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Interview with a Watershed

October 28 2004 1600 hours. Data points come up on a computer screen at the Forest Sciences Lab in Corvallis (0.162 14.3 12.0 0.123 9.34) fed from a T2 line running down the valley of the McKenzie River from a telemetry station at the HJ Andrews Experimental Forest. The numbers arrive at the telemetry terminal as a radio signal transmitted from a small box of wires out in the woods, where a chipmunk sits on the cover absorbing the modicum of heat from within. Wires run from the box to sensors that rest in the riffles of a burbling brook.

On the same day, at the same time I am sitting beside that brook resting on a mossy stone. The radio transmitters are silent and all I hear is water, trickling down, ledge to ledge over mossy boulders and sluicing under logs. Down nest to Lookout Creek, the sound is a white noise roar, but up here in the headwater stream the many voices of water are heard, low gurgles under rocky ledges, high notes of small rills and the bell tones ringing from deep green pools.

The elders used to say that you could learn a lot from listening to water. It will tell you what you need to know, what has happened before and what is on the way. My friend Frank Lake, a Karuk from the mountains to the south of here, tells me that his people still make a circuit to all the springs and streams in their homelands, to check on the health of the land. They'd taste the water, watch its flow and see how thick the plants grew. They clear any sediment from the springs and look for the Pacific Giant Salamander, a sign of well being of the waters. At each pool, they offer prayers of thanksgiving for the waters and hopes that they will continue to run. Long ago and to the present day, our people did not turn to sacred texts for understanding. We understood back then that wisdom lived in the land.

Set in a cleft between two slopes is a two story doll house, painted red with a moss covered roof. We stand on its miniature porch and John describes the weir below, a broad concrete V that passes beneath the stream. The water flows right from the mossy stream, across the weir, into a rocky pool and then again into its native streambed of rocks and fallen logs on its way downhill to join with Lookout Creek. John Moreau, a technician at the Andrews Forest unlocks the door and we step inside. He's a strong and wiry man, with salt and pepper hair and a youthful twinkle. He's been collecting data at the Andrews for 28 years now, and the peace of the place has rubbed off on him. He's been part of the team from the days of clipboards and paper strip charts to radio telemetry. Summer and winter he installs, maintains and collects data from a network of sensors all over this watershed. In summer, it takes just a day or so a week to collect all the values, but in winter on the snowcat, it can take 12 hours just to retrieve a single set of samples. He unsnaps the cover on the water sampler which stands in the middle of the room. Water samples are automatically sucked in from the stream, through tubing running up through the floor to an intake port in the pool outside. A telemetry box and a nest of wires

are fixed to the wall, radioing stream data from the sensors: flow rate and volume from the weir, temperature, and oxygen levels…data already on their way to Corvallis. The second floor of the little house is fitted with a well and a system of weights and levels to accurately read the level of the stream.

We climb a slippery trail winding up the steep slope above the weir, to where a tower of metal struts juts up through the canopy more than 100 feet above us. At intervals along the tower are more sensors, pyranometers to measure light, thermometers, anemometers to measure wind, psychrometers for humidity and sensors to measure atmospheric gases at different heights in the forest canopy.

Day after day, data stream from this stream, in a flow of electrons, representing the flow of this water. It used to be that they harvested trees from these slopes, today they harvest data. Input to the forest is measured as precipitation, output from the forest as streamflow at the weir, creating a hydrologic balance sheet. But, the accounting doesn't add up, there is water unaccounted for and now, the researchers are looking for it. White PVS pipes stand up from the ground in arrays along the streambed, hyporheic wells to measure the invisible flow beneath the surface. Wires run out of the ground, connecting to soil moisture meters. John describes to me the next step in inventorying the fate of the forests water. This season he will be installing sap flow meters on the trees, tiny thermocouples designed to detect the flow rate of sap up the tree trunks on its way to the atmosphere. One year they rigged some mossy branches high in the canopy with strain gauges, to determine the weight of water captured by the mosses.

John tells me that when he began here in 1976, they were cutting old growth at a furious pace. Log trucks full of ancient trees were barreling down the valley at a rate of one per minute. The Forest Service, the College of Forestry, many folks at the Andrews were embedded in a culture of Board Foot Forestry. A few had the wisdom to challenge this thinking, leaders at the Andrews among them. At a time when scientific forestry understood old growth forests as decrepit liabilities, scientists at the Andrews set out to understand the influence of their presence and of their absence as they fell to the saw. This did not make them popular in the valley.

This weir sits at the bottom of one of 3 small paired watersheds. It measures all the water that drains from this forest through the trickling stream. One of the three watersheds is intact, an old growth stand of massive cedars and firs. Another was partially cut in patches and this one where we walk was clear cut. They brought in a Swiss team with a new technology, new back in 19xx for skyline logging, to remove the trees without the damage of roads on a slope so steep you can hardly stand up. I ask John why they cut on such steep slopes. He looks at me quizzically and says "that's where the trees were". Every tree was cut and hauled away, leaving a bare slope behind. They planted Doug firs on the slopes and weir and gaging station on the stream. Day by day it sent out data of water flow and chemistry, data which told the story of a landscape hemorrhaging nutrients and filling the stream pools with sediment as the soil washed away, down to Lookout Creek where it silted up the salmon spawning beds.(?) Sensors recorded the increased temperature of the streamflow, warming in the absence of the shading canopy,

too warm for trout and salmon. Meanwhile, over at watershed 3, beneath the old growth, the stream ran cold and clear and pure.

Water is a storyteller, and listening to that story helped to write a new one, in which old growth has a role. It is a story nearly too late in being heard, but now there is a chance. These studies have been pivotal in changing our thinking about forest management, in understanding the connections between what we sow in the short term and what we reap over time. The opportunity lies in listening to the land for stories which are simultaneously material and spiritual. It is a hopeful sign that people return to the words of the elders and again look to the land for knowledge. Our people say that long time ago we could all speak the same language, the trees, the birds, the wolves and the water, but we have long since forgotten. Human capacities have been so reduced that we can understand only our own tongue. In the right hands, I like to think of scientific research as a conversation, an interview of sorts between two parties that don't speak the same language.

Lewis Thomas has said that humans have four kinds of language. The first he says is chit-chat, the patina of words we use to coat social interaction; the second is conversation, real talk where information and ideas flow with energy between two minds. The third type of human language is mathematics, a higher order code that transcends dialect and ambiguous interpretation. Mathematics is the language we use to interview the land. We cannot readily converse with the forest about what makes cedars grow slower when the temperatures rise. But we can ask questions. We can slide a sapflow meter under the bark and measure the rate of water uptake, at the same time a digital meter inquires after the amount of water in the soil. Tree bands tight around the girth of the cedars read out changes in diameter that indicate growth. We can read the temperatures from the meteorology tower and chart it all out, looking for the patterns that will tell us what cedar needs to flourish. And what might happen if the temperatures rise. The sensors and the weir I think of as a microphone, amplifying the voice of the water and translating it into numbers, so that we can try and understand. But there is danger in thinking that we do understand. We cannot say to the forest "Did you suffer terribly when the trees were all gone?" But we can measure the hemorrhage of nitrate washed away. We might want to ask about forgiveness, but instead we measure the increasing clarity and oxygen of the stream, and hope that it will suffice. Data alone do not bring understanding. You can collect data in a day, information over a year, knowledge over a decade, but wisdom takes a lifetime. Or more.

The digitized flow of data packets from the stream back to the university is quick and efficient and allows a massive pile of numbers to accumulate. And the scientist can do he work without ever getting wet. I'm not sure that's a good thing. There is of course, the problem of relying on batteries and wire to accurately sense the world. John is always screening the data flow for what he calls "wowies", anomalous readings in the data record that make you say "wow!" and go check to see if a weasel has burrowed beneath your temperature sensor. Isn't something important lost by having the data stream back to the terminal untouched by human hands? A column of data doesn't leave much room for surprise. The sensors and their numbers can only answer the questions that we ask,

and in the limited way we ask them. That might not be all that the land has to say. In conducting an interview, the good reporter asks questions and records the answer. But the real value of the interview comes when you read the unspoken body language, when you look into the eyes of the subject and see a truth that is different from the words. You can't see those things if your only way of knowing is data. Can you really understand a place without kneeling in the humus or standing quietly to watch the alder leaves drift down the stream? Being there, doing the field work is for me a way of becoming intimate with the place, really listening to the land. It makes for better science, because the land will suggest new questions. It makes for better scientists, too, because the land is more than data and we are more than data analysts. Most of us scientists were drawn to our work, not by the love of data, but by love of the land.

The stream is not yet full to its banks; the flow through the notch of the weir is only a foot wide. At the height of the winter rains, it can be more than five. John shows me the sampler for water chemistry and the bottles that will go back to the lab. He handles them with gentle care, knowing what they contain. "This is the very best time of year for water sampling", he says, "after the second rain of the season." The first rain soaks into the summer dry soil and is held there in a sponge of humus, rain filling all the pores. But, the second rain comes and flushes out the soil, carrying it to the creek and to the sampler. It carries messages from the soil; the dissolved nutrients that resided there all the rainless summer are now mobilized in water.

0.162 flashes by on the screen, only one of hundreds of data points. It seems like a lot and the researchers employ a team of data managers just to archive it and access it for analysis. But each data point is much bigger than a point; it is a line, a thread that pulled goes deep into the forest. Each number floating on the screen is one word of a story. 0.162 ppm nitrate in stream #124 is only shorthand for the nitrogen that leached from the epiphytic lichen Lobaria oreganum whose blue green algae pulled nitrogen from the air, that grew on the moss that cushioned the eggs of the last spotted owl in the valley. And today's dip in soluble phosphate, classed as "noise" in the data, just random variation, is not noise at all. It is the birth of a patch of coral root orchids whose network of mycorrhizal roots are scavenging phosphorous from a decaying log. These are the stories told in the water. Ravens scavenging a carcass, a thousand year old year tree falling, all are held in a data point of nitrogen concentration on October 26. Like alder drip and maple drop, if the voice of every drop of water is altered by its relationships, imagine the stories that a stream has to tell. The data from the Andrews, translations of the stories told by water, things that have happened, things that are coming, just as our elders suggested, we must listen to water.

The watershed clear cut 25 years ago is now a three-layered forest. There are massive stumps of Western red cedar and fir three feet across, reminders of those who are gone. Overhead is a thicket of red alder, their light bark just beginning to be masked by mosses. The third stratum is young Douglas fir. Foresters used to think that alder was a weed and did all they could to suppress it. Now, we know how important it is in rebuilding soil, replenishing nitrogen so that the forest can recover.

Comparing the clear cut watershed to the old growth, the stream tells a very different story. The young recovering stand is adding nitrogen to the system, by the stand of alders that are fixing atmospheric nitrogen into leaf and root for the future. Now that the trees are re-growing, no nitrogen comes out in the water samples at the weir; it is all being used within the watershed. Over at the gaging station that drains the old growth stand, the water is cold and clear. The undisturbed old growth retains its nutrients, holds on to its deep soils and slowly recycles its nutrients. By virtue of all the meters and sensors, watershed chemists have noticed however that in some of the oldest stands, there is a slow trickle of nitrogen from the forest. They hypothesize that old forests can become saturated with nitrogen. With fully intact nutrient cycles, they may have accumulated more nitrogen than they can use and so it is released in the water-going somewhere else where it is needed.

Forests can become nitrogen saturated. Likewise, we scientists can become saturated with the rivers of data we generate. And what do these data bring us? A chronicle of the land, a witnessing of the world, understanding and wonder, a way to predict our impact on the land. These are good things. But does it bring us any closer to saving what we love? I want a flow of data, streamed into some monitoring center that measures a change of heart. I want us to see clearly the jagged peaks of rising greed and their correlation with loss. Shouldn't we make models that predict the conditions under which destruction occurs so that an alarm will sound; shrilly warning us back from the brink? Couldn't the engineers give us special anemometers to detect dangerous shifts in political winds, atmospheric recorders that analyze the sighs of loneliness we feel when the only living beings we encounter are ourselves? The experiments we need to do are about how can we live and not hurt land. How can we heal the wounds that we inflict? For those experiments, I would sit with eyes glued to the terminal, watching for cultural change, to chart a rising tide of ecological compassion.

These data are valuable and represent a vital piece of our story. But, I don't think it is by information alone that we will be saved. My students, once they are filled up with new ecological knowledge, an awareness of our situation, they always say "we have to tell people what's happening in the world. If they only knew what they were doing, they would stop". But, it's not true. We are saturated with data. We do know what we are doing. And yet we continue, headlong toward our greatest loss, hand wringing all the way, and bleeding from a self-inflicted wound.

It's a hopeful thing when scientists look to the land for knowledge, when they try to translate into mathematics the stories that water can tell. But it is not only science that we need if we are to understand. Lewis Thomas identified a fourth and highest form of language. That language is poetry. The data may change our minds, but we need poetry to change our hearts.

Rich as they are, conversation, mathematics and poetry are but human languages. And we I think there is another language, the forgotten language of the land. Its alphabet is the elements themselves, carbon, hydrogen, oxygen, nitrogen. The words are living beings and its syntax is connection. There is a flow of information, a network of relationship

conveyed in rising sap of cedars, in tree roots grafted to fungi and fungi to orchids, orchids to bees, bees to bats, bats to owls, owls to bones and bones to the soil of cedars. This is the language we have yet to learn, and the stories we must hear, stories which are simultaneously material and spiritual. The archive of this language, the sacred text, is the land itself. In the woods, there is a constant stream of data, lessons on how we might live, stories of reciprocity, stories of connection. Species far older than our own show us daily how to live. We need to listen to the land, not just for data, but for wisdom.