[BY CHRISTOPHER CAMUTO]

In Praise of Science

IN A WORLD FULL OF OPINION, knowledge helps.

One of the pleasures of teaching at a university is crossing paths with professionals who are studying the world from a variety of angles, pursuing knowledge through disciplinary means that shed a little light on the world. Since I'm an angler and an outdoorsman, I especially like to see brainpower at work in the woods—faculty and students observing, analyzing and measuring nature, coming to understand it as well as mastering the methods by which it is understood by science. Knowing nature can be subjective—anyone can take a walk or fish a stream and come to understand the woods in personal ways. But it is science and its grasp of facts that grounds our attention in trout, rivers and nature.

It happens that if you walked north up the gravel road that leads to my humble woodland abode, you would ascend the modest southern slope of the leading edge of the Allegheny ridge system that bends through central Pennsylvania and gives our landscape a pleasant if undramatic topographical relief. In half a mile, my pot-holed gravel road would become a rutted dirt road, then a roaded rut, and finally a pleasant trail through a recovering oak-hickory forest. In a few miles you would come upon a small mountain stream—the Creek I'll call it—which meanders its way out of the mountains through farmland east to join the Susquehanna River at Lewisburg. Keep going north, cross another ridge, and you would come to the North Fork of the Creek, which joins the main stem a few miles to the east.

If you fished both these streams 10 years ago, about when I started homesteading here, you would have come back down the mountain with two different experiences. Both streams look the same—low gradient, meandering freestoners with small pools and pillowed eddies the obvious sweet spots for the angler with a fly rod. Perfect little brook trout streams, fine for a day of wrist-flick casts and dapping out of the rhododendrons in pursuit of a 10" or 12" trophy.

The main stem of the Creek would have disappointed you. However stealthily you waded and cast, however cleverly you chose tippet and fly, you would have caught no trout. A victim of atmospheric acid deposition, the headwaters of the Creek had ceased to support trout and the insect life they depend upon, a familiar story. You might have thought that the North Fork of the Creek was not worth fishing either—it flowed off the same mountain through a similar forest. But, in fact, the North Fork would have rewarded you with a good population of native brookies to catch and release. You would have known from your own "research" that one stream was worth fishing, the other not.

Acidification of eastern trout streams is a well-understood phenomenon, at heart a tussle between acidic inputs and buffering capacity of watershed bedrock and forest types. In 2002, these two streams, and others in the region, came under study by a team lead by Bucknell geologist Carl Kirby and his students who got into the details of the rock and soil over which this two-hearted river flowed. The acidified Creek, with a pH < 5, flowed over Tuscarora sandstone, which has little buffering capacity, while it's ecologically healthier North Fork, with a pH of 6.5, flowed over an exposure of Juniata sandstone which contains buffering clays. The Juniata could keep up with acidic inputs and maintain pH, alkalinity and dissolved aluminum levels tolerable for insects and fish, the Tuscarora could not. Subtle differences in forest type also came into play. In the end, geological facts— differences in the composition of Silurian Age sandstones—inform facts of stream chemistry which explain the ecological consequences that underwrites a day's angling. A detail from the Appalachian orogeny—that wrinkle of exposed Juniata—determines the likelihood of a wild brook trout rising to that cocky parachute Adams your tippet just turned over to the quiet current of a mountain stream up the road here from my house.

I especially like to see brainpower at work in the woods—faculty and students observing, analyzing and measuring nature, coming to understand it as well as mastering the methods by which it is understood by science.

Bucknell University seniors Rachel Celniker and Brandon Wesley at work on a limestone treatment system.

Impressive, I think, how many avenues of successful scientific theorizing understanding these two unsung mountain streams entailed—the formation of geological strata over deep time, plate tectonics and the processes of mountain building, physical details of bedrock composition, innumerable concepts from chemistry to track processes at the molecular level, and finally an understanding of the biology of stream species—their needs and tolerances—and the ecological condition of the stream as habitat. Add to that the creation, testing and improving of methods and instrumentation to measure the relevant factors under study to get consistent data across time.

Watching Kirby and his students at work up on the mountain refreshed my appreciation of the patient, consistent progress of science—and the teaching of science—as a way to sift through conjecture and establish facts, and then to connect those facts in explanations that serve understanding and problem solving. I wouldn't be struck so much by the obvious if science was not so consistently under disingenuous attack, or profoundly misunderstood, in our popular and political culture. This becomes a problem as we turn our attention to new problems—the effects of hydro-fracking here in Pennsylvania, for example, or the daunting task of studying the global biological consequences of climate change. Understanding acid deposition, which had its controversies and deniers back in the day, is now a straightforward affair.

Science solves problems when we allow it to. The acidified creek now has a two-stage limestone treatment system in its upper reaches, which has raised stream pH to levels habitable by brook trout and a diverse array of invertebrates. Trout from downstream have reoccupied the stream and grown fat and sassy. It would be much better if the average rainfall pH in central Pennsylvania was higher than 4.4 (it is improving), but for now the fishing in both forks of one mountain stream is what it should be. That pleasant fact rests on a mountain of good science and the hard work of ground-truthing, including hook and line fish sampling by five TU volunteers. I can walk up the mountain and enjoy the creeks and the forests as a realm of subjective experience, but thanks to work of Kirby and his colleagues and students, I also now *know* what is happening in the woods.

Chris shuffles angling tomes around the shelves at Wit's End, his home on Wolftree Farm in central Pennsylvania. The author of four books and the book review columnist for *Gray's Sporting Journal*, he teaches at Bucknell University.