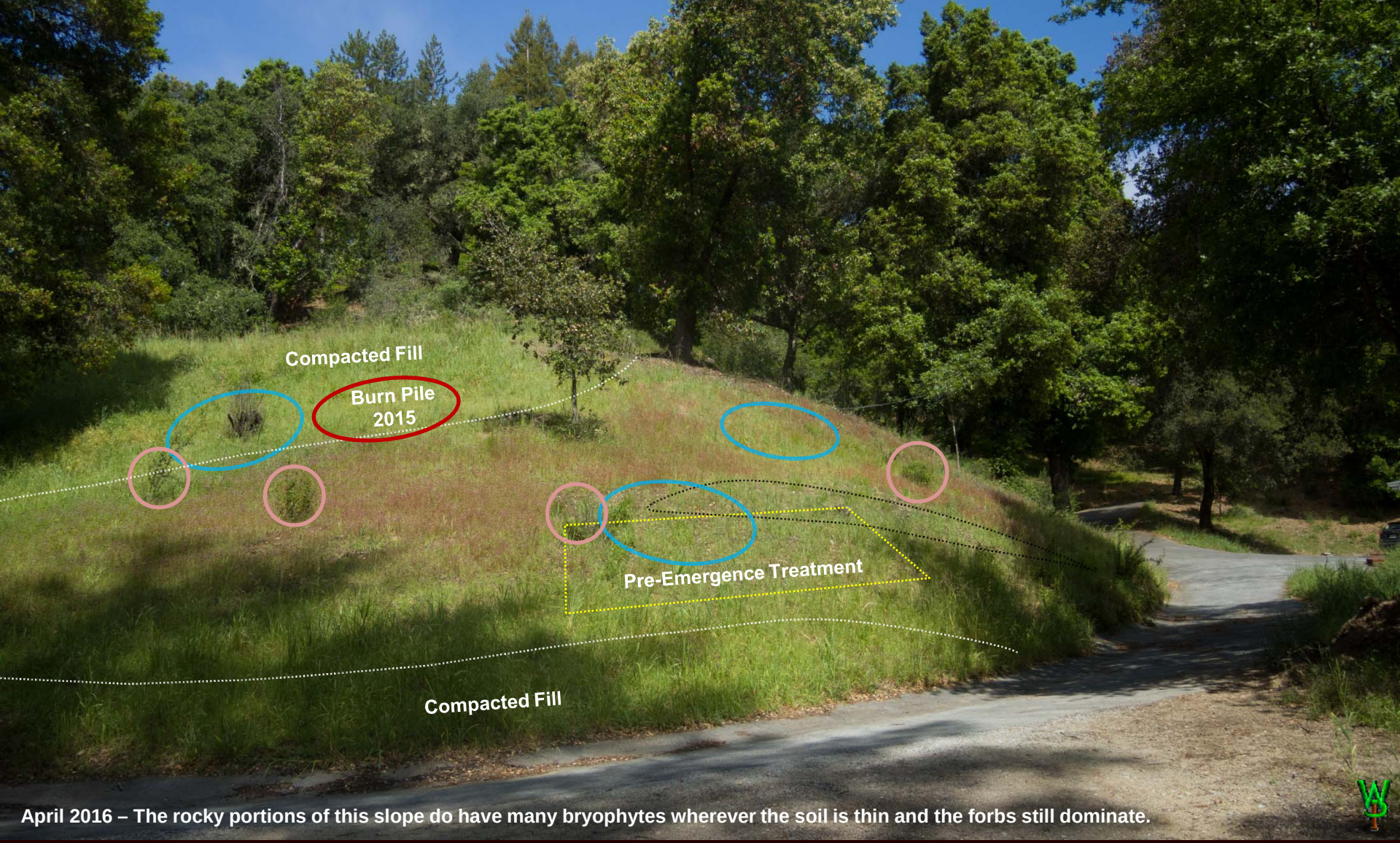
Native Invasion

November 1994 – Both the straw and the grass seed over fill dirt were exotic "Blando brome" *(B. hordeadeus)*. Observe the pattern of bare sandstone in the foreground and on the right slope in the next slide.

Recall from the introductory chapters that the project started with thinning forest and killing broom. There were trees, lots of stumps, weeds, leaf litter in the draws, and not much else. For the most part, the native seed bank was exhausted. Once the goal became a pure native plant landscape, having observed that lack of native response (and at the time still deluded with the idea of 'natural equilibrium'), I felt it important to document 'the return of the natives,' as I suspected that it might yield information useful to recognizing how native plants worked things out among them selves without the usual dominance of exotics.



April 2016 – The rocky portions of this slope do have many bryophytes wherever the soil is thin and the forbs still dominate.

Note that the clovers *(T. wildenovii* and *T. oliganthum)* are dominant only where there was bare rock in 1994 but for an area they usually occupy where pre-emergence herbicide was used (winter 2015) to treat bitter cress *(Cardamine hirsuta)*. I added some fill at the base of the slope in 2003 because I wasn't happy with a notch at the bottom of the slope. California brome grass dominates both the top and bottom fill slopes with needle grass slowly moving in. Two *Ceanothus papillosus* were transplanted here and grew old. A coyote bush volunteered. They were removed because new entrants are replacing them and I wanted to clean out the remaining weed seed bank underneath where they'd been (particularly *Trifolium dubium*). The beautiful oak prominent in the original design didn't survive an incompetent tree feller (me). A young replacement is in its place and is finally starting to take in what was solid rock.

Wildergarten 5.4

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 4.2 4.3 4.4 4.5 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

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April 2002 – Cat's Ear

In our "old sand hill" (prior chapter), the first task was to take on French broom. Roundup became the order of the day for several years thereafter as cat's ear *(Hypochoeris glabrosa),* rip gut, Spanish brome, and rat tail fescue *(Festuca myuros)* invaded the open niche. Recall from the introduction that much of the native seed bank here was exhausted (although one can see a lupine in here).

Three years after the war on cat's ear began, clovers, cudweed, and other natives began their comeback. I felt it important to report what happened as native annuals and grasses established with minimal exotic competition. This chapter will touch upon invading various niches, patterned hierarchies, unexpected behaviors, indications of genetic adaptation, or if there were responses to and with microbial symbiotes or native insects (and/or the lack thereof).

April 2009 – *Lupinus bicolor, Trifolium microdon, T. microcephalum* and *Pseudognaphalium stramineum* invade the open niche.

Once plants exhibiting extended seed dormancy have invaded and settled into a site, the seed bank is then reestablished, thus making the initial behaviors unlikely to be repeatable. Hopefully, some of what I have seen will alert whoever attempts this somewhere else for what they might see, such that more information can be captured before and during the process. Given that I have few analytical capabilities here, these will be fairly gross visual observations, as they must be at this point.

By 2010 the natives (mostly clover) had finished forming a complete annual groundcover, a process taking a total of eight years. After repeating the process elsewhere when thinning forest and dealing with the weed response with more knowledge, I have had many opportunities to witness the colonization process over larger and more varied areas, resulting in some interesting observations.

Of the 24 native species of legumes now found here, I estimate that only five were still viable in the seed bank and broadly distributed. The rest either migrated here by means probably involving animals or had so few viable seeds remaining that their behavior still resembled colonization of an open niche. Typically, they first they spread into the immediate areas in which they appeared, some also producing scions in satellite locations, sometimes at distances of over 100m. Usually these scion populations were in similar niches, but when otherwise (such as a clover appearing in a forest) they often took on somewhat different forms.

There Was a Duke of York…

April 2016 – Note the *Galium parisiense* among the lotus. Hopefully, this too shall pass, but until then, it's my life…

Among legume species in newly invaded soil there appears to be a distinction between those that always start out standing erect and those that begin with a prostrate or ascending form and then go erect in successive generations (above). This latter behavior, while programmatic, appears to be adaptive. They remain erect even when occupying an open space with no apparent reason to climb.

April 2009 – Note how tight and flat to the ground this mix of clovers and lotuses grows

There were two general hierarchical patterns among “prostrate first” natives as this process took shape**:** forbs-before-grasses (above) or grasses-before-forbs. From what I can tell, the character each system assumed over a decade resulted from that “order of addition.”” In other words, it suggests that entropy applies, as opposed to equilibrium. Indeed, there may be no such thing as “equilibrium” in systems subject to rapid succession when not perturbed by regular disturbance. Were I able to “start over,” things might have happened differently with more grasses and fewer forbs. In the photo above, *Stipa* grasses are invading a meadow that was almost exclusively forbs in 2008.

Typical of this ‘forbs-before-grasses’ scenario, the grasses showed up singly, here most commonly small flowered needle grass *(S. lepida)* and/or California brome *(B. carinatus)*. Note also that the lotuses *(Acmispon americanus)* climb into the grasses in reply, one presumes for light and in response to shading. So far, this would seem hardly remarkable.

One of our later “returning” clovers was *Trifolium ciliolatum v. discolor* (the larger variegated leafed clover leaf). This variety has been growing in this spot with California brome *(Bromus carinatus)* and *T. microdon* for several years since and both get along just fine.

As usual, *T ciliolatum v. discolor* at first grew prostrate but was then invaded grasses (here *Bromus carinatus*).
It now grows erect, even when not in direct contact with the grasses. The *T. microdon* is still here, but now relatively sparse.

On the other hand, this “tree” clover *(Trifolium ciliolatum v. ciliolatum)* grows absolutely flat in this open area lacking any grasses, to the point that several botanists (and I) are concerned it may be getting ‘weedy,’ simply because it is so exclusive. There is reason for this concern**:** this variant has never been seen this far south. We wonder if it is therefore effectively an exotic, even though the *species* is inarguably native to California. Yet few of the others had ever seen this behavior in a clover before. I have seen it often enough here in mixed clovers and lotuses to suspect that this behavior may be characteristic of these low groundcovers as a defense against herbivory. This region once supported large numbers of elk, pronghorn antelope, and deer. Frequent fire would suppress the grasses and force this adaptation. The prevalence of exotics is so ubiquitous that even botanists roaming the area had not seen this behavior before.

True to the “forbs before grasses” observation, these “tree clovers” immediately cease growing flat when they encounter pre-existing grasses. They grow up into the grass for light with leaves as much as three times the size. Growing flat happens here because this place has bare soil uncommonly free of competition. Growing flat means the seed will stay put. As it grows erect, it will be eaten. That means its seed will spread in animal droppings. They then continue growing erect until there is a disturbance, even without the grasses.

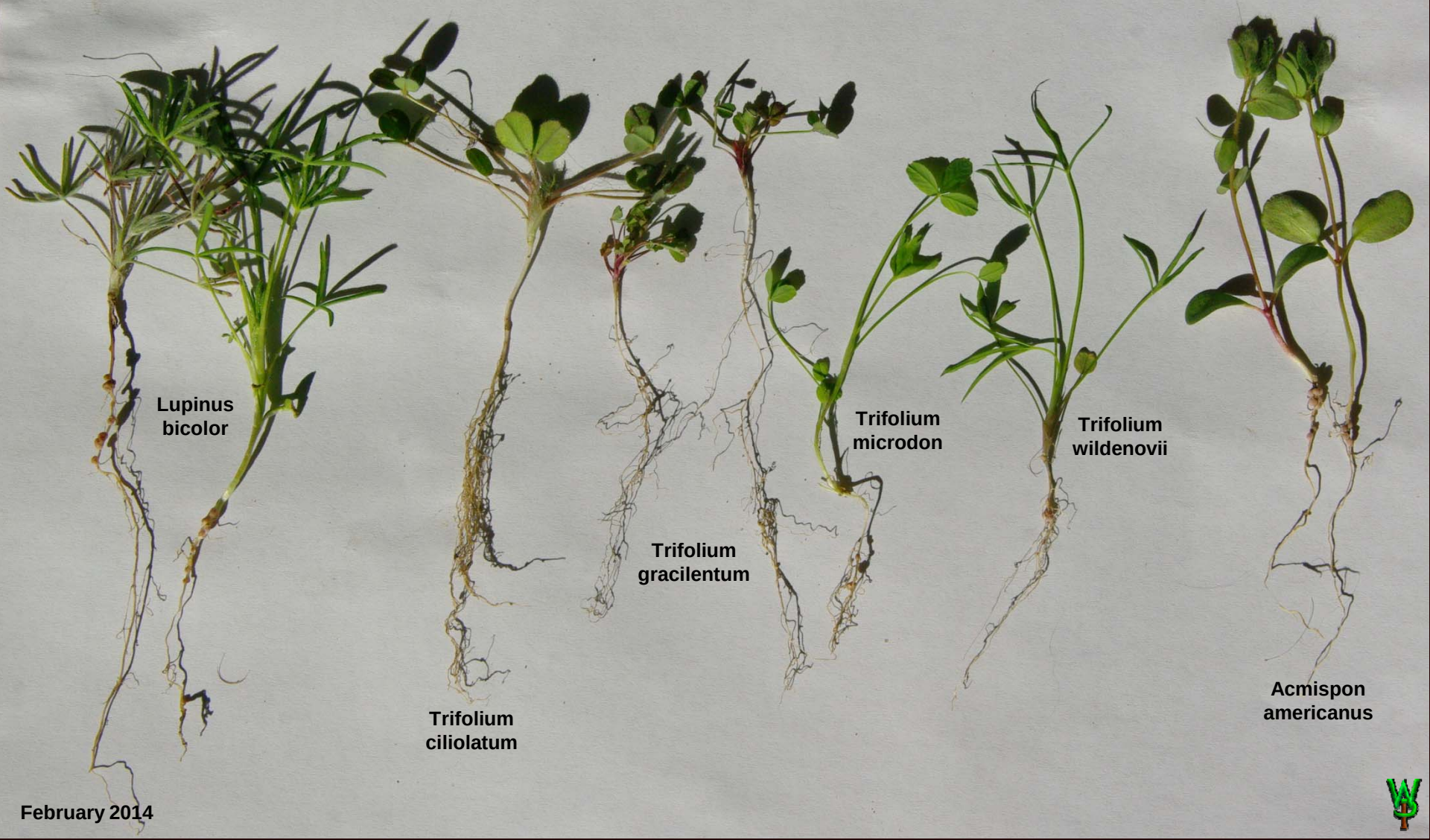
This flat used to be dominated by exotic dwarf hop clover *(Trifolium dubium)*. As I killed the exotic clover, it shifted to a small tarweed *(Madia exigua)*. The next slide will be an inset of this one.

As one might expect given the previous clover dominance, the pattern reversed, with native *Trifolium gracilentum* (purple flowers) taking up much of this flat. But note that the *T. gracilentum* assumes an erect form here. If a prostrate form was strictly phenotypical to open spaces, these would have grown flat. If an erect form was a response to population density, then those tight flat patches we saw would have stood up. If growing erect was a response to shading or taller competition, these would be prostrate.

That erect form may be a result of this clover having already adapted to grasses. This varient of *T. gracilentum* took a form that is almost completely prostrate when it first colonized in 2005, yet it too grows erect in this same location today.

February 2015 – *T. ciliolatum v. ciliolatum* displacing *Acmispon parviflorus* and *Trifolium microdon*

As to the questionable *T. ciliolatum*, given how strain-specific the relationship between clovers and their rhizobial symbiotes is, I checked if it was forming nodules (inset) and then started confining it to the hilltop. I eventually took out this patch out of simple fear.



I had wondered whether returning fabaceae would find their bacterial symbiotes still alive and well distributed in the soil here. So I did a survey, the results of which were mixed. The lupines all nodulated well, as did all of our small lotus species, all of which I had long suspected had survived in our seed bank. Nor are they as picky as the clovers about the *Bradyrhizobium* they require for nodulation. New exotic clovers showed no bacterial nodules on the roots. Long established exotics did, even though they were introduced long before people learned about the importance of finding the correct strain of *Rhizobium trifolii* for each particular clover. Not all returning native clovers formed nodules well. We know that *R. trifolii* is capable of genetic transformation, modifying itself by incorporating loose DNA. It is my guess that it adapts to plants over a period of time by horizontal gene transfer abetted by repeated shearing and incubation in ungulate rumen and is distributed by slobbering animals trampling in mud.

So given the confusion about *T. ciliolatum v. ciliolatum* versis *T.c.v discolor*, I waited and was rewarded with a surprise! *Trifolium ciliolatum v. ciliolatum* appeared to be forming a near monoculture on the left (what otherwise might be regarded as “weedy” behavior), but the right half of the split image is the same spot only seven weeks later, now fully occupied by a native annual lotus *(Acmispon americanus)*!!! Apparently, the clover just disintegrates once it’s done. So is this temporary “monoculture” a way of sharing spaces?

What it is not is “unusual”… here. Spanish lotus *(Acmispon “americanus”* - go figure) does the same thing by itself. It grows completely prostrate and dense and stays that way until it encounters the grass and starts to climb into this *(Stipa pulchra)* purple needle grass.

Accordingly, in this purple needle grass, these lotuses nearly all grow completely vertical. Eventually, they will form a moisture-retaining understory blanket up to 18 inches thick! This condition augments the growth of needle grass as well, here sometimes five feet tall.

Yet just down the slope from the above grass patch, all of the lotuses grow erect out in the open, with minimal influence from grasses!

Yet only one year before , most of the lotuses in the same patch were prostrate, even between grass clumps.

These two lotuses were less than 12” apart. The pattern of this behavior looks to me like more than a phenotypical adaptation. Yet it could just as easily be a response to communication of fungally-transmitted hormonal signals in soil as an epigenetic response to shade.

Burn it, and the process restarts. When I burn (this is the edge of the burn to the right), the forbs go prostrate again, remaining so even between the grasses on the left. Yet if the process continues, they'll grow erect in places where they would otherwise grow prostrate. Fungal signal? Heat does something to the seed? Hormones in the soil? Epigenetic adaptation? It would be very interesting to gather seed from these various forms and conditions to examine the seed coats for thickness and assay them for abscisic acid concentrations, thus indicating differential propensities for sustaining extended dormancy between the erect and prostrate forms.

In each instance of disturbance, because of the site history and the loss of a native seed bank, one confronts the rate of returning colonization on a spatial basis over time as augmented by disturbance. This burn spot had *T. microcephalum* working its way down the hill from the flat above toward a large patch of *T. wildenovii* on the slope below. After the burn, the *T. microcephalum* came up prostrate at the edges while the *T. wildenovii* appeared in the middle of where the burn pile had been.

On year two in that same spot, the *T. microcephalum* became more erect as it collided with grasses and itself. There is very little mixing of the two species so far, unlike what I see elsewhere. We'll see what happens.

This *T. microcephalum* established this matted colony on the opposite side of a dirt road from the matted *T. ciliolatum v. ciliolatum*. Would that mean the prostrate *T. ciliolatum v. ciliolatum* is actually acting normally? Then why doesn't *T. ciliolatum v. discolor* do that? Maybe it will? What's normal? Nobody knows. There is no other place in all of Western North America where clovers can invade an open niche without weeds and be observed in detail as they colonize the property and compete… or not . This is new territory.

So this “weedy” behavior in clovers may not be as unique as we thought. This borderline monoculture is also *T. microcephalum*.

But *T. microdon* can become decumbent to upright and rangy when growing in other vegetation, especially in a wet year.

One wonders if *'make a blanket and smother'* is a competitive strategy among trailing legumes. Here we see this behavior in American vetch *(Vicia americana)*, growing just across our property line under some eucalyptus. It's here because I keep the bedstraw out of it.

May 2016

Here is hillside wild pea *(Lathyrus vestitus)* smothering this fully grown hazelnut bush. In this area, it's made a blanket about two feet thick. Given the way other legumes seem to go prostrate after a fire, perhaps this behavior would be suppressed by regular burning?

The Other Way Around

May 2005 – The temporary piping was to germinate and establish the grass before winter rains.

In the case of grass-before-forbs, most instances here were fairly standard revegetation projects to stabilize newly graded soil. Here, California brome *(Bromus carinatus)* was seeded on a newly graded road.

May 2005 – *Deschampsia elongata* after a rain presents this swirling beauty, most captivating

Sometimes seeding projects worked great, for a year or two. This one did not. Although at 22,000 seeds per pound, this *Deschampsia elongata* was inexpensive and established beautifully, it did not reseed efficiently and looked so much like exotic 'rat tail fescue' *(Vulpia myuros)* that it was overwhelmed by the exotic within two years. 'One of those things you learn along the way.'

Here I had installed plugs, mulching the rest of the hilltop which I regarded as too contaminated to bother with revegetation until the weeds were under more control. More on this type of work is in the chapter Plugging Along. In short, 'grasses before forbs' DID NOT WORK in cases where I forced it, simply because I still had to remove weeds between and sometimes within grass bunches for years until the native forbs could move in. I won eventually, but events proved that this was a slow and costly way to win. Yet even then, if and when the grass bunch dies, guess what happens? I get to remove the entire onion of weeds all over where that grass bunch had suppressed them. In short, it was better to clean out the weed bank, allow the forbs to colonize, and then think about grasses.

Surprisingly (given what we have seen since), the clovers and lotuses invaded this pre-existing grassland and assumed a prostrate form that they no longer exhibit.

This was the usual appearance of our grasslands for a few years. In fact, I came to expect it. Frankly, it was preferable in a way because it was easier to detect and remove weeds from among prostrate forbs. But as the grasses became denser, the forbs began to stand.

It didn't stay that way. As the grasses continued to intensify, they forced out the forbs and started going senescent (getting old and crappy). Mowing helped remove thatch, but it was not enough. Competition was doing them in. As is discussed later on, the greener area at the top of the hill inside the flags is due to blood meal added the prior year as part of an experiment . As part of the same experiment I had burned a stripe of it (just over the crest of this photo) to see if things would improve. The burn thinned the grasses and things took off. Four years later, it still looks better than most of this, but realize that the hilltop had once been flat for an evacuation landing spot for a helicopter . I humped the soil again to make it drain properly. The result is that the center of the hilltop has deeper soil.

Yet as the *Trifolium ciliolatum v. ciliolatum* moved in, I am starting to see forbs take over grasses. I suspect the drought of the last two years took its toll on the grasses when faced with stiffer competition from both the clovers and this *Verbena lasiostachys*, a perennial sub-shrub that tends to succeed the grasses. The verbena dies back with freezing in the winter, leaving lots of organic root mass to make beautiful soil for forbs; then it bolts out to cover them as they die off for the year. I keep the verbena numbers down because they are so full of bees that they make weeding a challenge for a person with an allergy to the stings but these plants may play an important role in sustaining multiple stages of succession on a site as well as soil formation. We do have a lot to learn.

Illegal Natives

May 2012

In 2012, we had a new entrant to the property, *Deschampsia caespitosa,* or “tufted hairgrass.” This is considered to be a coastal species, supposedly requiring fog and marine temperatures. All the experts told me it would not survive here. I wasn’t so sure. So, what did I do?

I grew out some plugs and planted them in late the next February in the midst of a drought year in the most hostile place we have**:** the middle of a burn patch on that hot, dry, sandy hilltop. There was black charcoal all around them absorbing heat. There was no mulch. The only rain they got to get them established was 3.1 inches over the next two months. Then came the drought of 2013-14. Between May 1 to November 1, 2013, they received 0.6” of rain. Yet by May 2014, it was quite clear they had survived (above).

July 2015 – The dormant bunch grass is *Deschampsia caespitosa*

By the next year, they had bred scions successfully.

Note how much bigger the tufted hairgrass became where the forbs established around them than where they are less so (circles). Given the paltry evidence of leghemoglobin in legume nodules here, I doubt the difference is due to nitrates. I suspect the forbs retain soil moisture on a warm day. One must slide one's hand beneath them to appreciate the effect.

April 2016 – *Deschampsia caespitosa*

Now fully established, this “coastal” *Deschampsia* is doing great. Yet this is not the only instance in which we have plants supposedly growing ‘out of place.’ The point is that this system was so destroyed, and the fungal communities in the soil were so wrecked, we don’t know what “belongs” where. This grass might have been displaced by oats by the early 19th Century.

April 2004

Another plant breaking the botanical rules is this diminutive member of the everlasting family, **“**slender wooly heads” *(Psilocarphus tenellus)*. The experts will tell you that this plant is characteristic of mud puddles and vernal pools. Yet where it first appeared here was that same hot, dry, sandy, ridge hilltop. We see it here on solid rock in full sun. It does like moss though.

Instead of a vernal pool, here are slender wooly heads, spreading without competition, slowly working their way up another ridge some of almost bare rock 300 yards away (the same slope as the first slide in this chapter). The reason it is not seen in places like this elsewhere is that it is uncompetitive against weeds because it does not germinate until late February to early March. This area had been treated with a pre-emergence herbicide that killed off its exotic competition. More on that in a later chapter.

This tiny plant makes a small reflective mat on the surface. One wonders if the difference in infrared emissivity between dry *Psilocarphus* and bare soil helps reduce oxidation rate of soil organic matter and retain moisture for the brome grasses it is currently invading elsewhere. It comes up late enough in the season that it is unlikely to suppress germination of legumes.

April 2015 – Yes, those are bryophytes here on this rocky slope with very thin soil.

The point of discussing these “rule breakers” is to show how ignorant we are of how this system works. That slender wooly heads are an annual member of the everlasting tribe suggests that they might possibly recycle nitrates from deeper in the soil back to the surface. It could be important to the function of this system, but we simply do not know. It would be great to do simple soil samples in and around these little nitrate hogs, but the good news there is that we have easier examples with which to refine the test method.

Pink cudweed *(Pseudognaphalium ramossissimum)* can grow to five feet tall. It competes not only by snarfing nitrates but by simple physical dominance. In this case, it is visually evident that this plant augments the germination and development of other plants in its patch of rapidly decomposing mulch, putting that nitrate back into the soil at the surface. The hypothesis should be easy to test quantitatively comparing nitrate levels in and around one of these plants through a multi-year cycle with areas lacking them.

So I burn brush piles to maintain diversity. The process starts anew with lotus and clover. More on that in a bit.

Negative Impressions

It is hard to be certain, but sometimes it appears that clovers suppress germination among each other from year to year due to residual auxins left in the soil, thus possibly allowing other species in the cohort to express themselves in turn (which would explain a lot). I have seen patterns of germination that almost looked like a photographic negative from the prior year, both in instances of disturbance (because I had killed a patch with a burn pile) and without. Unfortunately, planning to document that photographically is very difficult because it is unusual to have two good successive years for clover germination. Maybe some day. At least now I know what to look for.

Early Pioneers

May 2010

Among the fabaceae, when lotuses and clovers first colonized a "sterilized" area, they were often huge. This *Acmispon brachycarpus (*was *Lotus humistratus)* is well over a foot across. In the second generation, the seedlings thereabout germinated in large numbers but developed as much smaller plants, at most 4” across with a half-dozen flowers or so (inset). I speculate that the seed of pioneer plants have thinner coats with which to establish many scions to control the spot and also either more plastic or genetically variable. Once established, the strategy becomes to hold the spot; so the same hormonal signals that make them smaller (Ludlow 2008) would have them producing seeds with thicker coats more capable of extended dormancy by reducing the leaching rate of abscisic acid.

Clovers do the same thing. This *T. wildenovii*, is well over two feet across where usually they grow erect as a single stem 6-8” tall.

It's Only the Beginning

July 2015

New plants just keep showing up over time. This is either a new entrant for 2015**:** *Lupinus bicolor v. microphyllus,* or it came up in the mud when I drilled a hole for a fence post, which would make it a **real** "post-disturbance" plant! (Sorry, well, no I'm not). We have gobs of the usual herbaceous *L. bicolor* here, but this critter is a small woody shrub over two feet across. Interestingly, while I normally tend toward being a "lumper" simply because too many biologists get all hot and bothered about differences in physical attributes as denoting separate species, our new colonizer may *function* here as a separate species from the more common flavor simply because *L. bicolor* is usually done flowering in April while this one clearly did not flower until early July. They cannot cross breed successfully here, a difference I have also seen between *Torilis arvensis* and *T. arvensis v. purpurea,* here. This idea that what separates one species from another may vary on a spatial basis because of differences in habitat may have global implications, where they might cross breed successfully in one place but not another, placing yet another demand upon determining what constitutes specificity.

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