So, a lot of what is special here is about very small plants. All of what you saw in the last photo series 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 here 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, to have accomplished this by weeding alone over such a large area as contains this photo would have been impossible.

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)* 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. When they open, they almost disappear. The work of separating the two can be 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. It could happen. You will see what *Dittrichia* can do.

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 sprayed it the previous fall. The blue wild rye *(Elymus glaucus)* is just fine and 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. wildovenii,* & *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.

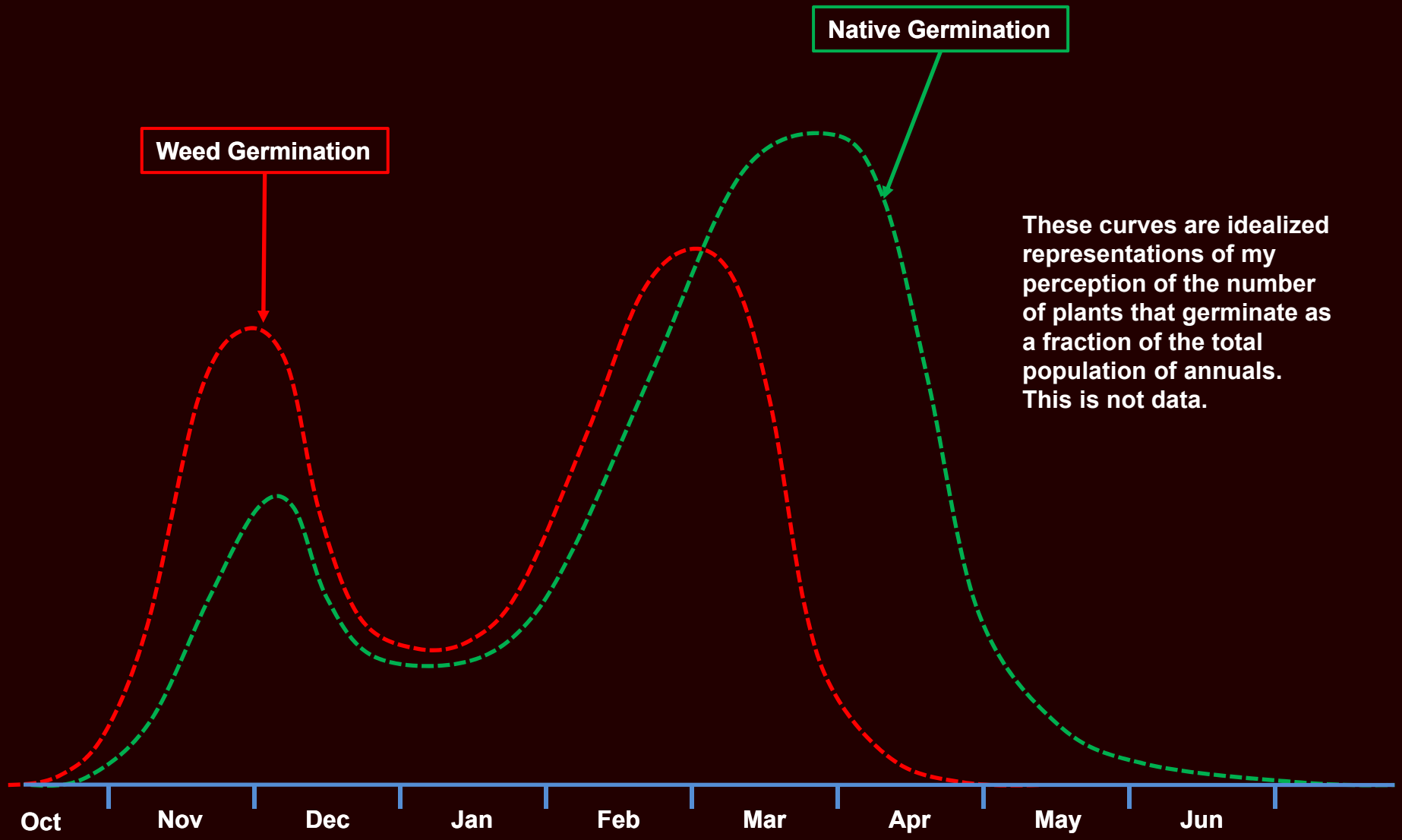
So here we are early the following spring with *more* native annual forbs in the treatment area on the left, including our “red spot clover.” Why? The exotic annual grasses that germinated on the right (that I then weeded) suppressed the germination of native annual forbs. A pre-emergence herbicide functions 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 the right side did. Now, can you see any difference?

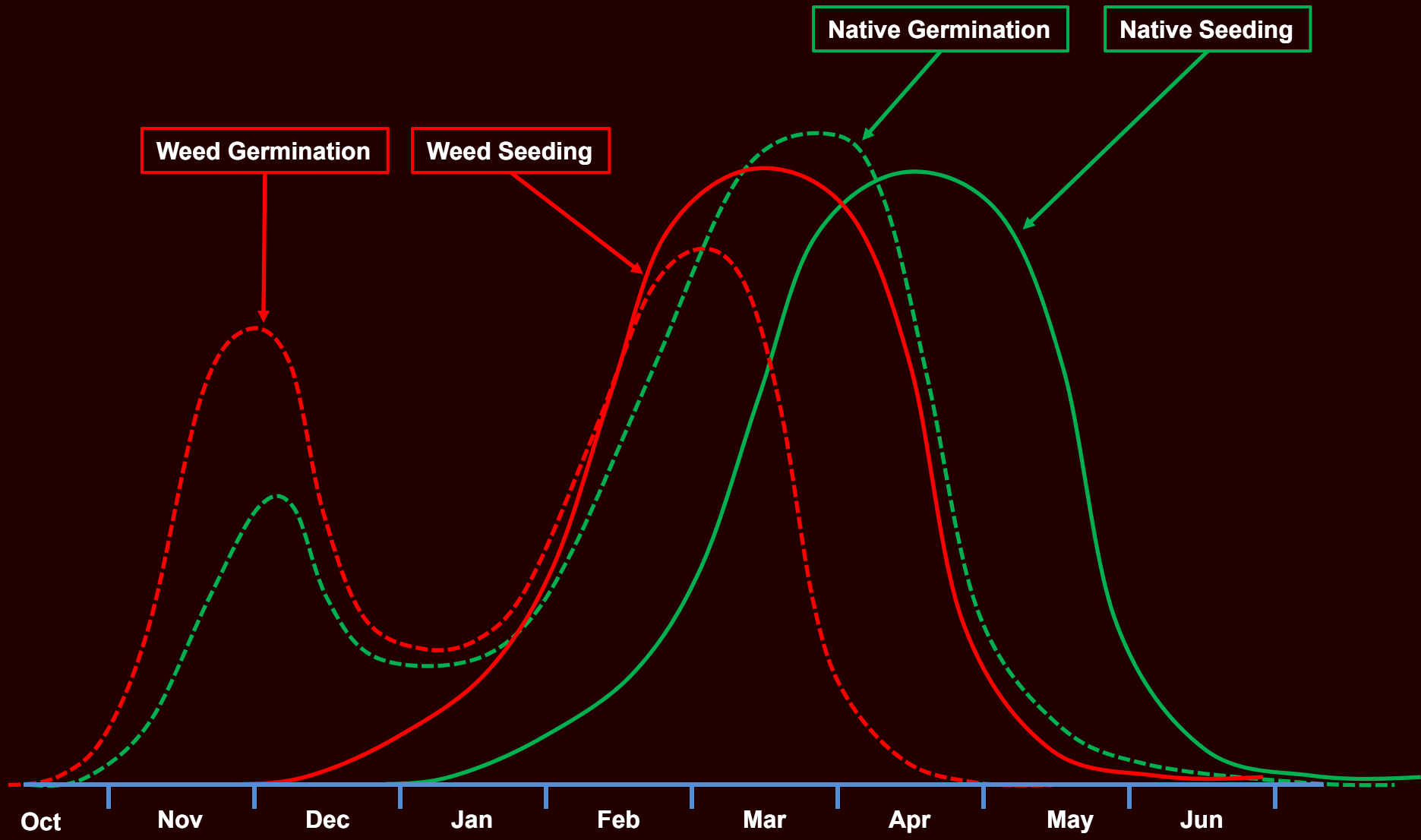
This was taken the same day from the opposite end of the ramp (it is a road). I repeat: can you see ***any*** difference?
Yes, I'm rubbing it in, because you are about to learn something remarkable, and it didn't cost you NEARLY all the pain it cost me.
I could have made serious money doing this as a 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. There is just no way this process damages the native seed bank.

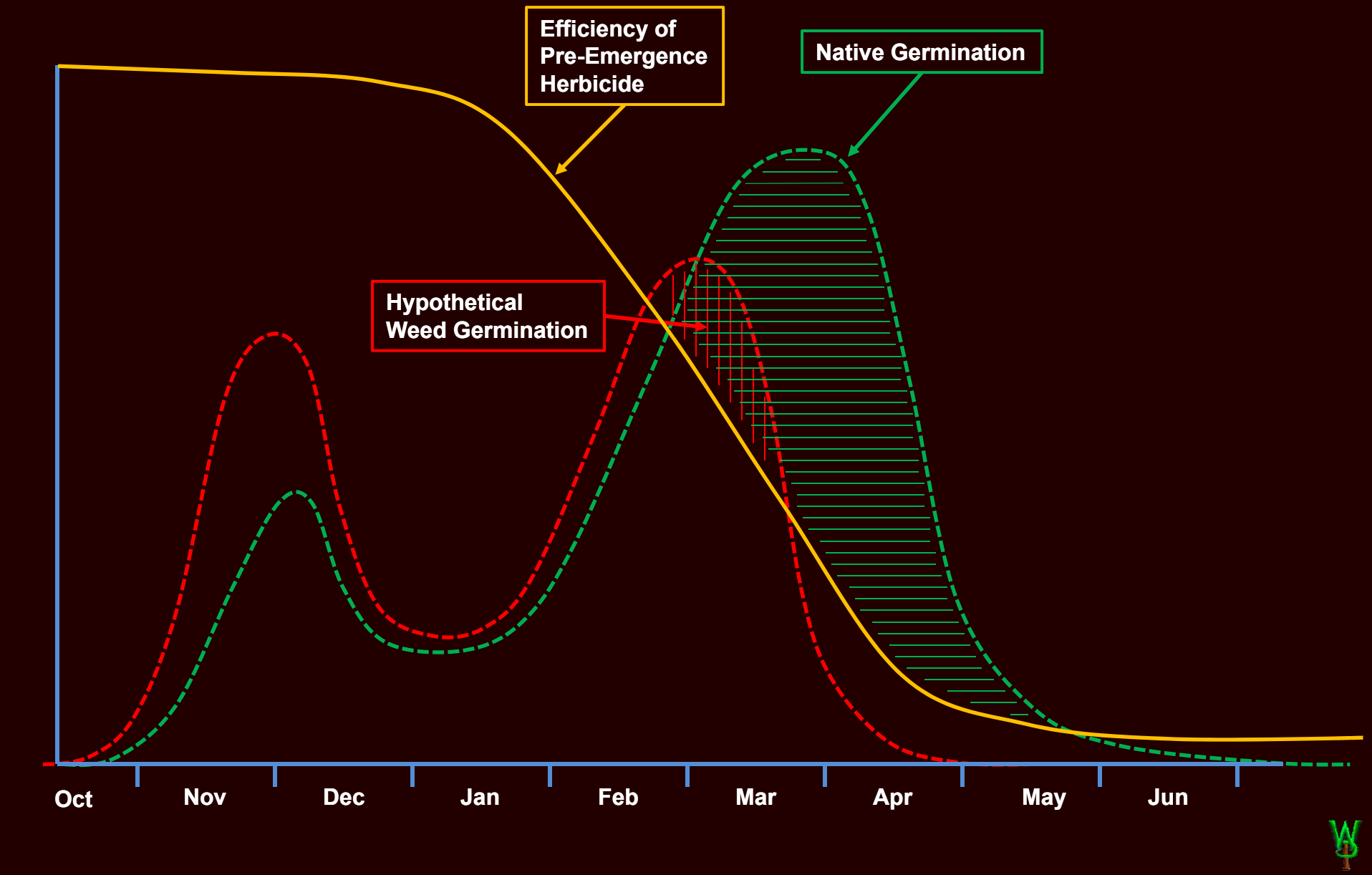
We're back to the ramp. Note that grass weeds *(V. myruros)* are the big labor factor on this spot. They are particularly powerful at suppressing annual forbs. So, how is it possible that this process displays such an impressive bias toward selecting for native germination? It's fairly simple actually;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



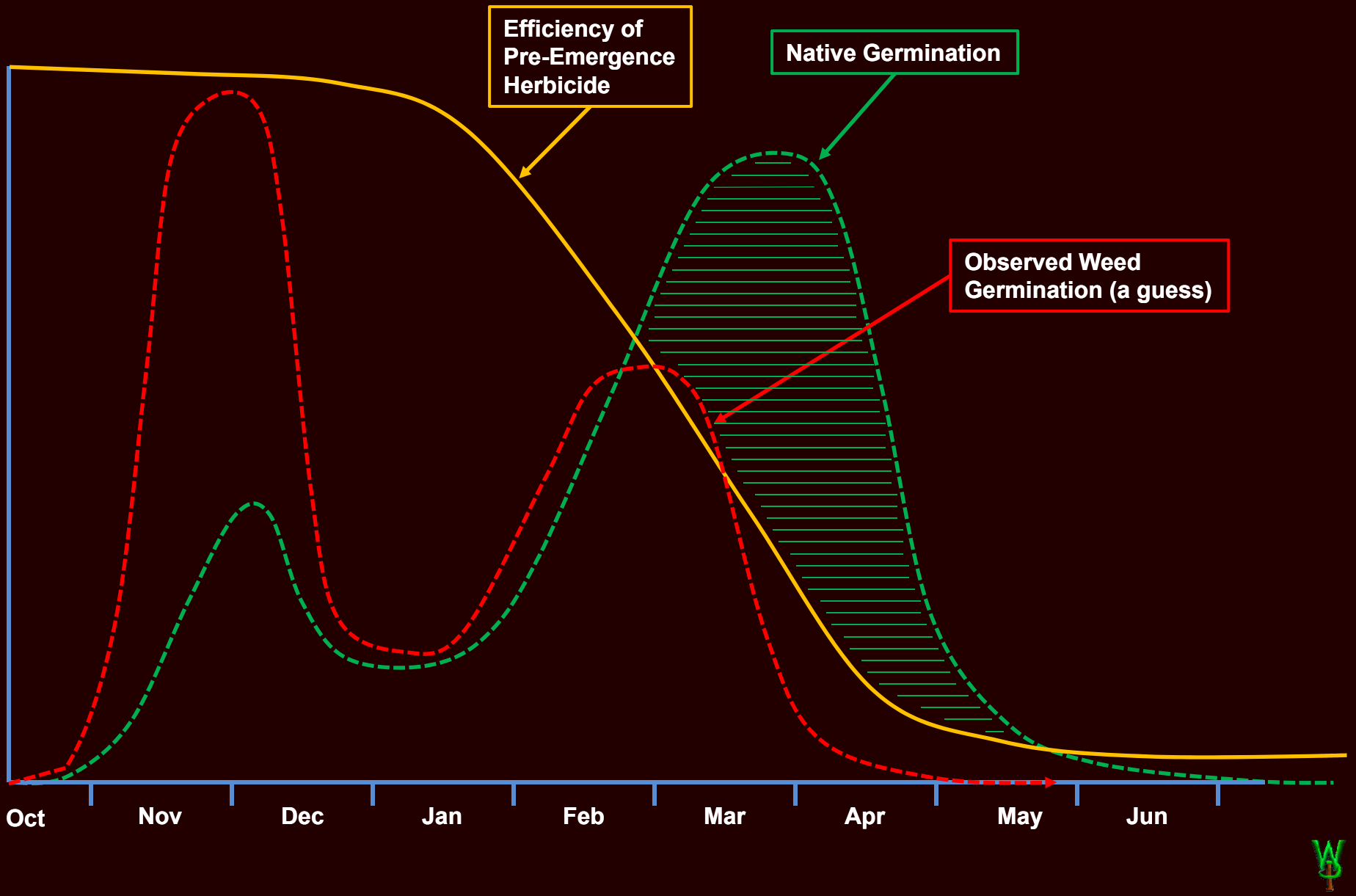
Most weeds are annuals from climates where the growing season is short. Their strategy is to germinate and get to maturity as fast as possible. California native plants are adapted to a climate with no rain in the summer; they often require three months of cold weather to germinate in order to avoid doing so when there is a freak rain during the summer with inadequate water to breed. Even those natives that do germinate as soon as it rains do so again in spring. Few plants germinate in mid-winter.



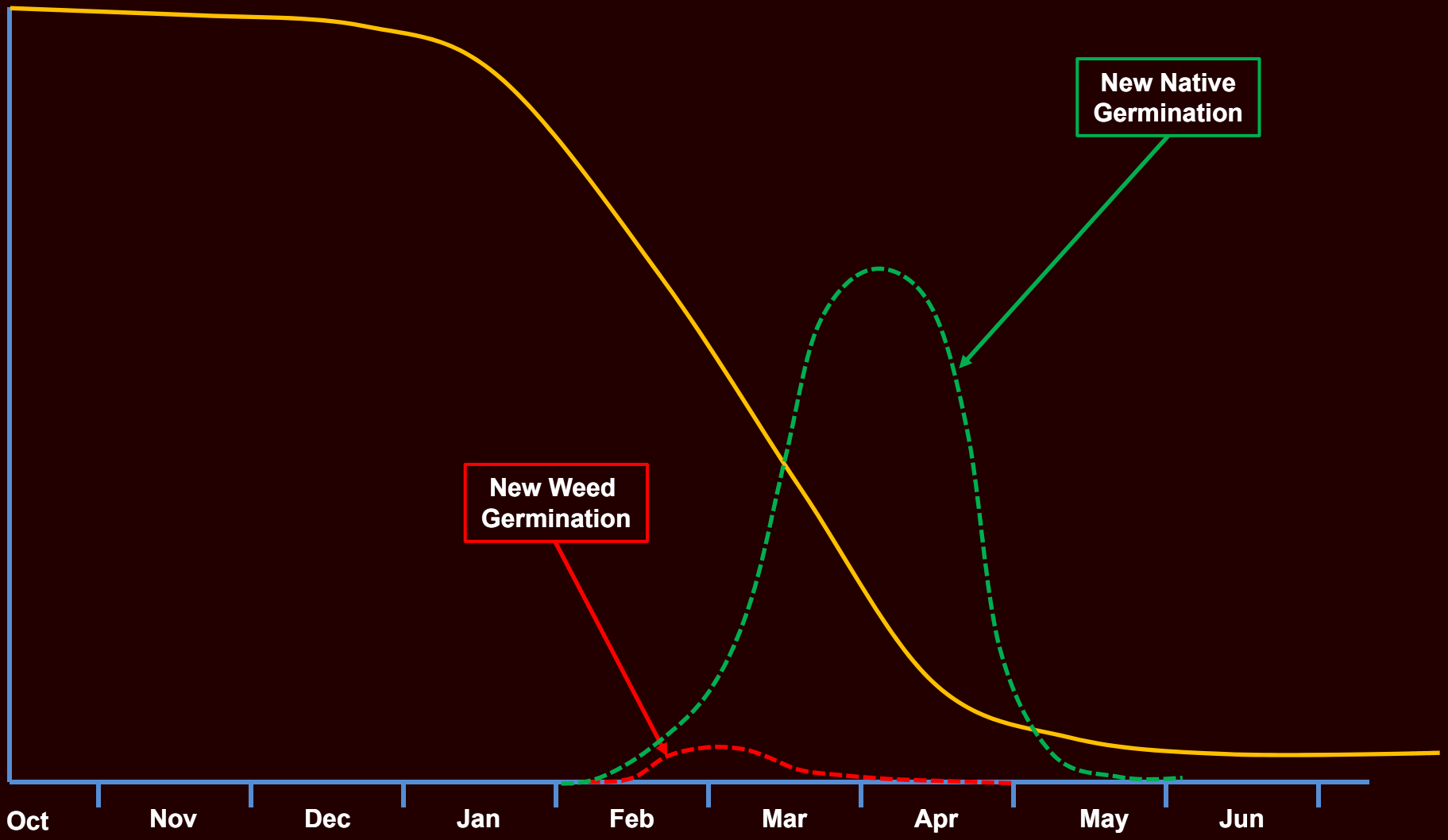
I am superimposing a similar ‘off the top of my head’ representation of when annual plants drop seed. There are some that do so later, but this is an effective representation for purposes of illustration.



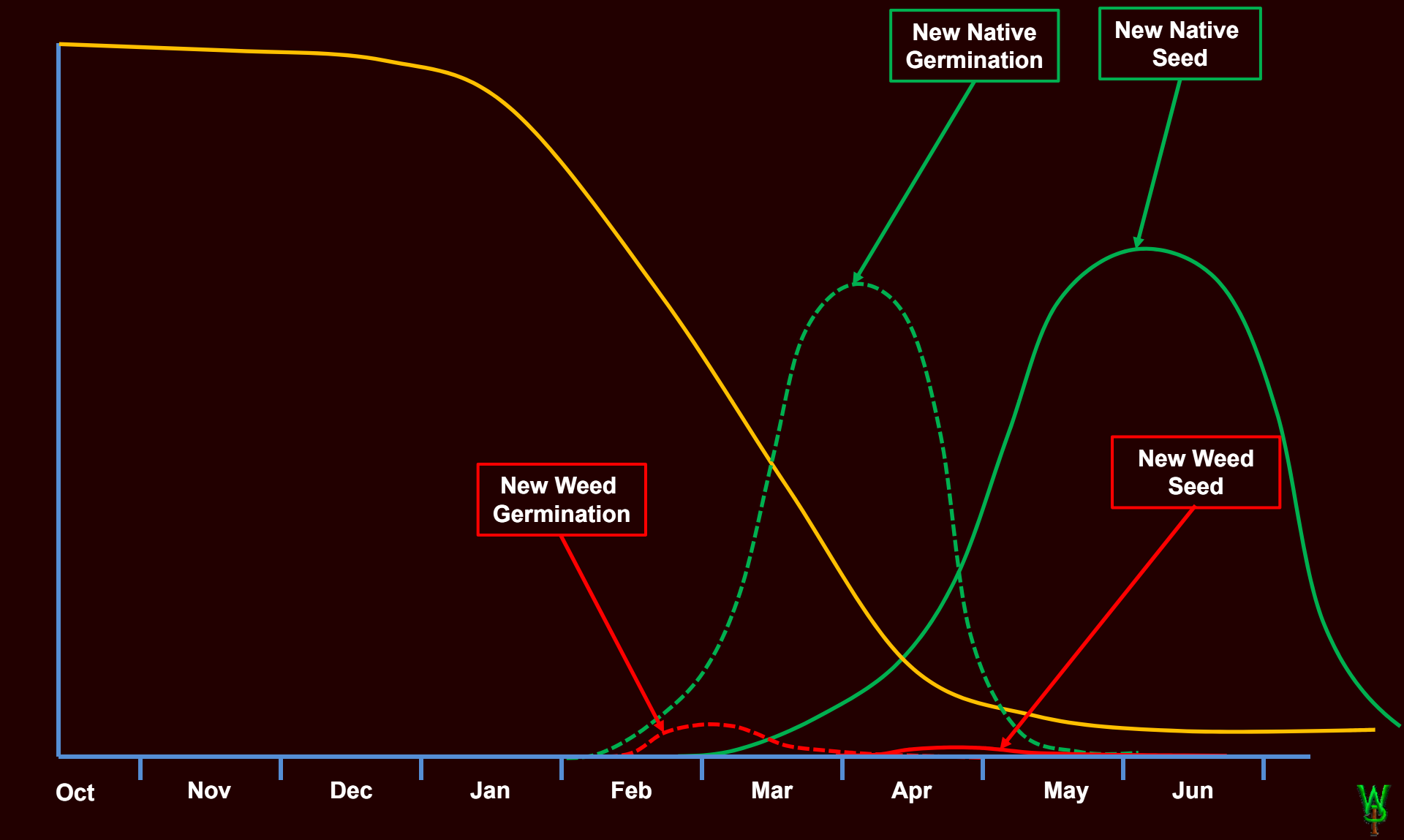
OK, now I whip out those eeeevil chemicals… in this case, oryzalin. The hatched area under each curve suggests the total number of plants that would germinate, ***all other things being equal,*** (which they are not). Now remember, those native species that *do* germinate in the fall *also* germinate 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.

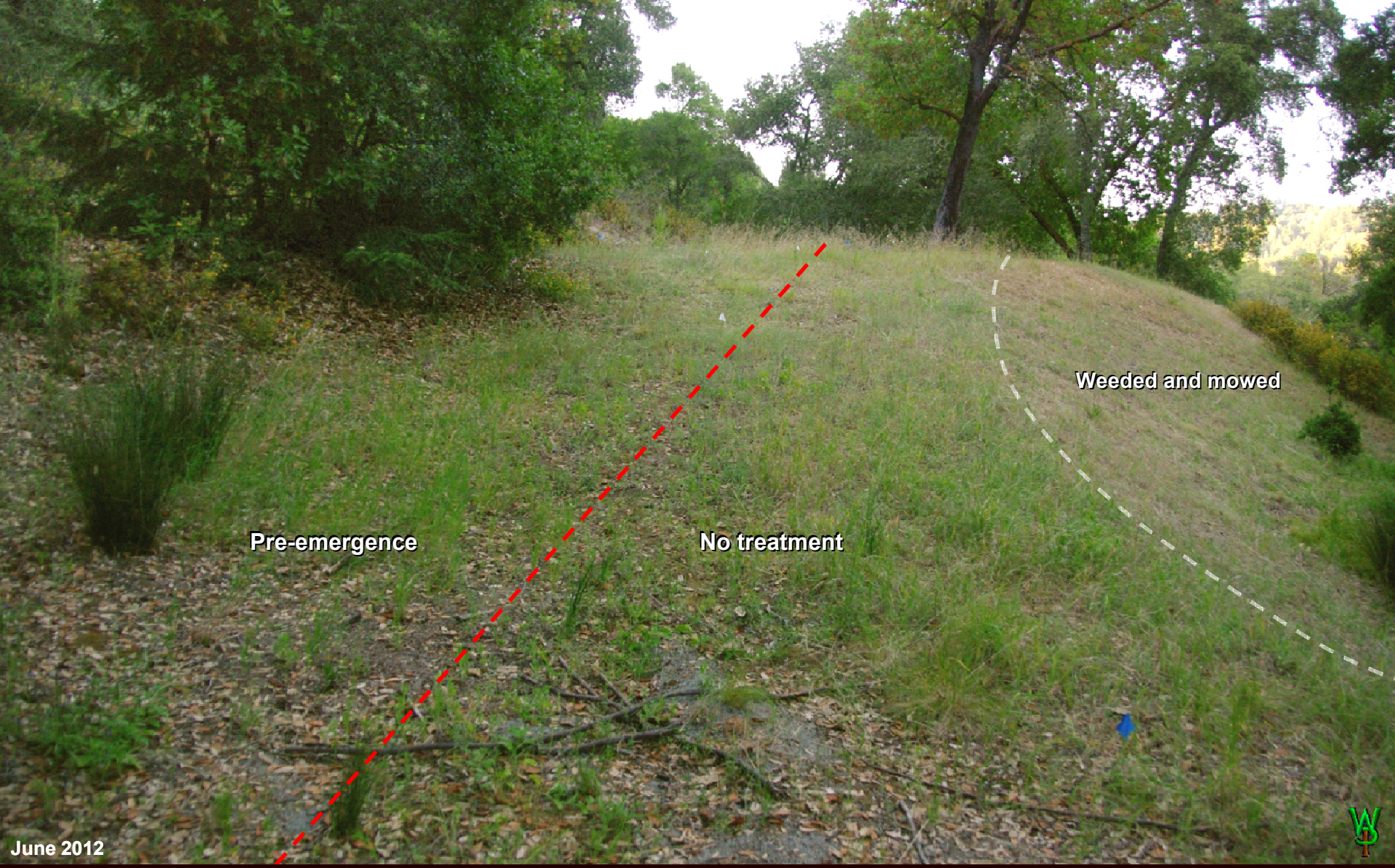


Replotted (and again by eyeball standards), this is what the respective germination looks like. Note: I STILL HAVE TO WEED, but at least my chances of winning are hugely improved. Nor can I do this everywhere. Weeding demand is greatest in the late season when things are warm and everything is maturing. 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…

This is *Madia exigua*, *Madia gracilis*, slender wooly heads, tomcat clover *(Trifolium wildenovii)*, Spanish lotus, and sanicle. 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.

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.

Spot pre-emergence treatment is the future by which to minimize our 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. 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 and possibly invention of a special quiver to make it easier to do flagging while weeding. 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. It is a tricky ergonomic design problem.

So, where is this going? Do you remember when I added blood meal filaree came up? Do you really think that, after all that work, I want to see this soil increase in nitrate content and *then* get slowly hammered with *more* weed species??? No way. The plan is for a multivariable experiment with pre-emergence treatments, nitrate amendment, charcoal, clay, and compost tea, with which to promote weed germination and force destruction of the "weed bank." 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.

The big jugs are to save left over mixed material and to reuse spray tank rinse water. There is no waste. I also use an anionic surfactant, an indicator dye to know what I've hit or missed and a non-extensive thickener (xanthan gum) to improve target control and minimize overspray.

June 2010

He uses CHEMICALS! Chemicals poison the land!!! You bet they do, but they degrade eventually. 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 Pro®, 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.

More Painful Conversation on Herbicides

Spot spraying is an exhausting thing to do. The eye-strain in targeting small individuals representing 120 weed species from their 225 active native lookalikes from six feet up as fast as you can go for hours on end is exhausting. It takes very quick decisions and reflexes to control application to one small plant or a collection warranting 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 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 control. Current spray technologies are ancient. I suspect that it is because people leave this kind of thing "for the Mexicans to do" that it doesn't get better. As harsh as that may sound, as far as I am concerned, the state of application technology, the unnecessary waste from lack of control, the way we treat people who do this kind of work, and the lack of biological knowledge behind the use of herbicides are worse.

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, possibly requiring far more herbicide than would have been necessary.

Grasslands Process Development Overview
An Explanation of the Graph

The top two lines of the graph depict the transition from single species management, when I ran around dealing with five or six major disasters at once chasing them to their limits. I don't do much of that any more except within the perimeter control boundary areas. That may yet change depending upon the choices made by my neighbors.

The "Mechanical" line was at first entirely bush whacking broom again with a perimeter residual. The rest was hand weeding as that began to displace chemical control.

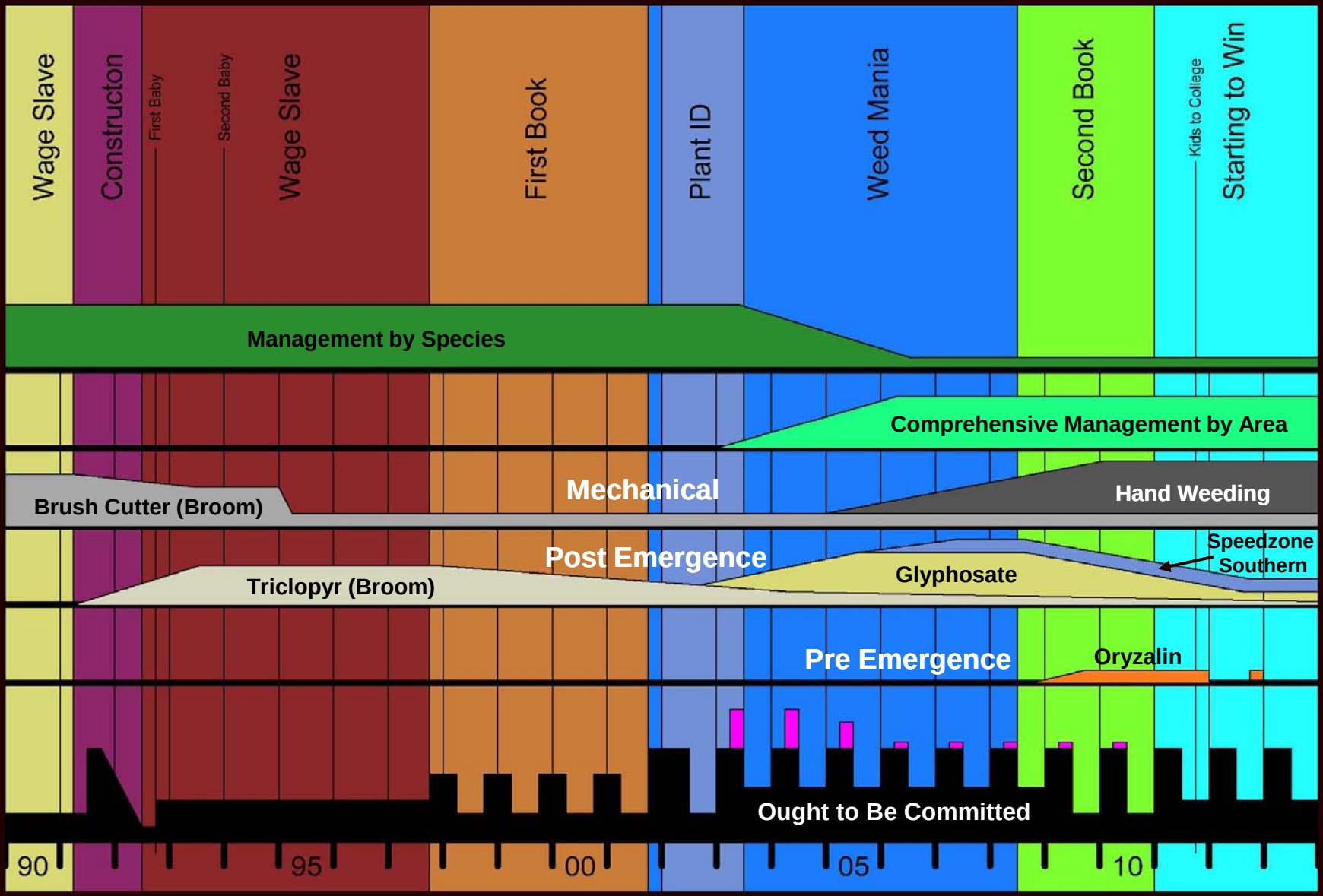
The height of each curve on the chemical lines DOES NOT indicate how much herbicide was used; it is more analogous to the emphasis, time, or area covered, almost always by spot spray. The Pre-Emergence line would be shorter in height but if it reflected actual area you wouldn't see it, so think of it as scaled by 5-10 times compared to the Post-Emergence line.

The tails at the right end of the Post-Emergence 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). On most grasslands I use little to no herbicide at all beyond the chickweeds earlier in the year (January and February), a process of which I hope to see the end in a year or two.

I am continuing my experiments with pre-emergence herbicides and nitrogen out of scientific curiosity and caution against the day if the soils here become more fertile over time and germinate weeds in the seed bank I have not yet encountered in quantity. Fertility is a double edged sword. It supports more wildlife and or grazing animals yet it also germinates more weeds and undergoes succession more rapidly to chaparral and then forest. I am interested in more vitality, but I am not interested in generating needless work to do. As you might expect, I have had quite enough of crawling around pulling acres of weeds and don't enjoy spraying any more than anybody else does. I much prefer searching for that one isolated pioneer 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.

The glyphosate half of the Post Emergence chemical "tail" on the right represents 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 *(T. arvensis),* catchfly *(Silene gallica)* or scarlet pimpernel *(Anagalis arvensis),* the latter of which is usually close to the bottom of the weed bank "onion." The second, although similar, is more distributed 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.

Grasslands Process Development Overview



Next