Pre-Emerging Technology

April 2011

A lot of what is special about this place is its focus upon very small plants. Almost all of what you have seen accomplished was done by hand. Having done so much work to get this far, far be it from me to contend that such a process is affordable on a large scale. Yet what you see above is nothing short of a miracle to me. This is a high-disturbance site (a dirt road) with virtually 100% native germination. I have not weeded it yet. Go ahead and zoom on it. These plants are tiny. With all the ground I have to cover elsewhere, to have accomplished this by weeding alone over such a large area as contains this photo would have been impossible.

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.

Revision History 1.0 2.0 3.0 3.1 3.2 3.3 3.4 3.5 4.0 4.1

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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It is very hard for most people to understand how detailed weed problems can be in a meadow, or how difficult it is to grow patches of lotus and clover such as you have seen. Here you have silver hair grass *(Aira caryophyllea* – white arrow*)* among native pinpoint clover *(T. gracilentum* purple) as well as a non-native hop clover *(T. dubium* yellow*)*. Notice that while they still have the seed inside the boot, the grass stems are thicker and have a whitish streak (arrow). When they open, they almost disappear, making finding them incredibly tedious. There are no herbicides selective for grasses that work on silver hair grass, so post-emergence treatment must be done by hand or by killing everything. These individuals are from the weed bank, so eventually I will win… unless the rate at which the seed comes in exceeds the rate at which I can detect and remove them.

Even if I do know what is going to happen, as the duff breaks down and there are more natives, the weeding demand goes UP, significantly, simply because of the time required to distinguish the weeds from the complex of natives. At that point, one cannot simply spray. This is why “transitional habitat” is a challenge. So when you see me thin acres of forest in just a couple of years, knowing what will happen as that forest duff rots down as it is doing here, you must know that I have something up my sleeve or weeding it out would not be something physically possible to accomplish. I don’t know for sure, but I just may.

Here we have the results of our first grass-selection trial using oryzalin, a pre-emergence herbicide. On the right you see where I applied it the previous fall. The blue wild rye *(Elymus glaucus)* is just fine but the *Vulpia*, chickweed, and annual bluegrass were **all** gone. Had I not done it, with all the grass we got that year I would have had to kill it all and start over with plugs from precious hand-collected seed. Meanwhile, my dear sweet wife weeds for the remnants of the chickweed *(Cerastium)* on Mother's Day (her idea).

Pre-emergence herbicides do have a potential down-side in that they might be destructive to a native seed bank. However, when the native component is nearly destroyed and the seed bank consists mostly of weeds, the consequences are less drastic. Inside the red curve was just such a situation, where I had so much annual bluegrass (a very exclusive weed) that it warranted treatment the year before. To you, this photo might not look like much. To me, this is an indication of hope for a returning foundation, but also a serious warning. Most of this is few-flower clover *(Trifolium oliganthum)*. It first colonized the area about thirty feet away. This photo represents a rebuilding process that takes many years because the supply of native seed left in the soil was so depleted. Clover seed can last a century, but the weeds have been here for 220 years. **If a clover seed bank was that depleted, so are a great many other species** (there's your warning cry). This year has about ten times more plants in it than last year, but also spread into the treatment area. The key was separating tiny mouse-eared chickweeds and rat-tail fescues from these thread-like clovers, by hand.

This is the same spot two years after treatment and ***before*** weeding. Not only is there few flowered clover, but also *T. gracilentum, T. wildenovii, & T. bifidum* (of which we have three varieties). The great news is that, although there still are annual grasses, the wall bedstraw and chickweed are almost gone. The threat from the grasses is still a lot to weed, but we are obviously winning here.

So to determine the threat to the seed bank of native annual forbs, I used a *very* heavy application of pre-emergence herbicide (oryzalin) on the right. On the left, I did not. OK, the difference is obvious, but there is more going on here than that. The white flag in the middle marks a spot where a (then) unique clover first appeared several years prior, a variety of *T. gracilentum* that has red blotches on its leaves (inset). Because it is not common on the property, I am using it as an indicator as to whether the process damages the seed bank of native annuals. Not surprisingly, weeding the left side took five times as long as where I had used the herbicide.

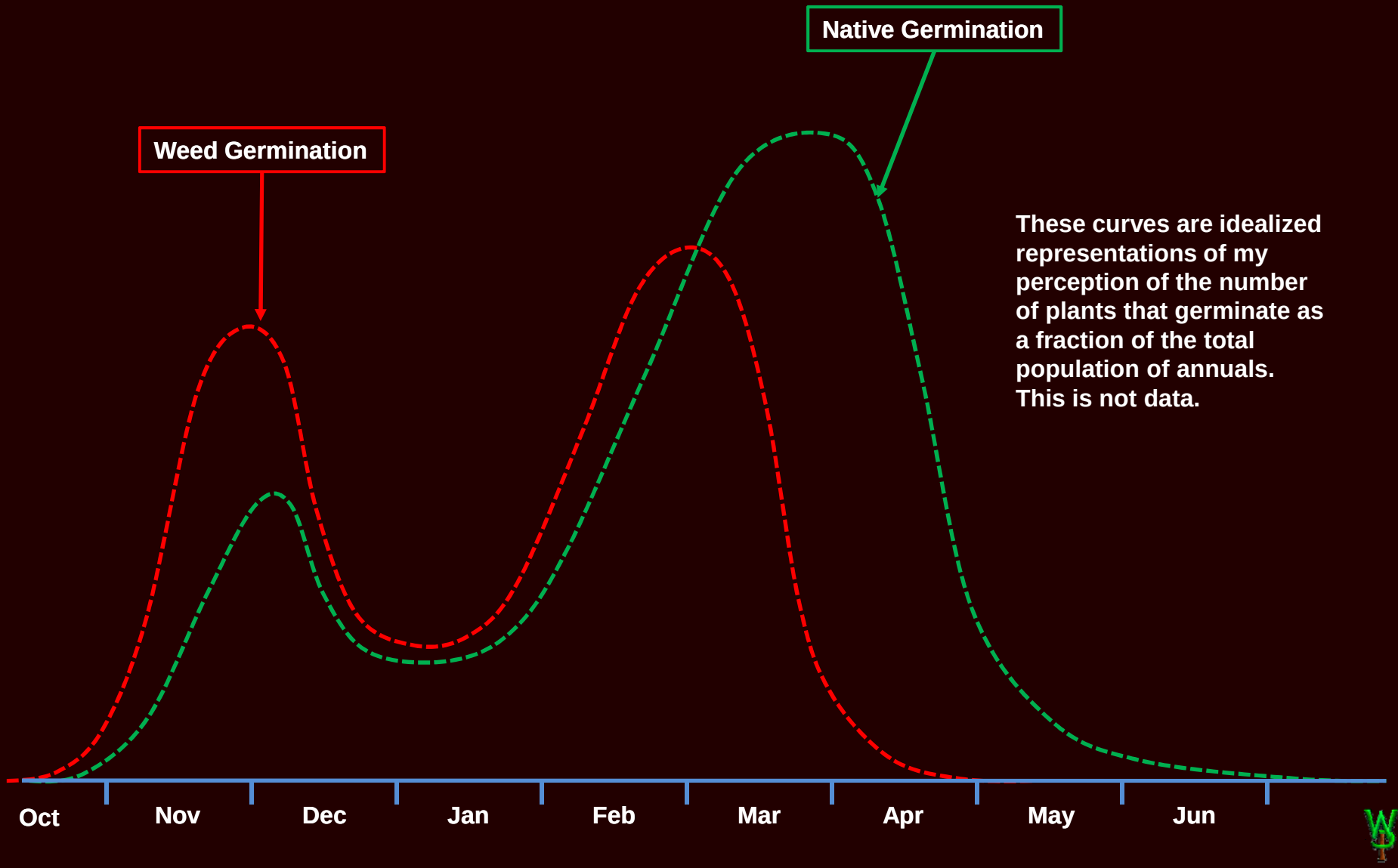
So here we are early the following spring with *more* native annual forbs in the treatment area on the left, including our “red spot clover.” Why? The exotic annual grasses that germinated on the right (that I then weeded) suppressed the germination of native annual forbs. A pre-emergence herbicide functions on the tip of the root radicle when it emerges from the seed. That means the root does not have the opportunity to produce the auxins it uses to suppress nearby seeds from *trying* to germinate. So they try and die, over and over. That means the process destroyed MORE than one year’s worth of the exotic seed bank because weeds germinate earlier.

Same year three months later (sorry for the stressed image). I had planned to spray a set of crossing stripes of the oryzalin in order to have no treatment, one-year, and two-year zones, but the rains came surprisingly early before I could get it down. So I let it go. This got weeding and nothing else. The left side still took twice the time to weed as the right side did. Now, can you see a difference?

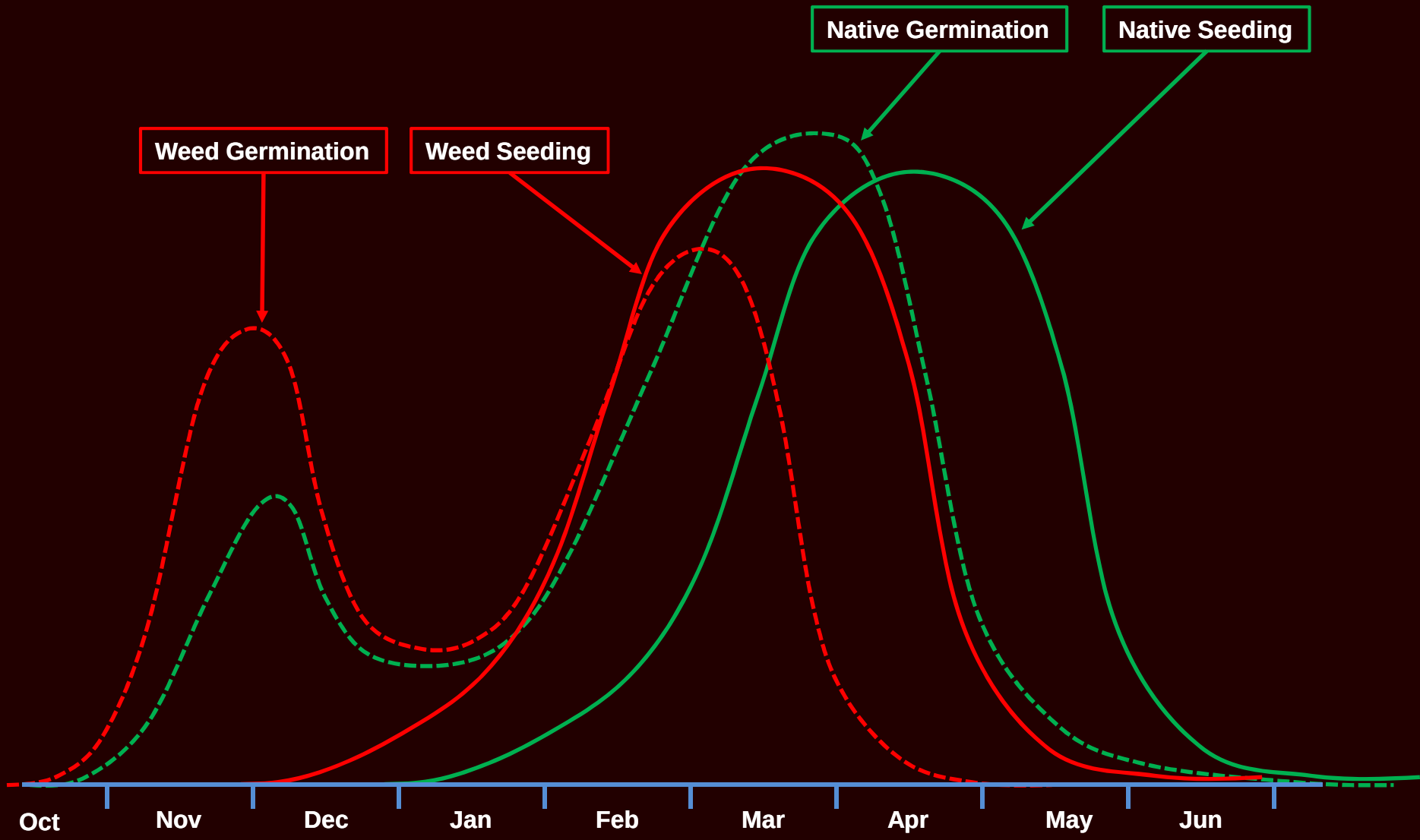
This was taken the same day from the opposite end of the ramp (it is a road). I repeat**:** can you see ***any*** difference?
Yes, I'm rubbing it in, because you are about to learn something remarkable, and it didn't cost you NEARLY all the pain it cost me.
I could have made serious money doing this as a contractor, but I have other things to do.

This is our usual pinpoint clover *(T. gracilentum)* amid largely slender madia and California brome. This particular spot had received a heavy early treatment of oryzalin early last year to see if it would damage the native seed bank. Obviously not.

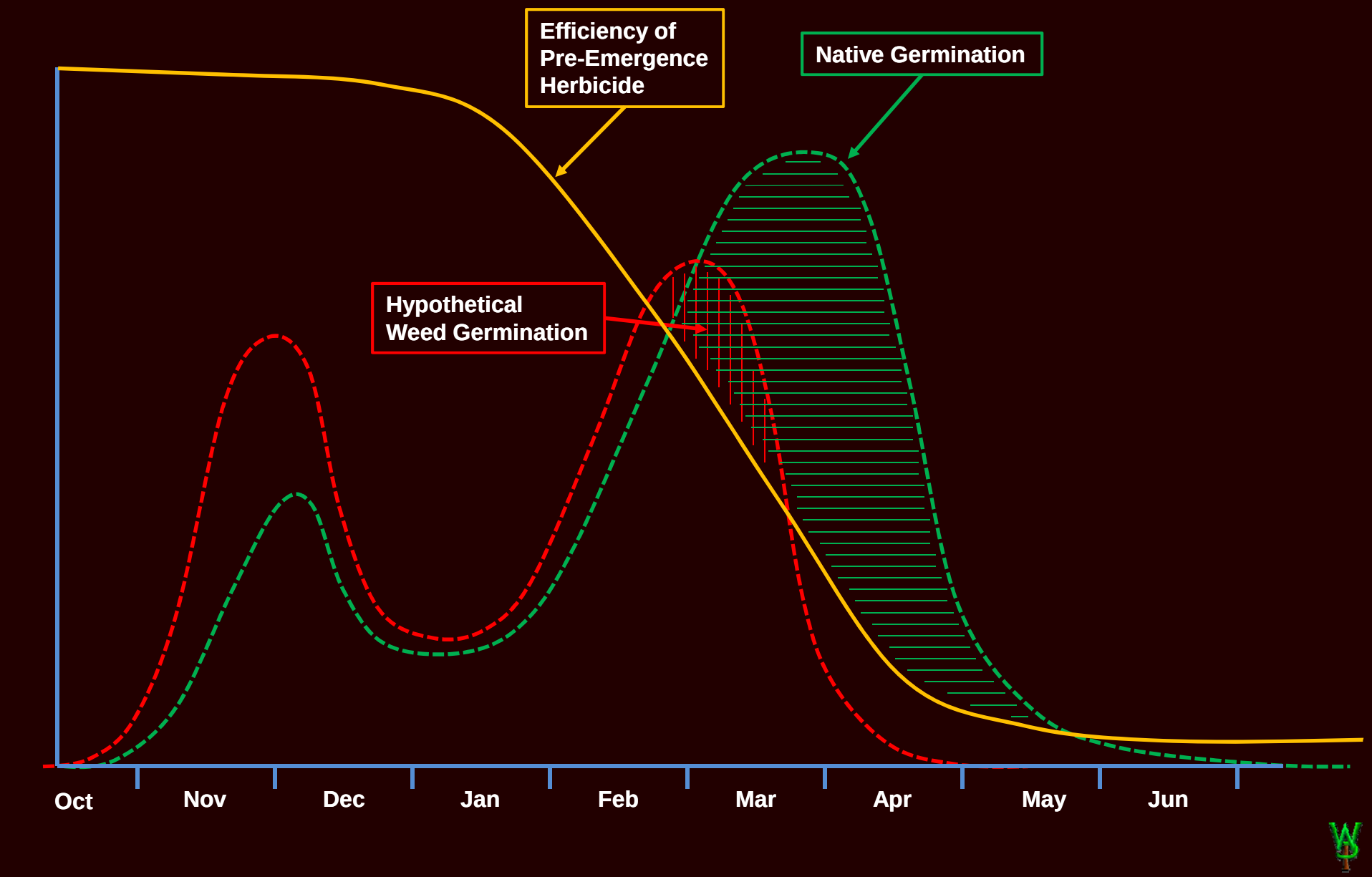
We're back to the ramp. Note that grass weeds *(F. myruros)* are the big labor factor on this spot. They are particularly powerful at suppressing annual forbs. So, how is it possible that this process displays such an impressive bias toward selecting for native germination? It's fairly simple actually; it just takes a little knowledge of the differences between native and exotic seed propagation.



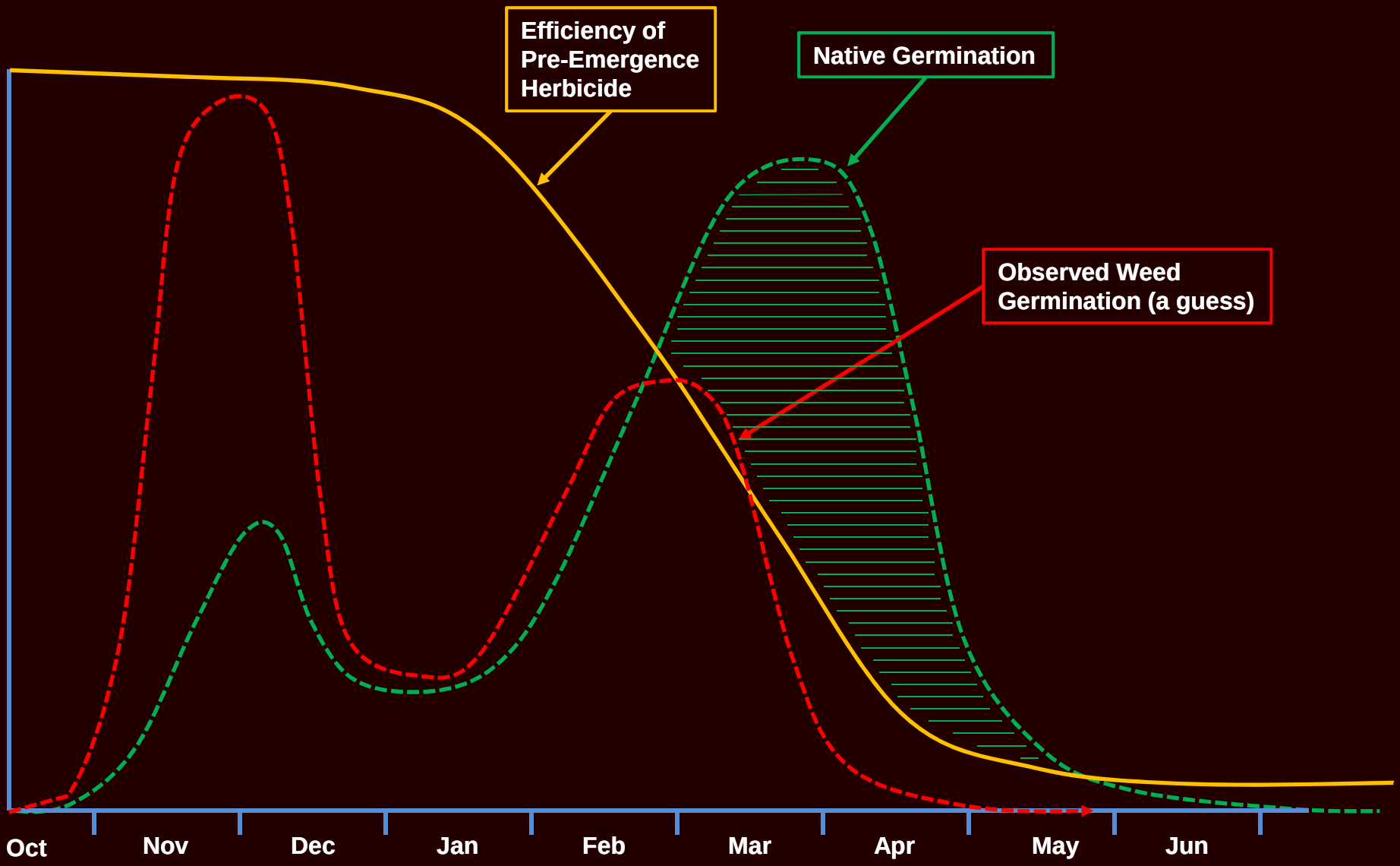
Most weeds are annuals from climates where the growing season is short. Their strategy is to germinate and get to maturity as fast as possible. California native plants are adapted to a climate with no rain in the summer; they often require three months of cold weather to germinate in order to avoid doing so when there is a freak rain during the summer. California plants are also adapted to aboriginal burning, which means that it might be advantageous to recover after a post-grass-harvest burn and *then* seed (as do tarweeds). Even those natives that do germinate as soon as it rains do so again in spring. Few plants germinate in mid-winter.



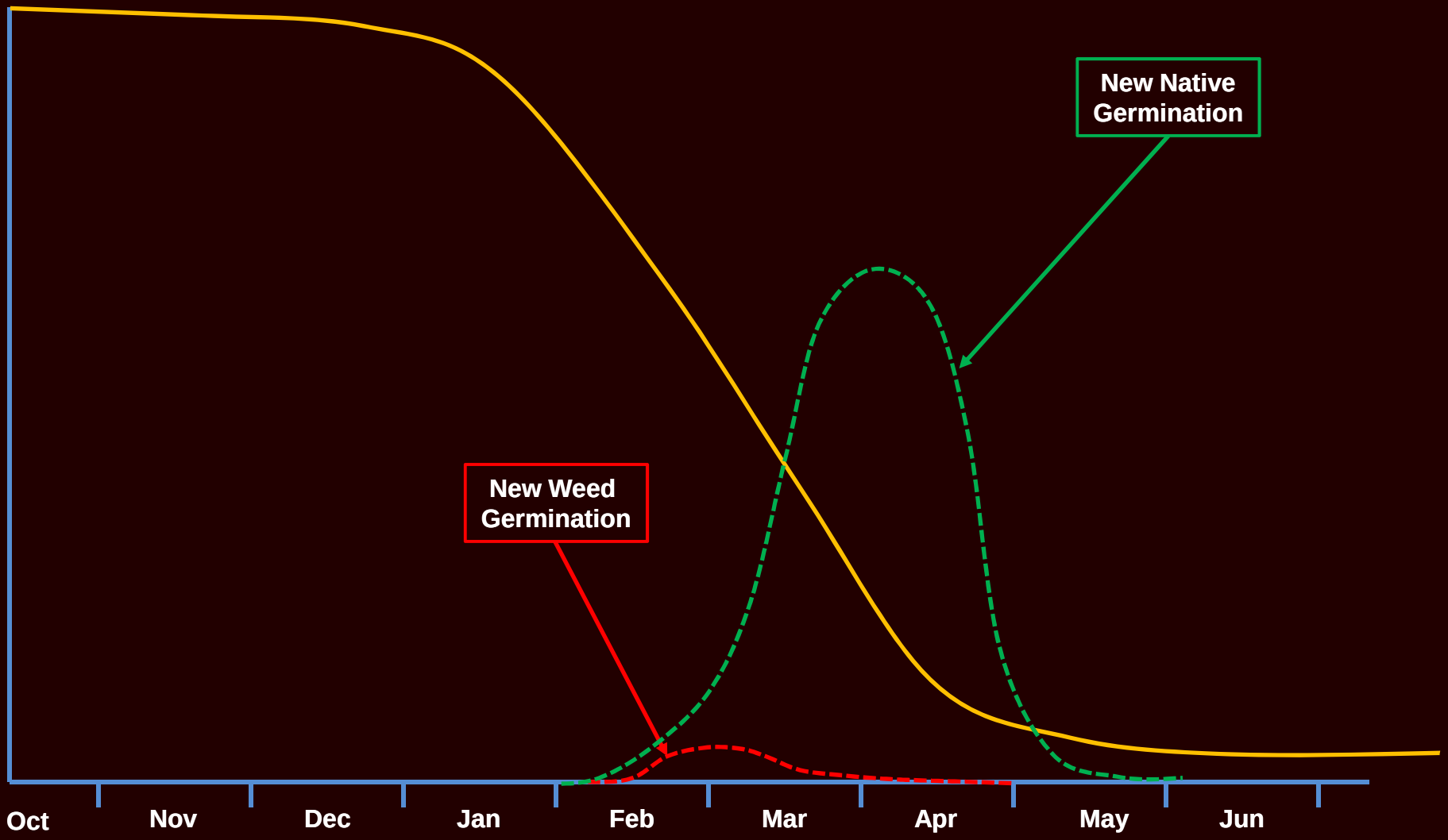
I am superimposing a similar ‘off the top of my head’ representation of when annual plants drop seed. There are some that do so later, but this is an effective representation for purposes of illustration.



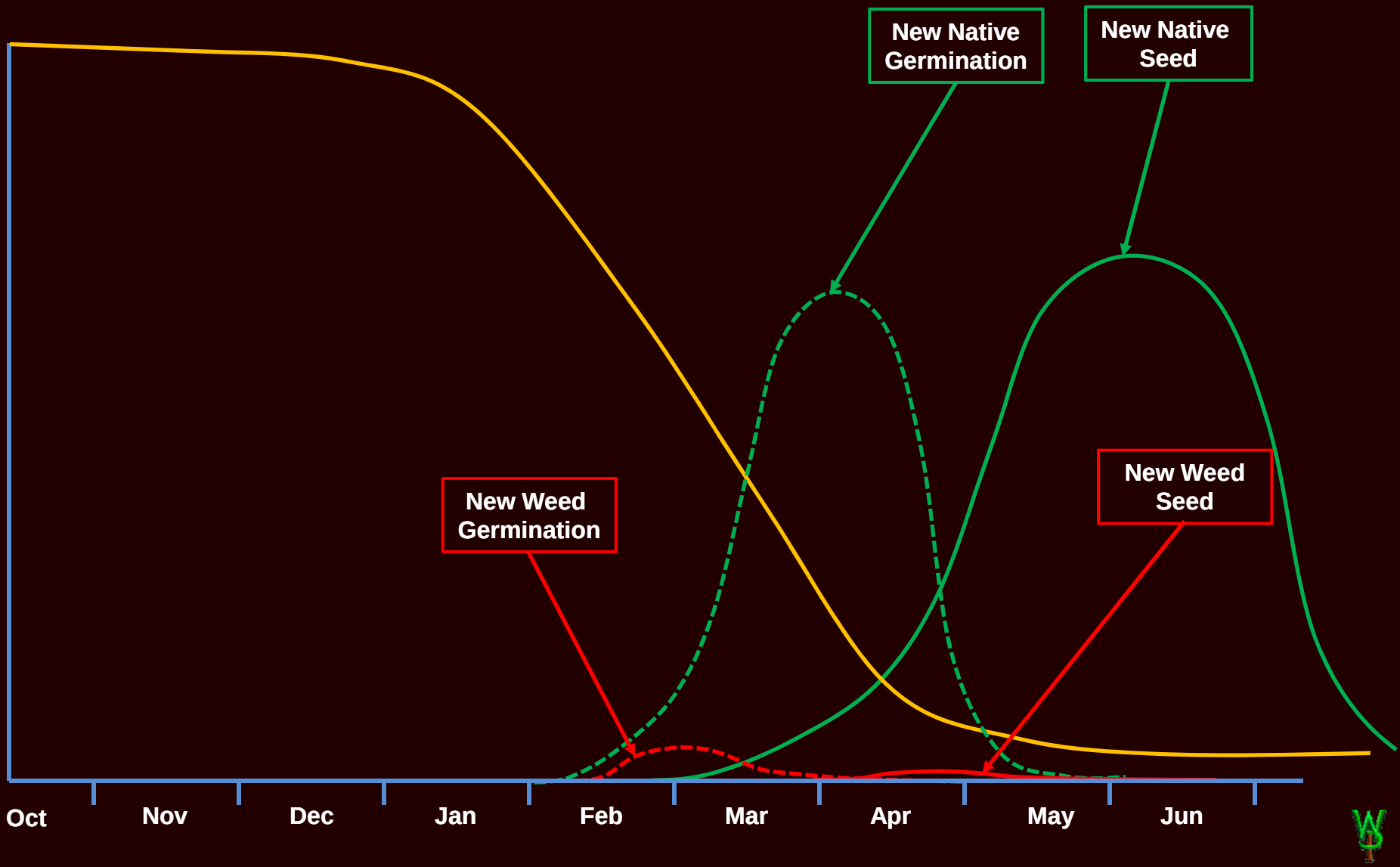
OK, now I whip out those eeeevil chemicals… in this case, oryzalin. The hatched area under each curve suggests the total number of plants that would germinate, ***all other things being equal,*** (which they are not). Now remember, those native species that *do* germinate in the fall *also* germinate in spring and tend to go later than the exotics. So I am not losing that much in the way of native germination because there are fewer plants putting out hormones telling their friends to hold off. But there is more to this…



Now, here is what I think is closer to what actually happens. Normally, a weed would germinate and its roots would put out auxins to tell its cohorts that "I've got this spot, it's mine, don't go!" But, the oryzalin kills that root *before* it can produce much in the way of auxins. That means more of the seeds in the weed bank will try and die. That so many of the natives then face less opposition to try later is but one more advantage that this method offers. Please remember that this is not quantitative data, but is representative of an analogy.

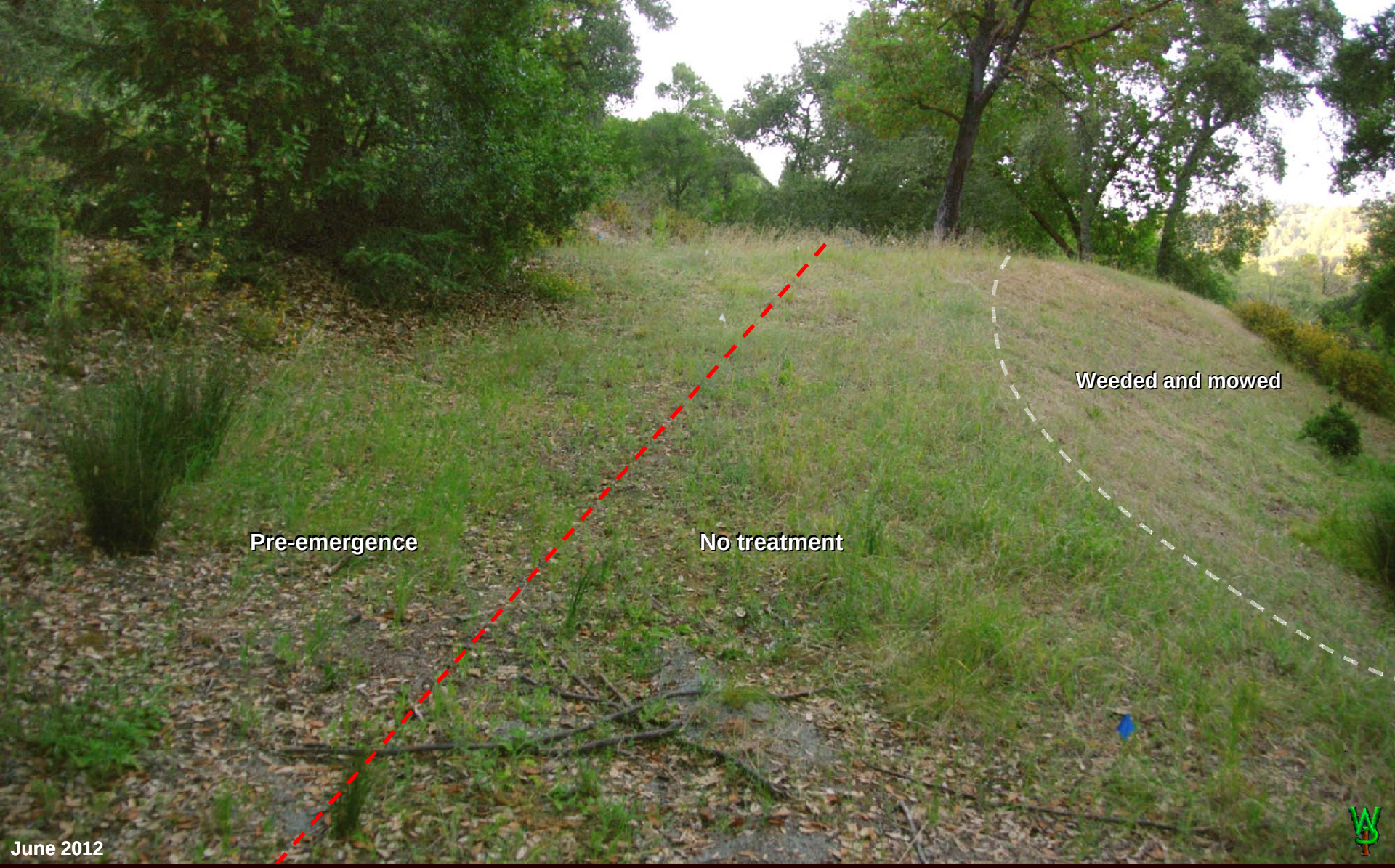


Replotted (and again by eyeball standards), this is what the respective germination looks like. Note: I STILL HAVE TO WEED, but at least my chances of winning are hugely improved. Nor can I do this everywhere. Weeding demand is greatest in the late season when things are warm and everything is maturing. This tool allows me to buy time during the critical early season to find juvenile exotics and remove enough of them that I can manage the work load when “crunch time” arrives.



Ladies and gentlemen, readers of all ages…. with sufficient hand weeding, this is victory. Needless to say, this does not mean the weed bank is gone, but in cases such as *Vulpia* spp., my observation is that but one treatment does massive damage to that weed bank. In other words, the earlier and more aggressively the weed germinates, the more damage this method does to that weed bank. If on the other hand, the substrate was a fill, with weed seed all through it and so deep it won't germinate, a disturbance such as a gopher bringing up that seed is a challenge to the hubris that vigilance is no longer required. Now, back to the photos…

Returning to our “miracle,” this is *Madia exigua*, *Madia gracilis*, slender wooly heads *(Psilocarphos tenellus)*, tomcat clover *(Trifolium wildenovii)*, Spanish lotus *(A. americanus)*, and sanicle *(Sanicula crassicaulis)*. Note that the mature *Bromus carinatus* (on the right) is doing fine as are some blackberry and strawberry. There are still a *very* few chickweed seedlings, some vetch, and even a sow thistle, that still require weeding but the latter two are slow to mature. The reduction in time required to grab tiny weeds and put them into bags makes control go MUCH faster and produces a MUCH higher yield (which is the name of the game from year to year). More of them are removed earlier, which makes crunch time in May a lot easier.



If I had wiped out the native seed bank you would see it. I repeat**:** can you see any difference? Yes, I'm rubbing it in, because you just learned something remarkable, and it didn't cost you a dime. Oryzalin clings to soil particles; is neither a highly mobile herbicide nor is it particularly toxic. It is therefore unlikely to affect runoff water quality. So far, we have treated 8,000 square feet with this process out of over 150,000 square feet of open grassland. Yet it made a BIG difference because those few places I treated would have required several days to weed huge numbers of grasses in mid-season when weeding time is precious. For now, I am restricting this to high disturbance or post disturbance spots where intense weed germination is more likely, particularly grasses.

Pre-emergence treatment left me the time to tackle challenges like this by hand, where the slope is steep and burrowing animals are so active that a pre-emergence herbicide treatment would have been deleterious. The treatment simply means I can handle more disturbance by hand than I would have been able to manage otherwise. This treatment has reduced the risk of a more accelerated schedule of thinning forests elsewhere, although I have not needed it yet. Restoration is all about load balancing time and endurance.

A pre-emergence herbicide affects only those seeds that attempt germination in that particular season, thus exerting no affect at all on seeds that remain dormant that particular year. Hence, the "graphs" only represent *relative* germination survival in any particular year. It is hypothesized that more seeds do attempt germination under treatment because those that have "tried and died" previously had less opportunity to inject auxins into the soil otherwise suppressing expression of adjacent seed.

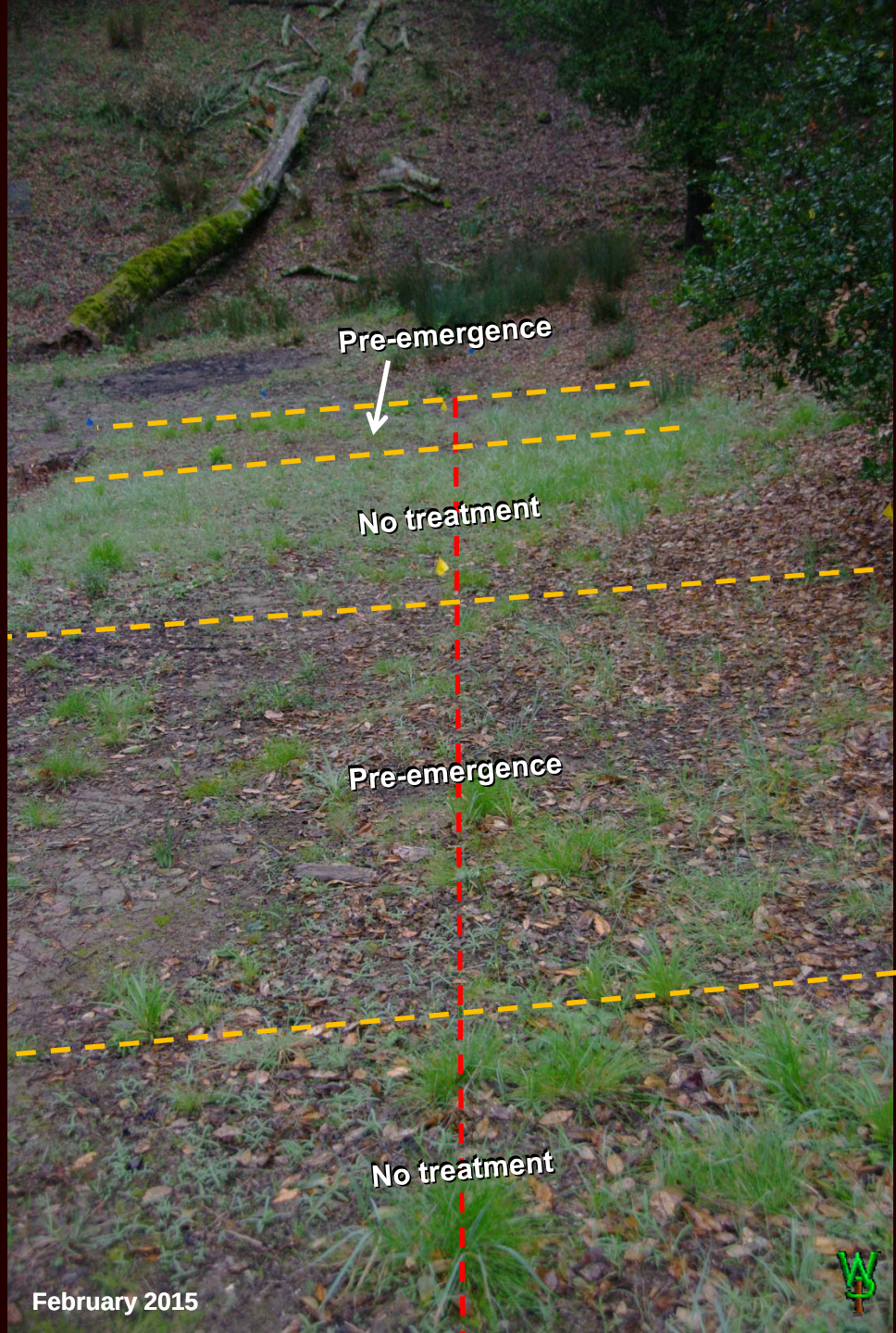
So at this point one must then ask:

1. How much of the weed bank is killed by this treatment?
2. Once the suppressive effect on native germination that weeds exert is gone, does one lose more of the native seed bank with subsequent treatments?

Certainly the largest fraction affected are aggressive weeds that do not tend to exhibit dormancy, particularly rat-tail fescue and annual blue grass. From what I have seen so far, one treatment and their response is vastly depleted in future years if not wiped out. Other weeds with hard seed coats (such as vetches) are reduced but not substantially. From what I have seen, Fabaceae are more likely to be influenced by a particular year's precipitation and temperature profile and whether the prior year had been particularly good, in which case they are somewhat depressed.

The use of these materials is highly weather dependent. One needs to water them in else ultraviolet light can break them down. The subsequent trial at right had skipped a year because I was caught unprepared by early rains.

In fall 2013 I laid the stripes of material *across* the prior experiment to generate combinations of old, repeats, fresh, and no treatment. The second treatment clearly had an effect. Whether natives are substantially affected appears dependant upon whether their dormancy reserves of ABA had been depleted by heavy rain or they would have normally responded to the atmospheric stimuli or biochemical residues and exudates particular to that year.



As I have said previously, this situation with *Cardamine hirsuta* has me more than a bit spooked. Burn piles this winter around the property suggested the weed is widely established in the seed bank. If a wildfire came through, it could germinate all over, some on incredibly steep ground. There would be no way I could keep up. Worse, because of my experience with the unique temperature profiles of the winter of 2014-15, it is clear that in most years the bulk of seed might not attempt germination. One could successfully break down dormancy, lack the right moisture/temperature profile, and the seed might go dormant again to come up in a year when I there has been no treatment in that spot. Seeds both produce and absorb abscisic acid (ABA) cyclically from leaf litter, a hormone that regulates seed dormancy. On the other hand, fungi also produce gibberellic acid (GA_3) which breaks down ABA. It's complicated.

S.D.S. Chiwocha, et al., Karrikins: A new family of plant growth regulators in smoke, Plant Sci. (2009), doi:10.1016/j.plantsci.2009.06.007, p2.

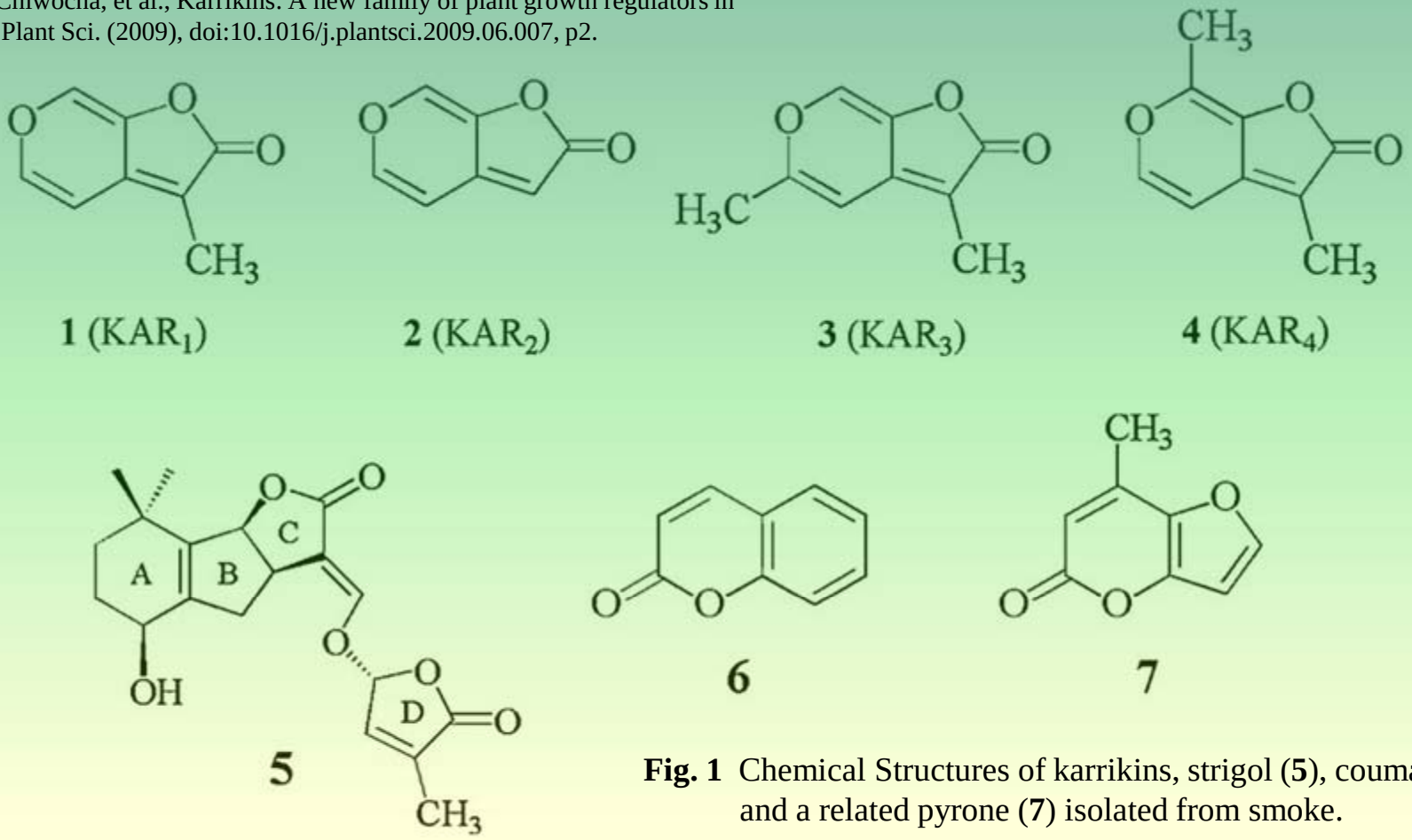


Fig. 1 Chemical Structures of karrikins, strigol (**5**), coumarin (**6**), and a related pyrone (**7**) isolated from smoke.

In recent years, much has been learned of how smoke from fire produces hormones that induce production of gibberellic acid within seeds (GA_3). The GA_3 in turn breaks down abscisic acid (ABA), which otherwise maintains seed dormancy. By soaking the seed in a GA_3 solution, if the subsequent temperature, and light conditions are right, dormant seeds will likely germinate. Giberellic acid also promotes cell elongation, so it is effectively a growth promoter. Accordingly, one can *buy* GA_3, but unfortunately it costs about $1 per gram, much of which would be lost into organic matter if applied in a broadcast spray. The hormones in smoke have recently been isolated and (just as importantly) synthesized, compounds dubbed "karrikins" (in particular KAR_1). KAR_1 has been found effective on the model organism *Arabidopsis thaliana*, which is biologically very similar to *Cardamine hirsuta*. Smoke is obviously cheap, but it takes an awful lot of it to make sufficient KAR_1 to do much, even though it is effective in the low parts-per-billion range (ppb) without need for a fire. To my knowledge (as of 2015), no one is yet manufacturing KAR_1, which I would hope is in the works because the leverage it provides over "smoke water" is obviously enormous, while it is also reasonably stable in water.

Fire infuses karrikins for free. It consumes leaf litter which otherwise produces ABA that preserves seed dormancy. It releases nitrates, nitrous oxides, cyanide, and phosphates also known to promote germination. Native seeds too, such as asters, require exposure to light to germinate that removing the leaf litter obviously promotes. The charred surface absorbs solar heat, increasing daily temperature swings known to signal other *Cardamine* to germinate. So if the goal is to germinate dormant weed seeds in order to kill them, fire may be the ultimate germination trigger, but it would possibly induce the ultimate crisis if I cannot respond appropriately.

Here on a soil that is relatively undisturbed, two years after burning, there isn't much response despite warm temperatures after rains last winter. So I planted the *Deschampsia* plugs. The drought has played havoc with the propensity for water to leach the ABA out of seeds. So using plastic sheeting to retain the moisture and trap the heat in late fall and early winter may be useful in places.

Yet in order to know if the treatment had been effective, I have to have a reasonable guess as to whether there had been weed seed in a particular spot, not all of which do I know without having tested it with nitrate amendment at the very least. Yet if weeds do come up in a cell without pre-emergence herbicide, I'll have to kill them anyway, thus confounding my results from that point on at least to some degree but probably harming only part of one year's worth of native seed. So this is not likely to be an experiment that lends itself to a tidy "scientific" array where differences between test cells are minimized by proximity. With all these variables applied with consideration to their locations, it will be a real challenge to keep track of what was done, where, and why ("What was I thinking!?").

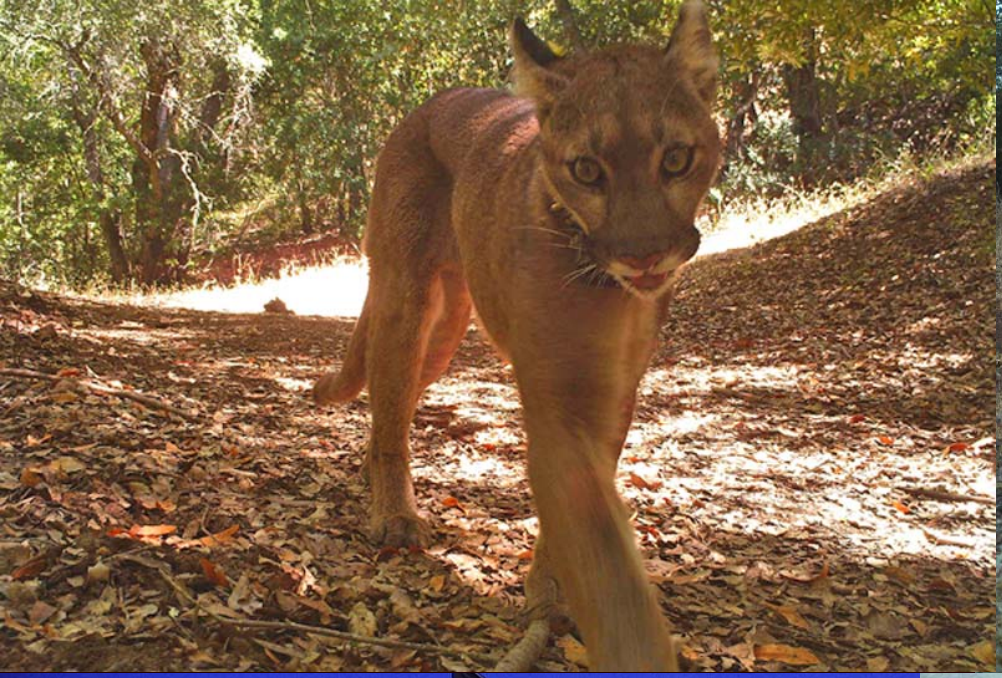
So, where is this going? Recall that the first grasslands chapter described how adding blood meal to the soil brought up filaree. It should be obvious that as native perennials help their symbiotes (bacteria & fungi) to increase soil nitrate content, that I might slowly get hammered with *new* weeds in a more difficult and complex grassland, a most unpleasant prospect. Then there is *Cardamine hirsuta* (bitter cress) an exotic the State had listed as native *C. oligosperma*. The plan is for a multivariable experiment with pre-emergence treatments, urea amendment, charcoal, clay, compost tea, trapped solar heating, karrikins, gibberellic acid… in other words, I'm going try combinations of everything reasonably possible to promote weed germination in a manner that is selective for early germinating weeds and force destruction of the "weed bank" on a spot basis. Interestingly, this is one instance in which chemical fertilizers such as urea may be preferable, as they stimulate weed germination in cold temperature conditions more than organic emulsions do. I will also be fooling around with adding molybdenum and boron to see if this gets my clovers going or if there might be another lack in bacteria specifically adapted to those native varieties left in the soil for which brewing compost tea may also help.

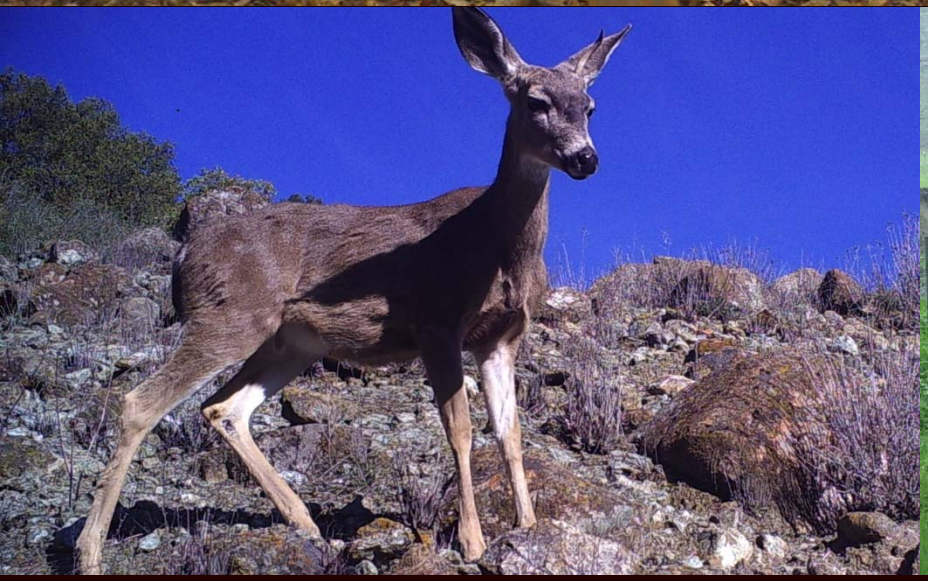
February 2015 – After thinning brush on the slope below the house

The “good news” is that any process capable of getting bitter cress to germinate will probably be effective against most any other weed I seek to control. The “bad news” is that *C. hirsuta* matures in five weeks, popping seed that is not yet dormant. It can then germinate in 12 hours if there is enough water! If the seed dries without germinating, it goes dormant. So, to control it by a pre-emergence technique, one must break dormancy to stimulate the ***entire*** seed bank to go to make a pre-emergence process at all effective. That requires water to leach the ABA, nitrate to promote growth, possibly karrikins or GA3, and a way to keep the seed warm after soaking.

My intention is to concentrate treatments on areas where (1) I know weeds such as bitter cress have seeded and (2) areas that, because they were probably grazed, there might be higher concentrations of seed from plants that respond to grazing (such as filaree). I will use burn piles, nitrate, plastic, and charcoal (another source of solar heat) as test patches to concentrate early germination in a very hokey sort of test array (from the standpoint of repeatability). The drought has obviously played havoc with the propensity for water to leach the ABA out of seeds. So this idea of using plastic sheeting to retain the moisture and trap the heat may be effective, but I obviously cannot do acres of it (imagine running around to pull it off every time it rains). This may have to be done in steps.

Spot pre-emergence treatment is the future by which to minimize my use of herbicides. The problem is that, when I go to spray the spot, the weed that dropped the seed is long gone. So, while I am weeding, I mark a flag with the planned spray radius and a code for the species, in this case annual bluegrass *(Poa annua*). The following fall, I spray that radius with oryzalin. This works great with plants that just drop seed, but it's not so great with weeds like bitter cress that shoot it ten feet! The process is particularly effective against a nasty allelopathic weed like annual bluegrass, which can sprout and produce seed in six weeks while but a centimeter tall and it will keep germinating all spring. The process requires considerable discipline. Carrying flags and a permanent marker capable of surviving sunlight is a hassle when crawling, squatting, etc. carrying bags, weed fork, camera, cell phone, squirt bottle, etc. (I made a special quiver to make flagging easier while weeding). It is a tricky ergonomic design problem that I hope can be augmented by a smart phone using numbered photographs with dictated notes and GPS path optimization between them that even plans material requirements. Couple that with weather forecasts and it would even help with the planning!






We either find ways of cleaning the weed bank or the native system will eventually fail, forever. Lacking food, bugs follow plants. Lacking food, birds follow bugs and plants. Lacking food, herbivores thin or subsist off suburban gardens. Lacking food, predators head for suburbs and cities… This is what we are seeing in the choices we have made and the ones we face. We either learn to care for the life systems of this planet or we give up on it. To do nothing and play computer games instead (for all you agency modelers out there) is just as much as playing God for a pension as it is to willfully destroy for a profit, either is a process in which a part of us dies with it.

September 2008, Yosemite Valley – Forest east of Cook's Meadow with sparse borderline monoculture groundcover

Somehow, I don't think that is what the people wanted when they screamed for the Clean Air Act, the Clean Water Act, the Endangered Species Act, or the National Environmental Policy Act. It isn't what was sold when the government instituted its armed monopoly in land entertainment… er, "parks" either. Yet the system of "protection" these laws have created is killing the very thing they were instituted to "save." Worse, it has become a corporate racket (if it wasn't so intended in the first place). It is destroying the liberty necessary to fix it. Yet worst of all, it is tearing out a piece of the human heart in alienating the people from the land, as is readily observable.

June 2015 – Foxtails, vetches, bachelor buttons, radishes, a few exotic poppies… while pretty at first glance, is all weeds. That it is isolated by streets makes it a perfect spot to experiment.

The Arboretum at Stanford University was bestowed for the purpose of agricultural and particularly arboricultural research, to find which plants grow best in California and to improve the state of the horticultural arts and sciences. Instead of heeding the spirit those founding intentions, having foregone the very idea of responsibility for the land to 'let Nature take its course,' what the University has clearly shown is that weeds are what grow best in California. Somehow, I don't think that this is what Mr. Stanford had in mind when he donated the property, but these geniuses at Stanford are so busy stressing over how to force the likes of me to do what *they* think is best for *my* land, that they quite apparently "don't have time" to learn the spiritual, intellectual, and economic benefits of devising new technology to care for their own. The goal of this pre-emerging process is to be selective; it should not harm established natives; it should not inhibit germination of plants that tend to do so later. This is a very tall order for an herbicide process, but one that, if successful, could render restoration of breeding patches of locally adapted annual plants within reasonable economic reach where one can isolate them from new infestations as long as there are intelligent and committed people to follow up, which would both require and constitute a complete transformation of perspective in education. Is such a worth the investment? Well, that's the next chapter.

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