the National Irrigation Congress in Los Angeles, to the swelling sounds of a choir praising "plenty's horn." Years before, Powell had been asked to map the uncharted Colorado River Basin and assess the river's capability of sustaining Western development – a perilous 1,000-mile paddle involving the first known passage through the Grand Canyon.

Everyone expects the national hero to add his ringing verse to the go-go jingoism of the Gay Nineties, like that of Irrigation Congress founder William E. Smythe, who famously declared, "When Uncle Sam puts his hand to a task, we know it will be done. When he waves his hand toward the desert and says, 'Let there be water,' we know that the stream will obey his command."

Instead, the audience gets a splash of cold water. "Gentlemen," Powell begins, "it may be unpleasant for me to give you these facts. I hesitated a good deal but finally concluded to do so. I tell you, gentlemen, you are piling up a heritage of conflict and litigation of water rights. For there is not sufficient water to supply the land." He is booed off stage.

December 12, 2012. Secretary of the Interior Ken Salazar holds a teleconference about the Bureau of Reclamation's first-of-its-kind study of the Colorado River Basin. When he announces the findings, it is as if Powell is speaking from the grave: There will not be sufficient water in the Colorado River during the next 50 years to supply the land. By 2060, the water deficiency could be more than 3.2 million acre-feet annually – the amount of water 3.2 million households use every year.

"We are in a troubling trajectory in the Colorado River basin," Salazar says. "We need to reduce our demand. We also need to look at increasing our water supply through practical, doable, common sense measures."

This time, there is no booing. The country had already seen Powell's predictions come true: the low-water marks on the lakes, the disappeared delta, the "heritage of conflict and litigation of water rights." This time, the forecasting of water shortages is not an inconvenient truth but, as Salazar says, "a call to action."

The Colorado River springs to life from snowmelt in the Never Summer Mountains northwest of Denver, then races through the Rockies. Almost immediately, much of the water is yanked away by the man-made Grand Ditch and sent to quench the Front Range Urban Corridor of Colorado and Wyoming. The remainder moseys south through the Kawuneeche Valley to the Colorado Big Thompson Project, where it's pumped and jostled through multiple reservoirs and aqueducts that carry away part of the flow to meet the needs of about 800,000 Coloradans. The rest of the river treks west, past tributaries like the Fraser and Roaring Fork rivers, which would contribute more water to the greater current were they not dammed themselves. When the river reaches the Grand Valley Diversion Dam, more of it is sent to work irrigating the farms of western Colorado's fruitful Grand Valley.

The Colorado continues southwest, where it meets its first major tributary, the Gunnison, itself weakened by eight dams. The river then crosses into Utah, gets recharged a bit by the Dolores River (dammed thrice) and meanders through Canyonlands National Park. There, its ruddy rapids clash with the pea soup flows of the Green River, and it tosses kayakers as it tumbles through Cataract Canyon. It calms as it plunges into Lake Powell, created when Grand Canyon-lookalike Glen Canyon was flooded by Glen Canyon Dam. Here, the river begins to reveal signs of diminishing: The rusty rocks are striped with a tall, white "bathtub ring" – the ghost of liquid past. After plodding through the dam, which helps provide hydroelectricity to about 5.8 million people, the river dashes and drifts through its most famous offspring, the Grand Canyon. Then it enters Lake Mead – also white-striped, a bit cotton-mouthed – which stores water for Southern California, Arizona, and Mexico, and sends water to the shower heads and fountains of Las Vegas.

The river generates hydroelectric power at Hoover Dam, then journeys down bone-dry western Arizona before slamming into a series of dams – Davis Dam, Parker Dam, Headgate Rock Dam, Palo Verde Diversion Dam, Senator Wash Dam, Imperial Dam, Laguna Dam, Morelos Dam – each sucking it drier as it shambles southward.

Finally, after enduring a 1,450-mile journey and more than 100 dams in its basin, the Colorado River crawls across the puzzle-cracked mudflats of northern Mexico toward its rightful destination, the Sea of Cortez. Parched, emaciated and choked with dust, it stretches its withered hand toward the ocean, but, 90 miles short of it, dies.

The Colorado River hasn't reached the sea since the late 1990s. "What once was probably one of the eight wonders of the world – the immense and diverse Colorado River Delta – is no more," says Pat Graham, Arizona state director of the Nature Conservancy.

In 1922, environmentalist writer Aldo Leopold explored the Colorado River Delta by canoe. In those days, the estuary rippled and flowed across almost 3,000 square miles. Leopold describes the journey in an essay called The Green Lagoons: "On the map the Delta was bisected by the river, but in fact the river was nowhere and everywhere, for he could not decide which of a hundred green lagoons offered the most pleasant and least speedy path to the gulf... The still waters were of a deep emerald hue... A verdant wall of mesquite and willow separated the channel from the thorny desert beyond. At each bend we saw egrets standing in the pools ahead, each white statue matched by its white reflection."

But 1922 was a life-altering year for the river. The Colorado River Compact was signed, sluicing its water between the seven basin states – Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California – plus Mexico. At the time, the Reclamation Service estimated the Colorado's average annual flow to be 17.5 million acre-feet, so they divvied up the water accordingly. The so-called Upper Basin states would get 7.5 million acre-feet, the Lower Basin States would get 8.5 million, and Mexico would get 1.5 million. This might have worked out swimmingly (population booms, dam-mania, and global warming notwithstanding) if the average annual flows had actually been 17.5 million acre-feet. However, scientists

have since discovered that 1922 was part of an unusually wet period and that the river now averages about 14.7 million acre-feet annually. "So when everybody is fully utilizing their allocation, there wouldn't be enough water," Graham says.

Fulfilling Powell's prediction, over the decades the Colorado River became "the most dammed, dibbed and diverted river basin in the world," according to the 2012 documentary *Watershed*. The river provides water to about 33 million people for municipal use, and about 70 percent of it goes to irrigate 4 million acres of agricultural land. It's the umbilical cord of 11 national parks, seven national wildlife refuges, and four national recreation areas. Hydropower facilities along its course produce more than 4,200 megawatts of generating capacity. Every year, more than 57 billion gallons of its water are tapped for fossil fuel extraction and processing, and that number is expected to double in the near future, according to *Watershed*. In many ways, the river serves the entire country. During winter, Yuma-area farms furnish 90-plus percent of the nation's leafy vegetables, meaning that a New Yorker who orders Cobb salad in January bites into iceberg lettuce that bursts with Colorado River water. If you drink California milk, sip Colorado beer, or wear U.S.-made cotton T-shirts, you probably have the Colorado River to thank.

So despite the fact that the Bureau of Reclamation's 2012 study was the first of its kind – corralling a more diverse group of governmental, environmental, and private stakeholders than other studies, plus factoring in population growth and climate change estimates – the prognosis of water shortages was not unexpected. Powell had suggested the Colorado could sustain pockets of pioneers and frugal farmers. But according to the study, as many as 76.5 million people could be depending on the river by 2060. Climate change will raise temperatures, increasing evaporation and replacing some Rocky Mountain snow (which provides 75 percent of the river's water) with rain, which doesn't release water at the right time to adequately fill the reservoirs, Graham says. The study projects perhaps a 10 percent decline in river water. But there are numerous variables – not to mention rivers – within the basin, so pinpointing exactly how a water shortage of 3.2 million acre-feet (more than 1 trillion gallons) will impact Arizona is difficult to determine.

"One part of the system may be experiencing shortages where another has guaranteed legal rights to water," Graham explains. "So the impacts will not be felt evenly... Basically what's going to happen is the water supplies that we have appropriated now will over the next 20 to 30 years be used up. And if there's a declining availability of water due to extended droughts and warming of the climate down here, then we're going to have less water to work with. It sort of depends on how much we grow and how rapidly the climate changes… Based on the numbers I've seen, we're probably out there 30 years or so in the Phoenix metro area, but there will be areas within the basin that will reach a stress point much, much sooner than that."

In the event of water shortages, the natural environment is often the first to be sacrificed, Graham says. It's the canary in the coal mine that signals trouble for humans is not far behind. "We have a number of cases where there are river systems that have been lost and are not likely to be recovered," Graham says. "And we have a number of endangered fish species as a result of the use of water. But

moving forward, the real focus will be on the economic calamity that would result, and the effects on our quality of life could be substantial if we don't deal with the water issue. You may see cases where the farmers who are irrigating will not have sufficient water. You may have communities that are running out of groundwater supplies and lack the financial ability to bring water in."

These threats are leading people to consider some radical water-supplying solutions, including one worthy of a Hollywood cautionary tale.

Imagine surfers and sunbathers frolicking on the Southern California coast. Suddenly they look up and gape at something great and white. It's not a shark; it's a huge freshwater iceberg that's been towed all the way from the Arctic – destined for irrigation, lawn sprinklers, and some seriously supersized Slurpees. Never mind that these are troubling times for icebergs; we'll just fix that with a little weather modification. Or we could build a 700-mile pipeline from the Missouri River, an investment of, perhaps, $18 billion and 30 years of construction. Problem solved.

Most people agree these potential measures – all mentioned in the study, albeit less colorfully – are on the extreme end of the solution spectrum. On the conservative side is a simple and inexpensive action: Use less water. "Water efficiency, conservation, reuse are very safe bets," University of Colorado professor Brad Udall said at a January 2013 webinar organized by the Water Efficiency Action Network. "They're in fact the safest bets we have. They're the cheapest, and they're the least environmentally harmful. And conversely, new supplies based on unknown hydrology with climate change are the jokers in the deck. Those supplies are actually the riskiest bet in terms of yield, in terms of cost and in terms of environmental harm."

Conservation, in its simplest form, begins at home. "This is one of those issues where each of us individually can make a difference," Graham says. "It's something that every one of us can have an impact on, and the collective impact of all of us individually will far outweigh what government can do... There are a lot of things you can do that do not diminish your quality of life." Those include xeriscaping, using water timers and turning yard water off when it's raining, installing water restrictors in the shower, and using graywater (water left over from activities such as laundry, dishwashing, and bathing) to water your plants.
"Just be mindful of how you use water, and how you use power, because power's tied to water," says Sandra Fabritz-Whitney, director of the Arizona Department of Water Resources. "It's not just turning off the water when you brush your teeth, it's [asking yourself], do you really need to be sitting in a 60-degree room when it's 100 degrees outside?"

But home conservation isn't as simple as it sounds, she adds. "You can evaluate whether you want grass in the front yard or you want to put in desert landscaping. Those things have a tradeoff, too. Some folks argue that there's a cooling effect with grass. Without that, it raises the heat island, which means you have to use your air conditioner more, which uses water because of hydropower."

On the larger scale, creative measures can be employed to increase agricultural efficiency. Graham gives an example of a project the Nature Conservancy is working on with farmers along the Verde River, an important source of water for the Salt River Project in the Valley. "[We've] installed automated diversion structures, and what that allows [farmers] to do is better manage the water they're taking off the river. They like it because it reduces the amount of effort. They can literally monitor it from afar and make changes without having to go out to the site, whereas before they might have to send out two or three people. But it's a much more efficient system, so they're getting all the water they need, but they're not taking more than they need. So in this one section of river, which in the low water season would often go dry, with this change and working together, we're able to keep water through that section."

In addition, the Nature Conservancy has employed a project around Sierra Vista to harness storm water runoff. "By capturing that water and recharging it into the ground, we're able to maintain a buffer between the community and the San Pedro River," Graham says. "So it's a very creative way of taking water that otherwise might be lost in the system and capturing it and reusing it in the ground... It makes sense because the water is going to make its way back into the river system anyway; it's just that rather than going off all at once and being lost in the system, it's going into the groundwater, and then it feeds into the river over a period of time instead of all flushing down at once."

There are also less obvious ways the state can save water, such as thinning the forests, which are so thickety they're prone to mega-wildfires. The Nature Conservancy and other organizations are working to accelerate this expensive and time-consuming process. "Not only does it make for healthier forests, it reduces the amount of water that's lost through evaporation and transpiration," Graham says. "So it ends up reaching into the rivers and the reservoir systems, so you have healthier rivers, better and more stable water supply." Preventing conflagrations also helps prevent post-blaze erosion and flooding, which, he says, can cause a deluge of sediment to clog reservoirs, degrading the water quality.

Unfortunately, conservation alone will not go far enough to reduce the water shortages. "Many folks say we need to do more conservation because it's cheap and easy, [but] we've sort of already done most of that conservation," Fabritz-Whitney says. "There may be some areas in the state that may or may not be dependent on Colorado River water that can do some additional conservation, but 80 percent of the population resides in active management areas where we already have mandatory conservation requirements, and those have been implemented since 1980."

Those measures apply to municipal, industrial, and agricultural water users, she says, noting that the state of Arizona has imposed conservation measures on every farm in Central and Southern Arizona. In addition, the Arizona Water Banking Authority is essentially saving water for a dry day: In years when the state's demand of Colorado River water does not reach our allocation of 2.8 million acre-feet, it stores the excess in aquifers throughout Maricopa, Pinal, and Pima counties. So far, it has about 3.5 million acre-feet in the "bank," Fabritz-Whitney says.

On top of that, communities can impose additional austerity measures such as drought restrictions, day-of-week watering limits, and fines for excessive water use. All of these efforts, she says, mean that in the event of shortages, "There's a relatively small impact to the end user. You're not going to see as large an impact as you would if we didn't have all those mechanisms in place."

As important as these measures have been, however, Arizona will still need to do more to increase our supply of water. "The basin study assumed that there would be additional conservation over and above what's already been done," Central Arizona Project assistant general manager Tom McCann says. "They didn't even get to the point of specifically identifying what those conservation measures would be but simply assumed that additional conservation would in fact occur, and that's baked into those demand numbers. So the point is we can't get to closing that gap just by doing more conservation and just by reuse. So we do have to have some programs, some projects to augment the supply of water in the river."

The next step, Fabritz-Whitney says, is maximizing the use of reclaimed water. "As your population grows, you're going to create more and more reclaimed water, and you can recharge it in the aquifers. You have to clean it to drinking water standards. It's not like you're putting potty water in the aquifers." Right now, she says, it's socially acceptable to use sewer effluent for turf or golf course watering, but there may come a day when we must put aside our qualms and drink it. "You're treating it to drinking water standards, so theoretically you could use it as potable water; it's just not socially acceptable right now. But when you start getting up against those kinds of stresses, you have to start seriously considering [it]."

In addition, the state could bring in water from other sources, for example, desalinizing ocean water or pumping in water from rivers in other parts of the country. But doing so would be extremely expensive. "When you go to large scale desalinization, that's when the cost starts to go up dramatically," Fabritz-Whitney says. "The cost of desal… [is] significantly higher than what we're accustomed to paying for water. There's a power component to it also. You need power to do the desalinization and to move that water over large distances. The bottom line is: Water's going to be more expensive."

The state has already taken numerous measures to buffer the populace from water shortages and price increases, Fabritz-Whitney says. "I think Arizona's so far ahead of where most states are, so far ahead of where anybody gives us credit for. Every time I do an interview like this and talk about all the great things we've done to protect Arizona, that is not the stuff that makes it in the article. It's 'You're running out of water, you're running out of water.'"

But those very protections have also shielded us from understanding just how connected we are to our rivers. A 1991 National Geographic article, "The Colorado: A River Drained Dry," describes a rafting trip through the Grand Canyon, a very different journey from the one Powell took in 1869. Today, Glen Canyon Dam's hydroturbines are turned up when urban power demand surges and turned down when less power is needed, altering the Colorado River's flow like the moon affects

the tides. One morning, the writer and his group awoke to find their boats moored on a sand bank; the river had receded 13 feet in the night. The guide explained: "See, the water is low today because it was cool in Phoenix yesterday and they didn't want as much air-conditioning. The beaches can't take this daily up-and-down stuff."

Most Phoenicians probably never think about how their decision to set the thermostat at 72 degrees verses 75 directly affects the "tides" of the Colorado River, however artificially. They also, understandably, don't think much about water shortages and monthly utility bill increases decades in the future. But, as the Central Arizona Project's McCann says, "If we're looking at a potential imbalance in 2060, for us that says we need to start now. We need to start identifying what those solutions are now and working to make them happen, because they're not going to happen overnight."

And let's face it: Sharing a not-very-big river with 33 million desert-dwellers and not worrying about water is akin to being in a real estate boom when a part-time birthday clown can get a $300,000 home loan and not thinking you're headed for a fiscal precipice. It's akin to ignoring John Wesley Powell and numerous scientists as they stand on the riverbanks waving their arms, yelling, "Cliff ahead!" as we row merrily, merrily, merrily down a disappearing stream.