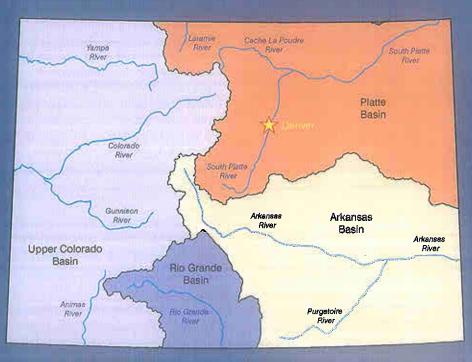


## **High Country Watersheds**

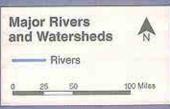
life. Our earth has a fixed amount, of the total) or fresh water. The including trees, are key to the proper indirectly influenced by the remainder.

utilize it for their sustenance and growth, and influence its storage and/or passage to other parts of the environment.

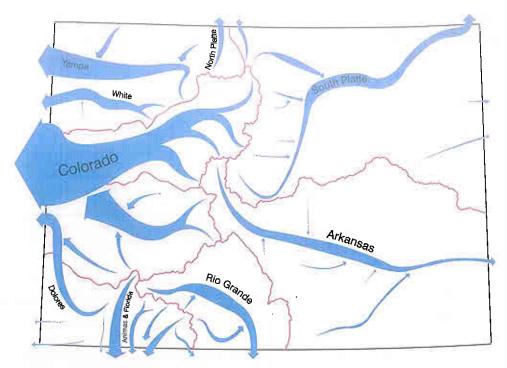
Three percent of the planet's water is be protected with vigilance. Looking other words, I percent of all water exists

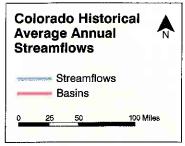


shows how important rivers have been to all areas of human civilization. The cities of Denver, Pueblo, Greeley, Fort Collins,



Above: Colorado's major rivers and watershed basins. Top: Molas Lake (photo by Ingrid Aguayo).





## Acre Feet (af.)

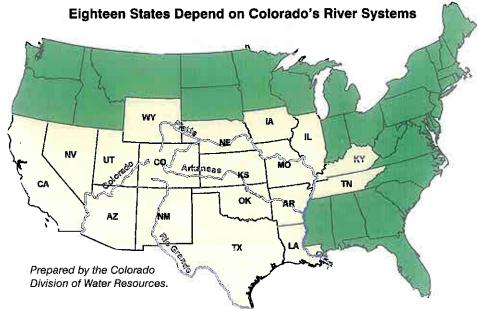
Water leaving Colorado West – 8,807,450 af. Water leaving East – 1,373,000 af. Total leaving Colorado – 10,240,500 af.

(Prepared by the Colorado Division of Water Resources. Historical averages obtained from the USGS Water-Data Report CO-02.)

contribute to water quality and quantity, and their importance to Colorado and other states is, indeed, significant.

As mentioned in the introduction of this report, four major river systems the Platte, Colorado, Arkansas, and Rio Grande – originate within the mountains of Colorado, and they drain fully one-third of the landmass of the lower 48 states. About 80 percent of Colorado's precipitation falls on the Western Slope, and about 80 percent of the state's population lives on the Eastern Slope between Fort Collins and Pueblo. Mountain snows supply 75 percent of the water to these river systems. About 40 percent of the water comes from the highest 20 percent of the land, most of which lies in national forests. National forests yield large portions of the total water in these river systems: North/South Platte, 44 percent; Upper Colorado, 74 percent; Upper Arkansas, 51 percent; and Rio Grande, 67 percent.

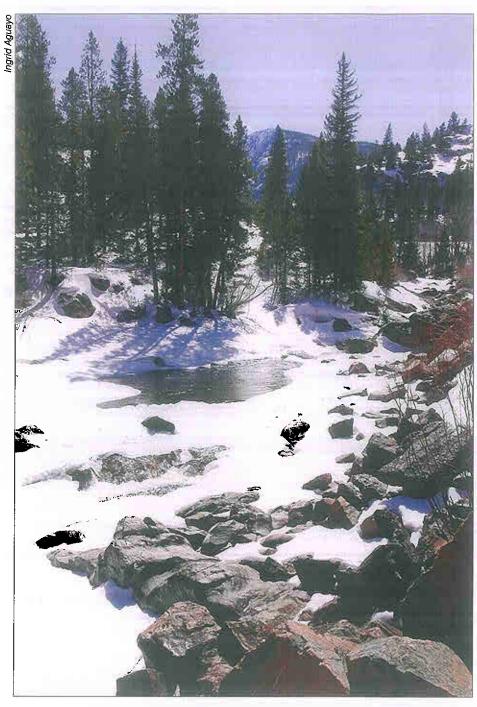
Via natural channels and a vast network of artificial conveyances such as tunnels, ditches, aqueducts, pipelines, and canals, 63 percent of Colorado's 4.3 million residents obtain at least part of their water from areas west of the Continental Divide. The potential



for forest influence, both positive and negative, on transporting water such immense distances is great.

A typical example of Centennial State water travel, the Northern Colorado Water Conservancy District pumps a portion of the Colorado River in Grand County west of the Continental Divide to Shadow Mountain Reservoir north of Granby, channels it to Grand Lake, then into the west portal of the Alva B. Adams Tunnel, which carries it eastward under Rocky Mountain National Park for 13.1

miles to the Ram's Horn Tunnel to Mary's Lake in Estes Park, then through the Prospect Mountain Tunnel to Lake Estes into the Olympus and Pole Hill Tunnels to Flatiron Reservoir, and finally into the Handy Ditch and Horsetooth Supply Canal to Horsetooth Reservoir west of Fort Collins. And this is a simplified version. The Adam's Tunnel, named for a U.S. senator whose father was one of Colorado's governors, is arguably the most amazing feature of this pathway. Built over a period of seven years



A view of the Poudre River.

beginning in 1940, it cost approximately \$1 million a mile. On average, it delivers more than 200,000 acre-feet of water annually to cities, towns, and agricultural communities, and makes 690 million kilowatt-hours of power available to customers in northern Colorado, eastern Wyoming, and western Nebraska.

The following phenomena occur in relation to forests and water:

Tree crowns, collectively referred to as the forest canopy, intercept precipitation that falls from clouds. The destiny of fallen moisture in forests depends on many factors but foremost are the physical state of the water (liquid or

solid), the density of tree crowns on which it falls, and the composition of the forest floor. Much of the moisture in snow that is intercepted and retained in the tops of dense forests, particularly coniferous ones, tends to evaporate back into the atmosphere. Rough forest floors topped by canopies that cast significant shade tend to allow slow infiltration of water into soil profiles without substantial evaporation or run-off. Once moisture travels to the root zone, the root tips actively absorb and utilize what they need; the rest is lost back to the atmosphere via evapotranspiration from the leaves. Moisture in excess of plant needs remains within the soil or moves gravitationally by surface movement or groundwater to lower areas. The rate and timing of exit influences water quality and quantity.

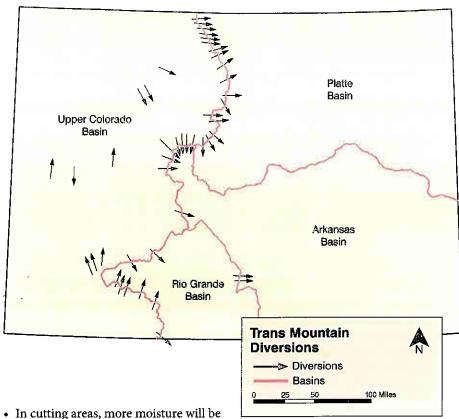
In summary, by buffering precipitation between its atmospheric origin and its various pathways on land, forests provide:

- · soil protection;
- erosion prevention and the costs of associated clean-up in running water pathways, storage facilities, and treatment plants;
- soil moisture recharge and storage;
- water stabilization, purification; and
- plant maintenance and growth, which indirectly does the same for plant-eating animals (that is, total biodiversity).

Colorado is fortunate to benefit from a century of forest watershed research conducted within our state. U.S. Forest Service scientists did, and continue to do, the majority of this research, beginning at Wagon Wheel Gap (Mineral County between South Fork and Creede) back in 1909. The vast majority of watershed information comes from ongoing U.S. Forest Service research at the Fraser Experimental Forest (Grand County) in the Fool Creek and Deadhorse Creek drainages.

Basically, from this research we know:

- Since 1860, water yield from our aging forests has decreased about 20 percent.
- At 5,000 feet elevation, about 22 percent of the year's moisture falls in summer and 12 percent in winter.
- At 10,000 feet elevation, about 7
  percent of the year's moisture falls in
  summer and 19 percent in winter.
- Removing trees increases water yield from forests.
- Most of the increased water yield from tree-cover removal comes from reduced evaporative losses (snow trapped in crowns), not increased deposition/infiltration, and begins in earnest the second year after the reduction in tree cover.
- Increased water yield from tree removal, while not dramatic, lasts up to 50 years or more before increased new growth reclaims excess water.
- Maximum stream flow from high elevation forests occurs in May.
- Our forests, even those at high elevation, need more water than is available in late summer.
- Following cutting, potential gains from deposition are offset by increased evapotranspiration from uncut trees and understory plants.
- Disturbances like fire, beetles, or cutting that result in the removal of similar amounts of vegetation have similar effects on water yield but not on the quality and timing of water released.
- The spruce beetle epidemic on the White River National Forest in the late 1940s reduced 30 percent of the spruce cover resulting in a 2-inch per unit area increase in stream flow.
- Fire is essential to proper functioning, including watershed function, of most Rocky Mountain forest types.
- Fires that involve entire landscapes are increasingly unacceptable within forest watersheds near human populations, and the lower the elevation, the more dire the consequences of these huge events.



In cutting areas, more moisture will be available for the establishment of new trees if organic debris that is taller than expected snowpack is left on site, as opposed to leaving the site "slick."

- A good scheme for increasing water yield from subalpine forests (spruce-fir) by 25 percent to 75 percent is to reduce the normal forest density by at least one-third; this is accomplished by cutting individual stems and small groups of trees or by creating small forest openings (diameter of openings should be 5 to 8 times that of tree heights), with renewal of the cuts about every 30 to 50 years.
- A good scheme for increasing water yield from lodgepole pine forests would be similar to the subalpine scheme, except that the cutting interval would be about 30 years and should involve early thinning of the newly established forest in the interim.
- Modification of riparian vegetation holds the most potential for increased water yield from montane forests, but the associated degradation of other resource values such as wildlife habitat/ biodiversity and erosion control precludes this as a viable option.

Forty-four ditches, canals and tunnels divert water to, from, and within Colorado's major watersheds. Of the Platte, Arkansas, Upper Colorado, and Rio Grande, the Platte and the Arkansas only receive water from diversions. No diversions send water from the Platte or Arkansas back to the Western Slope.

As with most things in natural systems, delicate balances are involved. There are no absolutes and serving societal demands while mitigating related human-induced impacts are complex and expensive. Abundant clean water is a necessity, but simply opening the forest spigot by allowing unchecked natural disturbances or unregulated cutting is not practical or desirable. Perhaps no aspect of forestry requires the combined knowledge and inputs of biological science, geology, hydrology, meteorology, social studies, and law more than the practice of wise watershed management. And perhaps none is more critical. (See High Country Fire on page 28).