

Fred Whoriskey's
FIELD NOTES

Lawn Fertilizer and Salmon Restoration

Rivers need nutrients too, but how they get it differs between east and west coast salmon streams.

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EARTH: MARK EDWARDS / STILL PICTURES / ALPHA PRESSE

Early springs, such as the one we are having this year, can be both a blessing and a curse. I was recently speaking with a local lawn care professional, who seemed quite worried. For him, an early spring apparently puts lawns “at risk” (At risk of what? Needing less mowing?), and the only effective strategy to counter the “threat” is apparently to fertilize immediately. My lawn can starve.

A mild winter and little snow pack probably means that river temperatures are going to heat up rapidly as well. This warmth also panics salmon biologists like me as we struggle to get field equipment in order months in advance of when it normally would be used.

My lawn fertilization conversation got me thinking about fertilizer in general, the role of “fertilizers” in streams, and especially the differences between Atlantic and Pacific salmon streams. Carbon, nitrogen and phosphorus are the key nutrients. Without them, there is no growth, repair or reproduction for any living organism. Low phosphorous levels, in particular, control the productivity of the waters in which Atlantic salmon flourish.

From a nutrient perspective, streams are constantly working against themselves.

Without nutrient input, living areas wither and perish. This applies to lawns, fields, forests and salmon streams.

Gravity rules streams, and water flows downhill to the ocean taking with it everything that it can dissolve, float, or push. Streams are constantly exporting their essential nutrients like phosphorous, nitrogen and carbon to the sea. These nutrients are needed in the streams to stimulate the growth of algae and bacteria, which feed the insects, which feed the fish. Without a regular replenishment of these lost nutrients, the stream becomes a biological desert, metaphorically speaking of course.

Replacement nutrients can arrive in a pristine salmon stream from a number of natural sources. Some are contained in particles suspended and transported by the wind, and fall back either as dry deposition or in rain. As rain percolates through the surrounding forest it dissolves nutrients that it carries into streams. The forest also directly contributes leaf litter and woody debris (everything from small twigs to entire trees), which are broken down by bacteria and stream invertebrates, contributing another portion of the critical nutrient cocktail.

And then there are the anadromous fish, which can either be putting nutrients back into the system, or stripping them away, depending on the species and its life cycle. Consider first the Pacific Ocean’s salmon. Pacific salmon scientists have found pink salmon (*Oncorhynchus gorbuscha*) are probably the ultimate, gravity-defying salmonid nutrient pump. Pinks return to their home rivers in massive numbers, spawn in the autumn and die. The small pinks hatch the next spring, and leave almost immediately for the sea, taking very little of a stream’s nutrients in their bodies away with them. By contrast, their parents’ decomposing carcasses deposit massive amounts of marine-derived nutrients to the stream or to the surrounding forest, if they are dragged up onto the banks by scavengers and predators. The other species of Pacific salmon are also nutrient pumps, but to a lesser degree than the pinks. While all Pacific salmon species, excepting the steelhead, die in fresh water after the spawning period, the others are less numerous than the pinks and their juveniles may rear and grow in fresh water for some years before leaving for the ocean. Sockeye, which have a relatively long juvenile stream residence, and which are one of the less numerous



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Pacific salmon spend less time in the river than their Atlantic cousins and they die after they spawn. As such, the Pacific salmon are better nutrient pumps than East Coast salmon, which spend more than three years in the river as parr.

species, might be considered one of the “poorer” nutrient pumps. Sockeye smolt migrations may take away 1-5% of the annual phosphorous load to lakes in British Columbia, whereas decomposing carcasses contribute 15-40%. From a fresh water nutrient perspective, even this worst-case scenario provides a pretty good balance sheet.

Atlantic salmon are a different kettle of fish, especially in North America. Unlike Pacific salmon, adult Atlantic salmon are not automatically programmed to self-destruct after spawning, hence the number of carcasses available to pump nutrients from the ocean back to streams is far less than for Pacific salmon. In addition, juvenile Atlantic salmon may rear in fresh water for three to seven years, binding up nutrients. We also have a cooler climate, which reduces forest growth and hence nutrient contributions to the streams.

In a study done by a joint US-UK team, researchers found that, especially in small streams with depressed adult returns, Atlantic salmon smolts may take more nutrients away when they migrate than adults replace when they come back, helping to impoverish the productivity of Atlantic salmon freshwater rearing areas.

Fertilizers have been applied to Pacific salmon waters in attempts to boost productivity, frequently with spectacular success. However, this is a costly process, needs to be done annually, and it is very difficult to pin down who precisely benefits from the increased fish production and, ergo, should foot the bill for the costs of the treatment. However, some research suggests that one place where fertilization can be extremely important is in rivers that have been damaged

by natural or man-made events. It looks like repairs to the population can be speeded up with a productivity boost driven by a nutrient infusion.

The beauty of the Pacific salmon’s nutrient pump system is that it should be zero cost, and self-perpetuating, if it is managed correctly. Exactly what one has to do for “correct” management is not yet clear. One of the key questions for fisheries managers is how many returning fish can be harvested, while leaving enough to maintain future healthy runs and fisheries. Classically, this was viewed as an “egg supply” problem; if you kill off too many adults there are simply not enough eggs being fertilized to provide recruits to the population.

Now a concern has developed that perhaps the situation is not so straightforward. When fish are removed by the fisheries, both the egg supply and the nutrient input are being decreased. Fewer carcasses in the stream will reduce its productivity, possibly to the point that it cannot support the numbers of juvenile salmon needed to rear for as long as they need to rear. At this point, it won’t matter if you have all the eggs deposited that, in theory, are needed to maintain the healthy runs. In addition, there will be fewer carcasses available for scavengers to drag into the forest. This will reduce the fertilization effect on the forest, decreasing its growth, which in turn will reduce future contributions of wood and leaves to help fertilize the stream and maintain the fish populations.

We have tended to discount the idea that marine nutrient pumps were important to Atlantic salmon. While we know that present returns both to North America as a whole, and to individual rivers, are well below their historic highs, our sense has been that this is due to direct human impacts from things like fishing. Nature clearly had a different design for the Atlantic salmon than it had for its Pacific cousins, and acting as a nutrient pump was not front-and-center in the plan. However, it is likely that in the past our East Coast streams had other species that functioned as marine nutrient pumps, to the Atlantic salmon’s benefit. This is a subject we will return to in my next column.

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