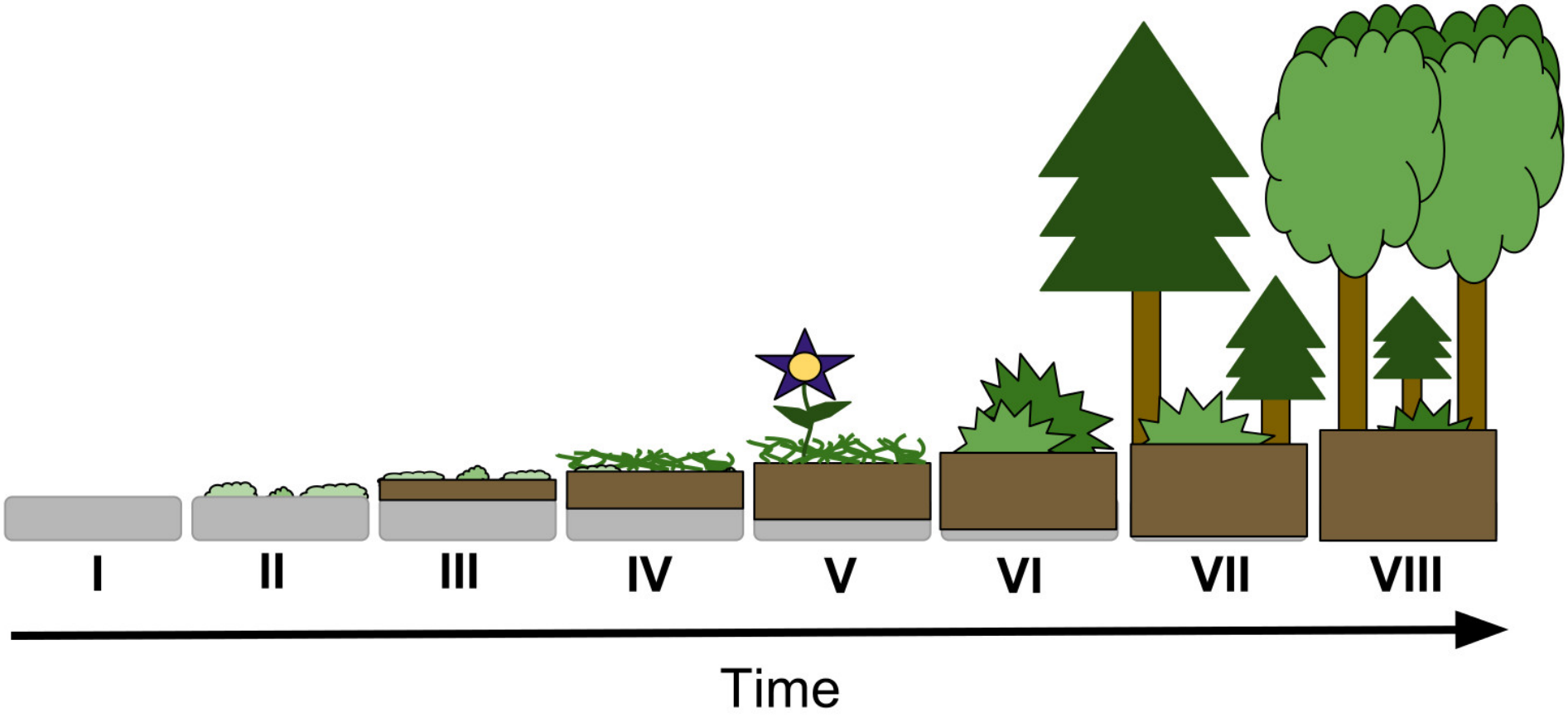
Periodic Disturbance And Feed-Forward Stability

April 2013

As you may recall from the Introduction, I spoke about two major causes of destruction of the post-disturbance system**:** exotic weeds and succession. Now that the weeds are more under control and because this project is about systems and not just nativity, I can revisit disturbance in those grasslands that had succeeded to perennials (thus crowding out the annuals), and forests 'preserved' in Phases 1&2 of stand condition which over time had reverted to shade out groundcovers entirely. Phases 3&4 are a true disturbance, reverting succession to increase the variety and vitality of the forest as a whole. So this chapter is about managed disturbance, or its lack.



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Anybody who has taken grade-school biology has been exposed to the idea of primary succession, with diagrams usually showing a bacteria starting on bare rock, lichens, soil, then forbs and grasses, proceeding to shrubs, and thence to either conifer or hardwood forests in turn depending upon which is perceived as locally dominant. This “final” state has been dubbed the “climax forest.” It’s a nice idea, ordered and understandable. Unfortunately, it distorts how we recognize what we see.

If what is there is a grassland, and it burns, you will get a grassland, albeit possibly with more forbs than before, for a while, but in one to three years it will be back to where it was. At that point, the idea of primary succession might seem inapplicable, but it is not.

Manzanita regeneration, August 2008, three months after the Summit Fire

If what was there was a chaparral of manzanita, ceanothus, coffeeberry, toyon, or chamise and it burns, the brush will regenerate from the root masses or seed almost immediately and you will again have a chaparral in very short order. In but six years, the manzanita that burned in the Croy Fire of 2002 only a mile from here was already eight feet tall.

Like this. This is six years' growth. Does this look like enough fuel to burn again? But wait!
The primary succession model predicts that this system was supposed to "start over," with forbs, then grasses, then brush, and then trees. Yet the trees and brush in this photo clearly started from adventitious buds on roots immediately after the fire. What gives?

If it is a conifer forest and it burns, it may show some grass here and there, but if it seeds successfully, it will not go back to the successional beginning but will return to conifer forest within a year or two. This is Yellowstone National Park, 22 years after the 1988 fire. This stand is but 6-12 feet tall. There was no diversity as predicted. There were nowhere near the shrubs, willow, or aspen as expected for wildlife. The topsoil is now thin and not rebuilding measurably. This unhealthy forest is obviously ready to explode again.

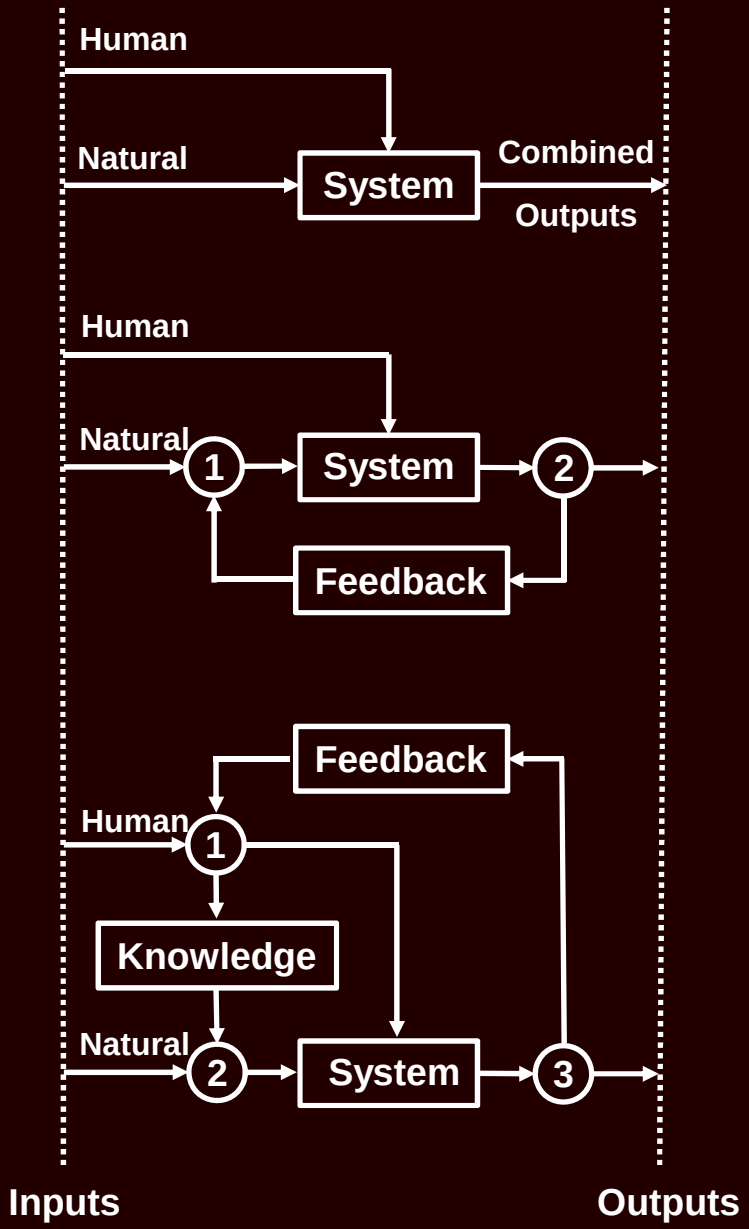
The successional model implies decades between stages. It exists because native Americans managed the land in early successional condition for so long that, once they stopped burning, it developed in *primary* succession… starting from wherever it was. Hence, when biology texts were written 70-100 years later, that is how the authors saw things. This is why people are surprised when cedar trees invade a Nebraska prairie. There was no means for these higher order plants to invade the area when it was burned annually.

So to summarize (and perhaps preach a bit)… we as an American culture have adopted this pathological mythos about stability in Nature: the completely unfounded expectation that forests stay forests, and grasslands stay grasslands only if we leave them alone… one that is built as much upon the desire that *something* stays the same as we strive for comforts amid our mad rush into a technological future whose only certainty is that turmoil will come ever faster. We want *something* to be reliable, a foundation upon which to even recognize ourselves, while the familial foundations of that social stability are under increasing attack and disintegration.

And yet, the demonstrable reality in nature is that the only true multi-century ecological stability this continent has ever seen was built by periodic disturbance, initiated by very stable extended families, inhibiting succession to whatever degree to maintain for the most part an early seral groundcover for their own specific purposes and benefits, even in forests. Early successional plants are the vegetables and grains people need for food, as do game animals. Even in forests, trees were typically selected for food. They were pruned in harvesting which reduced end weight and strengthened branches. Trees were spaced to maintain groundcovers and fruited shrubs that were burned or coppiced to increase their yield before they went decadent. People tended nature to make it more productive and predictable, and sometimes, an even more beautiful place to play with their babies while they processed the fruits of the land (right). Can you imagine being there with them?

Stability was built by regular disturbance**:** harvesting, gathering, burning, and hunting… *processes* initiated to satisfy human expectations based in *knowledge* of the land they maintained, taking action *before* the system drifted beyond control limits. Effectively, the land was stabilized by a human control system.

Acorn mortars
Niobrara River
July 2010



The way most people think “Nature” works, is that human and “Natural” inputs both induce change (or “outputs”) in plants, animals, drainage, etc.. The goal of environmental activists is to make human inputs negligible while simultaneously holding that everything we do affects everything else (thus justifying them telling everybody else what to do or not to do). Although that may mean “Natural” could never truly function as such, it also means that the environmentalists would be in charge of everybody else, forever. No wonder they like that model.

The simplest type of control loop is one with “feedback.” A good example is the control of your home air temperature. When a natural disturbance (weather) raises or lowers the temperature, the thermostat (circle 2) tells a relay (circle 1) to turn the heating/air conditioning system on. The equipment runs until the temperature *overshoots* the desired value to a limit and then shuts the unit off. The result is that the house is seldom at the desired temperature. This is how politics works when the public notices something has gone to hell and elects “that other party,” at which point if things get bad enough they are liable to over-shoot.

This is the most sophisticated type of control system**:** a control loop with “feed-forward.” A good example is your control of your car. When your visual sensors (1) see an external input (a red light) you use your sensors (1) to gather data and then apply brakes*, knowing* (from those sensory inputs ***plus*** an experiential base) roughly at what pressure you’ll drive your foot (2) against the brake pedal (part of the automobile system). This system requires smaller feedbacks as you feel and see (3) your rate of deceleration making you less likely either to overreact (stopping short) or to under-react (hitting the car in front of you). Each time you perform the task, you *learn* by sensing the feedback as an input, increasing knowledge of how to do it with less brake and tire wear, not to mention possible physical trauma to everyone and everything involved.

Feed-forward is a control architecture that applies ***prospective knowledge*** of how a system will respond to both a disturbance and the corresponding input as a way to correct system behavior ***before it drifts beyond control limits***. It’s what people do.

August 2003, US Forest Service Land, Rodeo Chediski Fire, Show Low, AZ

Same day, same fire on nearby Apache land; yes, it burned too.

So effectively, what we have today is a feed-forward control system, one in which knowledge is the critical factor, operated according to the popular belief that Nature will stabilize with no human inputs, mistaken ideas about succession, ignorance of exotic infestation, and no applied knowledge or feedback allowed. We just let it proceed until there the predictable catastrophic failure. Now, let's take a quick look at the consequences when it comes to successional processes and ask ourselves if those beliefs could use reconsideration.

August 2008, knobcone pine and manzanita regenerate in place six years after the Croy Fire

It takes time for successional invasions to progress. Yet once seed and root masses are established, everything already there wants to regenerate after a disturbance, in a sense, continuing the primary successional process that had been interrupted. Realizing this, biologists now use the term "secondary succession," with all the qualifications characteristic of an idea stretched beyond practical limits. One can see this in the "succession" model taught to students that places hardwoods at the "climax stage" versus conifers, because that is how things once were… Where? Back East. That *was* the way things were there, but not any more. But won't the Eastern system eventually return to its original condition? NO!!! Those pre-Columbian stand configurations once had dominant chestnuts and elms that are now virtually extinct because of chestnut blight and Dutch elm disease (both exotic pathogens). Indians maintained chestnut stands with fire because they were a source of food. "Nature" goes on from where it is with whatever happens to be dominant in a particular place and time, models notwithstanding. Models help us see, but they also distort what we see when we "re-cognize" our observations according to the model. Words have a way of doing that. Instead of succession, a better word in this case would be "regeneration."

August 2008, six years after the Croy Fire

Yet even the “regeneration” model I just offered is inadequate, in that if a knobcone pine forest around here burns, it may be set back a bit with some brush in places, but if the cones seed successfully (depending upon the fire temperature and the cone maturity), the forest will be knobcone again very quickly (left). On the other hand, if it does not seed successfully, it won’t (right, same fire).

Fire suppression effectively changes the species mix at the time of disturbance, and therefore thereafter. Under Indian management by frequent fire, harvesting, and hunting, this particular spot was early successional, consisting of whatever they were growing along their trail. Uninterrupted succession has changed all that. By the time we arrived here, oak-madrone woodland was the dominant habitat, having displaced dying chaparral. Even then, the oak was in trouble, because so many cam up, again because of a lack of disturbance. Here, just down the road from us and even without apparent weeds, decades of fire suppression made this dense hardwood forest structure, shading the understory sufficiently for it to die, and eventually allowing Douglas fir to colonize the stand. A mix of successional stages like this has probably never happened before at this kind of spatial frequency.

October 2013

Besides its aggressive seeding, high resin content, and thin bark, Douglas fir leaves its own fuel ladder in place all the way to the ground (it usually does not make good lumber here for that reason). On ridges, firs are also subject to split tops that threaten power lines. Here, the manzanita is dying and the oak is rotting. There is no telling what the composition would be immediately after a fire, but eventually the fir would take over with increasing density until the area could no longer support their demand for moisture.

When firs suffer from water competition, they become more subject to attack by bark beetles, as were the two trees in the foreground here at the Wildergarten, now spreading to more. The response is analogous to a disturbance, and what we see is oak, bay, fir, and redwood in a density that cannot support them all. If I leave it alone, the redwood would be the eventual winner. Unless I start thinning trees, the groundcover will be gone within 5-10 years. The reason this happened is that I could not afford thinning this stand because it is illegal for me to sell the logs. Blame the Sierra Club, please. They do a lot more damage than they realize, much less admit.

October 2013

People aren't used to how fir can respond after disturbance because they have no experience with having let succession run amok for so long. Here is a slope "recovered" with Douglas fir at the entry to our local middle school. In this spot, they just graded it off and let it go. With enough light, this is how dense fir stands can get if you do not thin them. The students at the school ride the bus by this spot **every day** having spent much of that day learning "how to protect the environment," probably without a thought about what they see. They have been taught to see this as "Natural," hence there is nothing to notice, and nothing to be done about it. This is what happens when propaganda displaces knowledge in a feedforward control system. There are consequences you know.

The Summit Fire (here) was only 6 miles from that school. Although this was not fir but knobcone pine, they both burn about the same. Yes, stand-replacing fires are believed to be “Natural” in knobcone stands to a supposedly greater degree than Douglas fir. But, is this a matter of fact, or is it a matter of experience uninformed by the consequences of a change in management? There were no similar fires in fir stands around here when the Indians burned every few years, and probably not for nearly a hundred years thereafter. But in the stands we are growing today, there is no doubt that it would be just as bad in fir as here, a direct consequence of unprecedented **seed dispersal** resulting from primary succession due to fire-exclusion. Reversing course from here is expensive, difficult, and, if you do not wish to see dozens of extirpated species, necessary. Who is going to do it?

Musk thistle, cheat grass, and dead trees at Mesa Verde National Park, July 2005
Photo by Steve Rich, Rangeland Restoration Academy

In other words, to say that we “know” what will be the “climax” stage of a site that for over 10,000 years has not been left to accumulate fuels like we now permit is the height of arrogance. The tendency of unmanaged competition is for dominant species to burgeon until they consume their nutritional or hydrological base (as do overstocked forests). To withdraw all management, suddenly, from so many interdependent systems of animals and plants and expect *them* to “know” how to optimize after a disturbance, and *especially* with exotic species present, is simply, well, ignorant, arrogant, lazy, irresponsible, distracted, and self-destructive (to fling a but few appropriate missives). More importantly, such results virtually preclude locally-adapted post-disturbance species from expressing at all, which means that those species, some possessing important relationships with soil microflora and insects, eventually go extinct. At that point, restoration of the native system becomes an impossibility. One can then only replace it with something else.

If what we want is true biodiversity**:** multi-aged forests with a vital, varied, spacious, and productive understory, clear of weeds, then the best way to do that is to manage succession by limited and regular disturbance, careful and knowledgeable monitoring, and fuel reduction *before* it blows up. So, who ***knows*** what to do here… the "environmental experts," activists, and government currently making a forest structured such as no one has ever seen before? Me? What if **nobody** knows what best to do among all the varied sites? How then do we develop the reliable knowledge base with which to rebuild this system without these catastrophes? The answers must come from the kind of long-term experiments and shared information in post-disturbance system management to which grant funding is not directed (such as you are reading here) with landowners willing to take risks and free to try something different.

One Example…

October 2013

So now let us consider four example applications of this idea of periodic disturbance to stabilize systems involving all five successional habitat types we have here at the Wildergarten**:** sand hill (forbs), grassland, scrub/chaparral, broadleaf forest, and conifer forest. Each of these systems requires periodic disturbance in order to stay in its particular configuration; else each fails without it in its own characteristic way, whether by senescence, succession, or catastrophe. When we started this project, we began with the easiest type of problem to see, namely, excessive fuel loads. Most people *know* intuitively that this broadleaf forest with dying chaparral and invading fir trees is too much fuel for anything to survive a fire (this is my neighborhood; I didn't have to go far to find it). Most people ***know*** what must be done; else they ***know*** what will happen (feed-forward isn't a hard idea; it's the propaganda that's the problem).

You may recall this image from the repeat photos in the introductory section. If you read the chapter of phased forestry, this degree of thinning approximates going straight to Phase 3 in order to grade in a driveway. Needless to say, the broom went nuts, to be followed by rip gut brome, bedstraw, and hedge parsley. It was many years before we were able to establish a native groundcover here.

One of our overall goals was to maintain a wide variety of habitat types on the property in various successional stages, but there are limits to the amount of land one person can weed. Forests here are many times easier to weed than open grasslands and redwood hardly requires any weeding at all. Yet the primary succession to redwood that started with the Spanish burn ban 200 years ago and built the redwood monoculture to the left, now threatens this oak-madrone woodland, ideally (to me) a dense cover of varietal forest groundcovers interspersed among multi-aged trees and occasional shrub thickets. This is 2002, just after I had removed the fir from this stand. This a Phase 2 thinning in the background and Phase 3 in the foreground. I used the redwood in between the two areas as a “dark barrier” to minimize weed transmission between sunnier areas until I had depleted the weed bank in both.

Ten years later, both open areas are now relatively free of weeds while the oak canopy had closed in the background. So now I am removing the redwood from this stand, thus removing the “dark barrier.” Then I will thin the oaks in the background, and deal with the remnant weeds. The rationale for removing redwood from a deciduous woodland can be either that they are not doing well, or that they are doing ***too*** well; i.e., shading out an oak forest I want to keep. This was the latter.

None of these redwoods was over 40 years old (15yo when we got here). There were no old stumps, nor was this area terraced for apples. As you saw in the site history, when the Indians managed this area the plants were early successional, mostly bulbs, food for both people and “special food” for predators (death camas). Effectively, I doubt redwood has been on this upper slope for at least 1,000 years, judging that the presence of conifers so high on this ridge was an artifact of fire suppression starting with the Spanish (there were 40-year-old firs up here too). The redwoods were shading the oaks and madrones to the point that they were showing signs of stress.

This is the subsequent Phase III thinning of that slope. I've piled and burned the tops; else you could not see the forest floor for all the material. This kind of thinning must be done in stages, in that one accumulates so many logs and tops that they tangle, making pulling them out a pain. After the mayhem, I go in with my plugs and transplants (black oak in the cage), particularly in burn spots. Foresters often wonder why I don't simply slash the material and let it rot. **You can't weed it that way** and very little grows on the surface until the slash rots (which can take the better part of seven or eight years) after which the weeds come up anyway. After a couple of years (and rain), this understory will be carpeted with life. I want the weed seed to germinate now while they are easier to find.

Even in July, with less than three inches of rain since it was logged, these groundcovers are already starting to spread. Tree removal likely reduced competition for soil moisture. Getting the redwood logs out will take heavy equipment. Note also the redwood sprouts, despite the fact that I treated the stumps with glyphosate. Other ecologists wonder why I leave so little wood for fungi or snags for birds. Good observations. For now, I have to weed it; growing fungi and leaving snags begins with logs from the Phase 4 thinning.

An arborist friend of mine has a maxim about oak trees**:** “If it’s over thirty feet tall and only six inches in diameter, then it will never be any good.” Of course, it depends upon what one thinks is a “good” oak tree. These make great firewood: they have straight trunks and long branches with few knots. They are easy to split and do not produce a lot of foliage to drag and burn. Of course, a stand of trees like that has no understory, nor do they live long or grow well.

Now remember: these skinny poles were the *best* trees in this stand. None of them will ever meet that arborist’s standard. Nor should they. These are not *architectural* oak trees. I want trunks long enough to minimize fire hazards. I want them tall enough to provide both openings and shade with which to maintain an intense groundcover without excessive stand density. I don’t want tons of acorns. So in essence, my preferences in oak trees tend toward a compromise between my arborist friend’s standards and growing them for firewood. The emphasis is upon total productivity of a varietal system, lower hazards, and ease of maintenance.

Not all of them do I intend to keep over the long run. In fact, I went to great pains here to spare the few young trees with decent structure. Once they need the space they’ll get it. I also put in about seven black oaks *(Q. kelloggii,* one of which is in the cage on the prior slide*)*.

This is the last major thinning I have do on this upper slope. The near future will be culling individual trees, weeding, developing shrubs, shaping seedling trees, weeding...

So where does it go from here?

…of Succession Gone Two Far

October 2013

To the north is that other successional condition in redwood**:** these 60’ trees are *not* doing well in a stand that was already at Phase 3. Their tops are frying despite being in the afternoon shade of a prosperous redwood stand on the other side of the County road. These trees are not doing any favors for the oak-madrone woodland below them. Given the gangly state of the hardwoods, I am seeking to develop the few smaller oaks in here to be broader and lower trees interspersed with more productive fruit-bearing shrubs for wildlife. Therefore, these redwoods were the next to go… *after* the forest yellow-jackets nearby *Vespula acadica* were done for the year!

This image is a good example of oak/madrone forest in transition between its original condition as I found it and what we are trying to accomplish in restructuring it as something between a multi-aged woodland and a savannah structure, primarily with perennial groundcovers for easy maintenance. Because this area is farther along, here we have several decent young trees. The redwoods in the prior slide have been removed in a Phase III thinning. What you see remaining are some very spindly oaks along the road and a few with potential down below. I'll be leaving these "spindlies" as a source of partial shade until the groundcovers and shrubs have recovered from the transition. Note the madrone (black arrow) overhanging the nicely shaped young oak below it (red arrow).

January 2014

This madrone in the middle of the stand was the last hazard tree to remove for the season. It leaned over my power lines and was rotting in the middle of the trunk. Eventually, it would have broken and fallen on both our power lines and said nicely shaped young oak tree below it (such trees are rare here). Hazard trees like this one cost about $350-500 apiece to take down. They are common in these mountains.

I don't like climbing leaners. The flip rope tends to sag and slack as you climb, making it easy to roll off to the side and turn upside down in the process (not good). I was also worried about the extra load on the trunk with the rot in the middle causing the trunk to snap with me tied to a log 40 feet up. So I called in a tree service. Their lead came out to look at it. Nice guy! He got out of his truck, turned around, and just stood there, staring at the forest. He knew how much work this had been, so his silence was a compliment. After a pleasant exchange, he looked at this one for me and said, "I'd climb it, but then," (with a smirk) "I weigh 140 pounds." Knowing my trepidation (and that I'm 180), he suggested the nifty trick of wrapping the flip rope around the trunk once to keep it from sliding so easily. We shook hands and he left, no charge. To him, it was a job too small to bother with, one he knew I could do anyway. To me, his appreciation was an honor and his advice a potential life-saver.

So I bought a longer flip rope and waited for a Sunday to do the job so that my wife could be around in case I had a problem. Among other things, giving her the job of taking pictures might make her a little less likely to fret (it's not good to be listening to your wife getting scared while you're up a tree). Besides, I don't get many pictures of me working, so it's nice to have it to share with people to give them an idea of what this involves. So… I sent this photo around to some friends and, frankly, their reaction was stunning… "Is that you???"

Really, after all these years, I thought they knew better.

There is a lot yet to do. But in places, we are getting there.

Despite my good intentions, trouble, and risk, this young oak came down with a case of sun scald, in which the removal of the canopy over the tree left it unprepared for the extra light. Strangely, the sun angle would not have suggested this reaction, but the good news is that it is not dead and will recover although that might take 10 years. To what degree depends principally upon rain.

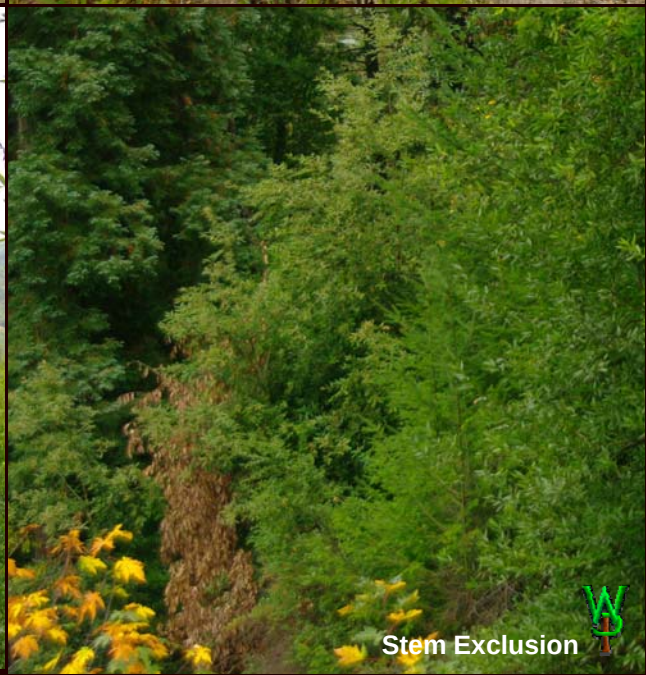
Thin enough (there are at least ten stumps in this photo) and in come the grasses. From a management perspective, grasses are undesirable simply because it is harder to weed among them and grass therefore slows me down at a critical time of year. If I burned it, grass is more of what I would get. I am counting on these blackberries and such to take over from the grasses in short order. So exposing this to sun was a gamble from a management perspective in that I am expecting succession to fix the problem for me.

This was just down the slope from the prior photo two years prior. So, how does specifically *periodic* disturbance apply here? Once it is thinned, in come tree seedlings that then displace the groundcovers, and at a rate that is shocking. My goal is a mix of annual and perennial groundcovers among the trees, so this many tree seedlings is a problem. The programmatic disturbance is to thin the seedlings with my root-slicer once every 2-4 years. It takes a few hours per acre. I could be done with fire, but the bureaucracy is excessive, never mind the risk. As I build that groundcover, it will resist the oak intrusion somewhat and soften the soil to cut tree roots.

Same stand from below. The goal here is a low maintenance perennial cover. I'll start with an annual show of bulbs**:** irises, blue dicks, globe lilies, death camas, blue-eyed grass, triteleia, and herbs**:** skullcap, sanicle, hedge nettle, snowberry, blackberry, yerba buena, and some sedges in between occasional shrubs and trees. Despite my having thinned this in late spring the year before, the groundcover response has been significant. Two species in particular responded intensely, "mountain sweet cicely *(Osmorhiza berteroi)* and blue wild rye *(Elymus glaucus)* (both are fine with me). There were a fair number of mountain lilac seedlings *(Ceanothus papillosus)*, some of which I'll probably transplant, although I'll leave a couple under this power line right-of-way. I planted some skullcap tubers *(Scuttlearia tuberosa)*, transplanted a manzanita, and added some plugs of California Fescue grass. 2014 was a terrible drought year, so that these transplants survived at all is simply amazing. I chose not to allow California brome in here, as it would be harder to weed.

Setting Third

This primary succession process takes only 30 years.



So now that we have covered successional processes between broadleaf and conifer forestry with the goal of mixed successional stages just short of a savannah configuration, we will move on to an example of succession from annuals in sand hills and grasslands, brush invasion, and then to trees with an experiment designed to slow that successional process and retain it in a more stable form.

As you have probably surmised, developing a cover of annual forbs is a LOT of work. I had been using disturbance (burning piles of tree tops) to get the grassland "weed bank" to express itself so that I could see if it was 'cleansed.' In effect, I had reverted primary succession to post-disturbance forbs first by killing everything with Roundup for 2-3 years) and *then* continued to reset it by burning repeatedly. Accordingly, I can only allow 30-50% of the property to have annual forbs as a major part of the mix until I have more control elsewhere, preferring to maintain perennial groundcovers and bulbs there. But, what if I told you that there could be a need to cleanse the seed bank of certain types of *native* seed as well? Heresy! Well, if you want a grassland, maybe not…

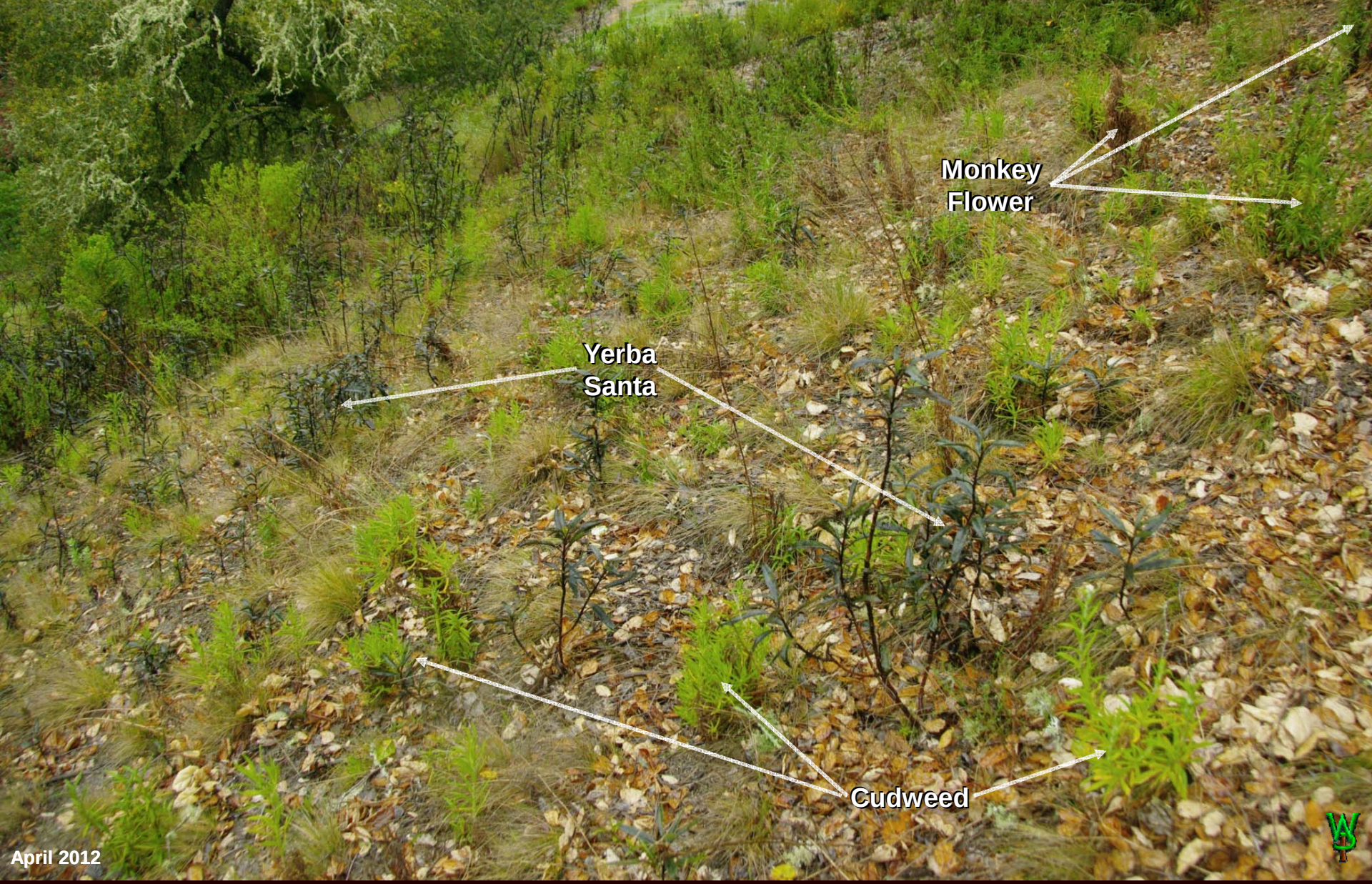
I pull shrubs and kill trees in this sand hill to keep it from succeeding to brush. Note the increase in the size, number, and density of the shrubs on the right in only one year (left to right from a different angle). There are also oak seedlings here that have to be pulled, cut, or treated every couple of years. So, in a historic sand hill, if what the Indians wanted was to harvest forbs, then how did they keep out the monkey flower and yerba santa if they could invade in but a year or two? Burn, probably every year or two. How do I know?

May 2014, Primarily *Filago californica* being invaded by *Bromus carinatus, Elymus glaucus,* and *Diplacus aurantiacus*.

In this sand hill area, I burn brush piles here every 1-2 years to instigate a successional reversion to type, thus limiting succession to a degree. As the grasses invade it, I do it again, but the grasses start from where they were. Effectively, this is 'preservation by periodic disturbance;' else each of those successional cohorts becomes decadent, will soon be invaded, by the next higher rank. Wait longer and baseline regeneration happens at the succeeding higher levels. Once the brush seed is deposited then the brush comes up *with* the sand hill species *and* the grasses until the sand hill species are crowded out, essentially a "recovery" of everything at once. The longer succession progresses before a disturbance, all levels of succession (up to the highest present at the time of the disturbance) respond simultaneously, if they can, thus increasing the rate of the successional system as a whole, simply because one does not have to wait for the seed to invade. If I want to take it backward, I must either burn before the grasses breed several times until that grass seed is consumed or use chemicals. Grazing would abet the grasses.

This is about 70 feet from the prior slide. This area has been maintained as a native grassland (previously a French broom infestation). This needle grass *(Stipa lepida)* won't last more than two more years if I don't do something to set back the brush invading it from just down the hill. These are monkey flower *(Diplacus aurantiacus)*, deer weed *(Lotus scoparius)*, pink cudweed *(Gnaphalium ramosissimum)*, and yerba santa *(Eriodictyon californica)*. The first three I can simply pull. The yerba santa sprouts from lo-o-o-ong root runners from the parent bush below; it is a total pain to deal with. I don't have a good method yet, as you will soon see!

In 2011, this area just down the slope looked like the prior slide. So, do I “have something against chaparral”? No more than I do against grasses invading sand hills. Each is a habitat type with specific attributes that demand different types and degrees of management. There are hazards and benefits to all of them, just like anything else. The reason I do not want the brush taking over this grassland is that the meadow is a fuel reduction buffer above an existing chaparral that allows a fire to lay back down on the ground after flaring in the chaparral below. This interface would probably respond well to the disturbance of annual grazing and browsing.



Although 2012 was a drought year, this was April after a March with almost 13 inches of rain. Yet this well-established small-flowered needle grass *(Stipa lepida)* has gone senescent with built-up thatch and is dying off. This area did not get mowed like most of my meadows do. The reason is that I have limited time and it's a pain to do with the shrubs moving in because the string on the brush cutter gets wrapped around the stems and shears. The other reason the grasses look bad is that pink cudweed sucks up nitrate just like purple cudweed does. Yet I "must" keep the chaparral down here because this is the burn buffer above the chaparral below.

Here it is again two years later. Obviously, “must” didn’t happen. I did say this happens fast, didn’t I? The brush is so big I couldn’t take the photo from the same spot and is now a threat to the stand of trees immediately above. From this point, the trees will invade the area and it will quickly becomes a forest again *unless* I burn it, whack and spray, or take goats to it. Else, the fuel accumulates. I still have time for a controlled burn in conjunction with State Forestry Vegetation Management.

And So Fourth

If I left that prior slope of yerba santa alone, it would grow to 6-8 feet tall like this but in 3-5 more years. On a 170%+ slope like this (it averages 60°), reversing course can be hazardous. Unless I can burn this brush, I get to chop it with a chainsaw while dangling from the end of a rope (done it twice before; it's scary). Now, wouldn't it be easier if I could get something to eat it? Well, animals are a big commitment. Installing temporary electric fencing on a slope like this to keep a goat or two safe from the government's mountain lions and coyotes is an unlikely prospect. Then there's building a similarly secure pen, a barn, a water supply, cleaning pens, and making sure that the animals have enough food over the whole year. **I cannot import feed or hire temporary animals** (weed seeds).

When we first got here, this slope was a mix of acacia and fir trees with a few buckeyes and some monster eucalyptus. The fir went down in 1990, before I built the house. The eucs were gone a few years later. I chopped up the acacia and filled a groove in the side of the hill with a pile of chopped cuttings about 100’ long, 20 wide, and 7-10 feet thick. I contacted the fire department, borrowed a hose, and it took a week to burn. I trimmed the buckeye and cut the bay trees without treating the stumps. After fighting rip gut, broom and other big weeds, it slowly filled in with the yerba santa and bay trees. By 2006 it looked much like the previous slide, so I went in and chopped it up again, cut out the bay (a fire hazard on a slope like this and also destructive to groundcovers), and planted more buckeye with a poor yield. Poison oak succeeded the yerba santa (above foreground) making the project even more inviting.

In classic primary successional order, after the shrubs, in come the trees**:** oak, maple, and bay. Yet this is a regeneration after the last time I cleared this slope eight years ago. It is *way* too steep here to allow a chaparral or forest immediately below a house. The oak and bay in particular are fire hazards, but any large tree on a slope of crumbly sandstone this steep is also a possible threat to its geological stability. When competing for light, they tend to lean outward, which makes them likely to fall, tearing out a large hunk of soil with them, thus destabilizing the slope above. To start them straight growing upward for sun, one must keep the brush down.

At the foot of the first slope I cleared this oak had gone down. I thought this one was stable too; it was out of the wind and reasonably balanced. I should have cut it when I was last here in 2008. To the left we have a big leaf maple *(Acer macryphyllum)*. Of the trees, maple may be best on a slope as it is lighter aloft and allows more light for groundcovers but one still does not want them to get big here.

Poison oak is a tremendous erosion control plant. It has roots like cables across the entire slope. It provides great cover for quail who (once I got a cat to take out the ground squirrels), came in great numbers because of the abundant food (grasses and tarweed) nearby. Poison oak can get pretty dense, so it can be a fire hazard too and the fumes can be fatal. So these are trade-offs. What to do?

So, to “keep the brush down,” I chopped it with chainsaw while on the end of a rope. This is the third “periodic disturbance” of this type in 23 years. Being 60 years old, an area about five times this size took about a week and a half. The plan is a combination of earlier successional groundcover selection under deciduous shade. For shade, the buckeye and maple make enough to slow things down while losing leaves seasonally to allow a groundcover sufficient light in winter. Farther down I could use hazel nuts for seasonal shade.

This is a view of the same slope from farther back but before cutting. This was a trial using Santa Barbara Sedge *(Carex barbarae)* as a retardant groundcover under a maple with buckeye immediately below. The sedge holds steep soil, stays green in full sun without irrigation, burns easily and slowly with low fuel value, responds well to fire from rhizomes, and is easy to propagate. It is not competitive with poison oak or blackberry but a few squirts on the first shoots with triclopyr fixes those until their propagating root masses recede (¼ oz per year here). While triclopyr is not very effective against yerba santa, that has not invaded the sedge in the shade of the maple. So, why the herbicide? It is both impractical (because of my neighbors' fuel loads) and massively illegal to burn it by myself. That leaner oak has to go, but because of the buckeye underneath and lack of room to winch it, I'll probably have to climb it.

Here at the bottom of the slope is another trial of seven-year grass *(Calamagrostis rubescens)*, so named because it spreads by rhizomes and seldom seeds. This is July. In partial shade this grass stays green all summer. It makes a beautiful groundcover and seems to resist invasion by higher ranked plants. This is my favorite erosion control grass because it is great for holding soil on steep slopes but for the fact that it is slow to establish.

Farther up that slope, I have hedge nettle *(Stachys adjugoides)* and California brome *(Bromus carinatus).* This slope is so steep that to expend the labor weeding annuals every year without causing more erosion is a big job every year. So I started a thousand plugs of *Festuca californica*, which is big but not tall, grows well on steep slopes, and (unlike the *Calamagrostis*) reproduces adequate seed. Thereafter I'll bring in coyote mint *(Monardella villosa)*, with the hope that it will be as beautiful a cover as I anticipate. This is an example of mitigating succession and fire and landslide hazards by selection of species that are light, have extensive root systems, respond well to fire and drought, and resist invasion. From there, I could burn it every ten years or so and it should be reasonably stable, but if I allow too many trees here, particularly bay, fir, and oak, or if I let any get too big, the system breaks down and becomes unstable.

Now, back to the brush problem on this slope. We now recognize how fast this successional process progresses. We also recognize that one can maintain it as brush, but it only takes a very few years to regenerate, then requiring a very expensive and hazardous management process. So the real question is, how does one proceed from here? Burn it with the house only 50 feet above? That is not exactly a safe or inexpensive process long term. Goats? Maybe, but how does one herd goats to keep them eating only what one wants on a 60° slope? What if one could slow it down? How? We will take this cover to an earlier successional phase and find a way to stay there primarily by species selection with a lower-hazard disturbance at less frequency. But first, one must deal with what's here.

Allow me to digress for a moment to explain how fast trees grow here. This 180 foot fir was only 80 years old and 50inches in diameter about 150 feet from the house. In 1994, it was hit by a massive lightning bolt. Five years later, I examined the base of the stump and noted developing rot, so I concluded it should go. This was a job that was too big for my equipment so I brought in Steve.

This is the same view only 13 years later (the stump is somewhat obscured). There are obviously way too many trees here for them all to get big and still be healthy. The tanoak is dying, although it may not be Phytopthora (there are no weeping cankers or sign of amphora beetles). Which do I want to keep? The 25 foot maple immediately to the left of the stump. Don't see it?

November 2014 Photo by Diane Vande Pol

Here it is! On the near side of the stump, one fir had grown 36' feet tall in but 12 years. Now you know one of the reasons why a Board of Forestry dominated by big timber companies owning less productive sites allows environmental groups to force unequal regulations in our area. Note the redwoods to the left. Here,14 trees all sprouted from a single stump that is about 36" in diameter; or *maybe* a 50 year old tree when it was logged 120 years ago. With one root mass now supporting 14 trees, they do not grow as fast, but they are still getting large, some leaning out from this *very* steep slope, which below them is close to vertical. Before they go down and tear out the hillside, my intention is to remove the trees on the *downhill* side of the stump, leaving the largest scion with decent structure on the uphill side, thus reducing the moment-load on the slope. If you think I should just let it be, I suggest you read the chapter on conifer forestry in this picture book, where I document an old landslide due to an oversized tree on this very slope just behind this stump cluster. Slope failure resulting from oversized trees is a significant cause of erosion in this area. Guess where the environmentalists want to ban tree removal to inhibit erosion? Steep slopes.

To preclude slope failure here I must *remove* trees. Retaining one on the upper side of the stump requires that they must each be climbed to set chokers to pull them over, as the outer trees lean *away* from the slope. Else they will fall across the gully, break, and tear out other trees on the equally steep slope opposite this one. Doing it right takes time and costs money, to which permits and oversight add no value. If I cannot offset those cost by selling logs, then it does not get done, and the slope fails. That means much more sediment in the precious public streams than would be released by my tree removal effort. This is not about wishful thinking, but real choices, real money, and serious risks to life and limb. Please, call off the activists and bureaucrats and let us get this kind of work done.

As to what to grow under the maple on this north-facing slope, there are toyon bushes to which I will add hazelnuts, coffee-berry, sedges, irises, and ferns , that's the fun part of this job.

November 2014, still breathing pretty hard
Photo by Diane Vande Pol

For me, this kind of thinning is not for the sake of entertainment; it’s about the satisfaction of seeing the land respond.

So, What Is He Getting At?

Periodic, and sometimes frequent disturbance of successional systems is necessary to build varietal habitat, both by species and by successional stage. Essentially, programmatic disturbance constitutes a form of feed-forward stability for the system, without which the system proceeds to an eventual catastrophic failure. Frequent fire, soil movement (grading, landslides and floods), harvesting, grazing, and even herbicides are all means of effecting disturbance; they are tools. One can also reduce the necessary frequency of disturbance by species selection to reduce the rate of succession. Some tools are preferable to others, but in general, one can say with confidence that "the right tool for the job" varies by the situation, both spatially and temporally. No two places are exactly alike at any particular time, if only in terms of their site histories. Even within my neighborhood, I can have a tough time finding places that resemble ours before we started. A long record of observation of the system response to small disturbances lends tremendous insight into how the system might react to a larger event.

It is this combination of site specificity and dynamism that is just another reason why I think it such terrible hubris to believe that a public agency subject to the winds of organizational fads, career ambition, lack of local knowledge, political corruption, organizational momentum, unionized job-security, communications overload, and simple distraction is capable of making such decisions justly, efficiently, or even correctly. Errant knowledge in feedforward systems is even more perilous than no control at all. If you doubt that, just look at what fire exclusion and borders open to exotic species have done. It's not getting any better.

We now have amazing communications tools with which to find accommodation with our neighbors to manage the influences our choices in land use exert upon others. What we don't have is sufficient reliable **knowledge** with which to build objective actuarial risk assessments with which to weigh the host of options under consideration. One is oft tempted to think that this was a role for government and universities (and certainly has been historically), but no, the power to inflect "knowledge" can be just as influential as a thousand page rule book (which is how big the California Forest Practices Rules have become), while politicized grant money and group think have unfortunately done just as much damage to the university system.

This is why I quit my career and wrote *Natural Process*, because I wanted to understand that problem. As I began to grasp that the source was really collectivized control without accountability for risk, the engineer in me wanted to come up with a workable solution (we're hard-wired that way). It really does center on data collection, processing, "lumping variables" and all the other impenetrably complex problems markets have solved, from making cars to developing the computer you are using. Developing those automated data collection systems, calculated risk architectures, and real-time actuarial risk-offset contract management software as a way to manage mobile commons (such as air and water) was the dream of that book in 1998.

Yet since publishing *Natural Process* in 2001, I've realized that people prefer specifically that "knowledge" which gives them power, whether true or not. They don't want to give up their claim with which to control somebody else's property, because they assume that the exercise of that control is, by "virtue" of *their* good intentions, necessarily benign. So I thought a dose of reality-based feedback might help, and duly gathered together gobs of ugly pictures of National Parks as compared to photos of far better private ground nearby to convince them otherwise and put them on the *Shemitta* CD.

Manage Succession, or Face Failure

But of the picture books on that CD, the one that became this one was to be different, because virtually nobody who manages land today owns the means to market services for management of *all* of the living possibilities that their land *could* produce: aesthetics, insect habitat, landings for migratory species, contracts for forage improvement, soil science research, monitoring quantitative impacts of introduced species or GMOs, drainage management, improving hydrological infiltration to mitigate flooding and replenish groundwater, development of processes to mitigate or improve infrastructural development, or refugia for reproducing plants and animal symbiotes (of which a pure post-disturbance native plant habitat might qualify as a paragon). It is about building the data with which to develop the knowledge to manage that bigger actuarial picture of long term productivity at minimized risk. One purpose of this book was to help people recognize those needs and opportunities.

Was I Successful? If not, what is it going to take? You see, it certainly looks to me like we're headed for catastrophe when it comes to America's soils, never mind its economy. Agro urban civilization is a system in need of a periodic reset too, albeit I wouldn't let the horde of politicians, lobbyists, and bureaucrats in Washington DC manage one any more than you would. Urban control of rural areas has never worked.

That was the whole point about the Biblical Sabbath for the Land as it was originally intended but never understood. It was to be a year to "let it go," a year in which cultivated lands were to be cleansed and renewed by the impact of animals, a year to realize that we have basic responsibilities to **develop** the poor, maintain productive wildland habitat, and recognize our frailties. It was a year to rebuild relationships with the people who manage the wild, thus strengthening the nation by inculcating knowledge as supported by hands on experience. It was designed to interrupt the otherwise inevitable cultural propensities that lead toward the collapse of civilizations. This was a form of periodic disturbance and feed-forward stability.

The point about this is ***not*** religious; it is cultural and technical. The observations that precipitated this idea had repeated throughout history, as collected into the knowledge of a people with thousands of years of continuity with which to recognize those patterns, propensities, and instabilities in civilizational behavior. Spending time with a nomadic people with which to learn respect for their observations, intelligence, and perspective, was to be the other point of instituting the Sabbath year, an extraordinary idea unique in history. Yes, I want you to read it, and not just because I am the author. It was simply an amazing political, social, economic, and ecological feed-forward control system from totally outside our urban experience.

Tragically, we have nearly killed off the last vestiges of such tribal nomadic peoples, worldwide, many now surviving on EBT cards in the shadows outside and among us. Nor am I convinced that any one ethnic group inherently possesses particular wisdom when it comes to land management. Hence, I am proposing the deliberate construction of a 21st Century nomadic cohort operating in a competitive market of land management by making conscious allowance for them in our laws and land use practices. We really do need them to manage predators, fuels, and simple awareness of what is going on around us. It is an economically valuable service, to renew soils and help keep the mess around us from harming itself.

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