

GRASSLAND WEED MANAGEMENT BY SPECIES: MEET “THE ONION”



November 1989



Although this may look like a grassland, it is not. The surface is covered with broom seedlings that grew to 2 feet in the next three months. At that point, broom is all one sees. Guess which weed one tackles first? Yet what I was looking at was but the skin of an “onion,” ordinal “layers” of weeds that took more than a decades to express.

WILDERGARTEN 5.4

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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.

Revision History [1.0](#) [2.0](#) [3.0](#) [3.1](#) [3.2](#) [3.3](#) [3.4](#) [3.5](#) [4.0](#) [4.1](#) [4.7](#) [5.2](#) [5.4](#)

Vande Pol, Mark Edward, 1954 –

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

[Articles at Wildergarten Press](#): collected writings on Constitutional history and regulatory racketeering by tax-exempt “charitable” foundations

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GRASSLANDS WEED MANAGEMENT OVERVIEW

The top two lines of the graph to come (next page) depict a transition from one strategy to another. I started with “Weed Management by Species,” dealing with only a few extremely virulent weeds organizing a separate strategy for each one over large areas of the property. As those weeds started to subside and natives started to return, “Comprehensive Management by Area” dealt with all exotics place by place. Effectively, this represents the transition from chemical to multi-process control methods as the weed population dropped and natives returned. The “Mechanical” line was at first entirely bush whacking broom, again with a perimeter residual. Hand weeding then began to displace chemical control.

The height of each curve on the chemical lines does *not* indicate how much herbicide was used; it is more analogous to the emphasis, relative effectiveness, or area covered, usually only once or twice by broadcast spray and thereafter by spot spray. The tails at the right end of the Post-Emergence spray line represent two entirely different processes. The upper half, labeled “Speedzone Southern®” represents continuing amounts used in the same areas for residual early germinating weeds such as chickweeds (both *Stellaria media* and *Cerastium glomeratum*). The Pre-Emergence line would be shorter in height but if it reflected actual area you wouldn’t see it, so think of it as scaled by 5-10 times compared to the Post-Emergence line.

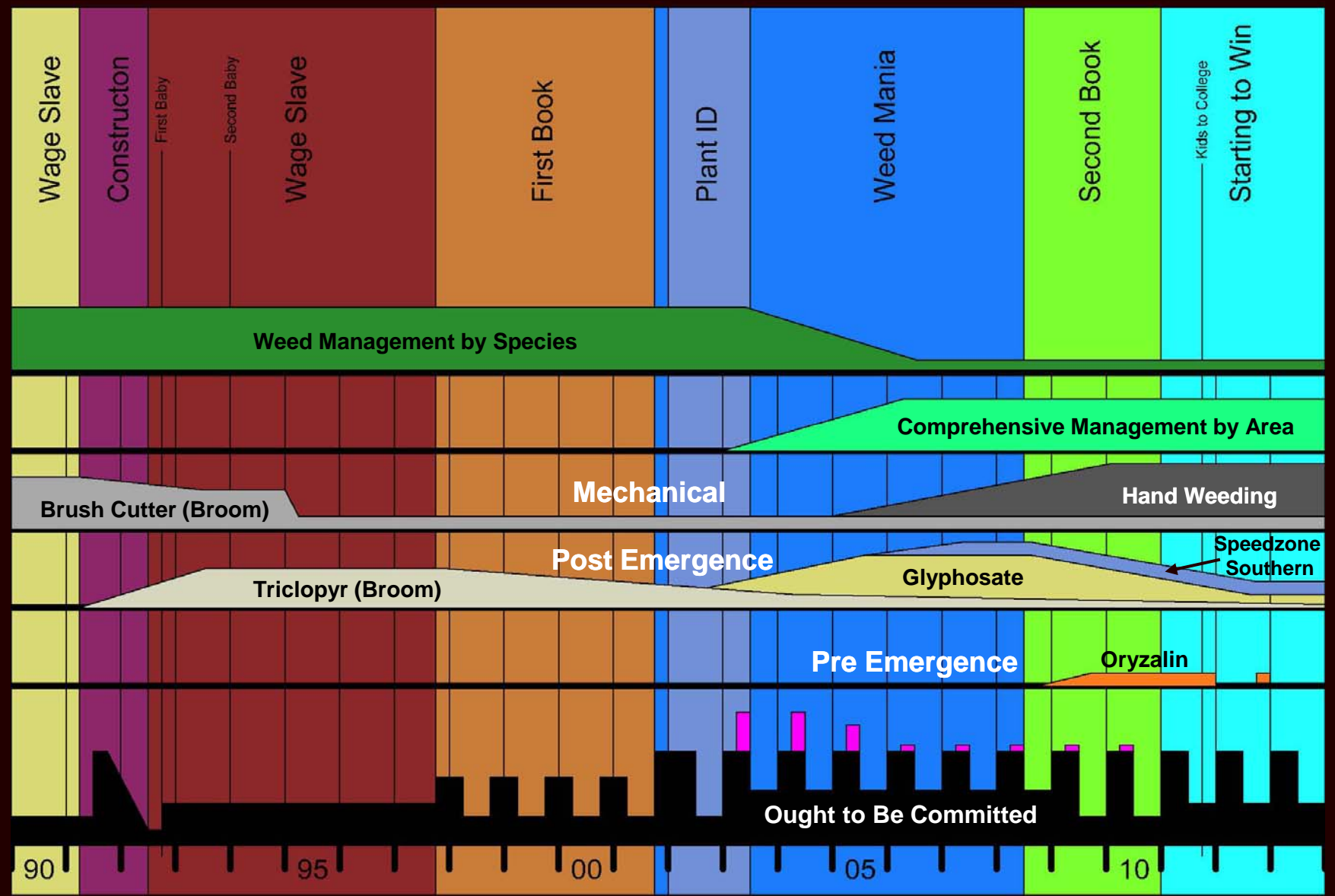
Up until late 2014, on most grasslands I used little to no herbicide at all beyond spot treatment of chickweed in January and February, a process of which I had hoped to see the end in a year or two but for the fact that the State weed management bureaucracy, for over 50 years, had misidentified exotic bitter cress (*Cardamine hirsuta*) as a native (*C. oligosperma*).

I am continuing experiments with pre-emergence herbicides, gibberellic acid, karrakins, and nitrogen to help break seed dormancy with which both to control bitter cress and as a caution against the day if the soils here become more fertile over time and germinate those weeds in the seed bank I have not yet encountered in quantity. Fertility is a double edged sword. It supports more wildlife and grazing animals yet it also germinates weeds and abets succession. I am interested in more vitality, but I am not interested in generating needless work. As you might expect, I have had quite enough of crawling around pulling acres of weeds and don’t wish to use chemicals any more than anybody else does. I much prefer searching for that one isolated pioneer weed among a rich variety of native plants of increasing complexity. Most of the 19 eradications we have attained so far are instances when I have controlled a new infestation before it could breed, a control process which requires detailed inspection of the entire property over a period of six months no matter how good it gets.

The glyphosate half of the Post Emergence chemical “tail” on the right represents the perimeter plus newly disturbed areas of two types. The first is when I take a stand of forest from Phases 1 or 2 to Phase 3, the usual response to which (besides broom) is herbaceous weeds such as hedge parsley (*Torilis arvensis*), catchfly (*Silene gallica*) or scarlet pimpernel (*Anagalis arvensis*), the latter of which is usually close to the bottom of the weed bank “onion” (more on that later) The second, although similar, is more distributed dealing with the multi-species response when I remove individual trees exposing spots that have never expressed their weed bank to light and warmth, then to lose their accumulated mulched leaf litter over time.



GRASSLANDS WEED MANAGEMENT OVERVIEW





Diane, March 1991 – Just about to start with the day's burning. The broom is already 2-3' tall.

As mentioned in the [Project Overview](#), we dealt with broom most everywhere except for redwood monocultures. Broom germination in grasslands was so high that the bulk of the seed bank gave out there in about 5-7 years. Forests were another matter, especially where I had just cut a tree. "Weed Management by Species" thus began with broom and later differentiated between forests and grasslands.



April 2004 – Whence it came, just across the property line

I had built a house, got an engineering job in the 1992 recession, plopped out two kids (OK, the wife did the plopping), and made the company gobs of money they didn't share. In my "spare time" I killed broom, graded roads, put in culverts, removed the eucalyptus and acacia, made my first pass at thinning the forests within 200 hundred yards of the house. Then I quit the job and wrote **my first book**, all within 13 years. Needle grass had come up in places. Most people would say I had done a great job. Then, I got **nailed**.



May 2004 – Same area on my neighbor's property





By this.

This spot is 500' from the prior photo, two years after I realized what a serious problem we had.

I'd been busy you know, working 60 hour weeks at an engineering job with international project responsibilities. My wife worked as a nurse manager. We carpooled with two babies, in separate daycares. I'd worked my tail off on thinning the forest and getting rid of broom. Then I'd quit my career to write a long and involved book about environmental policy. So I wasn't about to pay heed to something as pedestrian as a small dandelion...

This is no dandelion. This is a monster. This is cat's ear. We have two varieties. The first (*Hypochaeris glabrosa*), is a smallish annual. At first appearance, it doesn't seem like a huge problem to most people because virtually all the native meadows in this region are so long gone, primarily due to exotic grasses and fire suppression. Other weeds keep it from dominating. It doesn't look like much, does it?

It can be easy to miss!



*Hypochaeris
glabrosa*



This is the other form of this genus, *hairy cat's ear*, (*H. radicata*) which was also among the cat's ear you saw in the first of these photos (the larger flowers). We had this one too. In fact, this was the first one I noticed, or rather, which my wife bugged me about as I was finishing that book. It's hard *not* to miss; they were popping up all over with a fat rosette on the ground and great big flowers.

This "dandelion" can get almost two feet tall and make *lots* of heads. I've counted as many as 70 heads in the making on one plant, each capable of producing about 50 seeds, for a total of 3,500, each. It is also a perennial, which gives it the potential to be the dandelion from hell.

3,500 dandelion seeds, per plant, per year. There were five acres infested with at least a two-year head start. Big problem, right?

So, you are probably wondering why I regard the little guy on the previous slide as so much more of a serious threat. Well, left alone, it might be true that the bigger weed is more of a problem. Under management however, this one matures far more slowly. At the time, digging them out was so slow that they would breed faster than I could control them but I had plenty of time to stab each one with a sock tie-wrapped over a sponge on the end of a stick dipped in a bucket of mixed Roundup.[®] I control it by hand now on one or two that blow in from my neighbors' properties every year. Compared to other weeds though, this one is now relatively easy: it's big, slow, and easy to treat.

So, hairy cat's ear is both easier to detect and I have more time to find it before it blows all that seed. The serious problem with *smooth* cat's ear plants is first finding, and then getting rid of enough of them that you don't wind up worse off than when you started. As you saw, they can be very hard to find...

Well, sometimes...





April 2002

...until you suddenly realize that you have a lot of them. When I first saw this from a distance, there were so many stems I first thought it was grass. While I was “busy” writing *Natural Process*, cat’s ear was quietly colonizing our sand hill area from pioneer seed blown in from our neighbor’s land. Up until then, my principal enemy had been broom, followed by rip-gut brome that went crazy on the nitrate the broom had left behind. I had no idea of the magnitude of this problem, but it took me 3-4 years before I had it fully under control. Nor did I understand how particularly vulnerable sand hills are to post-disturbance plant invasion, even natives.



April 2002

By this time, it was too late for me to stop it from seeding. When the seed heads opened, the land looked like it had snowed. I estimate this infestation to be in its third year. So what you now know is how much worse it was *going* to get. Having written a book claiming to have a better way to manage the environment, it wasn't as if I could let this go. It took me three years to control this disaster at great cost to our meadows. Note all the bare sand; there wasn't much diversity here.

I didn't want to kill my needle grass, so I tried 2,4-D because the chemical company said it would work. The smooth cat's ear on the right had been treated with 2,4-D. As you can see, it seeded anyway. The real keys to getting control of this little beast were proximity, persistence, and Roundup® (no, I didn't like killing my native needle grass). Then it was demanding accuracy spot-spraying . **Then** it was hand-weeding.

Places with more sun develop the weed more quickly. Steeper ground facing neighbors acquires more seed. Think about finding them all, hidden in clumps of other plants over 5 acres. So, why bother? **PEOPLE either take action to control weeds or there won't be any native habitat left, anywhere.** Otherwise, we should just admit that what the land becomes is of no concern to us, at all. That is your eventual and inevitable choice.

Smooth cat's ear often hides underneath other plants, which means that your first notice is the flower-bearing stalk. The yellow bloom is only about 2-4mm and only opens in the warmer parts of the day. The specimen at right has about 15 heads, each supporting 15-25 seeds. Published germination rates are above 90%. In sunny spots, I have two weeks to find them all from the time the shoot first appears to when they blow seed. So, if you are 95% efficient in killing them, that means you are losing. If you try for better efficiency, that means you slow down, a lot. If you fail to cover it all, the seed blows over your head and you lose anyway. So, if the best one can do in a weeding session for cat's ear is 95%, one needs to weed 5 acres three times in two weeks, about **every 4-5 days** in order to win. One has to know where they are likely to be from the prior year, how mature, how many there are at any one time and place, how much sun has been on each spot, *and* the weather forecast in order to cover enough ground fast enough to win. If you want any "Natural" left, that is what it takes.





May 2002

This patch was 3-4 years in the making. It is almost entirely cat's ear. Let us assume (charitably) there are an average of 10-15 plants per square foot. It is too steep and erosive here to till. So, if one is going to hand weed, let's say (charitably) that one can find, move to, remove, and bag ten plants per minute on average over an eight-hour day, which works out to **nine days per acre**. You have five acres to treat and (in May) two weeks to get them all. All winter and spring, as one removes them, more of them germinate. Some recover. Do the math. The only thing that worked was Roundup.[®] Now that **the patent has expired...**



March 2003

This is what we had, and worse. Think what this means to wildlife forage. It is hard to appreciate what this did to our property, but cat's ear totally destroyed our meadows. After broom, **cat's ear was the prototype for single-species grasslands management here** at the Wildergarten, in that it would seemed that the whole world was coated with it and everything I did was directed toward its control.

But did we really have to spray it with Roundup? That stuff kills everything! The surfactants ruin your ground!! NOOOO!!!!



June 2010 along the County road

This is what a weed monoculture can do, and it is impressive. Oh, and did I say that **cat's ear is toxic to horses?**

This is a vertical sandstone promontory just down the road generally upwind and at a higher elevation than most of our property. From a ridge like this, seed can disperse over our entire property. Cat's ear is so tough it can root under moss on a rock just as easily as it can ruin a meadow. Anybody in for weeding the face of a cliff overlooking a road below a blind corner, by yourself? I do, but I don't recommend it.


The key to winning is to extend the control area to include 'launching points' from which the seed can disperse in large numbers AND beyond which the landscape is inhospitable to the plant. So not only did I clear our property of cat's ear, but also places like this one on a neighbor's property from which it could blow in. That means broadening our control area to logical control boundaries (if such exist). There is broom here too.

Once I had control, maintenance was a matter of vigilant spot-spraying at the edges of the control area, plus policing our own property for cat's ear manually while looking for other weeds. Of course, one could always dig them out by hand tearing out chunks of rock and covering less area...



February 2003





Here is same that rock wall 7 years later. Armed with my newfound knowledge I had made sure all the plants were native!

Was I done?

There is no such thing as “done” when it comes to caring for land. All I *had* done was isolate the constituents of a system. I had not in any way optimized a total system in a manner representative of what the Indians might have done, never mind learned what its potential might be. Worse, the continuing demands of weed control severely limits experiments I might do. Still, I now have choices: The wire lettuce (*Stephanomeria virgata*) is inedible, obnoxious (up to 6 feet in height), sends seed on the wind, and looks at first like a dandelion. So, I'll let somebody else grow wire lettuce. The Cammissonias and silver puffs make more food for wildlife. So, for now, I'll grow more of those until I learn what else might be done with it.

That is what the Indians did with this land. This return of native “crop plants” is a direct result of knowing the land intimately, but that does not mean we know how to grow them. NOBODY has done enough restoration work for long enough to truly understand how the various native systems were managed. There isn't even an organized effort to collect the necessary base data to make weed management more predictable to facilitate getting there (such as how many seeds per propagating body, the term of possible dormancy, expected germination rates, degree-days to maturity...).

There isn't any grant money in it.

As weird as it may sound (and frankly, it's sad), I am told that we are farther along than anybody on the entire Central Coast of California and possibly all of North America, parks, conservancies, and “pristine areas” included. I wish it wasn't that way, but apparently that's just how it is. There is an enormous amount of scientific work that needs to be done just to understand how the living elements of our immediate surroundings get along. What better living laboratory could there be than a purely native plant habitat?



March 2010

This is the worst of what I see in cat's ear these days, representing what I call a "systematic error," a location I missed late in the year resulting in two heads (white circles), luckily still with some seed. Needless to say, there are other things I would rather do than weeding. So the desire to declare victory *some* time in the summer is great. This incurs the risk that something will make it after I've quit for the year. The immediate problem here is mouse-eared chickweed (*Cerastium glomeratum*, gold) with the whitish tube for a flower. Besides grabbing the cat's ear seed, the chickweed is an immediate problem as the seed inside that small, whitish tube is already viable (it is "pseudo-cleistogamous"). There is also a single *Briza minor* (red circle). Unfortunately, even though the weather is too cold for cat's ear to mature and blow seed, it demands attention now. The natives are small-flowered lotus (*A. parviflorus*), Spanish lotus (*A. americanus*) and slender tarweed (*Madia gracilis*). If I 'come back to it later,' the lotus will cover the cat's ear, leaving it both numerous enough to slow me down at a critical time, *and* hard to find when it matures, which is when I have less time to find them all before they blow. Moreover, the ground is softer in March and the weed smaller, so it's easier to pull. So I have to keep the biology of each weed in mind and the treatment method for each while I plan my hand weeding. In this case, I must deal with them both now.



Early April 2010

This is what "leave that for later" looks like in a grassland. One can still find the cat's ear, but the chickweed is now very hard to find. There is now not much more time left before the cat's ear will start to bolt and seed. At this point, that means one must weed more frequently in order to attain sufficient yield to reduce their numbers in succeeding years. This spot is particularly bad every year because of the pattern of air currents on the property. One must know all such places. I have found that breaks in slope tend to grab more seed, convex edges because of eddies and vertical inflections because the seed has mass and momentum. This represents only what came in last year. This is what "winning" looks like in the real world until I can get my neighbors to cooperate more fully. The yellow area on the lower left is a chemical burn from a 2-4,D treatment for chickweed from which the natives will recover.

WEED MANAGEMENT BY SPECIES: NUKE IT 'TIL IT GROWS

Cat's ear came in and took over after the removal of broom. It was followed by rip gut and soft brome grasses (*B. diandrus* & *hordeaceous*) from the seed bank. Meanwhile in the forests, bedstraw (*Galium aparine*) had invaded from the County road and hedge parsley (*Torilis arvensis*, *purpurea*, & *nodosa*) came up from the seed bank. These weeds were spreading while I dealt with cat's ear. It was a mistake to focus only on cat's ear, but at the time, I felt it was all I could handle.

So, why didn't I kill them sooner? Simple! I was an engineer, not a botanist. In the case of most small plants and grasses, I didn't know native from exotic. Besides, nobody likes spraying things when they're not sure what it is. I bought every book I could get to learn how to distinguish the two. The problem is that most botany books (besides their impenetrable language) identify plants by their fruiting bodies: flowers and seeds. That is TOO LATE to make management decisions about what to kill or keep. I consulted the few useful photographs that were on [CalPhotos](#) at that time. There were misidentifications even there. It only slowly dawned on me: The experts weren't always right. Once I'd done my best with what I could piece together, I begged Dr. Grey Hayes of the Elkhorn Slough Coastal Training Program to spend an afternoon here filling in the gaps. In succeeding years, Grey was instrumental in facilitating early weed identification, especially once I had acquired a digital camera with which to obtain the ID by email. By 2002, we had identified and I had documented 190 plant species here, a number that had tripled since I had thinned forests and killed broom. That total has since nearly doubled again.

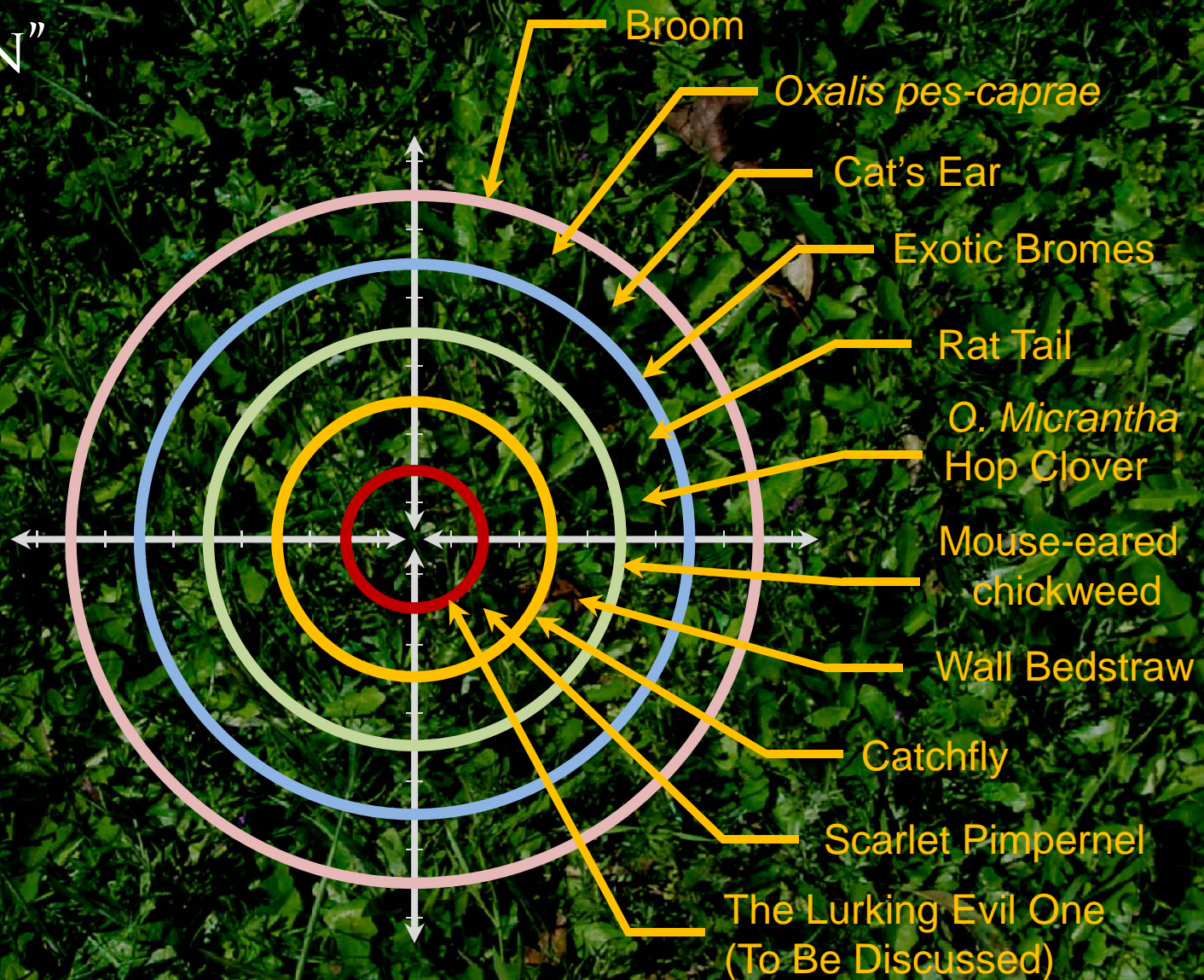
The identification process had been very costly. Effectively, I spent a year photographing and cataloguing native plants and weeds but probably cost myself more than three years of future labor because of the delay during which the weeds were breeding while I did that ID work. The consequences were much more weed removal in subsequent years (principally bedstraw and hedge parsley in the forest understory). The delay did considerable damage to the native groundcovers I had at that time and for years thereafter. In a couple of places we are *still* recovering. Even then, our efforts were not entirely chemical; as mentioned before, we pulled some 37 garbage bags of hedge parsley alone in one year but the consequences of the seed it dropped lasted far longer.

Do I regret killing virtually everything over acres? Not a bit, but as you will learn, there is likely a better way to do things. In some ways though, even based upon what I knew then, I wish now I had been more aggressive back then, as I would have used a lot less chemical herbicide over the long run and would have got past that phase of the project years sooner. Nobody likes looking at an area denuded by herbicides.

There is quite apparently a biochemical and physical hierarchy to weed germination, where more aggressive weeds suppress those that follow once the dominant weeds are removed. The weeds try first, and while they do, the "slower" seed lies dormant, especially natives. I call it "[The Onion](#)." As the onion is depleted, the natives do come back, some by expressing dormant seed, but more by virtue of seed mobility colonizing an open niche.



"THE ONION"



* Large patches of *O. pes-caprae* have only been found on neighboring properties

This is a typical grossly over-simplified graphical representation depicting the usual hierarchy of weeds as they germinated over a half-dozen years in our bigger grasslands. This hierarchy has more or less repeated elsewhere nearby, albeit occasionally lacking one or more of the elements. These "layers of the onion" can sometimes be virtually impenetrable to succeeding weeds. I am only going to treat one more example of management-by-species here, as it would otherwise be a very long chapter.



April 2009

This is the same spot that had so much cat's ear in 2002 that I had thought was grass, now all native cover, mostly clovers. Why is it so sparse? Well, first of all, it is almost pure sand, so it is relatively infertile. Second, it's April, and the place fills out in May. But the biggie was removing layers of The Onion. The cat's ear seed bank was gone within two years, but then there were rip gut, soft brome, red brome, rattlesnake grass, catchfly, horsetweed, *Filago gallica*, wall bedstraw, and scarlet pimpernel (in that order). Each species in the "weed bank" suppresses others until depleted, much like peeling layers of an onion. Early on, our weed control efforts were by species, to deal with the speed at which they spread. As we gained control, we were able to manage by location, but that meant dealing with the differing maturation rates of many species on each spot.



May 2010

By the next year, when we had a good rain, it was fine (I had pulled some of the brush too).





Oxalis micrantha on a neighbor's property, February 2015

This spot is on a neighbor's property where I removed a different series of "weed layers," starting with Bermuda buttercup (*Oxalis pes caprae*), then Italian thistle, and then rip gut brome (*B. diandrus*). Then *Oxalis micrantha* took its turn. This monoculture indicates that *O. micrantha* probably was once a dominant weed, yet the UC herbarium had **no record of this plant in this County!!** The probable reason it went unnoticed was because other weeds suppressed it. Only once the other layers of the onion had been removed, did the *O. micrantha* appear, and then with the vengeance you see here. The acacia and Oxalis will be removed soon and we'll see what comes up. In places it will probably be chickweed (*Stellaria media*), but we are finally starting to see natives down here.



Obviously, this book cannot detail all of our “layers” of the onion (I don’t have that many good photos of them anyway), But we’ll go through one more case of a weed, not because it gave me fits (it still does to a degree) but because wall bedstraw (*Galium parisiense*) is not well known as a weed for two reasons: (1) Other weeds suppress it and are a bigger problem and (2) Most people treat weeds only if they are an economic problem. Restoration of a native annual system is more challenging in that one must pursue full eradication of all but a very few exotics (there are exceptions). That means chasing every weed down to the last individual. Some weeds may not be a big economic problem or competitive against other weeds, while still being ubiquitous when other weeds are removed AND exceptionally hard to eradicate. Such is wall bedstraw (I circled one - red; there are a lot of them in the photo). When wall bedstraw mixes in with the lotus it just disappears. Nor is this hide-and-seek game wall bedstraw plays unique to lotus.



Perhaps you have heard that “old wives’ tale” about how weeds can hide. This is wall bedstraw in three different types of plants. We have about five acres infested with it to varying degrees. In this instance, I’ve pushed the contrast to *help* you see them! The bedstraw has a whorl of five pointy leaflets around the stem (inset), while the lotuses have three. We had to develop specific techniques to separate them efficiently when weeding, that differ with the mechanical attributes of each host species. Remember at the beginning of this picture book I said that high visual acuity was a must? There is more to it than that, as you will see.



Here was a wad of tiny wall bedstraw seedlings *under* that deer-weed bush (the third one on the prior slide). Deer weed gets 4-6 feet across and about 2-1/2 feet tall. It's a tangled mess of wiry strands. Can you imagine weeding tiny bedstraw plants, out of a hundred shrubs, some full of ticks, some with Lyme disease?

No? Frankly, neither can I. So, I pull the whole bush, frequently. The reason is that it is prolific. Deerweed run amok would make such a mess of this place it is no wonder the Indians would just light it on fire. So, if pulling that native bothers you, consider the bureaucratic approach to this pull-or-not-to-pull decision:

1. Call a professional botanist and get an appointment to assess the situation. Wait a week for a letter.
2. \$500 (at least) later, send the botanist's written opinion to the bureaucrat for approval.
3. Meet with said local public official for a site inspection.
4. If all goes well, pay another \$350 for a removal permit.
5. Wait two months for approval to remove the plant (they're really busy because of budget cutbacks).
6. Put up a \$1,000 bond just in case something bad happens.
7. Meanwhile (of course), the weed has bred.
8. Get a final inspection to verify that there was no other harm to the environment.
9. Oh, and your bond money will be returned (eventually) without interest if and (only if) they didn't find something for which to fine you.

Now, if that seems far-fetched to you, just remember: **This is exactly how things work in many communities subject to the California Coastal Commission** if the host plant in question is a tree. Now, before protesting about how different a case that is, please consider the results of what I did to care for my land, especially by thinning it. By the time this picture book is done and you witness the comparison, I think you will realize the absolute futility of managing such a complex problem the bureaucratic way. It is not only unaffordable, it cannot work.



*Stachys
bullata*

*Madia
sativa*

April 2010



We had a lot of rain in fall 2009, followed by a succession of warm rains the next spring. These combined events made the blast of wall bedstraw especially virulent, even after the area had been re-colonized by native *Stachys bullata* and (native maybe) *Madia sativa*. These seedlings are evenly dispersed, indicating that this was an expression of the weed bank, as opposed to clustering around a spot where an animal may have bedded down for the evening or a plant I missed the prior year had bred successfully (what I call an “incidental error”). Here, the bedstraw stem is strong enough to pull the root, but the root is not too deep. Such optimal weeding conditions after rain deteriorate within hours (yet another reason why it is important that a land steward lives on-site).



April 2010

Remember that I said wall bedstraw can wreck a meadow? This is the same area, only **six days** later. The bedstraw has almost doubled in size. I promise you: the roots have grown just as much. These plants are now at the extreme limit of what one could weed by hand with effective yields in this hard packed soil. Elsewhere, in looser soil, this size is just right, a level of detailed site knowledge that is *critical* when it comes to planning where to be and when. Once it sets seed, one can tear the root and perhaps kill it, but one does not want so much left that getting it all takes too long. So, because we need to get a lot of it early and are at the size limit *here* and because we have many spots just like this one only vastly bigger in area, and with other weeds just as bad, do I spray or weed?



April 2010

In this case, the answer was “both” because a black plastic tarp over a compost pile had precluded bedstraw germination across the top left of the photo. We did not yet have much native groundcover here, so I hand-weeded around the natives (the tree clover (blue) and lotuses (yellow)); then I spot-sprayed the area inside the red line. Next year, I expect a similar problem where the tarp had been. Note the difference between the area treated similarly last year (bottom) and the sparse lotuses in the “weed” area with the dots.



April 2010

Once the bedstraw “onion layer” is mostly depleted, that spot will start to express other weeds. Only ten feet away from the last slide here we had a sparse weed bank “layer” of scarlet pimpernel (*Lysimachia arvensis*; red), with two non-native clovers and some random grasses. Typically, the first clover is exotic hop clover (*T. dubium*, not in photo) or rose clover (*T. hirtum*, yellow thanks to you US government and Santa Cruz County). Some, such as small-seeded rattlesnake grass (*Briza minor*; green) are imported annually, while others, such as this remnants of nit grass (*Gastridium ventricosum*; blue) are from the weed bank (note: I am only circling only one example of each weed species present here). I need the few natives to breed. Pimpernel is easier to remove than bedstraw, but more toxic and harder to wet with herbicides. The pimpernel is often the last broadleaf weed layer in the onion. Then the natives slowly colonize the area from elsewhere. The pimpernel is a much slower developing species than the wall bedstraw, so it won't drop seed until June. So, do I weed or spray? If so, when? Weed, NOW. Why? The natives and weeds are closely mixed with two cat's ear plants starting to put up stems (white; just one in the photo). At this stage, it will blow seed in three weeks. The small seeded rattlesnake grass will drop seed almost as fast but the *Gastridium* won't seed until June. So, once I started, and with so many species calling for varying processes, I finished. If the spot had been larger or if I had more demand elsewhere, I'd have addressed the immediate needs here and come back later. When weeds are breeding, control is all about speed. So, am I done?



March 2008

To give you an idea of what weeding grasslands is like, consider this photo. This needle grass seedling is infested with wall bedstraw (*G. parisiense* circled) from the “weed bank.” Wall bedstraw is relatively inedible, difficult to kill selectively with herbicides, hides easily, can seed when less than 1cm tall and grow up to two feet across with thousands of seeds that can travel long distances as burs. The seed can remain viable in soil for 30 years. The root goes deep as it matures and breaks easily unless pulled at the right time. At this density, wall bedstraw can produce about 50 seeds per plant. If I don’t get them ALL, they will grow to about six inches in height and take over this needle grass completely, producing a carpet nothing wants to eat (it is both coarse and mildly toxic). This area had been hand-weeded since 2005. I count 9 species here. Do the lime colored seedlings on the right side of this grass appear aggressive to you? They are exotic *Gamochaeta argyrynea*, which until 2012 keyed as native *Gnaphalium purpureum*, yet another error on the part of the government sponsored academic species identification business.



January 2003 – Maltese starthistle, mouse-eared chickweed, catchfly, *Oxalis pes-caprae*, bur clover, and grass weeds along with *Calandrinia ciliolata*

As the ubiquitous weeds began to fade and natives started to colonize, those areas graduated from “contaminated” to “transitional.” When a site became transitional I started comprehensive weed management by area, usually with spot spraying. Until then, the process of attrition with the big weed problems took precedence in terms of time and planning.



May 2010



This is the way it looks when weeding once it is fully a grassland. Finding a few 6" tall bedstraw plants, or any of the other 110 weeds we manage in this half-acre spot is a challenge, but if you want a native meadow, **this is what must be done** until we have better processes (more on that later). It may *look* impossible to do by hand, but there are ways to take it from virtually impossible to merely painful. First, the grasses mature before the bedstraw does. I have developed visual vegetative keys to identify and remove the exotic grasses when they are small, long before they set seed. This means that I can ignore them unless they are "**sore thumbs**;" i.e., the few weed that I missed early on now showing up as obvious because of their fruiting bodies. Similarly, I reduce the bedstraw to a few per yard *long* before the native annuals get big enough to make things difficult. By this time, the bedstraws are few and large enough to reduce the mayhem one inflicts while looking for that last one which is then huge and easy to find.



April 2005 – Looking for cat's ear in mixed exotic rat-tail and squirrel-tail fescue (*Festuca myuros* & *F. bromoides*).
I'd mowed the grass to make it easier to find. They look tired, don't they?

From "contaminated" through "transitional" to beginning hand weeding typically required 4-7 years of spot spray and hand weeding to be "clean" enough for hand weeding alone. Transitional status is far more labor intensive than maintaining either fairly pure or "sterile" areas. Hence, I could only handle so much transitional habitat in any one year. There are now no areas left on our land that require broadcast spray and few that require any spraying at all, usually only then with a hand squirt bottle.



April 2005



Single-species weed management in grasslands lasted for some 4-6 years, depending upon the location, as I was bringing patches out from under total sterilization only if I could handle the additional labor demand of “transitional habitat,” where natives were starting to show up in sufficient numbers to justify the extra labor of helping them breed without interference.



This photo the next year, (4 years after starting on grasslands) is of a masking operation with which to make the leap to “transitional” cover. The term means that enough weed seed has been used up and the native annuals were sufficiently numerous that I chose to start saving all the breeding natives. The short pots covered forbs and the tall pots grasses to mask them from foliar application of glyphosate. This is a painstaking process laboriously executed by my two girls, but over the year it was a lot faster and had a higher yield than hand weeding. We never had to do this more than once. The foreground was still “contaminated,” and was maintained as such for another two years, in part because it was begun two years later, having once been covered with a pile of chips.

“GARLIC”

Crane's bill
Vetch
Red sorrel
Chickweed
Allseed
Corn spurry
Henbit
Willow-herb
Forget-me-not
All *Conyzae*
Filago gallica
Pineapple weed
Shepherd's purse
Maltese star thistle
Gnaphalium luteo-album
...

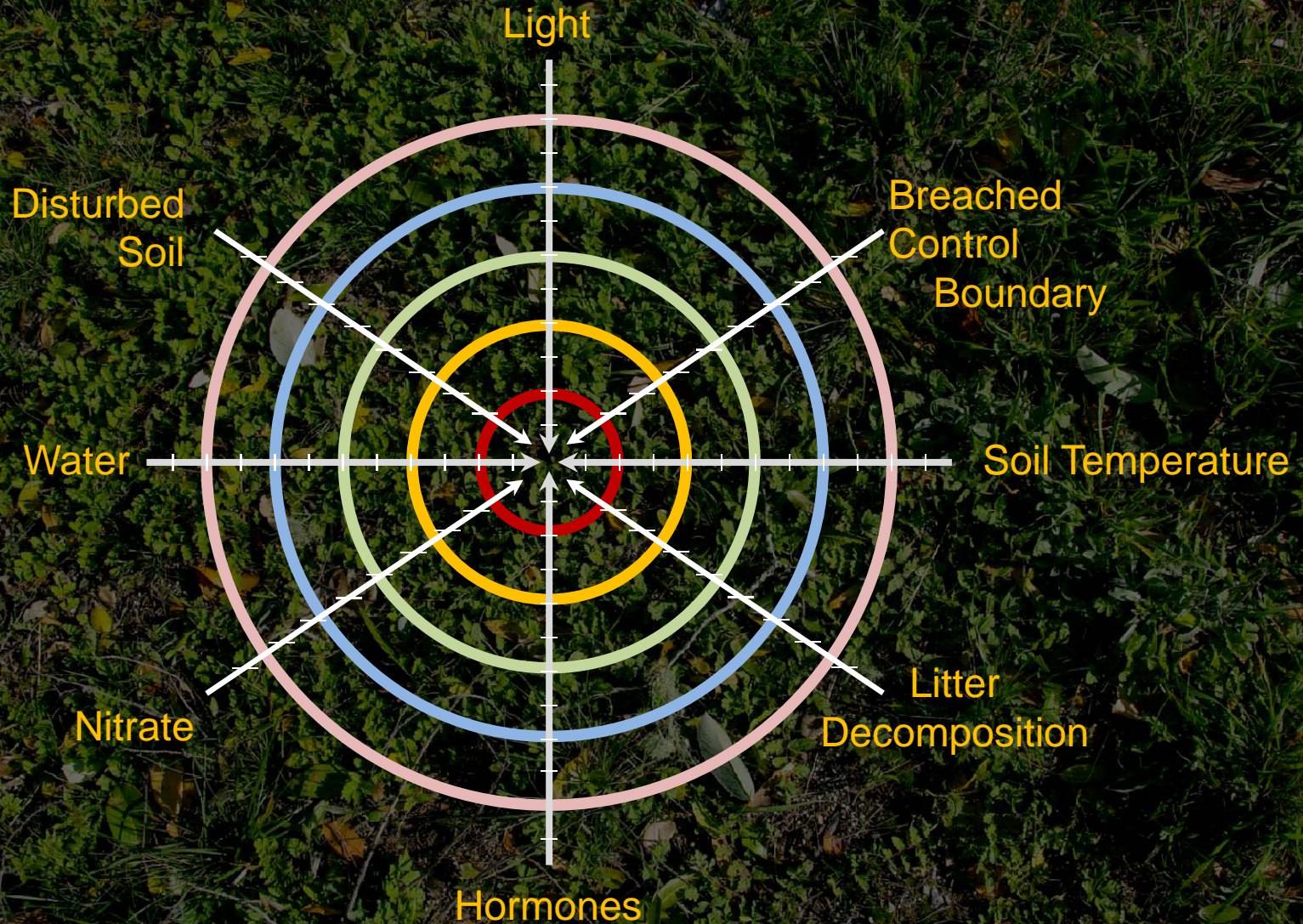


* Large patches of *O. pes-caprae* have only been found on neighboring properties

There are also weeds that seem to respect no orderly hierarchy at all, some of which still fit within single species management in that they require a special process. In particular were the geraniums, cut-leaf and soft-edged crane's bill (*G. dissectum* & *G. molle*) with which I also treat common chickweed (*Stellaria media*). The vetches (*Vicia spp.*) always seemed to be around. Red sorrel is so difficult to kill it deserves special mention. Allseed is here because I don't know where it fits but it scares me as do forget-me-nots.

Corn spurry is low-powered, but seeds early and spreads easily. Henbit also fits that description. Then there are the horseweeds of the *Conyza* genus which make so much seed so late as to be a special headache... There are a bajillion *Filago gallica* every year that almost all have to be hand-pulled because they're mixed with *F. californica*. Now there's *Gamochaeta spp.*

THE “N-DIMENSIONAL ONION”



The onion expresses differently in different places with variation in external conditions depending upon the amount of rainwater runoff, the exposure to light, the amount of residual decomposing organic matter (such as after chipping), deposition of animal feces, or whether the soil has been recently disturbed by anything from a mole to a bulldozer. Still, it has been a useful model for planning from year to year, particularly when I disturb a site by removing the cover such as thinning trees, or burning a brush pile.



December 2011

This filaree (*Erodium moschatum*) germinated in a spot where I had never seen it. I had amended it with blood meal as part of a soil nutrition experiment. This was the first indication of a multi-dimensional onion.



Stump



April 2015

Another variable axis is light, to which some seeds are sensitive. Another is karrikinoline (KAR-1), a hormone produced by smoke. I put a burn pile on this stump to drive both. To this day, I must monitor every spot where I cut a tree especially carefully for 2-3 years. Up came broom, small-seeded rattlesnake grass (*Briza minor*), rip gut (*B. diandrus*), and dwarf hop clover (*T. dubium*), all were expected.



June 2015

On another stump nearby, I also put a burn pile, but on this one I added grass straw on one side from my harvest elsewhere (*Bromus carinatus*) on the hypothesis that the leachate from the straw might stimulate germination of sympatric weeds. Out of the straw, up came two brome grass weeds, rip gut and soft chess (*B. diandrus* & *hordeadeus*). I fought both here all spring like nowhere else on this ridge!



Late January 2009

When I first burned brush in this meadow, the bunch grass (*Stipa lepida*) died. Over the next two years, first filaree and then wall bedstraw went nuts. These grass plugs were planted in February 2007. They survived with almost no rain thereafter, from the end of February to October with over 40 100°+ days and most of the rest in the 90s in a soil with less than 2ppm nitrate. Yet they hardly seed and have not spread since then. Then lupine, various clovers and two lotuses made a blanket of it. Yet there was nitrate levels were still virtually non-existent (for reasons to be discussed later). Not knowing what it wanted to do, I waited.



April 2015

This is a very sandy soil within 100' of my sand hill. If I burned this spot regularly as the Indians did, there might not be grass at all. Since 2012, blue dicks (*D. capitatum*) have been coming up in profusion, finally flowering here this year (above). There are a couple of Clarkias in the area too, which the aboriginal tribes also farmed. There may be no way to know if Clarkia was dominant here as I am told Clarkia seeds are good for only three years. Seeds of the lily family remain viable for a long time.

THE “N-DIMENSIONAL ONION”

So, given that I have induced these responses, does that mean I have actually cleansed the seed bank as one might think I've implied from the introduction? First, I wrote in [the chapter on the topic](#) that I had attained “nearly pure native germination,” which is true. I said that it is unprecedented, which is also true. I said several times that I was still weeding it. I said that it was indication for hope. I did not say I was done. So if there is anywhere I might have slipped a keystroke, please let me know. The distinction is important and so is consistent accuracy. I don't have a proofreader or editor.

To what degree I have cleansed that “weed bank” I do not know yet. In addition to filaree I have seen indication that four-leaved all-seed (*Polycarphon tetraphyllum*) may be lurking and we'll be talking about another exotic in a bit that is definitely around, but again, to an unknown degree. There may also yet be a residue of still dormant bromes. What else, I cannot say.

This is the price of “getting there first,” in that I am dealing with the unprecedented. As soil fertility improves, it is conceivable that I get to “start over” some day. Does that mean this is all futile? Heck NO! It means we have learned a lot with a lot yet to learn. It simply means there is process development work yet to do. Does that mean I don't know what to do?

I certainly do know what I want to try, which will be discussed at length later among these grassland chapters. The challenge (as should be obvious by now) is to induce the weeds to germinate, which, considering how much grading I've done may be impossible to achieve completely. Some of those factors (such as nitrate, light, or hormonal levels), are somewhat controllable. Others, such as the amount of organic mulch I am not allowed to burn covering that seed, are subject to either regulatory constraints governing burning or considerations regarding erosion of a steep slope deprived of cover. Still others (such as the sequential history of the expression of various annual genera leaving chemical residues) is also in question. I've certainly seen indications suggesting it.

Yet other factors, such as when it rains, how much, or what the temperature profile might be in a particular year are entirely out of my control. At that point, one is left with the exercise of judgment of when to take the drastic action of killing large areas versus when to fight it by hand. One is always tempted toward the latter, as nobody wants to kill an area once blooming with wildflowers infested with a fast-moving weed. Yet more than once I have been not only surprised at the results of a heavy hand, but pleased (next slide). At least here, the land really does seem to have a forgiving character in that respect. Give it an open niche, and something does want to establish there.

There are many natives that do not get to express their seed because other plants occupy that niche before they usually germinate. *Trichosema lanceolatum*, *Psilocaphus tenellus*, and various cudweeds of the everlasting tribe typically do not germinate until at least March. These may be plants adapted to spring burning by aboriginal peoples. We just don't know.

We won't until know somebody tries something and the findings are deemed repeatable within acceptable tolerances (one of my big beefs). My hope is to engender a horde of new studies built upon the hypotheses indicated in this book.





October 2012



This is an area that had been overwhelmed by winter weeds. I was overwhelmed at the time and planned to dress this area with a loader anyway. It is level here, so the consequences of nuking this spot were minimal. So in late March, I sprayed this patch. Yet even as late as that, *Trichosema lanceolatum* came up. It is both native and very attractive to bees as a critical source of late season pollen.

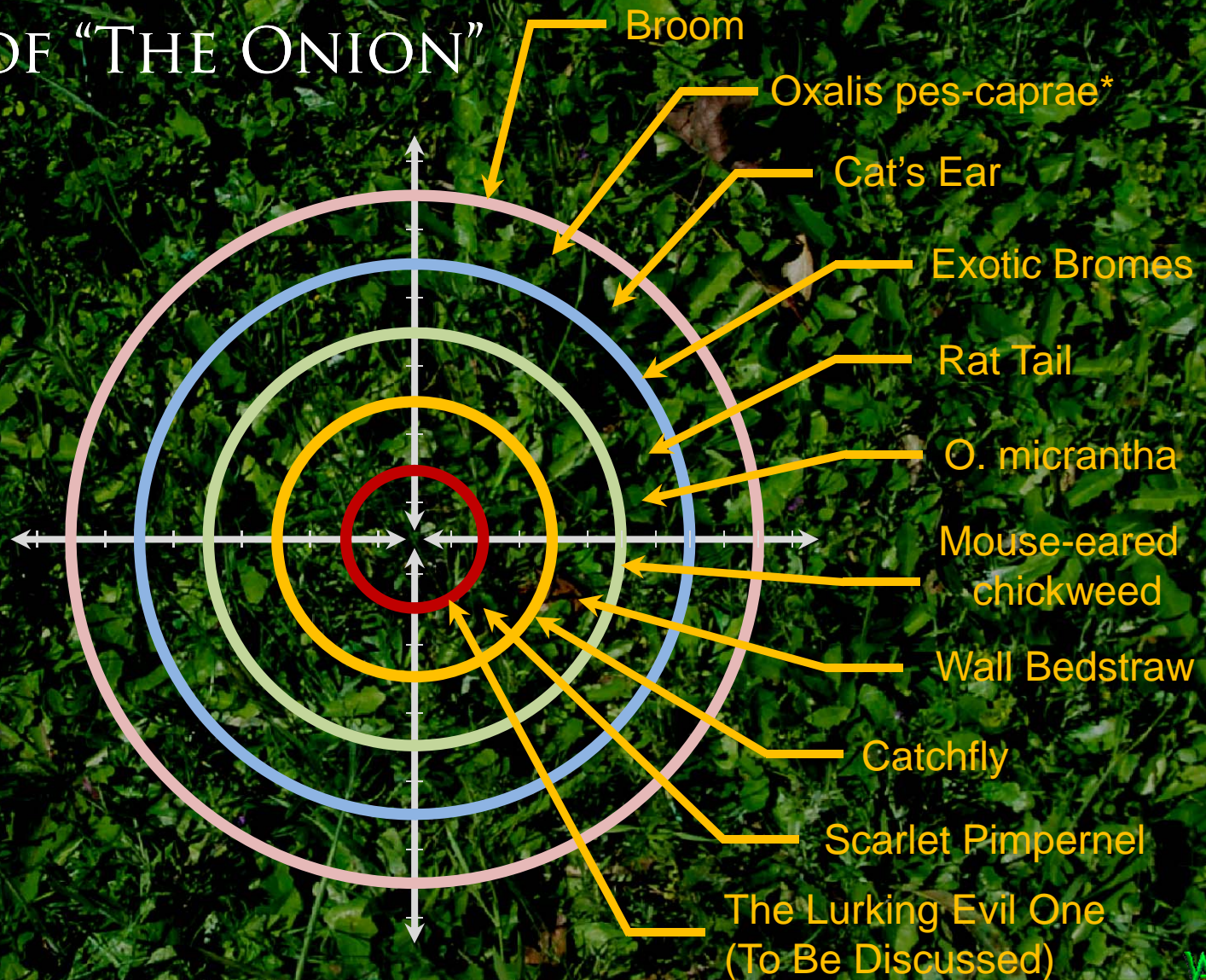


January 2013



By 2010, almost a decade after grasslands management began in earnest, parts of the property had begun to come under full control. From 2012 to December 2014, things were under such control that I started back into forestry, believing that I could handle the extra labor of the weed response to more light there. As predicted, the main weed under forest cover was the hedge parsley above (*Torilis arvensis* – above). No problemo. Then I got nailed, again.

THE CORE OF "THE ONION"



* Large patches of *O. pes-caprae* have only been found on neighboring properties

Here we are, at the core of the onion with "The Evil One." For this I have to thank the State of California, its Universities, and its weed management bureaucracies, all so busy "saving the environment" generating justifications for ever more minute control over private land use, advocating causes that somehow involved regulating landowners into selling, cheap, either to the State itself, tax-exempt "charities" or to developers. So no wonder these intellectual titans "didn't have the resources" to pay attention to a weed that costs millions annually to the nursery industry alone.

Cardamine hirsuta (Bitter Cress)

Five Weeks from Seed to Seeding

Four crops **per season**

(1 pod/plant X an average of 10 seeds/pod)⁴
= 10,000 seeds/plant season

February 2015

For over 50 years, this plant, commonly known as “bitter cress,” has been identified as “**native**” *Cardamine oligosperma*. Yet there was another “bitter cress,” well known to industry, that until 2007, **had never been recorded in our County** (**sound familiar?**), **nor south of Siskiyou County**. In fact, this is *Cardamine hirsuta*, a European **exotic**. I had suspected and resisted it for years as it is so aggressive I had my doubts. The total above is for one pod per plant per generation in one year. Each plant can make a lot more.



← This plant has about 30 pods.
At four crops per season, it has the potential to
produce 8 MILLION seeds/plant season

February 2015 – Yes, these numbers are theoretical, but you get the idea

In the spring of 2014, one of the half-dozen botanists aware of our project was kind enough to tell me that my suspicions were correct that “pop-weed” is non-native. As if by coincidence, we had a VERY unusual succession of fall and winter rains that each was followed immediately by 80°+ weather. Bitter cress came up everywhere, in places I had never seen it in the forest stands I had thinned over the preceding three years. This was a war in which I had no idea where the enemy was or how many. I was back to where I had started, operating under single species management in the early part of the season. The scarlet pimpernel also in the photo is slower developing and a lot easier to control. After 25 years of labor, finally thinking I finally had things under control, imagine how I felt.



April 2015

Bitter cress can be hard to find (there are 15 in this photo). Imagine acres of it, with no idea how much there might be. Does this mean I have to start over, nuke the entire landscape, and kill everything? No, as you will see later in the book.

SINGLE-SPECIES WEED MANAGEMENT OVERVIEW

Weed management of both forests and grasslands took on an interestingly parallel logic, albeit shifted somewhat in time. Both areas suffered from broom, so that problem was obviously managed simultaneously for the first few years. Yet broom germination numbers in grasslands were so high in full sun that the seed bank was depleted much more rapidly than under tree cover, with grasslands effectively requiring only a 5-7 years of intensive focus. On the other hand, broom in forests continues to be a task to this day, particularly wherever I remove a tree, though such is merely an occasional annoyance at this point as well as proof of the durability of the broom seed bank, now proven to exceed 35 years here. Hence, the broom weed-control process was discussed in [the chapter on forest understory restoration](#) along with other weeds more characteristic of forest habitat.

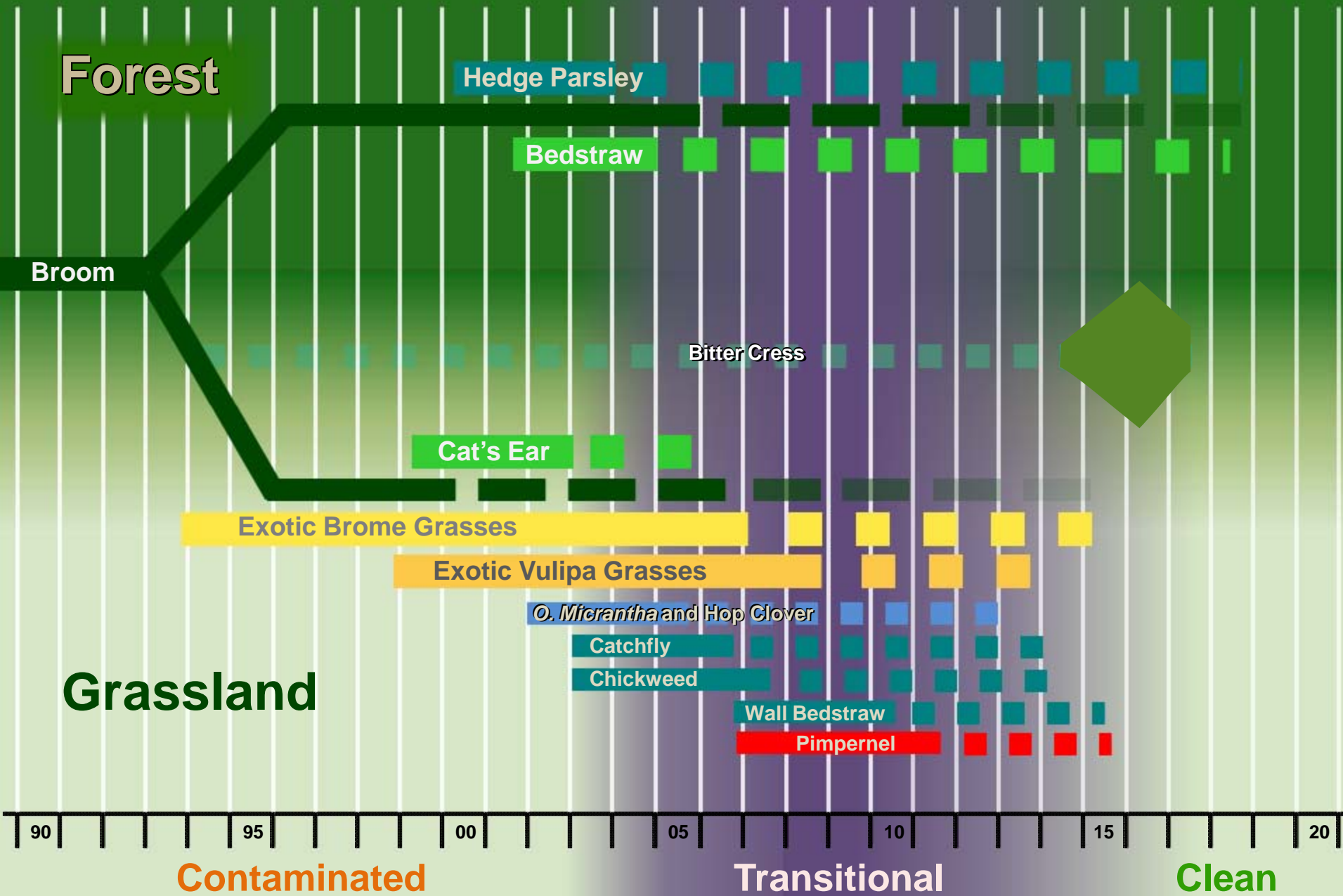
In parallel, not long after I had control of broom (“control” meaning that I had killed the entire season’s crop) forests and grasslands were then each inundated with weeds from outside the property: catchweed bedstraw (*Galium aparine*) in forests (with seed carried by burs on animals) and cat’s (*Hypochoeris spp.*) ear in grasslands (which is windblown seed). Each was a discrete management project with its own sense of timing and criticality. Getting rid of both was very destructive to what little native groundcover that had recovered to that point in their respective areas. More importantly, had I understood how bad these plants were and known more about the early existence of the threats, their behaviors and control processes, then both episodes would have been totally unnecessary. To confirm that point, I knew about thistles since long before we started and they have never been a big problem here.

Once the disasters of cat’s ear and bedstraw began to abate, the weed bank began to express in earnest, with hedge parsley (*Torilis spp.*) in forests and grasslands hosting an array of weeds to be described in more detail in later chapters. Several grassland species were notable in that their germination was so intense that they demanded management by species: brome grasses, annual fescues (then *Vulpia spp.*), mouse-eared chickweed (*Cerastium glomeratum*), and wall bedstraw (*G. parisiense*). The drawing on the next page depicts how these species expressed in turn. It is temporal only, although there were both temporal and spatial shifting of timelines. They are meant to suggest the *relationship* between them of how they each tended to express in turn. The dashed lines indicate when I was no longer broadcast spraying patches of these plants, and could shift to a combination of spot spraying and manual removal. Over time, the research strategy shifted toward learning what made these weeds want to germinate so that I could deplete their stock of seed.

By now it is obvious my opinion is that trying to suppress weed germination, while possibly useful when trying to get the upper hand to prevent making more exotic seed, is a counter-productive strategy over the long term. After all, once one has planted natives that hold down the weeds, one need only to wait for ants to move that seed, or for the cover to die for the weeds to do their thing. Best to get the bad stuff to germinate, kill it, and replace that exotic seed bank with natives. Weed suppression (mulching, shade, or planted cover) is a band-aid tactic at best. At worst, it precludes native annuals and can be outright fraudulent in claiming a site has been “restored” when evil lurks under cover waiting for the right moment to multiply.



WEED MANAGEMENT OVERVIEW



A FINAL WORD ABOUT *CARDAMINE HIRSUTA*

I am certain that no one reading this book would fail to note how bitter I might be about this institutional error on the part of people paid to manage such information, how badly I feel having long ago suspected that the various authorities were wrong in believing it native, and not having taken sufficient action to eradicate it when intuitively I knew better.

But, in a way, it is a good thing that I did not, as it would have been futile for me to try it at that point because I had no idea what the scope of the infestation was. I was informed about it in the spring of 2014. I tried some processes that showed promise of at least somewhat selective control (in addition to those I hope to use at larger scale once this technology is more fully developed and tested). Yet it is the reality of those “factors beyond my control” that really played into what happened in winter of 2014-15, as it was a unique rainy season.

I use the term, “germination event” for a sequence in which the weather is wet followed immediately by temperatures over 80°F. Not all winters have even one. We have had a couple of years with two. The rainy season of 2014-15 had four. Particularly potent were the heavy rain in mid-September followed by both warm days and cool evenings. It turns out that *Cardamine* germination is known to be augmented by such a temperature profile. There were heavy rains in December followed by an unusually warm January, and then another heavy dump in February also followed with heat. There was a fourth brief storm in April again followed by heat. The winter overall was unusually warm (we burned just over half the usual amount of firewood to heat the house). It was a series unprecedented in our time here. Worse, because of the early rain I was unprepared with spot pre-emergence treatments I have used the past several years to great effect.

Worse yet, I had thinned some 4-5 acres of forest in the prior two years as well as removing the brush on the 100%+ slope bisecting most of the length of the property. Hence some 40% of the property closest to the County road had been subjected to a disturbance. Both of the prior years had been exceptionally dry, effectively retaining seed for the event.

It was overwhelming, the longest weed season I have endured since 2005-6 extending over nine months. In terms of how many seeds were produced versus how many plants I killed, I probably lost ground, but I did learn a great deal. Needless to say, I have since read a great many scientific papers, particularly on the physiology of germination in *Arabidopsis* and *Cardamine* species and *Brassicaceae* in general. Then came 2017, with over 70 inches of rain, 51 in 7 weeks, enough to rinse the abscisic acid that maintains seed dormancy. As of this writing, I do not know whether I can keep up. It's everywhere.

Needless to say, after having invested so many years developing a native seed bank (particularly in *Fabaceae*), I am seeking to develop a process that is selective for *Brassicaceae*, of which we have relatively few natives in niche locations so far. I have been contacting manufacturers of products with promising attributes, I must say, with a very poor response, albeit not unexpected. So in a way, this is where I am, back where I started with Single Species Weed Management, although this time I have the Internet to do research before taking action. I'll take it as a learning opportunity to go on, to ask, to seek, and to knock. Life is good. So far, it looks like I might be winning.



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These are LARGE files; they do take time to load

Please offer suggestions and comments [HERE](#)

References are [HERE](#)

Next



April 2015

There is a class of exotics I call “benign” in that they are not invasive and do not cause any problem for the native system. Most of these are plants that represent a historic legacy of the occupation and settlement of this area, first by the Spanish (there is a mission olive on top of the hill (above)) and then by Americans (there is an oleander near an old house site too). There is no ecological reason to remove them while there is a historic reason for keeping them. So I do the latter as having a few living monuments is pretty cool. The olive actually produces a decent crop, so I have offered it to a neighbor who farms them and he baits the tree for a recently introduced fly, thus assuring that it remains productive but will not reproduce elsewhere. (Return)