Search and Destroy

March 2015 – The grasses are small, so this is the optimal time for weeding *Galium parisiense* and *Lysimacha arvensis* from *Stipa lepida*, and *Acmispon americanus* and *A. parviflorus*.

This is the chapter, although unfinished was to be the heart of this book. It is the least developed and will take the longest to complete, as there are many line drawings needed that I will have to sketch and ink myself. It could even become a book itself. Most of what you have read so far is either history or theory, while this is practice. Detecting and killing 120 weeds among 350 natives is visually, intellectually, and emotionally demanding, while physically protracted, hazardous, and strenuous. If you think it can be done by robots, high-school graduates, or illegal aliens, you don't get it. There are many reasons why I have succeeded where others have failed.

Wildergarten 4.1

This book was originally produced under the name *The Responsible Party* for which there were two revisions, 1.0 & 2.0. Major revisions are for complete rewrites. Decimal revisions are for revised chapters or navigational changes and are not archived. Back revs are viewable by the numbered links below.

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Other writings by Mark Edward Vande Pol:

Natural Process: That Environmental Laws May Serve the Laws of Nature, ©Wildergarten Press, 2001, 454pp, ISBN: 0-9711793-0-1, LOC Control #2001092201.

Shemitta: For the Land is Mine: ©Wildergarten Press, 2009. Contains: 217pp text, 980pp overall, 14 picture books, 2 tables, 963 photographs, 9 maps, 2 drawings, 2 charts, 145 footnotes, 358 citations, and 216 other source references, not including external Internet links. ISBN 978-0-9711793-1-8

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Hide and Seek

May 2015 – *Galium parisiense* about to drop seed amid *Stipa lepida*, *Acmispon americanus*, and *A. parviflorus*

To kill the weeds you have to find them first. Finding takes time and education. If the goal is to kill as many as possible as fast as possible, not to spend time looking. Any motion or pause in getting weeds into bags is repeated by the number of weeds.

This is how many there were in the prior photo.

Botany books identify most plants by their reproductive attributes. Yet recognizing plants, and particularly grasses by their inflorescences (bundles of seeds on stems), spikelets (the seed bundles themselves), or by seed alone is relatively useless for the purpose of managing them. The problem with it is that by the time a said reproductive parts appear, one often has as little as a day or two before the seed drops. Obviously, I could not rely upon a method that feeble to achieve what we have here. So I had to learn how to identify grasses by their "vegetative" features.

Most botanists regard keying grasses as difficult. My elder daughter was dubbed "a grass wizard" and got her first job at Stanford because she knew how to recognize some of our local varieties. Interestingly, documenting how to recognize grasses by their leafy parts was the original request that began this book as a writing project. Unfortunately, I needed better a better camera to get such photos in total, but I did get some easy ones now that I know better how to portray the distinctions than when I was first documenting the grass species on the property. Now that I have a decent small camera capable of macro photos, I'll give it a go in 2015-16. While many of these weedy grasses are now rare here (making them harder to photograph), given that the decent photos I have are so few, and the amount of descriptive text needed with which to make the distinctions clear will be so great (particularly among brome grasses), this will probably be a much larger chapter in the future, if not a book of weed biology on its own. I will get to it (I have another book to finish first); because weeding will always be necessary, certainly to catch that first exotic invader before it breeds. One cannot achieve eradications without early detection.

The key (pun intended) to rendering the job of separating exotic grasses from local natives early and quickly is to realize that the goal is NOT to identify them but only to distinguish them. Here at the Wildergarten, I must separate some 26 native grasses from about as many exotics. Statewide, there are 258 native and 177 exotic grass species. Thus, keeping it local is critical to identifying features that are both more distinct and definitive. Some keys here involve texture, a quick and powerful signal when weeding, as most native grasses are scabrous, meaning that they feel faintly like sand paper. Other keys are by color chrominance although that is more of a relative distinction than absolute. The amount and length of hair is useful. The shape of the bunch at the base, in-rolled leaves, twisted leaves, the height of the first joint, or a "fan-shaped" bunch. Some weed grasses here (particularly *Briza minor*) are so variable that their forms need to be treated as separate species when weeding.

Remember: unlike a botanist, I do not need to identify the specific weed; **I only need to know whether I want to kill it**. That simplifies detection greatly. Nor do I need 100% accuracy in early detection; indeed, I can easily afford to pull many a native and still come out ahead over the years given the seed they produce. Nor do I need to remove ALL of the weeds in any one spot *early* in the year. Looking for the last one takes too long. Speed is everything in this kind of work. The goal is to be putting as many weeds into a bag as fast as possible. I'll be back to get the rest of the weeds later when they are "sore thumbs" ;i.e., easier to distinguish, as there are fewer to stand against the background and I will be suffering less from visual fatigue.

So, when in doubt, **kill it**. This is hard to make oneself do. Nobody wants to spend their entire time killing. The human desire is to make things grow. Nor is anyone really looking for unnecessary plants to pull when already removing over a million weeds per year. But this is the job and it must go as fast as possible so that when the last few are all that are left, even squeafs stick out like sore thumbs. It does feel good to know that there are only a few and one is getting the last. So here follow some easy ones.

Early germination, erect, shiny, lime green, usually with very few and long tubular leaves, therefore either *Festuca bomoides* or *F. myuros*. I take native *F. microstachys* as well, because I cannot afford the time to make the distinction at this point.

This is a *Festuca rubra*, which although listed as native was introduced here and is therefore removed. The leaves are fine and round, dark, and red near the base. It branches early, radially symmetrical, and not quite erect. The roots are tough.

Early germination, small, yellow-green, shiny, flat leaves, smooth texture, decumbant, no twists, therefore *Poa annua*.

Poa annua again, showing the classic decumbant curl as it grows toward a more erect form.

Highly twisted, fleshy, almost rubbery in texture, pale green, therefore *Briza minor*.

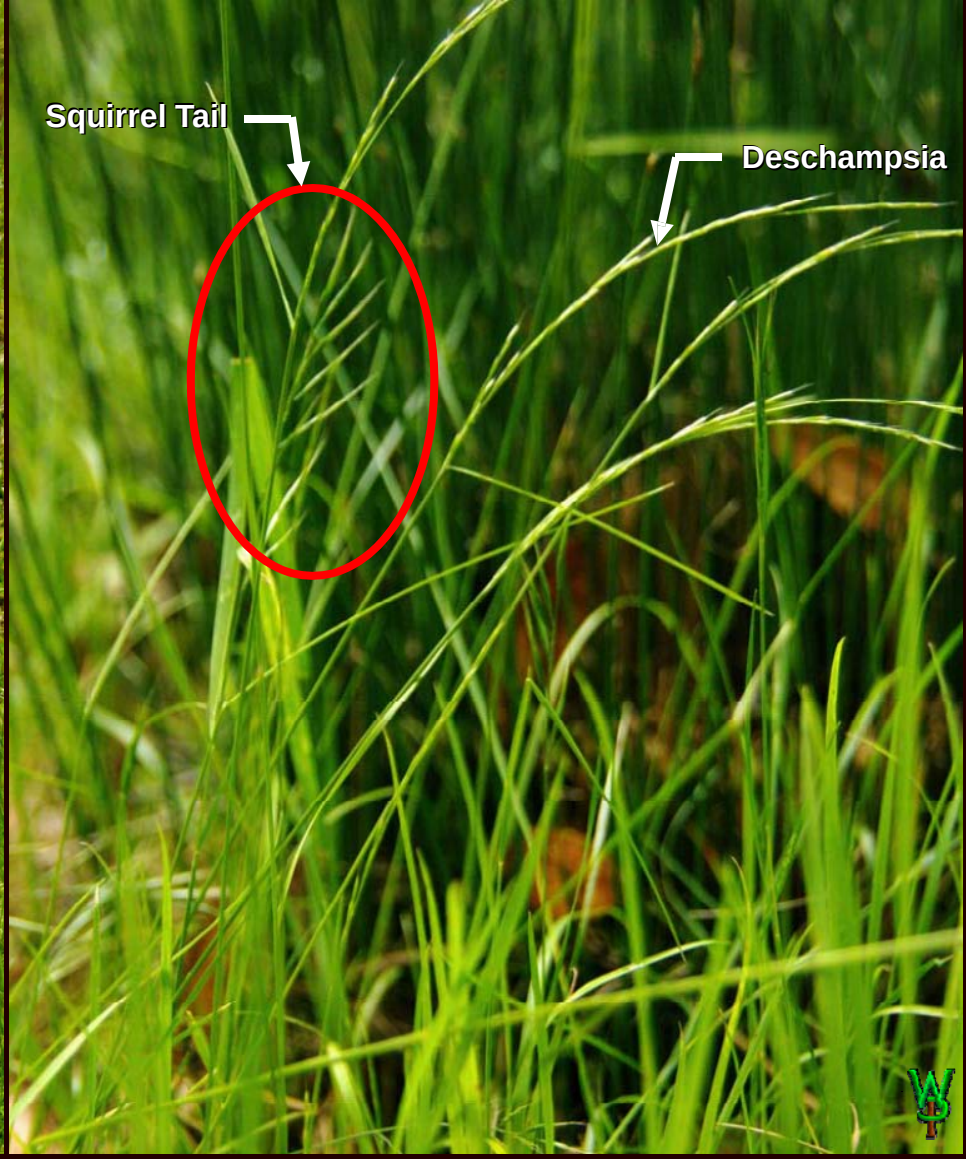
This grass comes up in the shape of a flat fan, with its leaves staying in a plane. There is only one grass here that does that.
This is “nit grass,” probably the best name for a weed, ever *(Gastridium phleoides)*.

May 2010

Now find them in here! This isn't like weeding in a suburban backyard; this is serious work requiring intimate attention by an educated person. This is mostly California brome interspersed with a clover / lotus groundcover.

By Their Fruits Shall Ye Know Them

Even when the fruiting bodies finally appear, grasses can be hard to distinguish. The most numerous were annual grasses, which take about 6-7 years to deplete the seed bank by weeding alone. The challenge was when they infested native perennials with similar visual attributes. Here amid perennial slender hair grass *(Deschampsia elongata)* are annual rat-tail fescue *(Festuca myuros.* formerly *Vulpia myuros)* and squirrel tail fescue *(F. bromoides).* And thus is a tale to be told.



Early distinction between the annual *Festuca* and native perennial *Deschampsia elgongata* is difficult until seed heads appear (right). The appearance of seed makes for easy separation, but it is too late to control the annual ‘tails of woe’ over large areas because removal takes so long. The problem is that weed seeds accumulate over a number of years before suddenly germinating in huge numbers under favorable weather conditions (as they did in 2010). So, after weeding the two tails for years, what I did was use pre-emergence herbicides (chapter to come) that kill only the seed as it *attempts* to germinate. That reduces the tendency for the weeds to suppress later germination of their own kind, which cleanses more of the weed bank in any one year. This is one reason why I use disturbance (such as burning) to force weed germination. It also favors perennials until the annual weed is brought under control.

Here I must weed exotic annuals from native perennials of the same genus. This photo is toward the end of the season. Before there is seed, the differences are far more subtle, shape, color and texture being chief. To cover acres, they must be distinguished rapidly. Early on, I need be only 70% accurate, because that is good enough to reduce the problem to a manageable level at the end of the season when everything is maturing rapidly and I have little time to get the few remaining exotics before they seed. With seed on them, those exotics that do remain are more obvious than if there were a lot of them. I call this the “sore thumb effect.”

Do not let the color difference fool you; they'll both be red in a matter of days. In fact, Spanish brome *(Bromus madritensis)* is also known as "red brome." Each of these brome patches must be inspected almost bi-weekly to get enough bad stuff out to make it possible to see the exotics amid the natives. The annuals mature so rapidly that if I waited, the more mature would be dropping seed before the later germinators even headed out. That is why the native is redder; the red brome here germinated late.

“Blandо brome”
(Bromus hordeaceus)
from erosion control mix

Offending *B. hordeaceus*
in *“B. carinatus”* bag seed

B. carinatus

It gets worse**:** The *B. hordeaceus* to which I was accustomed (left) was sold under the trade name “Blando Brome.” Notice how much more appressed the inflorescence is than the *B. hordeaceus* in the center, the contaminant I purchased later in *“B. carinatus”* (right). It is easy to see the differences here (especially the awns), but at a distance they were more easily missed. Still, it was an embarrassment. As to why I bought “*B. carinatus*” in the first place, the answer is simple: I had a major grading project to do, nowhere near enough local seed, and this property had been traversed for so long while the adjacent road was a major trading route that I am certain none of it was “endemic,” albeit it was well adapted. If I was “wrong,” time and natural selection will fix it.

This has been the job description**:** Clear the soil of weed seed by using up the "weed bank" while native annuals propagate. It's the hard way, but until I had developed some other techniques we will cover soon, it was all I had. Besides, it beat sterilization and seeding with collections, in part, because we just didn't know what might be there and we had so little native seed. The visual demand of weed control is intense, especially when spot-spraying (it takes so much concentration that after a few hours, you want to run for the exits).

In this picture are (weeds in gold)**:** mouse-ear chickweed *(Cerastium glomeratum)*, few-flowered clover *(T. oliganthum), pinpoint clover (T. gracilentum), notch leaf clover (T. bifidum),* little hop clover *(T. dubium)***,** small-flowered lotus *(A. parviflorus),* Spanish lotus *(A. americanus),* California brome *(B. carinatus)* which I had been pulling here until I got the foundation put back. Brome grasses have a fairly powerful allelopathic chemistry that excludes other plants. Also present are small-flowered needle grass *(N. lepida),* rat-tail fescue *(Festuca myuros)*, pop-weed *(Cardamine hirsuta)* (I hate it), wall bedstraw *(G. parisiense)*, two non-native vetches *(V. disperma and V. tetrasperma),* slender madia *(M. gracilentum),* and coast tarweed (*M. sativa,* of disputed origin). The worst are the wall bedstraw and the rat-tail, but the chickweed is not far behind. We focused on chickweed first, because it is the earliest to germinate and set seed.

So, is this just an aesthetic exercise for a would-be intellectual with nothing better to do? Are the non-natives really so bad? After looking at this and the other picture books, I hope you share my opinion that the damage weeds do is far beyond the mere aesthetic. If exotic species are truly responsible for one third of all extinctions in North America, and I promise you, THEY DO NOT STOP SPREADING ON THEIR OWN, then this is the most critical environmental issue we face. If all the activists in your area can offer is futility, they need to be shamed, loudly and publicly. It is time to take the moral high ground away from the organized environmental movement and let people get to work, making meadows.

July 2015 – Nit grass *(Gastridium phleoides)* making its typically huge bundle of seed

There is a strange, almost sort of spiritual capability that develops while walking around**:** I learned somehow to notice a problem in a particular spot well before I could recognize it visually. Something just catches the eye, you stop, and look, sometimes with your mind raging at you, “Get going, there’s nothing there!” It takes a bit of faith sometimes to stick with it, but virtually always, I am rewarded with the discovery of some nasty plant that is just about to do something really bad. It’s uncanny. Sometimes “the find” is obscured from the original view, in a bush or under another plant… It just happens. Some part of me knows to react to that dark brown spike.

July 2015 – This is an easy one; *Torilis arvensis* in native deerweed (I've circled one seed cluster; the rest are left as an exercise).

I mused on the phenomenon a bit and it hit me**:** Every time I see these weeds I regard them as a threat, reacting emotionally as well as intellectually. Emotions release hormones. What if I was mapping subcortical ganglia with the associated shapes? People do the same thing in picking out an enemy from a crowd. It's one heck of a processing problem considering all the variations in object from background with weeds. Yet maybe it works here is because we have so few; else the threat would desensitize into ubiquity.

Feeling Apprehension

There are dozens of different methods I have developed for weed removal that vary by soil, species, size, and conditions. When I confronted the combination of drawings and video necessary to teach them, I realized how long this was going to take, especially when I investigated how paltry useful graphical raw material is on the Internet. I don't have that much time this year (2015) and at this writing there are very few weeds upon which to demonstrate. Therefore this section is seriously lacking in graphics because neither computer drawings, video, nor photographs yet communicate this material adequately (animation would, but at what expense?). Worse, at nearly 60 pages, this chapter is hitting the maximum I will allot for file size and more images will blow that total unless I can reduce them to the equivalent of line drawings which, though doable also takes considerable time. Until I figure it out, I hope you find the text of use. - Mark

May 2010

Selecting a weed removal technique is dependent upon its root structure, size, stage of development, reproductive rate and potential, soil conditions, and competing vegetation. Generally, weeds have two types of root structures, those with branched fibrous root systems and those with tap roots, each with several subtypes, on which there are variations such as multiple taps, detachable corms, or rhizomes. Tap roots must be removed axially while branch roots are removed with forces that cause the soil structure to fail (particularly grasses). Soil rigidity and tensile strength is comprised of interlocking soil particles, chemical cementing, void spaces, roots, bacterial exudates, and fungal fibers. These techniques were developed for our soils consisting of fine and relatively spherical sand particles that that form relatively isotropic structures interspersed with varying types and degrees of organic components (roots, litter, and compost, with few "rocks" although it can pack and cement into one). We will start with the simpler case of tap roots.

Tap rooted weeds break down into two types. Those with a basal rosette (left) are usually of a weaker starchy hydrated material than weeds that come straight out of the ground which are more fibrous, or even woody. The exceptions to the latter are those erect tap-rooted weeds with a crook or bulge at the ground line (right) which, while of strong material, is a “designed” break point at the bend. It has been best to grab those below the kink.

Broom seedlings, as a woody weed with a tap root connected directly to a strong straight stem, can usually be removed in direct tension, as can many other legumes as long as the soil is not too hard. In plants taller than 1 foot in harder soil, put both feet on either side of the point of entry to avoid pulling up a clod of soil. In plants over three feet tall, bend the stem over your thigh and straighten the leg to provide the force. Failing that, leave it, brush cut it, and spray it next spring. It beats lugging a weed wrench around.

When removing tap roots, as with many other weeds, there is an interesting progression in your favor. When you apply tension, the root hairs and small laterals start letting go from the top down like a zipper. As the upper roots let go, it extends slightly, its diameter decreasing in the hole hydraulically as the root stretches. You'll feel it slowly giving and then come out smoothly without a sudden snap. It may take 0.5-2 seconds longer than just tugging, but that is less-than-to-equal the time required to deploy the weed fork unless you are plunging the fork into a group of similar proximate weeds in series.

Larger tap-rooted weeds (usually thistles) often develop multiple and forked taps if they have started to bolt, all of which must be extracted (although they do not regenerate as well as cat's ear). Before even attempting a pull, I yank the top and put any flower heads into the bag. They tend to take less room in the bag and less time to pull before separation than getting a whole weed out to remove them later. If they are seeding, I carefully bend the weed down into the bag before touching the heads. Usually pulling thistles after bolting does not require slapping the soil, working the fork to heave the soil around the stem is usually sufficient. I treat the rosette as I would a dandelion.

Seedlings start as tap rooted weeds. Almost all tiny seedlings are usually addressed when it is wetter earlier in the year. Super tiny weeds can stick to your fingers, particularly when damp, making it possible to grab a dozen or so before they start falling off. Find a comfortable total before they do and then leave small piles on the ground to scoop up to make the trip to the bag.

May 2010

When a fleshy tap rooted weed with a basal rosette is pulled in axial tension, unless the soil is sloppy mud, the root is likely to break and regenerate from the remnant. One loosens these before removal with a weed fork (above). The goal is not to dig out the weed but to fracture the structure of the soil so that it cannot compress against the root and retain laterals, then to be withdrawn intact. Insert the fork parallel to the tap root. Lever it only slightly so that the surface heaves just a little and then withdraw the fork straight out of the hole (hopefully clean). Slap the ground on top of the bulge with the heel of the weed fork (usually atop the offending plant). This shatters the soil structure such that the root can then be removed without either breakage or pulling out a chunk of soil with it. That way, the soil entraining the weed bank stays nearer to the surface for future treatment. Sometimes I'll plunge a whole group and then slap them as a group, thus using less time in operational transitions as the body position is a little different to get one's weight atop the plunge as opposed to the slap. If the weed is growing in rock, pull off any fruiting bodies and spray it.

The act of gripping the stem of a weed with softer tissue puts considerable stress at the pinch point at which it is liable to fail if it is also to be the locus of tension in the stem. People often then grab the stem lower where it is stronger in order to avoid breakage, often so low to the ground that when it breaks it is hard to grip again, thus requiring the time to dig it out or risk regeneration. The easy way to reduce that stress concentration is to reduce the combined forces of gripping and pulling on the stem at the same spot. Simply grab the weed higher up with the thumb and first finger and apply either lifting or shear forces as desired with the edge of the pinky finger. Shear is applied by twisting the wrist and lift with a curl of the hand. If the weed is larger, the pinky can gain support from the other fingers. It does get a heck of a callus along the bottom edge! Palm the weed and grab another until the hand is full. Keeping the movements small like this means the removal cycle goes very quickly. With stronger stems and soft soil (such as hedge parsley after a rain) I can execute the maneuver by simply flicking and curling my pinky while barely turning the wrist, so fast that the weed floats in my hand without time to fall while I grab another. The full cycle time of grab and extract can be less than a second.

May 2010

Among the many different methods I have found for removing weeds with branched or fibrous root structures, several are counterintuitive; you may need to study the diagrams carefully. The first group consists of simple manual extraction, which can be done with very small grasses and broadleaf weeds. Grab the stem or bundle and shake the wrist from side to side to release, and cup the weed twisting the wrist until your hand is full.

May 2010

In those instances when I am removing smaller weeds by hand alone, I usually put reciprocating radial tension on the weed by cyclically twisting my forearm in a rolling motion instead of lifting it straight out. That carries fewer loads into the back (not lifting the weed plus the arm) and saves the lifting muscles of the forearm. If the weeds are small, I palm them as I remove them to minimize the number of trips to the bag.

May 2010

Most people grab a weed and pull vertically. With a fibrous or branched root system, this tensions all the roots radially simultaneously against the soil, compressing the root ball into a solid mass. The forces then transmit to the ends of the root zone putting the boundary of the zone wall in shear, thus requiring *much* higher forces on the stem(s) to fracture a larger area of soil in shear to permit removal, either breaking the stem(s) or yanking out the entire compressed clod of dirt. Then one tries to knock the dirt off, thus burying surface seed, not to mention leaving a divot and weighing down the bag with dirt.

Rotating the tension radially around the center puts only about a third of the roots in tension at any one instant and low shear forces on the rest, nor does it compress the soil in the root ball. The tension put on the soil at the surface has no support and soil is weak in tension, thus allowing the roots to work their way out. This transmits higher forces farther down to fewer roots at any instant so that less tension need be put on the stem, so it is less likely to fail. As the roots on the far side let go, the roots on the near side loosen the soil around the stem and curl out until they too break farther down than they would have if one simply pulled the bundle straight out. This method has high final yields on smaller weeds, as most branch rooted weeds will not regenerate from small roots. It also induces less disturbance likely to germinate another weed that year. As a method, it's better used on smaller plants, as the forces imparted on the weeder are fatiguing and it is slower than simple reciprocating shear.

May 2010

On weeds with branched root structures and weak stems (such as *Stellaria media*), I'll plunge a weed fork under the plant, heave it ever so slightly, and then pull the fork and slap the surface in the same fashion as I would for a tap root. This again fractures the soil structure so that pulling on the stem does not concentrate as much stress in shear at the ground line or the first fork of the root system, thus the roots fail farther down, again coming out much cleaner and at higher yields.

May 2010

On smaller grasses in hard soil, I place the weed fork just above the surface setting the notch across the clump and *pushing* to loosen the weed. Then I grab it and repeat the circular shearing motions on the prior slide. This is very fast on medium grasses with relatively little effort (we don't have any annual grasses here that make rhizomes). Just as important, pushing on the weed fork allows one to transmit force from upper body weight plus abdominal muscles as opposed to tensioning against back muscles also holding suspended upper body weight. The downside to this method is the time needed to grab and deploy the weed fork.

May 2010

On larger grass bunches in hard soil, I slide the weed fork just UNDER the surface thus cutting the roots going immediately downward. Sometimes I'll slap them too if it looks like the process is lifting a clod. Again, I grab it and put the roots in shear.

May 2010

In those instances when I am removing smaller weeds in soft soil by hand, I usually put tension on the weed by twisting my forearm in a rolling motion instead of lifting it straight out. That carries fewer loads into the back (not lifting the weed plus the arm) and saves the lifting muscles of the forearm. If the weeds are small, I palm them as I remove them to minimize the number of trips to the bag.

May 2010

In the cases of weeds that drop their seed from a pod or cup as if from a salt shaker one must be very careful to keep them contained gravitationally until in the bag. Sometimes the pods open in your hand. Particularly tricky are henbit, chickweeds, and bitter cress.

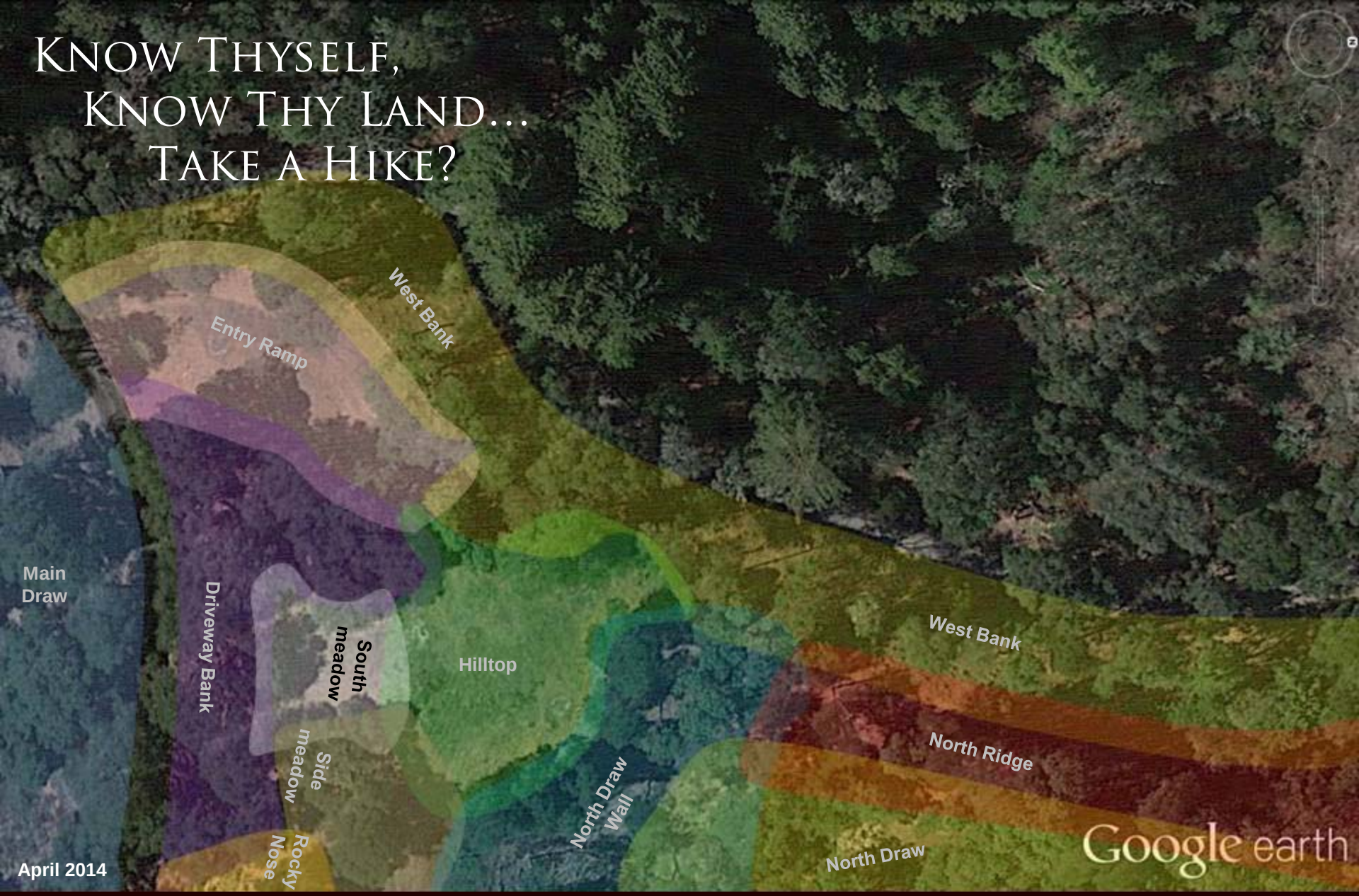
May 2010

Bitter cress is a unique case. Just the act of getting close to this tiny weed can bump a blade of grass that touches it and sets off the pods, shooting 10-60 seeds 6 feet or more in all directions (including stuck to the weeder). I had to learn to judge the color of the pods very carefully, and devise a means of getting close and reducing or (better) containing the spread of expulsion, catching and closing my hand on the seed in mid-air milliseconds after it is flung from the pods, literally pouncing on it with the hand in a grabbing motion with the palm facing down (even spray droplets can set them off). If I can, I then break off the pods in my fist, leaving the stem(s) for extraction, and wipe my hands in the bag to get off the sticky seed. One must be extremely careful to know where they all are before getting even close. This demanded the time-consuming and nerve wracking process of planning the movement on the way to the plant, a wholly new discipline for me because my tendency was to simply work an area, focusing upon each weed I saw in turn, often failing to note the nearby bitter cress. One can touch a honeysuckle or blackberry tendril and set off a bitter cress several feet away. It is a miniature minefield. Weeding it is a very stressful and frustrating process.

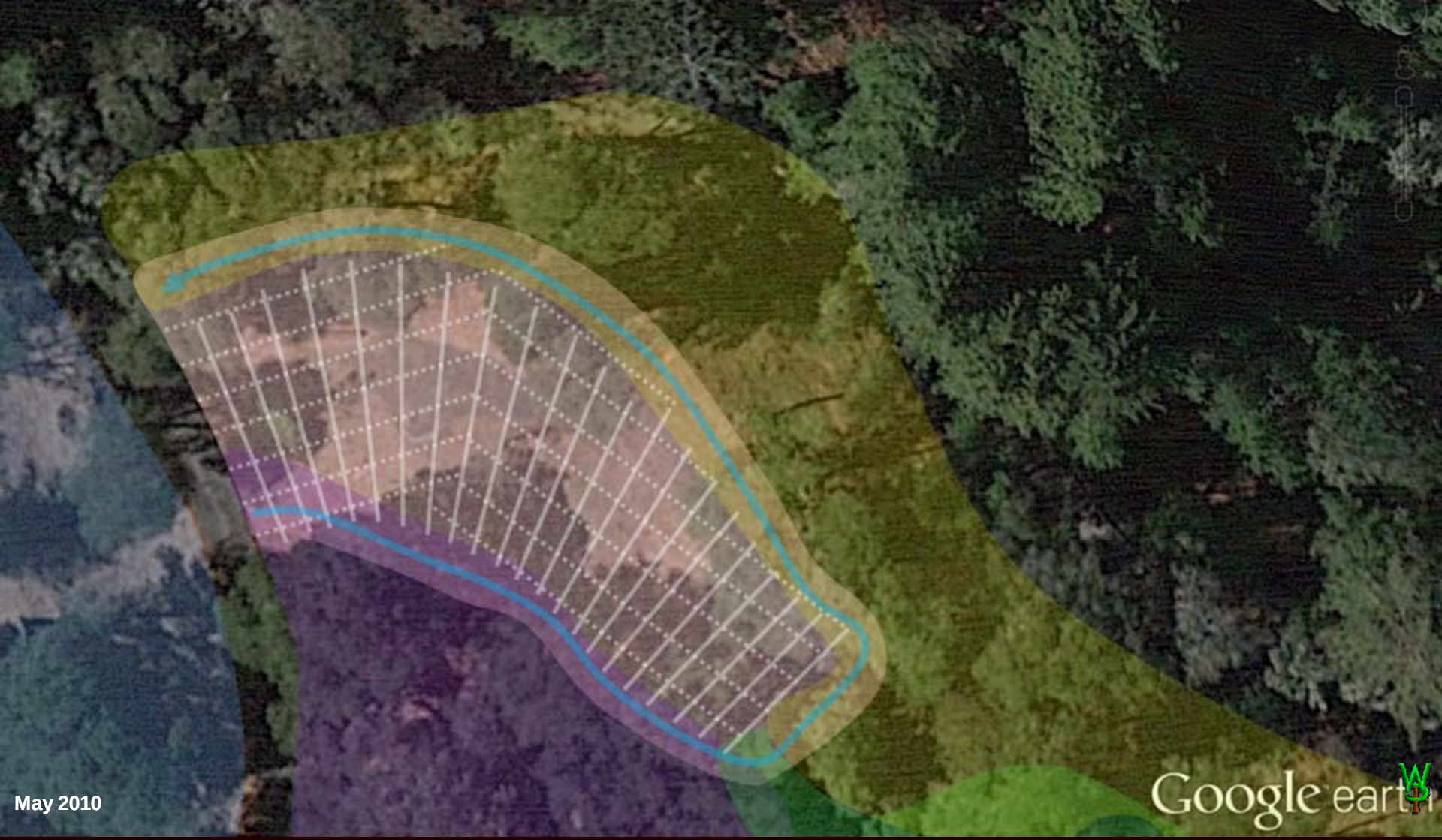
May 2010

These techniques are designed to minimize repetitive stress against the back. It is bad enough to be bent over with one's upper body and arm hanging from the back muscles without adding the extra force to lift one's arm removing the weed. I usually rest my chest on one knee or scoot on my butt to relieve my back of that upper body weight. These weed fork techniques are designed to reduce extraction forces that put repetitive stress on upper forearms and biceps.

Know Thyself, Know Thy Land… Take a Hike?



With nearly 100 separate named locations on the property, each with its own particular differences in maturation rates, weeds present, or removal patch orientation, keeping track of maturation rates such that yields are optimal among the entire array is very challenging, especially in May when the soil is drying out and conditions are changing hourly. One cannot afford to spend time walking around assessing the situation. Instead, one assess and weeds while and walking from weeding spot to weeding spot, back to the house...



Psychologically, it is important to define the attainment goal of a patch in such a way that one tends to stick to it until done, or at least have a very clear idea of how much is left to do and where to restart. Hence I will usually attack an area weeding the perimeter first as a form of area containment, such that it overlaps with the adjacent area. These edges around grasslands often extend under shrubs and are usually a lot more effort than one plans. Getting that done first makes it more likely that one will not get discouraged in the reduced area that is actually the target. Then I set up a pattern, working generally uphill in rows across the slope, each one above the prior. I set flags at the beginning and end on both sides of each row thus defining the axis and its width as a sort of rectangle. This helps avoid missing a spot while rounding a shrub or other obstacle. Then I run a series of stripes directly uphill, thus rotating the pattern 90° over the defined area. This cross hatching reduces the chance of both systematic and incidental errors.

One can sample a series of grassland areas demanding intensive weeding on the way to or from another, thus grabbing off the most mature weeds, or reducing the scope of work in a tough spot to complete later without getting discouraged. So, when I get tired of working in one spot (or if it gets too hot), I simply move on to another area, choosing a non-repeating path through forest along the way (much faster weeding in forests). This method is a way to assess a lot of ground while focusing upon (typically sunnier) spots that develop rapidly, such that things do not progress beyond control anywhere. When I move to another quadrant of the property, I usually set my first attack at the far end such that I can cover less demanding areas with this series of meandering paths looking for early maturing individuals and assessing each area. I can weigh the choice of path according the maturation rate of weeds.

July 2015 – There is hedge parsley in the circle

These not-at-all-random hikes are to assess changing situations, to see if urgency demands a different process that might require particular temperature conditions, to cover a cleaner area within a sampling frequency, to witness the first of a new infestation, to nab those sore thumbs (!), to check for the unexpected… But most important, they are to reset my brain for a few minutes, get a change of scenery, and manage the uncertainty about places I have not visited for a while. For example, if the weeds are starting to set seed, one might have to spray them because one cannot get back to pull them in time because of demands elsewhere. One must know precisely when that “last minute” is pending to avoid the need to spray, or (worse) being too late to stop the weeds from seeding.

Chemical Warfare

The big jugs are to save left over mixed material and to reuse spray tank rinse water. There is no waste.

June 2010

He uses CHEMICALS! Chemicals poison the land!!! You bet they do, but they do biodegrade. Yet toxicity is all about dosage. On our 14-acre property in 2014, I sprayed ½ oz. of Turflon Ester® (1,1,1 triclopyr, mostly for broom and oxalis), three cups of Speedzone® (a 2,4-D, dicamba, mecoprop selective for chickweed, allseed, and crane's bill), ½ oz. of Transline® (clopyralid, selective for thistles), about three cups of glyphosate (generic Roundup®, it kills most anything green) and 3 cups of Surflan® (oryzalin). Does that sound like very much to you on 14 acres? It used to be a lot more than that, but it is less every year. All that time, we have grown, harvested, and sown native seed to offset the effects. In years to come, I'll do more pre-emergence treatments but less of the others, mostly for research purposes, but also to drive some of our nagging problems down to hand weeding levels.

Using herbicides is analogous to an antibiotic treatment. Antibiotics are NOT good for you, but they can save your life. After treatment, you should introduce beneficial bacteria to get the gut going again just as I manage for native seed production. Weeds are often far more toxic than the materials we use to kill them, and they manufacture ever more of those toxic chemicals as they reproduce and spread. Natural toxins work despite ages of opportunity for pests to develop resistance. By contrast, herbicides are developed by people who truly care about making them as benign as possible (I used to work with a guy who had done R&D work in that industry). In rat-feeding studies for EPA herbicide qualification, the most common cause of death is drowning.

Oxalis pes caprae can kill even native blackberry and poison oak! In such cases, broadcast spraying is absolutely necessary and triclopyr is the best active. It is impossible to stop this weed on large scale mechanically because it regenerates from tiny bulblets in the soil. I am nearing eradication on a one-acre infestation like this elsewhere, needing only a hand spray bottle these days.

March 2011 – Ideally, I would use all three materials on the various weeds in this image

First in importance is using the correct active chemistry. Glyphosate may kill most anything green, to which there are exceptions (it is relatively ineffective against legumes such as broom or vetches). Similarly, 1,1,1 triclopyr is very effective against woody plants and legumes and won't harm grasses, but it is lousy on yerba santa *(Eriodictyon californicum)*. The 2,4-D mixtures are effective on many ruderal leafy broadleaf weeds such as chickweeds (depending upon concentration), but not cat's ear, and so on. All of these intersecting sets together with their exceptions have a lot to do with what gets treated and when. To do it well takes research and trials, but it also takes equipment, as one does not want to put the wrong material on a weed after having spent the time to get there and identify it, then needing to remember that individual, weed it, and then return with a better material in time. The solution is to carry more than one herbicide mixture, but batch mixed backpack sprayers don't lend themselves to that. More on that in the tools section.

As I reduced the weed population in general, I needed less material for any one area. I was then capable of mixing hand weeding with spot spraying. Over the years, that demand has fallen so that I can work from 1 qt spray bottles on my tool belt select from among three separate formulations. While it might seem that a quart won't go very far, the method is a lot more efficient on small plants simply because one can get so close to them that there is much less mist overspray and missed application. It is not as good on larger plants both because of time and nozzle design. I can shoot a spot of but 2cm where I could never do that with a backpack sprayer. Modulation of application pressure or pattern is almost instant. Most important, one do it when down on the ground where to *see* small weeds better earlier in the year when they are less tangled among other plants, which means one can use less material to kill each one much faster than pulling. Unfortunately, these still produce a hollow cone spray pattern (a circle). More on that in tools.

The solution to the “tank size” of a squirt bottle is to carry a jug of mixed material into the field to reload the bottles with a funnel. That way I can have up to a couple of gallons each of three formulations with me at all times that I can switch in only a few seconds when weeding. The difference in total usage between this approach and going back and forth with a backpack sprayer is sometimes substantial. It also means I can carry other weapons (such as a weed fork) so that I am not tempted to spray plants I should pull.

For those few situations in between broadcast spray and spot spray when one has but few natives one is seeking to breed, particularly when the site is overrun with annual grasses, masking is the preference. We're still setting pots here.

This is the same slope from the opposite direction two months later. The coverage is from the natives under the pots. This process has worked exceptionally well for us, having never needed doing more than once. Only two years prior, this road was covered with large-seeded rattlesnake grass *(Briza maxima)*.

Spot spraying, although nerve wracking, is terribly important. I would NEVER have succeeded without it simply because small weeds were so numerous they would have bred faster than I could remove them by hand (that 'getting around in time' relationship described in the previous chapter). Experimentation has been the key to developing effective processes requiring a minimum of material.

Obviously, the most wasteful kind of spraying is that which doesn't go into the target plant, of which there are several failures: overspray, bounce, mist drift (destructive to non-target plants), and runoff from the leaves. Optimizing the formulation with adjuvants to help get the spray mixture into the target plant, improves that transfer efficiency. There are three types of adjuvants I use: colorants to make sure that all target plants are sprayed and none more than once, surfactants or solvents to make sure that the material gets through surface waxes, doesn't de-wet, bounce, or run off, and finally thixotropic thickeners lacking an extensive viscosity component to give more control over droplet size by controlling the ejection pressure at the nozzle.

You can have any colorant you want as long as it is blue or blue-green, neither of which shows up well. Sometimes the formulation goes into the plant so fast the dyes cannot be seen within less than a minute, thus defeating the whole purpose of adding a dye when spot spraying. The reason for this is politics. People get so whippy about chemicals that the manufacturers try to help practitioners hide what they are doing. That *increases* the use of the toxins (thank you eco-ilk) because some plants get missed and breed while others go untreated and thus require a revisit after the ones that are treated show distinguishing signs of woe. I don't care if it's day-glow orange, I just want to see what I'm doing for at least 10 minutes. It would help me do a better job with less active material.

Another way to augment selectivity is with the time of year selected for the application. These dormant brome grasses (*B. carinatus* and *B. laevipes*) are not nearly as susceptible to glyphosate as when green. The herbicide will decompose substantially by winter.

The combined case is trees that sprout from stumps after felling despite proper treatment. This is particularly true with trees with having adventitious buds on their roots, such as madrone or bay. These can be very difficult to kill in one treatment, especially when on steep slopes. I plan to try a fine “stair-step” cutting pattern on those stumps immediately prior to treatment as a way to increase absorption and process efficiency, thus reducing the need to re-treat sprouts in the future. Here are sprouts as far away as two feet from the original stump. They have to be big enough to absorb sufficient herbicide to kill the root system for any useful distance.

This is an early stump treatment that did not work (I didn't cut it low enough). I still have to deal with it. Spraying stump sprouts is a special case, requiring high-concentration formulations to be effective, simply because the ratio of collection area to root volume is so low. Cutting them back the prior fall allows one to use less material with less damage to non-target plants.

Unfortunately, while cutting stump sprouts back the prior fall allows one to use less material with less damage to non-target plants, there is a downside in that fresh growth produces surface waxes that inhibit absorption, then causing runoff and dripping. Here I am testing straight tinted glyphosate on new sprouts on very old oak stump and learned I may need to add 5-10% diesel to make it wet more efficiently. I tend to avoid that unless necessary as the solvents can reduce shear viscosity and increase mist overspray.

In cases of shrubs such as broom or this coyote bush, mechanical pre-treatment starves the root system of carbohydrates such that a higher concentration formulation is unnecessary. It makes no sense to spray a full sized bush, because it usually requires more material than necessary, much of which gets shot into the air and misses the target plant. It is better to whack off shrubs and either treat the stump or wait a year to spray the sprouts. This requires much less material at no higher concentration. Triclopyr being a growth regulator, it is more effective against a rapidly growing recovering shrub and can be applied at low concentrations. There is also much less overspray and drift, and there is also less of a dripping problem when what is applied goes into denser leafy material.

Spot spraying is an exhausting thing. The eye-strain in targeting small individuals representing 120 weed species distinguished from their 225 active native lookalikes all tangled together from six feet up as fast as you can go for hours on end is draining. It takes very quick decisions and reflexes to control application to one small plant or a collection warranting a shaped stroke in application. One has to know which formulation works on which weed, under specific conditions with regard to the species life-cycle without allowing wishful thinking or the Law of the Instrument to override better judgment. I often carry a weed fork and a bag while I spray to get down and hand weed while wearing a backpack sprayer (the breather on the tank can leak down my back when I do that, another design problem). I sometimes wear special dark glasses to amplify distinctions in chrominance that are among the special keys I use to identify individual species early in their development. I can tolerate spot spraying for about three hours and then I have to give my vision a rest. What I do typically for "a break" at that time of year is to go back to the areas starting to show effects from the spray and hand-weed them, which is not so hard on the brain because the speed is slower.

Could I have hand weeded it all? No, the method is too slow to cover that much ground under early transitional conditions.

I am very unhappy with current nozzle and delivery system technologies. I would love to consult with a manufacturer to develop means to deliver several different mixes from the same sprayer perhaps with manual pattern and voice-actuated formula controls. I suspect the reason that current spray technologies are so ancient is because in some respects because of racism; 'let the Mexicans do it.' As harsh as that may sound, as far as I am concerned, the backward state of application technology resulting in unnecessary waste, the way we treat people who do this kind of work, and the lack of biological knowledge behind the use of herbicides are borderline criminal.

Typically, I spray earlier in the weed season and at the very end, catching what I could not do by hand in time to stop them from breeding. One tries to do as little spraying as possible early on, mindful of the fact that underestimating the demand would necessitate spraying areas that I've hand weeded for those weeds that came up later (it's happened). Late rains can totally change the estimation of weed populations, producing a late crop that will germinate and seed very rapidly as the season warms into summer. The whole season is governed by an over-arching stress that so much of the work done for a decade could be blown in weeks. There are tough decisions involved as well as personal risks. I don't recommend it.

I would be delighted if there was an ethical scientist with whom I could arrange access to a reputable independent lab interested in testing our soils for pesticide residues. In many respects, our situation here is highly idealized for dissipation of such residues because the soils are primarily sand. If such residues are detected here in quantity, they would persist just about anywhere. If they are not, then the "antibiotic" analogy is correct and we can then think in terms of "how long" they persist instead of pretending that whatever damage they might do is effectively permanent.

We simply must get past this. To my observation, too much time and treasure are wasted out of fear and uncertainty while we have irresponsibly allowed the problem to grow, eventually requiring far more herbicide than would have been necessary

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