2012: Consolidation & Diversification

2012 Goals

After a year full of very hard work establishing the system, it was time to begin to allowing nature to do the work for us. At first, the title of this section may seem a bit contradictory. How can you, at the same time, consolidate *and* diversify?

By consolidate, I mean to hold on to the gains that we made in the first year and reinforce them while concurrently reducing the amount of time and energy we would invest. The age old method of cover cropping: hardy, multi functional species improving the soil and occupying the majority of the niches available would prove to be a valuable tool in this effort. I wanted to use the second year to increase biomass production on site and replenish the soil's nitrogen. Expanding comfrey to widen our nutrient net was also a high priority (and is ever so easy to accomplish).

Diversification would be mostly geared towards incorporating more natives into the garden. We focused on native perennial nitrogen fixers and specialist insectary species to continue improving the quantity and quality of niches available in the garden. Very often native species provide more ecosystem services than introduced species.

Diversification would also be promoted through the use of a combined endo and ectomycorrhizal inoculant in hopes that our existing trees would receive some additional benefits from new species of fungi. Lastly, with the worm compost (vermicomposting) working quite well, regular soil drenches of aerated compost tea would boost soil life. Taken together, our efforts to diversify the structure and species composition of the garden would work hand in hand with our goal of consolidating the benefits that came with extreme site remediation in 2011.

While I was interested in assisting some plants to grow some food for us, I was mostly focused on giving back to the system and racing against the closure of the canopy. Observation was the name of the game in the second year with only a few tweaks around the edges to further optimize

Photograph 3-1 Sunflower seed head serving as an overwintering site for insects and a visual reminder of the need to replenish the soil's nitrogen, accomplished with inoculated common vetch. January 10th, 2012

water harvesting or species composition in mind. Of course, by doing all of these things, we were accelerating the speed at which the canopy would close!

The only place we would really focus on expanding the garden to was the north side of the larger pond- the greater portion of the southern facing berm with its excellent aspect and microclimate created by proximity to the pond. I started collecting sheet mulch material in later winter for this.

Perhaps the most important reason to consolidate and diversify was that I was set to emigrate to Finland in the summer of 2012 and I wanted to make sure that I was doing everything possible to transfer the garden over to the family in a state that would be much easier to maintain.

Photograph 3-2 Cover crop of common vetch and winter leaf vegetables continues to exhibit strong growth through the middle of winter. January 10th, 2012

Soil Development & Cover Cropping

Soil Sample Results

Continuing to emphasize healthy soil, we sent soil samples at the end of 2011 (12/12/2011) to the state lab in order to gauge the after effects of the site preparation techniques I had implemented. The report was completed on January 18th, 2012.

I have reproduced 2010's Soil Sample Results on the opposite page underneath this years results to make comparisons easier. You will note that the names of the Soil IDs have changed, but I have kept the colors to match the general area. The names changed simply because with the amount of site preparation and one year of gardening, those same soil zones have had entirely new patterns imposed on them. We can still compare the results as they have changed quite dramatically. I'll start by examining the southernmost and highest guild on the property and move north and down through the garden.

The green guild had no direct comparison since we did not take samples from this area in 2010. It is interesting to note that because we did not grow any "fruits" or other demanding vegetables here, that the phosphorus index is the highest of all the samples, with the exception of the small garlic beds which had high quality topsoil added to them from the raised bed. Therefore that sample is an outlier. The pH has been raised to a little higher than optimal, but still within a good "garden soil" pH range. Of course, the pH of the soil has only been increased in the top 10-12" of soil (about 25cm). Below that first shovel scoop, the soil had simply been decompacted. Still, the green guild's cation exchange (CEC) and humic matter percentage (HMA) are double any result from 2010 (besides the raised bed, which is again, soil that had been imported). It is very encouraging that in the short span of 10 months, the soil's ability to capture and store nutrients and water has been greatly increased.

The nightshade guild's results are also quite positive: CEC & HMA have been dramatically improved as well, with the pH sitting inside an optimal garden soil range and phosphorus levels (according to the index) increasing by 6x! This in direct comparison to the "Willow" and "Oak" samples from 2010. Calcium and potassium are also in a better position, while magnesium has stayed roughly the same and manganese and sulfur have slightly declined. Magnesium levels are, according to the literature available for interpreting these results, below optimum. Whether we should specifically address this is going to be up for discussion when we get results back from 2014's soil tests. Rather than target one or two specific nutrients, I will probably continue to recommend building soil through diverse organic matter inputs. We should pay close attention to whether or not the plants exhibit signs of deficiency.

Next, the four sisters guild results show that, once again, that the addition of leaf mould compost (with an organic soil conditioner mixed in) protected by wood chip mulch has already made an impact on the top layer of our soil (see the CEC and HMA results). PH is well balanced, phosphorus levels are much better (remember that they were almost non existent!), and the other nutrients have also increased, but not by too much. Slow and steady.

The results from where some Garlic had been growing from 2010-2011 demonstrate very good results in line with the changes seen elsewhere. The Bramble Soil ID corresponds with the area behind the fence where we transplanted raspberry crowns and amended the soil. The results are encouraging here as well, but since this lies in our permaculture Zone 4 and 5 edge, we will not be spending much time addressing soil here for a while.

Overall, I was very pleased with these results with particular attention being paid to how well the soil had responded to the addition of organic matter on top of the soil. Of course, there were plenty of roots digging deep (deliberately inoculated by mycorrhizal fungi to boot) into the decompacted and amended beds as well. Remember, that samples are taken with the mulch and visible compost layers removed to get at the mineral soil, rather than testing the amendments. These results run contrary to the commonly held belief that organic matter needs to be tilled into the soil itself. In just ten months, feeding from above can make verifiable changes in soil organic matter.

It was decided that we would wait two years before exercising our right to free (tax subsidized) soil testing because we were not going to be making very great changes to the system in 2012 or 2013. Better to give the soil some time to respond to the coming cover cropping, chop & drop, and mulching regimes. I am eager to see how the soil's pH has changed and whether or not we will be seeing any discernible changes in macro or micro nutrient levels through these additions. The only additional fertilizer would be sparingly used with certain vegetables or transplants and as always, these would remain organic or mineral in nature so that we would feed slowly from above.

2011 Soil Sample Results

Soil ID	Bramble	Four Sisters	Blueberry Mounds	Garlic	Green Guild	Nightshade Guild
Soil Class	Min	Min	Min	Min	Min	Min
HMA Result	0.51	.56	0.76	0.71	0.6	0.66
W/V Result	0.91	1	0.94	1.01	1.08	0.99
Cation Exchange	9	9.9	9.4	9.7	7.7	10.3
Base Saturation	96	97	89	93	100	96
AC	0.4	0.3	1	0.7	0	0.4
pH	6.1	6.5	5.9	6.4	6.8	6.6
P	20	33	38	46	40	29
K	111	111	166	131	84	99
Ca%	78	77	60	67	80	75
Mg%	11	14	20	20	15	17
Mn	226	219	193	345	182	210
Zn	89	124	177	171	109	156
Zn Available	89	124	177	171	109	156
Cu	57	77	70	61	65	121
S	108	57	65	30	49	40

Table 3-1 2011 Soil Sample Results. Note: In order to test the mineral layer of the soil, any pure organic matter on the top (the O horizon) is removed.

2010 Soil Sample Results

Soil ID	Behind Fence	Low Lying Area	Raised Bed	Berm	Willow Oak	Willow
Soil Class	Min	Min	Min	Min	Min	Min
HMA Result	0.13	0.18	0.36	0.32	0.09	0.18
W/V Result	0.94	1.11	1.12	1.18	1.05	1.06
Cation Exchange	3.1	3.7	8.8	4.5	3.6	4.5
Base Saturation	68	73	94	78	56	76
AC	1	1	0.5	1	1.6	1.1
pH	5.3	5.6	6.7	5.9	4.9	5.6
P	1	10	47	41	6	5
K	50	49	111	58	61	37
Ca%	40	51	67	52	34	56
Mg%	20	15	21	20	14	16
Mn	516	320	199	252	436	295
Zn	34	82	153	103	36	81
Zn Available	34	82	153	103	36	81
Cu	50	50	30	43	33	79
S	105	42	23	38	113	42

Table 3-2 2010 Soil Sample Results reproduced with widened columns to visually match with those from 2011.

Winter Cover Cropping

The winter of 2011-2012 was exceptionally mild and our cover crops were able to grow throughout the entire period and even flower as early as the first week of February! Since our chosen cover crop species were well established by the new year, the first few months of 2012 were really as simple as "watching plants grow."

Care was taken to observe the garden each day and keep an extensive photographic record of different patches for future comparison. Fish were active in the ice-free ponds throughout the winter and frogs were even observed on the move during this period. I was continually amazed by the amount of activity in the garden during the winter months. Even our cold hardy winter food crops continued to grow and thrive, when usually without some protection they would go dormant at some point. By rolling with the season and attempting to extend the collection and utilization of solar energy through photosynthesis, we were able to create a haven for local wildlife that typical gardening styles would leave to their own devices.

Photograph 3-3 clearly demonstrates, once again, the disparity between conventional landscape management and one oriented by permaculture principles. The neighbor's lawn is largely dormant and almost one dimensional. Even just the small sections of garden visible on our side of the fence, in contrast, exhibit species diversity, ground cover diversity, ground water recharge through passive rainwater harvesting, structural diversity through the trees, bamboo stakes, and remains of sunflowers that are available for use by all sorts of creatures. It is a truly different environmental situation.

Not only is our soil being actively protected by living ground covers and leaf litter, but we have winter crops growing as well. Self-sown lettuce and mustards along with daikon radish and wild crops such as dandelions, chickweed, and henbit are thriving in these conditions. While small, their great number allows for periodic harvest without inhibiting the plants ability to gather and store energy. Permaculture based gardens are dynamic and multi functional, which is difficult for many people to understand.

Lengthening days at the end of January provided the plants with just enough energy to begin moving towards reproduction (*Photograph 3-5 opposite*). While not visible yet, the cabbages (bright yellow) were well on their way towards flowering. Abundant standing stalks from the year prior along with diverse mulch materials act like insect hotels without the fuss of constructing them. Where you see orange, this is evidence of my collection of pine needles to use as mulch on the pathways. One can also observe, center left, the soil enriching qualities of comfrey by the dark, nearly black, layer of leaves that has begun to form around one growing on the second swale's mound.

Seen from above (*Photograph 3-6*), the garden appears well organized, even without enough pine needles to mulch all of the pathways. The house, situated up slope from the garden, combines with the low angle of the winter sun to cast deep shade throughout the majority of the garden. Only the river birch (white tree, center left) and its environs escape most of the shadow's march. While this is not so much of an issue mid winter, it does become a problem in early spring when plants are flowering: the rapid shift in temperature can be enough to cause bud drop! It is important to track the movement of deep shade cast by buildings or other features and plan accordingly (that is, don't plant something borderline for your zone in a place where it will be hit by sudden changes in temperature!).

Photograph 3-3 Upper swale nourishing lush winter growth in comparison to the mostly dormant lawn behind. January 11th, 2012

Photograph 3-4 Self sown lettuce in the old green guild adjacent to the upper swale. January 10th, 2012

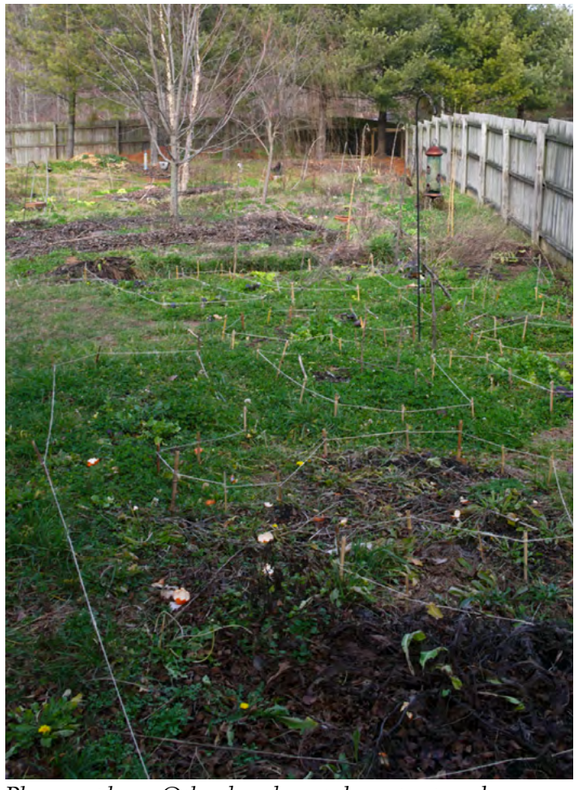
Photograph 3-5 Full lower pond and accelerating growth in the cover crop. January 25th, 2012.

Photograph 3-6 View from upstairs window depicting the severity of shade. January 25th, 2012

Photograph 3-7 Kale on southern facing mound under pines with rough mulch, sorrel, and a stone for neighbors. January 10th, 2012

Photograph 3-8 Bamboo stakes left for spiders and other insects to use over the winter in lieu of actual shrubs in the old nightshade guild. January 10th, 2012

2012: CONSOLIDATION & DIVERSIFICATION



Photograph 3-9 Other bamboo stakes repurposed to outline pathways in the old green guild. Note leaf deposit of comfrey bottom. January 25th, 2012

Photograph 3-10 Red maple in the early stages of healing. Compare with Photograph 2-6 from one year ago. January 25th, 2012

When February came around, temperatures warmed up enough that I could complete the mini hugel mounds underneath the pine trees. I had to move a huge pile of clay that had been dumped in one spot when my brother and his friends dug out part of the pond while I was away in the summer. Once that was out of the way, I could finally get around to digging out the rest of the pond at my own pace. Not only did I have time to finalize these earthworks, but the wildlife in the garden was beginning to stir as if spring was already upon us.

At the end of February, we had our only snow of the season which mostly melted away by midday. The following two pages demonstrate the effects of microclimates are readily apparent: snow melt follows deep shade (you can clearly see where the fence line was) and southern aspects (the left/southern side of the swale mounds have melted completely while the right/north still have snow). Both of these facts are on display in the final image.

Photograph 3-11 Cabbage flowering in the middle of winter. February 6th, 2012

Photograph 3-12 Three bronze frogs hanging out by the lower/large pond. February 6th, 2012

Photograph 3-13 Mature goldfish feeding at the surface of the upper/small pond. February 17th, 2012

Photograph 3-14 Mini hugel mounds under pines finally finished with soil from lower pond excavation. South sides mulched. February 6th, 2012

Photograph 3-15 Upper swale filled with snow melt. Notice the straight line of snow that follows the fence's shadow and how the snow's integrity holds as you get closer to the fence. February 20th, 2012

Photograph 3-16 As the lower swale fills with snow melt, just how much even small changes in aspect affect microclimate becomes evident with the right side of the mound, north, still holding onto some snow. February 20th, 2012

Photograph 3-17 The combined effect of a location's aspect and shade is obvious here. The berm's southern aspect is completely snow free, while the mound in the shade of the pines still retain snow. February 20th, 2012

Water Harvesting and Feature Upgrades

Water features- ponds, swales, etc. are all systems that will be continually adjusted and played around with as long as you live with them, especially on this scale. Our property is just large enough to accommodate many different kinds of earthworks and water features. Observing the interactions between the terrestrial growing beds and our aquatic ones is a joy. Even though the ponds are not well established yet: we could use many more plants along the edges and within them, they still provide us with many different benefits. *Photographs 3-18 & 3-19* reveal how seamlessly these features blend into the landscape: subtle, yet beneficial.

Winter in North Carolina can be a good time to do some digging: temperatures are comfortable for long periods of manual labor. It is also a season when precipitation is greater than evaporation: therefore, any earthworks done during this period will infiltrate more water than during the summer months. We do not experience any larger quantities of precipitation in the winter here, but we want to capture as much water as possible. Additionally, since the cover crops were taking care of themselves, I could go ahead and fix some errors.

Towards the middle of February I was able to bring the lower pond to a holding stage. I was very excited about this because up until then we hadn't had any fish in there due it lacking the fish kettle and number of steps I thought would make for a good start. I took the time to manually remove a lot of water from the pond (and put it in the swales) to draw the water level down so I could work. Excavating a small pond is similar to a strip mine: you dig each successive layer lower while allowing space to steer the wheelbarrow down each step via ramps. In this way, you create a nice stepped pond which allows for diverse plantings (that each require a different water level) as well as providing shallow

Photograph 3-18 Upper/small pond (left) and its birch tree's environs. January 25th, 2012

Photograph 3-19 The lower/large pond designed to be wider and deeper to the east and thin and shallow to the west where water exits for strength. January 25th, 2012

and deep portions for aquatic life. I eventually dug down about 8 feet deep to create a "fish kettle" in case the goldfish would need to escape a real winter.

I intentionally left the area to the west, where the pond overflows, shallow and narrow (as well as being the start of the ramp for the wheelbarrow) to compensate for not putting in any kind of "key" for the "dam." Since the overall quantity of water being stored here is actually quite small, I did not feel that going through the work to "key" the downhill side of the pond would be necessary. Still, better to leave a very large wedge of soil between the "wall" (water exit site in this case, where there wouldn't be any wall) and the deeper sections of the pond. As I write, the pond has been completed for two and a half years and we haven't experienced any problems. The pond has overflowed its bounds on numerous occasions and remained intact. Keep in mind that in addition to the pond being dug into soil rather than being backed up with a wall that the soil is severely compacted from the construction of the house, so there are many factors in play here that help keep these ponds from becoming disasters. Lastly, it would probably be more accurate to describe them as pools rather than ponds!

I used some of the extra clay from the pond excavation to put elbows on both swales. Previously, whenever the swales would fill, they would overflow around either end. Not only that, but their maximum fill level was much lower because of this situation. By adding an elbow of soil (clay) to the eastern end, I could back more water up in the swales and direct the overflow in a single direction. In the case of the upper swale, this would direct water west, which also happens to be a small ridge. In this way, I am taking excess water from the valley end (east) and watering the drier ridge. The second swale, because it was dug off-contour, however, still had a problem of water accumulating in the center. I would have to amend this later.

Photograph 3-20 Winter crop of cabbage with the larger pond in its final excavation period. February 16th, 2012

Photograph 3-21 Adding an "elbow" to the upper swale. February 16th, 2012

Photograph 3-22 Swale "elbows" visible as exposed red clay along the fence (left/east). February 16th, 2012

In *Photograph 3-22* you can see how the garden slopes towards the bottom left corner of the image into the "valley" where the ponds are situated. It is clear that the area near the house and dog fence is much higher than where the second swale abuts the fence. In keeping with the permaculture mantra of storing water as high in the landscape for as long as possible (and the keyline principle of watering ridges from valleys), by blocking the lower edge of the swales with elbows, I was keeping water in the system for longer. A lot more work remains towards the center of the garden so that we can move water along the longest edge possible (another permaculture water principle). If water is allowed to flow along the fence line, it is shunted out of the system much faster and we do not receive as much benefit from it.

How did this work out in practice? Well, just four days later, we had our first snow. It did not stick around very long (*Photographs 3-15 - 3-17 p. 74-75*) so we had to wait a few more days before a swale filling rain event would come our way.

The upper swale fills more regularly than the bottom due to its smaller size as well as being the first catchment we have, arresting water before it can get to the second. Growth along it has been strong since implementation and I have considered digging it even deeper. This may happen the next time I travel back and prepare a site for a persimmon tree. Still, it works as intended. Bamboo stakes on the mound (left of water) mark where new comfrey cuttings were planted a few weeks prior. Now the entire length of both swales have been planted with comfrey to close gaps in our nutrient nets.

The second swale also filled on the same day and it became quite clear that I would need to do something to rectify its propensity to overflow in the center. I knew that something had to be done when it overflowed the previous summer and helped wreck the four sisters guild as it made its way through the loose soil and into the lower pond. Luckily, this particular rain had stopped just short of that critical point.

The blocking of the fence-side overflow meant that, finally, given enough rain, the swale would fill along its entire length. Looking at the bottom left, you can see how it appears there is less water than center (and the swale continues in a curve all the way to the fence). This is before I remediated the swale using steps (*Figure 2-8, p. 34*), so the western edge of the swale does not receive as much benefit. This is because as captured water

Photograph 3-23 Upper swale nearly brim full, about to overflow towards bottom of photograph. February 24th, 2012

Photograph 3-24 Lower swale filled to the brim. February 24th, 2012

infiltrates into the ground, the water level drops and the remaining water concentrates towards the center and east from the western edge. Still, putting the elbow on the end has enabled more water than before to enter all sections of the garden adjacent to the swale.

To ensure that the swale no longer breaches the berm, I installed a "monk-like" device at the east end. *Photograph 3-25* (next page) shows the location of the "monk," while *Figure 2-8* (p. 34) depicts its inclusion as well. Essentially, the idea (a monk is just another word for overflow pipe) is adopted from Sepp Holzer's method of controlling the water level in his ponds. An adjustable pipe is situated with the mouth controlling the highest level desired. When water reaches this mouth, it enters the pipe and is sent to another water harvesting feature. In this case, the short pipe elbows through the swale mound and down to the upper pond. This is a failsafe measure and only in the most extreme weather events does it do this. I would like to adjust this in the future to be a little lower so that we can have an overflow on the ridge as discussed earlier.

When it comes to the swales, it really becomes quite clear why designers like Ben Falk and Geoff Lawton are so adamant about their inclusion in spaces like this- and why they are always seeking to increase the number of them on a property. To actually watch earthworks you dug catch, hold, and infiltrate water throughout the entire year is positively reinforcing. When considered in conjunction with a deepening topsoil and the root/fungal networks developing there, I can appreciate how it can, as Geoff Lawton says, take up to 7 years before a landscape is rehydrated. We were only starting the second year of swales and already the landscape was responding. I look forward to seeing the garden in 2017!

Photograph 3-25 also shows quite well how the garden is responding to our treatment and cover crop: quite lush and flowers of many species creating ideal conditions for prolonged ecological activity. Again, notice how swale is well and level until the middle section, before it climbs uphill. Making the mistake, however, has been the best teaching tool regarding earthworks because I've developed new ideas as to how to compensate and turn them into a potential solution. My eyes have been opened to the potential benefits of using ditches and swales in conjunction, which greatly increases the possibilities of structural diversity when it comes to water harvesting.

Photograph 3-25 Eastern end of the second swale before "monk" installation. March 2nd, 2012

Figure 3-1 depicts the changes made during the course of spring and early summer of 2012. The addition of elbows to the swales has rerouted surface runoff. This has worked well for the first swale, although still not ideal as the overflow is not purposefully directed anywhere (although the second swale can capture some of it since it extends further west than the first swale).

As just discussed, the addition of the monk (greatly exaggerated in size here [pink "Overflow Pipe"]) has stopped the water from overflowing in the center of the second swale. But it has also prevented the water from overflowing in the center of the garden (to the ridge)- so this is something I would like to address in the coming years.

Comfrey has been divided and planted densely along the length of both swales, consolidating the nutrient net (see Site Preparation Conclusions p. 27-29). These new cuttings need a good year before being actively harvested.

Lastly, I have chosen to depict the addition of Zai Bowls before they were dug in early summer. Zai bowls, mulched with wood chip, will capture and infiltrate water before it reaches the second swale. These bowls, each at least 20 gallons (75 liters) in capacity, are connected to one another through small overflow depressions. They are filled with wood chip mulch, which makes it easy to walk along the fence line without risking breaking a leg! The wood chip also will become saturated and thus become a feeding zone for fungi and tree roots. The mass of wood chips and the ensuing fungal network also affords another level of biological filtration between the neighbor's lawn, which is treated chemically, and the main garden area. Eventually, Zai bowls could be dug along the entire fence line. I believe they are an excellent means of harvesting water even in humid landscapes. Their only drawback, in this instance, is the need to be filled with some kind of mulch to prevent injury- ground covers grow exceptionally tall near them and so their presence can become masked to those who are unaware of their existence. Still, they allow for water to be "slowed, spread, and sunk" in places where more "traditional" earthworks would not function.

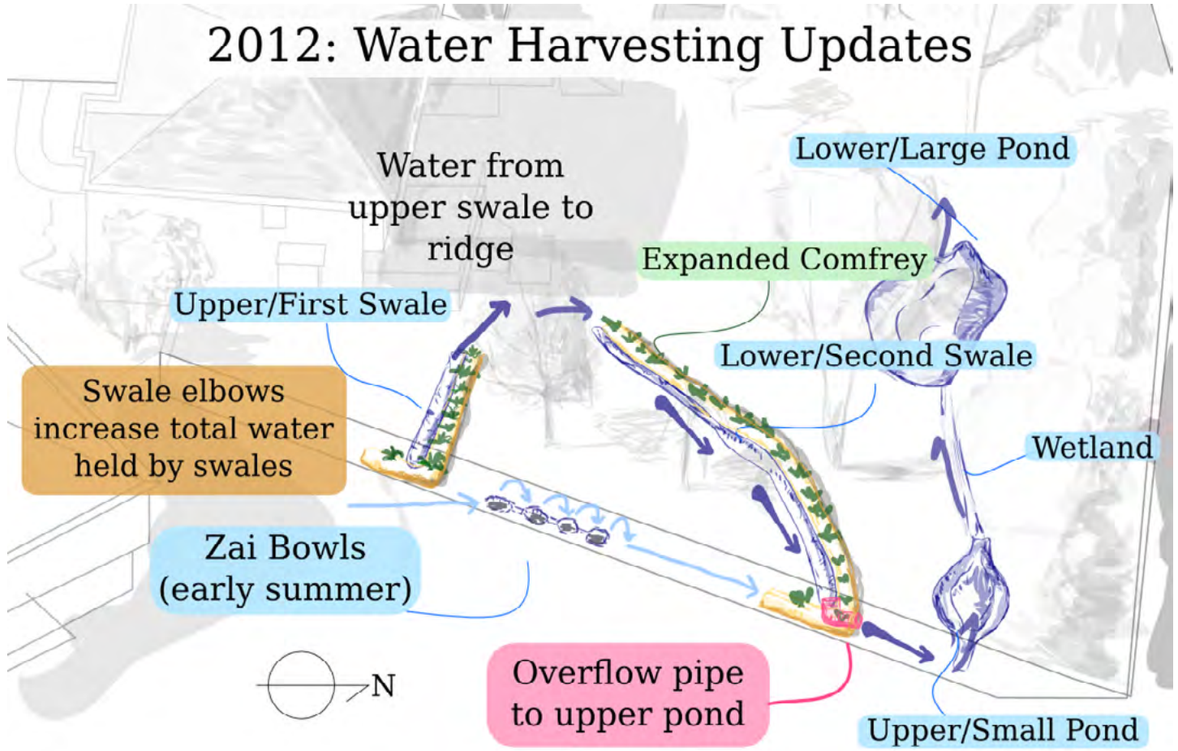


Figure 3-1 2012: Water Harvesting Updates. Notice reroute of water and addition of Zai Bowls

Photograph 3-26 Later winter cover crop of mustard, clovers, garlic, spinach, cabbage, daikon radish, vetch, and oregano. February 29th, 2012

Photograph 3-27 Late winter/early spring cover cropping as the deep shade cast by the house sweeps across the garden. March 11th, 2012

Photograph 3-28 Goldfish spawning in the upper/small pond March 15th, 2012

Spring Cover Cropping

March: Late spring

Water harvesting feature upgrades, complete by the first week of March, were installed just in time for an explosion in plant growth and general garden activity. By March 14th, total temperature variation during the day was well above normal: the lows were higher than the average high temperature. We experienced over ten days where the low temperature remained around 60F (15.5C). Growing temperature is considered to be 50F or 10C, so we were well into spring. Remember that the "last frost date" for our region is May 1st. A month and a half beforehand, the garden burst into life.

Photograph 3-27 displays quite well the strong growth our cover crops experienced through the winter, as well as the tendency of willows to break dormancy well before the natives (all the other tree branches are from native species). A couple of days later, I captured a photograph of the first bumblebee to make the rounds in the garden. Bumblebees work harder and pollinate more effectively than the introduced honey bee. They also forage at much colder temperatures. This particular worker bee is gathering nutrition from a cabbage plant.

The bees weren't the only ones enjoying the warming weather. The goldfish I introduced to the upper pond for mosquito control the year prior were spawning as well. In *Photograph3-28*, water hyacinth can also be observed breaking dormancy.

Photograph 3-29 One of the first honeybees foraging amongst cabbage blooms. March 11th, 2012

Photograph 3-30 First bumblebee of 2012. March 13th, 2012

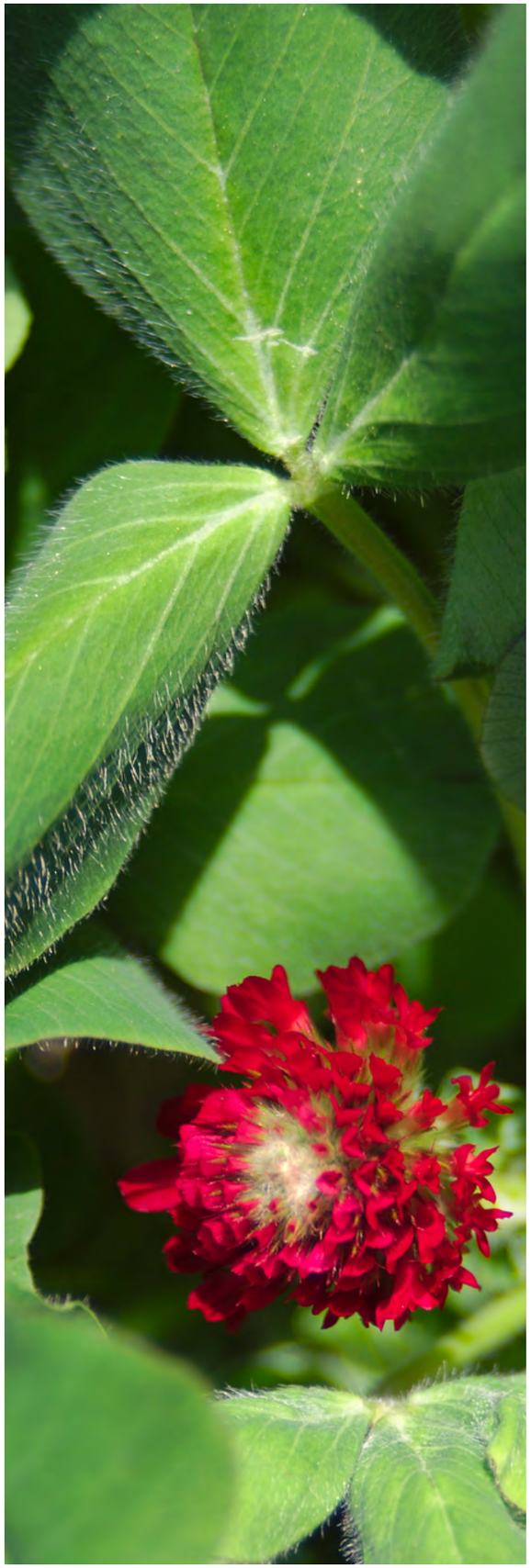
As we enter the end of the first week of the warm spell, the garden- fresh off months of good rainfall and water harvesting- began to grow much quicker. All of our brassicas (cabbage family) have entered full floral displays and the cover crops are soaking up all the solar energy that a clear canopy allows to reach ground level. This is a crucial period in a garden: these herbaceous plants that can tolerate cold weather are holding onto and putting to use any waterborne nutrient. When they are cut back and allowed to decompose/return to the soil over the coming months, these nutrients will become available to the trees and other plants which wait longer to break dormancy. I would like to find more native (and non native) early bloomers to enhance this "vernal dam."

You can also see how clearly the native trees are resisting the warm spell's charm. They have genetic knowledge that these warm periods can quickly end, and therefore, bide their time.

One of our Russian comfrey plants on the berm of the second swale, right where water pools in the center of the swale's length, was at full cutting size by the end of March- over a month before the last frost date. The key to utilizing comfrey for biomass production is to cut the plant before it begins making flowers for the first time. It is at this stage that you will get the most leaves and the plant will be conditioned to keep producing lots of leaves rather than flower stalks. Although the comfrey had proved itself extremely hardy (it never rested from putting out new leaves all winter), I wanted to make sure that they were as healthy as possible in the face of a sudden cold snap. I did not take advantage of this very crucial moment in time, however, I am happy to have captured the moment in a photograph.

Photograph 3-32 Russian comfrey (Symphytum x uplandicum Bocking 14 cultivar) at prime cutting size. March 20th, 2012

Photograph 3-31 Panorama of the back yard's exponential growth spurt. March 20th, 2012



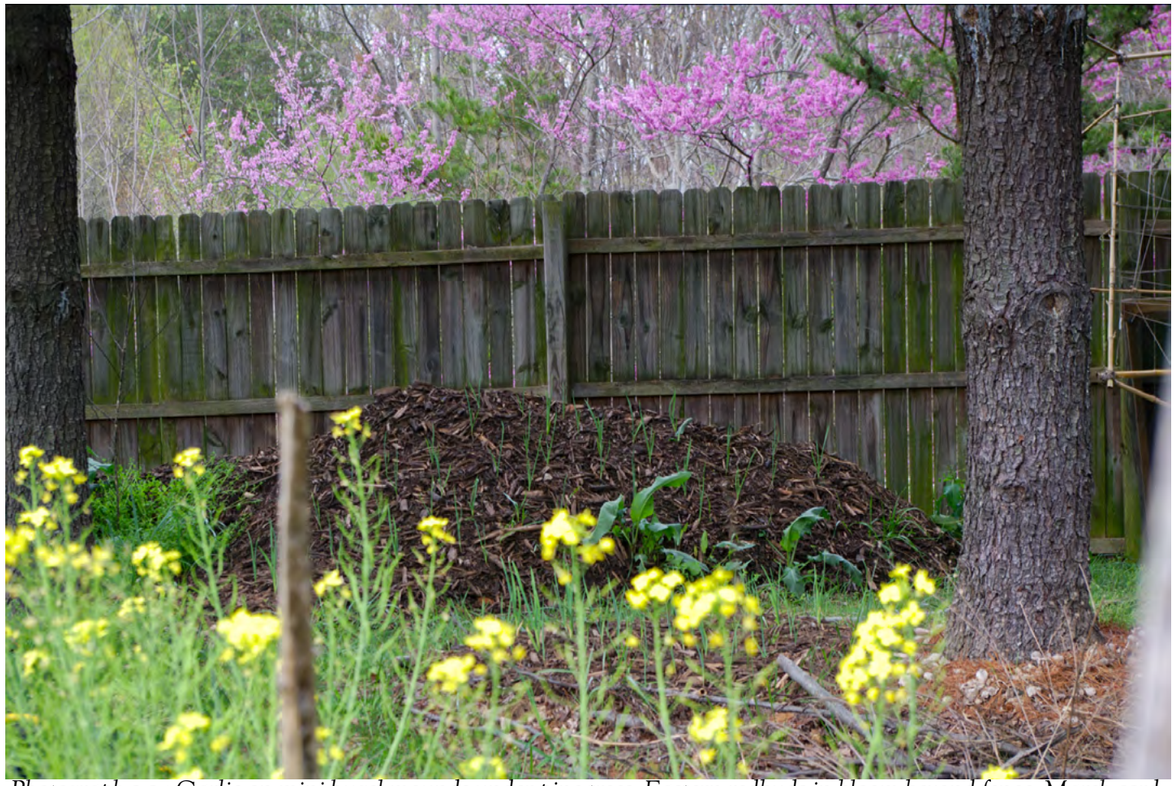
Three days later, the eastern redbuds (Cercis canadensis) planted alongside the interstate were blooming. Contrary to popular belief, they have not been observed to fix nitrogen although they belong to the legume family (Fabaceae). A cardinal, the state bird of North Carolina, can also be observed in the branches in the background (left, red). The foreground is dominated by flowers from the brassicas we planted the previous fall. Center of attention, framed by pines, are our mini hugel beds that I mulched with wood chip from the city. Planted there were dozens of garlic cloves. They grew to a very small size due to a number of factors. One of those being not enough sun: the angle of the sun does not drop low enough for these beds to get proper solar exposure during the winter. If the trees were limbed up another meter, I believe they would. However, we would lose a line of sight visual break that shields part of the highway from view. I was still happy that they survived because they could be dug up and transplanted to other locations in the garden (as well as being eaten!).

The last photograph from March, which I have annotated to become *Figure 3-2*, captures the moment of transition from winter cover crop to early spring in the garden. Fall sown winter crops are in their final stage of development: they've grown into an over story of flowering stems while perennial herbs break dormancy and other cover crops, such as common vetch and red clover just begin flowering. Stacking space and time for the longest period of blooms possible is an important part of our plan to regenerate our landscape. Nothing says that leaf crops cannot be used in this process!

Photograph 3-33 Crimson clover in bloom. April 20th, 2012

Table 3-3 Species in Figure 3-2

1.	Osaka Purple Mustard	Leaf vegetable
2.	Common Vetch	Nitrogen fixing climber
3.	Red Clover	Perennial nitrogen fixer
4.	Dead Nettle	Fall-Spring ground cover
5.	Garlic	Favorite vegetable
6.	Arugula/Rocket	Leaf vegetable
7.	Spinach	Leaf vegetable
8.	Hyssop	Perennial herb
9.	Chickweed	Fall-Spring ground cover
10.	Crow's Garlic	Almost palatable bulb
11.	Oregano	Perennial herb & ground cover
12.	Cabbage	Leaf vegetable
13.	White Clover	Perennial nitrogen fixer & ground cover



Photograph 3-34 Garlic on mini hugel mounds under pine trees. Eastern redbuds in bloom beyond fence. March 23rd, 2012

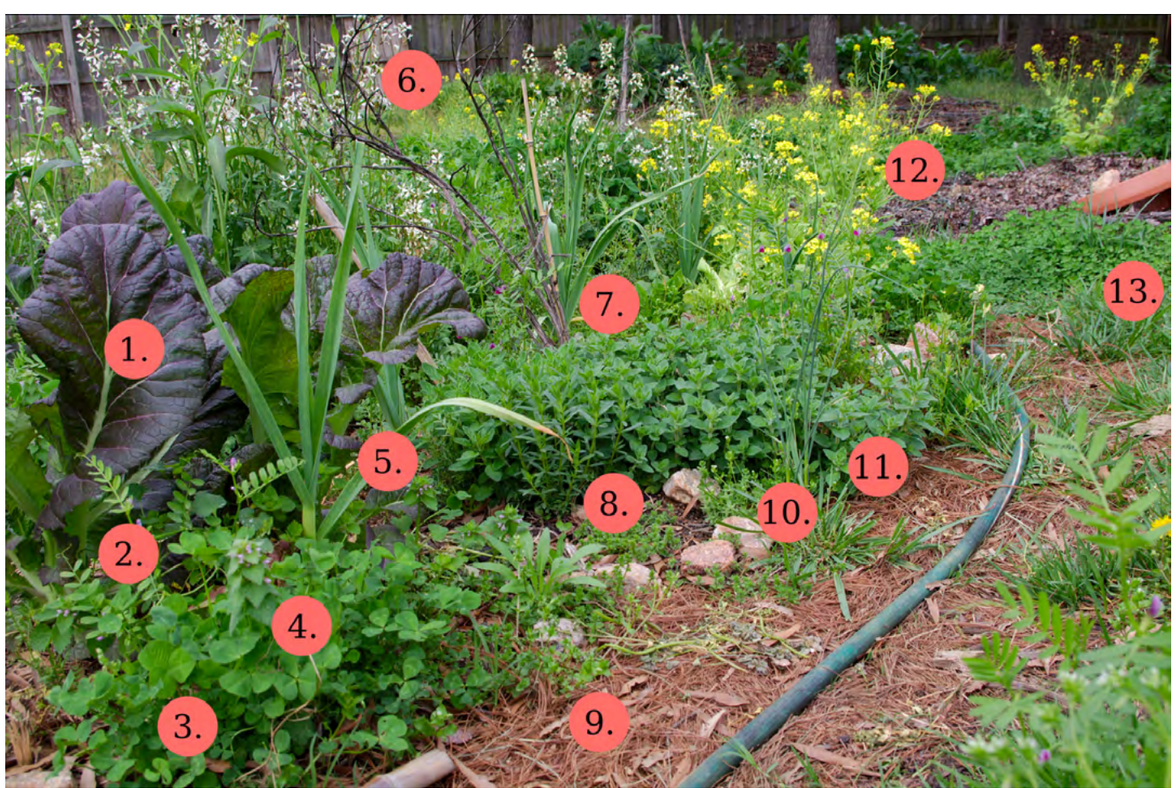


Figure 3-2 Winter polyculture transitioning to spring. March 23rd, 2012

Photograph 3-35 Old nightshade guild's nutrients being replenished with a cover crop of red, crimson, and white clovers and alfalfa. April 1st, 2012

April: Summer arrives a month early

Looking back on the meteorological record for April, we couldn't have been more lucky. The unseasonably warm weather in March fostered extremely strong early spring growth- which is exactly what we needed to help meet our goal of producing as much biomass as possible before the trees close the canopy. Unseasonably warm weather can be a double edged sword: if that trend had continued through April, much of those gains could have been compromised. If temperatures climb too high, humid conditions could easily begin to create mildew problems and otherwise stress the plants. So we were lucky that temperatures fell back into the "normal" range between 50 and 65 F (10-18C).

Photograph 3-36 Sunflower and pea mounds along the dog fence. April 1st, 2012

While I held off on planting summer species in March, by April I was ready to make the bet and we planted sunflowers and peas along the temporary fence. With the motto of "let the plants fend for themselves," we simply made small hills of compost and mulch all along the dog fence. The peas would have little trouble climbing the fence and sunflowers are rather hardy. However, we since we didn't do anything to amend the soil here, there was a risk that they would not grow very well with only a little compost on top of compacted soil.

A few days later, I observed some of our first mushrooms emerging from the soil. I should make friends with some mycologists so I can ask them to help identify these amazing creatures. At any rate, it shows that the wood chip mulch was starting to be broken down exactly as predicted. It is a humbling experience to sit underneath a tree and contemplate the living, breathing mycelial networks that are busy colonizing a garden. It is relieving to know that they are working out the most efficient pathways to nutrients, holding onto the soil, organic materials, and water while promoting their microbial allies underground- all beyond the naked eye.

The only sizable addition to the garden was sheet mulched during the first week of April. Before sheet mulching, we slightly decompacted the soil through the use of a garden fork (in the same action as a broad fork, but less efficient) and spread a thin layer of dolomitic lime along with a dusting of organic fertilizer. Then, dampened cardboard was overlaid thickly. We did not add any compost to this layer in order to save money. The intent here was to transplant some native plants we had stratified during the winter and otherwise colonize this area of the property with cover crops. Some vegetables would be sown as well for added diversity.

Photograph 3-37 Mushrooms emerge after a rain from the mulched garden beds. April 3rd, 2012

Photograph 3-38 Sheet mulching begins on berm. April 4th, 2012

Photograph 3-39 Red maple breaks dormancy. April 7th, 2012

It wasn't until the end of the first week that the red maple leafed out. About the same time, other natives, such as poison ivy (*Toxicodendron radicans*) were also emerging from their winter slumber. Poison ivy can be considered the Achilles Heel of forest gardening in eastern North America. If left unchecked, poison ivy will quickly take advantage of better growing conditions and can prevent human activity. Since the entire plant produces a highly allergic oil, it is extremely difficult to get rid of. Strong root systems- including air roots on older vines- allow it to quickly regenerate after being set back. It is perhaps the only plant we consider the use of herbicides to help in our overall control scheme. Prevention- by filling the niches- and early eradication while the plants are still young are the long term realities of sharing the same ecosystem with this plant.

Even in the newly sheet mulched bed, we needed to create pathways. Keyhole design came in handy here. Short, terminal pathways running perpendicular to the slope do not create much potential for erosion in this situation because the catchment of this berm is so small. These paths were mulched deeper than the rest of the bed so that our compaction underneath them would be minimized.

Photograph 3-40 Poison ivy along the fence by the upper pond. April 7th, 2012

Photograph 3-41 Sheet mulching on berm complete. April 8th, 2012

Shortly after, crimson clover (one of three clover species in the garden) began to bloom. Crimson clover is hardy, self seeding annual. We have sown it on the swale berms between the comfrey to ensure that the comfrey has enough nitrogen to support its incredible metabolism. It will self sow and return to growth in the fall. We will still collect some seeds for future use in other areas though! About the same time, the older comfrey plants were in full bloom as well. The entire garden was resplendent with generalist nectary species. What was still missing, however, were enough specialist nectary plants to really support the populations of predatory insects.

With a full herbaceous layer, the soil has a better chance of being protected as spring turns to summer. Strong, healthy plants covering the soil allow the soil to come to life as the rood exudates and mycorrhizal associations accelerate. Without plants, the primary producers in the ecosystem, the soil will not improve. Additionally, this community of plants is better able to protect the soil from the elements: wind, UV radiation, and precipitation. Soil organisms are able to work the entire soil profile since the surface stays cool and moist. We have multiple functions all without needing to pick up anything other than the camera at this point.

Photograph 3-42 Abundant nectar and pollen available almost a month before the last frost date. April 9th, 2012

Photograph 3-43 Spring herbaceous layer or mulch fully covering the soil. April 12th, 2012

Photograph 3-44 Facing east for a more or less horizontal cross section of the garden. This view of the garden reveals that more work needs to be done on the south side of the willow oak (left, with wooden branches as mulch) and the first swale (right, immediately behind stairs to deck). The willow oak has rather acidic soil so I will be recommending blueberries be transplanted there, with accompanying earthworks of course. The upper/first swale will also be filled in with a shrub and tree layer after 2014.April 17th, 2012

It always helps to observe other landscape practices in addition to our own. Our neighbor's lawn to the east just so happens to be the one directly observable from our garden. Contrast the dull, almost brown and dry looking lawn to the area around our first/upper swale. While we still have the shrub layer to fill (the tree layer is taken to the north by the red maple), we have a very strong start to a diverse and resilient system. Comfrey acting as a cornerstone species of the function we wish to derive from the swale: water and nutrient harvesting. Comfrey is supported by crimson clover for nitrogen fixation, and lemon balm plus garlic for aromatic pest confusion. Additionally cilantro (or coriander for the rest of the English speaking world), is providing abundant specialist nectary solutions for the polyculture. Into all of this, other species such as oregano, lettuce, mustards, echinacea only add more complexity and uses to this multi functional system. This one small patch of garden probably has more life in it than the entire lawn!

The existing trees in the forest garden are receiving a tremendous influx of nutrients and soil building capacity. The willow, pictured below, has crimson clover, red clover, white clover, and alfalfa all fixing nitrogen within its root zone. It sits just above the low spot of the second/lower swale and so is periodically flooded when large rain events occur. This is a niche that willows thrive in. With comfrey also planted under its drip line, the willow will have access to a slow release of minerals mined from deep in the soil. Other herbs and plant species also find their home amongst this sea of green.

Photograph 3-45 First/upper swale in full spring splendor backdropped by an American lawn. April 17th, 2012

Photograph 3-46 Willow with no less than four nitrogen fixing species supporting soil development. April 17th, 2012

Photograph 3-47 Willow and maple crowns inching towards one another. When the canopy closes, the amount of sunlight we will be able to transform into topsoil through cover cropping will diminish drastically. April 17th, 2012

Photograph 3-48 Yet another species of spider moving into the garden This one has set up a web to capture would be pollinators attracted to the brilliant crimson clover blooms underneath the willow. April 17th, 2012

Photograph 3-49 Looking south from the northern fence line. A blueberry mound with comfrey, garlic, tomatoes, and lemon balm is in the foreground. On the left are the sinuous hugel mounds that were covered in clay 2 1/2 months prior. April 20th, 2012

Stepping back a bit, this next photograph captures the changing light conditions brought about by summer solar angles and a canopy in leaf. When the western most trees- the willow oak and twin river birches- have closed their crowns, the northern half of the garden is in deep shade by mid afternoon. This is desirable in an environment with high summer evaporation rates. The trees will shade our water harvesting and storage features, creating a cool retreat. Because solar energy at this latitude is so intense, even 4 hours of direct summer sun is enough to produce garden vegetables. Dappled shade during the course of the day and a deep shadow during the peak of the afternoon creates a wonderful microclimate. The area around the willow and maple, (center, background) is fully exposed to the sun and care needs to be exerted not to allow the sun to desiccate the soil.

Going to the other boundary of the garden and looking north (and downslope), we can see yet again how patches of the garden develop differently in relation to the amount of sunlight. The foreground is the old green guild, where I had planted plenty of white clover along the pathways. Being rhizomatous, the clover has spread to form very thick ground cover. Perennial herbs and strong winter crops like brassicas are able to hold their own ground and compliment the clover nicely. Still, things are a bit slower here. The comfrey, while flowering, is perhaps only half as thick as comfrey grown on the swale berms with access to full sun. The slower growth is a boon because we can extend the season on cool weather crops.

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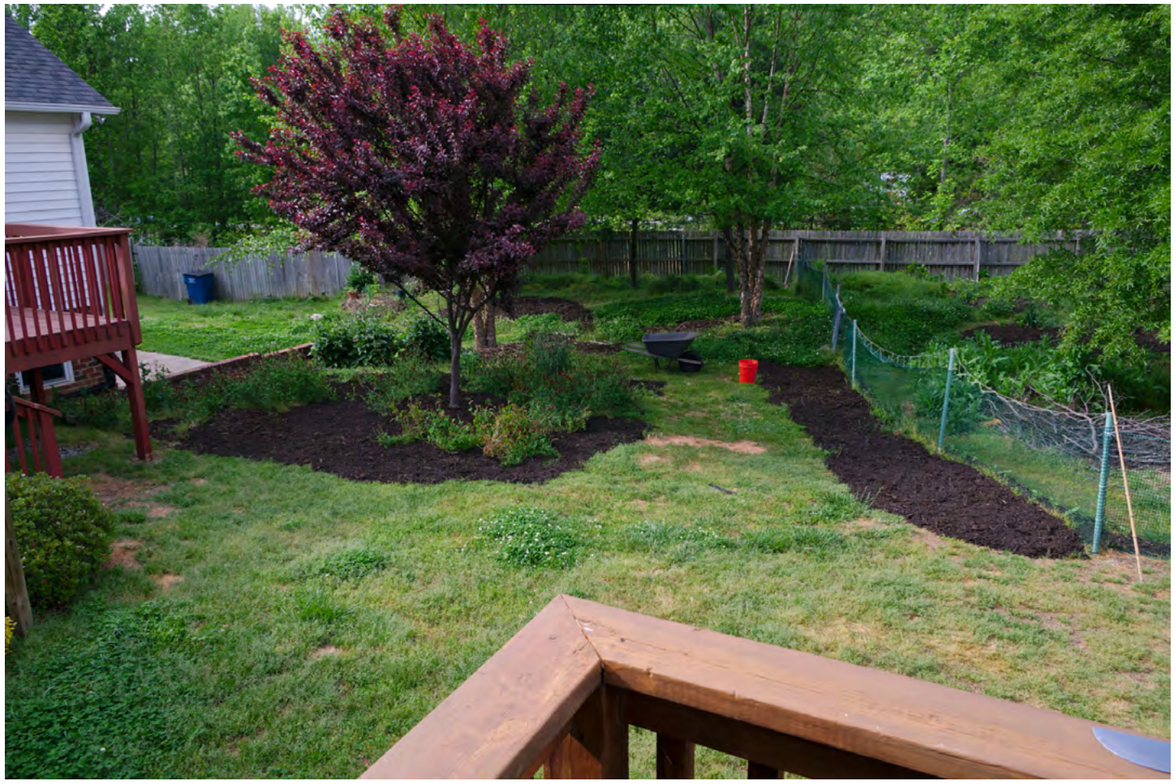
Photograph 3-50 Looking north from the southernmost part of the garden. April 20th, 2012



Photograph 3-51 Wood chip around plum, temporary fence, and scalped lawn under trees. April 20th, 2012

Before the mulch sale season came to a close, we invested in a few more cubic yards of wood chip. Here, you can see how we have heavily mulched underneath the ornamental plum to about its drip line. Because the soil in this area had been scalped by the lawn mower, it was in dire need of some repair work. Underneath the twin river birches (framing the wheelbarrow), an extra thick layer- about 8" (20cm) of wood chip was laid down. These areas are highly trafficked and without supplemental wood chip, the soil would once again be exposed to the elements. Very thick mulch will allow the tree roots and fungal associates to slow, spread, and sink water. We also laid a strip of wood chip directly adjacent to the temporary dog fence in order to provide a place where we could sow some flowers to help break up the harsh transition from lawn to garden. The one very clear patch of clay that is shaped like a shallow U is the remains of a water retaining feature that was to be included in the garden, but never completed after the fence was moved.

The last photographs from April depict the areas around the first and second swales. Both are thriving plant communities helping us meet our goals for 2012: consolidation and diversification!

Photograph 3-52 Detail image of Russian Comfrey Bocking #14 inflorescence. April 20th, 2012

Photograph 3-53 Detail of first/upper swale polyculture. April 20th, 2012

Photograph 3-54 Relative detail of second/lower swale. Huge Russian comfrey plantings, large patches of clover, and maturing winter crops. Egg cartons (bottom right) will be shredded and put into swale bottoms as high carbon inputs. April 17th, 2012

Summer Soil Building

May: Chop and Drop Begins

May is the first month during which temperatures should only in a very rare event drop to freezing. By the first of May in 2012, the threat of frost was so marginal that I almost felt ridiculous to have waited so long before engaging in the chop and drop regime we had planned. Part of this is because, as I mentioned earlier with comfrey, many plants we want to use in a chop and drop regime, like alfalfa and red clover, have their greatest biomass ready just before flowering. Once they begin to flower, they start to get leggy, like many vegetables do when they bolt. Cut for mulch at this point, they will have less biomass available. Still useful, just a little less to work with. And as with comfrey, some plants, once they have already flowered once, will regrow with reproduction in mind rather than staying in a strictly vegetative state. Of course, another potential downside to waiting so long is that even if the flowers are not quite yet ready to set seed, it is possible that there will be enough strength left in the stems to ripen seed after cutting. So you risk spreading seed from plants you cut. This isn't really a problem in our situation, since we would be happy to spread red clover and alfalfa around our garden at this point in time. However, if you apply the "chop and drop" regime to undesirable species, attention should be paid to whether they have flowered or not.

You may be asking, what is "chop and drop"? The technique refers to the literal "chopping" of a plant (or parts of it) and dropping the organic material onto the ground. Plants maintain a certain root to shoot ratio, so when you cut back portions above ground, the plant will shed some roots. This is called "rhizodeposition." Why this matters is that, as plants are the primary engines of the soil food web, intentionally forcing plants to shed roots means that more carbon can be pumped into the soil than if the plants were left to go through their life cycle without any interruption.

Since the red clover and alfalfa was planted all the way back in the fall of 2011, the plants had all winter and the warm spring to grow deep root systems. By waiting until plants are established, we can rest assured that they have the root infrastructure necessary to withstand this kind of shock treatment. Also paying attention to the weather- will there be enough rainfall for the plants to regrow with vigor- is necessary if you want to maintain this regime. Chop and drop should not be a chore done every other week without regard for how the system is evolving.

The material chopped is oftentimes just "dropped" onto the soil. In small systems, where attention to detail is possible, carefully placing the cut material around the crown of the plants you just cut is important to allow the crown to get air. This will help prevent crown rot. Cut material can also be transported throughout the garden to locations you think would benefit from some extra mulch, such as recently transplanted vegetables or trees. Care should also be taken to avoid cutting too late in the season. Allowing the plants to gather as many resources as possible late in the summer/ early autumn means they will have enough stores to withstand the coming winter.

One other reason I waited so long to initiate the rhythm of chop and drop was that I wanted many of them to flower to provide nectar. If I waited long enough, the entire garden would be in bloom. If I began to cut back plants at towards the top of the garden, there would still be flower-based food available throughout the rest of the garden.

Photograph 3-55 Looking east from under the twin river birches. The lower/large pond overflows through this large patch of white clover and Russian comfrey. May 1st, 2012

To help compensate for the amount of stress that these plants will be under, I began to brew aerated compost tea. Any permeable material that will not allow large particles to leave will work very well for holding vermicompost and other high humic acid materials as an air pump/stone keeps the concoction oxygenated. After about 24 hours, a thick froth appears on the surface and the tea has a strong, earthy smell. It is then ready to be diluted and either sprayed or used as a soil drench. It is best to use right away as the number of organisms begins to decline rapidly once aeration is ceased and the organisms have used up many of the nutrients present. These compost teas were then used to boost plants stressed by being cut. Whether the influx of millions of organisms actually helps out compete with disease causing organisms or if the plant available nutrition from the tea is what helps prevent the "patient" from falling ill is hard to say with absolute certainty, but it is probably a combination of the two.

Photograph 3-56 Three Russian comfrey plants cut after their prime. Still a lot of mulch material! May 1st, 2012

The decision to dig ponds is a major attractor for birds of all kinds. With fresh water available throughout the year, birds will begin to keep our garden on their migratory flight path. Year round residents already know our garden and visit often. Before the garden has a proper shrub layer, birds can be encouraged to scout for food by allowing the dead stalks of annuals to stand throughout the year. Bamboo stakes, fallen limbs with branches, bird feeders (without any food even!), and anything else remotely resembling a perch will be put to use in no time. I have found that adding stakes to the ground is a great way to improve spider habitat before any plants are tall enough to meet their needs. If untreated wood, especially branches, are used in this manner, they will also act as soil stakes which will eventually be colonized by fungi and break down as a high carbon input.

Photograph 3-57 Compost tea ingredients ready for brewing. May 1st, 2012

In the first few days of May, I sowed the newly sheet mulched bed with a diverse range of cover crop seeds and vegetables, including okra that we harvested from the year prior. These were simply broadcast by hand Sepp Holzer style in an effort to minimize work and meet the maintenance goal of letting the plants do the work for themselves. If the seeds survived, great, if not, then they weren't meant to be there at the time. We also had perennial natives and some other vegetables started that would be transplanted later.

Before heading out for a long weekend, I cut a large amount of white clover from the former green guild to mulch the seeds. The mulch would prove to "wet" and the seeds were too quick to sprout, so many were smothered by my good intentions!

Photograph 3-58 White clover as mulch. May 5th, 2012

Photograph 3-59 Song sparrow, American robin (Turdus migratorius), and northern cardinal (Cardinalis cardinalis) checking out the lower/large pond. The song sparrow has spotted me! May 2nd, 2012

Photograph 3-60 Song sparrow (Melospiza melodia) perched on a dried sunflower stalk. May 2nd, 2012

Photograph 3-61 Crimson clover ripening and alfalfa/red clover in full bloom. Time for chop and drop! May 5th, 2012

Photograph 3-61 captures the moment when the garden was absolutely covered in blooms, and thus, ready to begin chop and drop. Growth was so thick that our secondary paths were entirely engulfed by red clover and alfalfa. Cutting them back will improve the flow of air throughout the garden.

Using nitrogen fixing plants as the major species for chop and drop soil building regimes means that some of the nitrogen in the root nodules will become available to the soil food web, potentially fertilizing neighboring plants like the lettuce, garlic, and cilantro photographed here. Before their stems and leaves are consumed by the soil, they will act as a bulky mulch to protect the ground in the same way they did as in life. With a little bit of breathing room and more nutrients available, the vegetables will be able to grow a little quicker and be ready to harvest shortly.

Photograph 3-62 Red clover cut and laid as mulch around lettuce and garlic, while cilantro is left to feed specialist insects. May 16th, 2012

Photograph 3-63 Four bird species captured in one photograph: American goldfinch (Spinus tristis), northern cardinal, house finch (Haemorhous mexicanus) and an unidentifiable sparrow. May 22nd, 2012

With the brassica seeds ripening, birch catkins on the wane, and insects in demand for baby birds, our garden became a hotbed of activity. Simply being still for about 10-15 minutes was enough to have multiple species drop by for a visit. *Photograph 3-63* captured four species in one shot. A cardinal swoops in top center left, a house finch perches on a mustard plant devouring seed, an unidentifiable sparrow perches atop a bamboo stake that was holding the mustards upright, and a goldfinch is sitting on a birch branch (top center). The diversity of food available through the deliberate encouragement of niche diversification opens the garden to many interactions. I am happy to allow bird populations to feed on seed from our crops because they cannot eat literally every seed (leaving the missed ones to join the seed bank) and their presence means that insects are devoured and guano left for fertilizer. Of course, they also can bring in seed from elsewhere, but we focus on the positive. Additionally its just a lot of fun to watch so many different birds enjoying themselves!

Photograph 3-64 Sunflowers and peas along the dog fence with a mix of wildflowers and chia coming up in the mulch on the other side. The peas didn't grow so well with the Mark Shepard STUN method. May 9th, 2012

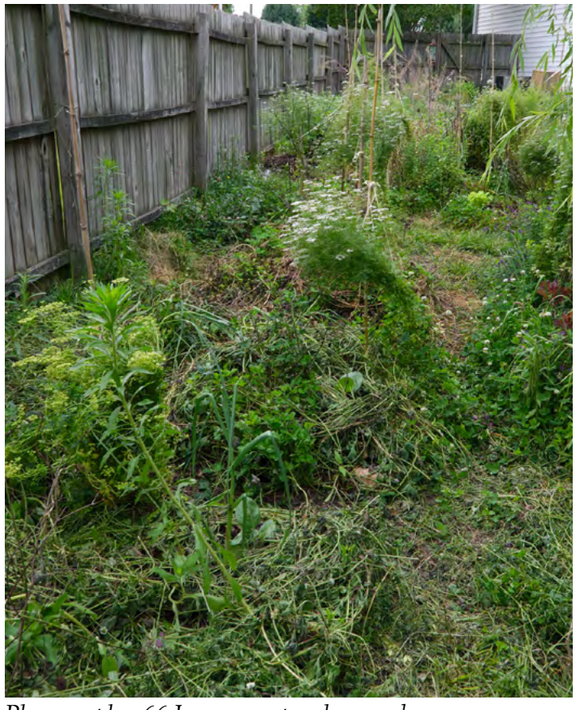
Photograph 3-65 The amount of biomass here, in comparison even to the Stress Test is stunning. May 22nd, 2012

To truly appreciate how intense the herbaceous layer grew by early summer, one needed to step back onto the berm and take it all in from under the pines. What looks to the uninitiated observer as a field of weeds, is to a permaculturalist a sign of rapid carbon capture and nutrient gathering. The garden even shocked another permaculture enthusiast with in its "feral" condition! I thought it was an absolutely incredible experience to behold plants not just being allowed to express their potential, but actively encouraged. I can see how this kind of gardening may be intimidating , but once you get out and walk the pathways and peek closer, it should be very clear that everything has a purpose.

All of the cabbage, mustard, arugula, radish, and other winter greens have long since finished flowering and have had their generalist nectary niche replaced with white clover, red clover, and alfalfa in the main with comfrey backing them up. Yarrow, cilantro and parsley were, at the time, our only obvious specialist insectary species as the sunflowers and New England asters would bloom later in the summer.

The red clover and alfalfa (to a lesser extent) grew so densely that other species living amongst them were stunted by lack of sunlight. Those that rose above, like cilantro, suddenly lacked a dense support of foliage around them when the nitrogen fixers were cut back. Therefore, I needed to tie them loosely to bamboo stakes in order to prevent them from falling over completely. Granted a reprieve from the highly competitive red clover and alfalfa, the other plants in these guilds were able to take full advantage of the extra sunlight and the soil was protected from the suns rays from the cuttings.

Largely left to its own devices after being opened up to the dogs when the fence was moved, I brought in a lot of very rough acidic mulch to bunker this the west berm extension down for what



Photograph 3-66 Lettuce, parsley, tobacco, oregano, garlic, New England Aster, and other plants emerge from the dense cover crop after a round of chop and drop. May 22nd, 2012

2012: CONSOLIDATION & DIVERSIFICATION

was clearly going to be a hot summer. As it turned out, 2012's persistently high temperatures wound up being for the record books. I obtained these boughs from some landscaping I did for a neighbor and instead of breaking them into smaller pieces, I simply left them whole to seriously shade this berm extension. As it faces west, it is the hottest and driest part of the garden- conditions that blueberries aren't known for tolerating. Yes, that is an entire young eastern juniper on the west side! At this point, with a wild cover crop in the main garden and this rough and ready approach to mulching, the garden was seriously breaking with convention.

Photograph 3-67 Western berm extension "bunkered down" for a hot summer. May 22nd, 2012

Photograph 3-68 Blueberry on small mini hugel mound with- among others- garlic, comfrey, black eyed Susans, and crow garlic as companions. May 30th, 2012

The Berm: More than a Vantage Point

Despite being the vantage point for many of the panoramas of the garden, the southern facing berm, with its original topsoil and excellent aspect, hasn't had much attention in this project review except on a rare occasion. Before closing the segment on May and chop and drop, here are some of the developments that had been underway.

I haven't written much about the blueberries that I planted back in 2011. They've been largely left to fend for themselves- pretty much the habit we want to instill when it comes to perennials in the garden. If they survive with little to no attention, then we want more of them. In this case, the blueberries simply aren't able to get enough water. Even though this photo has plenty of berries coming on, the fact that they are on mounds on top of a dry berm means that they will have to struggle to ripen many of these fruit. It will be best if they are moved to a better location.

The sheet mulched section of the berm needed to be resown after smothering some of the initial seedlings with white clover mulch. At the same time, we transplanted many perennials and vegetables. Wood chip that has been sitting in a pile in full sun for weeks on end will be rather dry, even to the point of being water phobic. To overcome this, we started filling buckets with pond water and packing wood chips into them. After letting the chips soak for at least half an hour, the much heavier, fully saturated wood was put down around vegetables and transplants.

Since I had finished digging the lower pond, I moved some water hyacinth and goldfish into it. As the surface area is quite large, I kept finding most of the plants languishing in the shade of the willow oak. I can't have a sun loving plant doing nothing in the shade, so I crudely lashed a couple of bamboo canes together and used them as makeshift barrier to keep the hyacinth in full production. Finding a good source of native aquatic plants is still on our to do list: it seems very difficult to find anyone who has them as a priority. Perhaps this is because water features of this size and type are not quite yet popular. As I mentioned in the site analysis section, there are no natural lakes or ponds in this region of North Carolina, so finding even ubiquitous plants like cat tails (bulrush, Typhus) is difficult. Seeds may need to be purchased or bartered for online.

Lastly, we cut back a lot of chickweed in one of the most exposed hugel mounds and planted tomatoes and cucumbers along with herbs and cover crops as a mini vegetable patch.

Photograph 3-69 Soaked wood chip around vegetables and transplanted native perennials. May 30th, 2012

Photograph 3-71 Newly planted vegetable bed in a hugel mound. May 30th, 2012

Photograph 3-70 Bamboo canes used to promote growth and nutrient sequestration. May 30th, 2012

Photograph 3-72 Sea anemone-like fungi on white pine stump. May 29th, 2012

June: Last month in North Carolina

My flight to Finland was June 18th, leaving me with a couple of weeks to tie up loose ends and say goodbye to my family. When it came to the garden, I was very happy with the way the summer was shaping up. The garden was responding very well to our implementation of mainframe design elements. The soil seed bank was expressing itself and we were able to manage many of the undesirable plants at the same time we systematically moved through the garden chopping and dropping.

The same lack of local sources for native aquatic plants is also affecting our ability to fill the marshy area between the two ponds with marginal species. Luckily, we already had horsetails growing on site and after a year in their new location, they were beginning to reproduce quite well. Horsetails are an ancient genus of plants that perform quite well in damp conditions, spreading like wildfire sometimes. Which just means (in a garden) that they should be harvested and used as mulch, to ferment into liquid fertilizer, or otherwise put to use as dynamic accumulators.

The sheer number of blooms around was a pollinator paradise. We still have a long way to go in providing them with other needs, such as food for their young which often comes from native species. Still, when compared with the lack of diversity before our garden began, things are definitely looking up!

A friend donated a lot of plants to us early in the summer when they did not find homes in the community gardens he runs. He also shared with us some divisions of plants from his own garden. Since the margins of our ponds were still glaringly empty, we jumped at the offer of some crowns of irises (*Iris pseudacorus*). While not native, they will still provide us with filtration and an early spring floral display. They crowns were further divided and planted into four or five locations in the ponds- at varying water lines- to maximize our chances of establishing a colony. When he returned for a visit in the summer of 2014, they had grown so tall that he believed they were cattails until I reminded him that they were, in fact, irises from his garden.

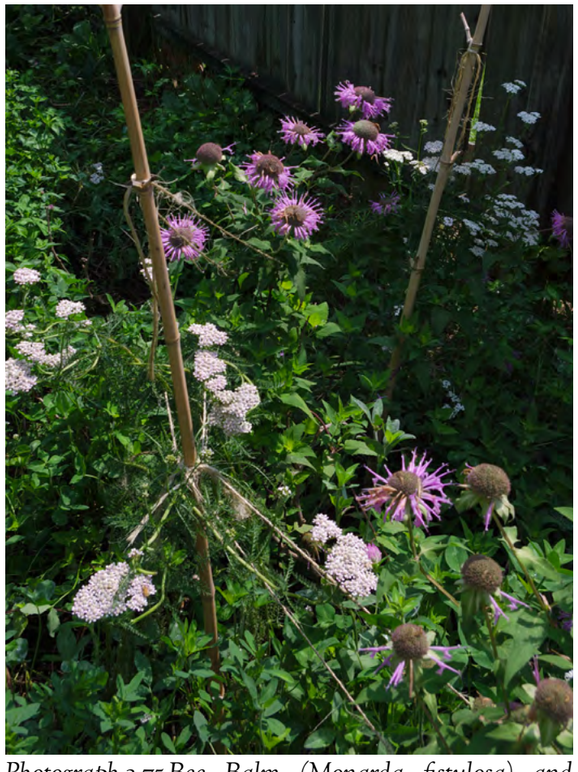
A little more practical diversification taking place was the spread of some native pollinator and tea plants we planted the year prior. Since many perennial herbaceous plants don't reach maturity until their second year, it was a pleasant realization that they had survive the winter and were thriving. Wild bergamot is a very useful native plant: it is used to make tea while the fresh leaves and flowers are edible. We also had spread seed for its cousins Monarda didyma and Monarda citriodora elsewhere

Photograph 3-73 Horsetails establishing a foothold in the marshy area where the upper pond spills over towards the large one. June 5th, 2012

Photograph 3-74 Irises planted at the edge of the marshy channel and the lower/larger pond. Tops were cut to promote root growth. June 5th, 2012

in the garden. These are plants we would love to divide and grow all over wherever enough sun is available for them.

In addition to the irises, we were also given about a dozen strawberry plants that had not found a home. Although midsummer is not the ideal planting time, with a little bit of attention in overcoming transplant shock, strawberries do extremely well on their own. We planted small patches of them throughout the garden in the hopes that they would take to at least one spot from which we would be able to make divisions in the coming



Photograph 3-75 Bee Balm (Monarda fistulosa) and yarrow (Achillea millefolium). June 13th, 2012

Photograph 3-76 Strawberries, creeping phlox, a rose, and tomato in a new patch adjacent to the second swale with comfrey for chop and drop. June 13th, 2012

years. At the time, yarrow, oregano, and white clover were our dominant desired species for that niche. Now, with the strawberries, we have brought into play a fruiting perennial as well. One other great thing about strawberries is that many of them carry on growing well into the cooler season, so we have yet another season extension of soil building. They also make a good ground cover around ornamentals like roses, seen above, planted for Mother's Day.

Photograph 3-77 Strawberries diversifying ground layer with lettuce, echinacea, mustard, & clover. June 13th, 2012

Swales are truly multi functional earthwork features because, in addition to rehydrating the landscape, they offer multiple niches. The swale berm is well watered, but also well drained. This is a perfect location for water demanding plants that do not like wet feet. The swale bottom, on the other hand, is the perfect place to plant water loving species. Here, we have Great blue lobelias in their second year. This particular swale was dug with a narrow shelf on the high side, putting into play a long bed for water loving plants. These Great blue lobelias are native so they support large numbers of insects, in addition to being beautiful. They are short lived perennials and produce very large quantities of seeds each year that can be spread along wet areas in the fall to encourage colonization.

I feel that the ponds were one of the best features we chose to implement early on. They offer year round interest and attract a wide variety of creatures to the garden.

Pulling up a chair under the shade of the pine trees and observing the garden while seated next to a pond is simply relaxing. The vantage point from under the pines offers unobscured views of the nearly the entire project.

The upper pond stays full much longer given its smaller size and its situation as the "first flow diversion" of runoff from the neighbor's lawn. Both ponds are situated such that they are well shaded in the afternoon by the existing trees. This helps keep them from losing too much water to evaporation as well as keeping the temperatures from fluctuating too much. It may be that they are buffering the surrounding air temperatures as well during the summer. Since they are not too deep or large, preventing the temperature from climbing too high is conducive to healthy fish, frogs, and habitat. They still get enough sun in the morning to fuel the growth of the water hyacinth, which as mentioned before, we keep at about 1/3 to 1/2 the surface area by harvesting it for mulch.

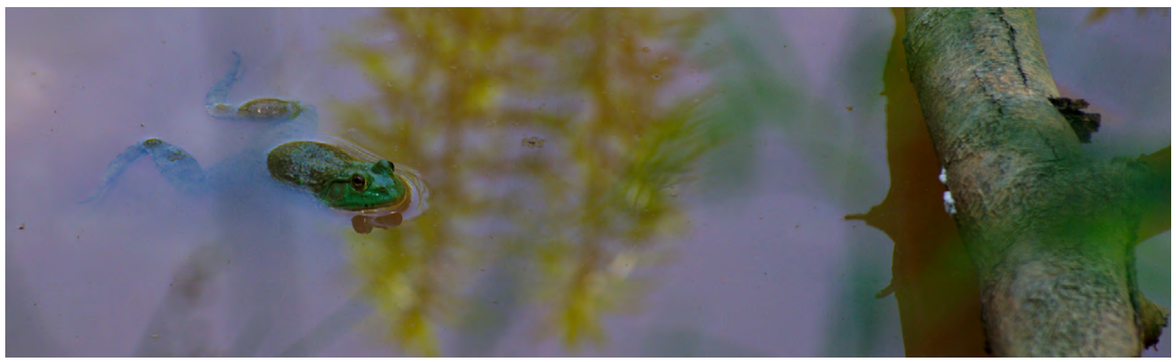
Observable near the pond in Photograph 3-79 are "towers" of lettuce that sprang up around the garden as the winter-cropped lettuce began to flower. While we continue to bring in new lettuce seeds to increase the genetic diversity, we allow nearly all of our vegetables to breed and self sow to establish local varieties.

After two years of gardening with ponds integrated into a passive water harvesting system, I've come to appreciate their benefits to the point of not being able to imagine a garden without a pond of some kind. They simply make sense, even if you don't have much space.

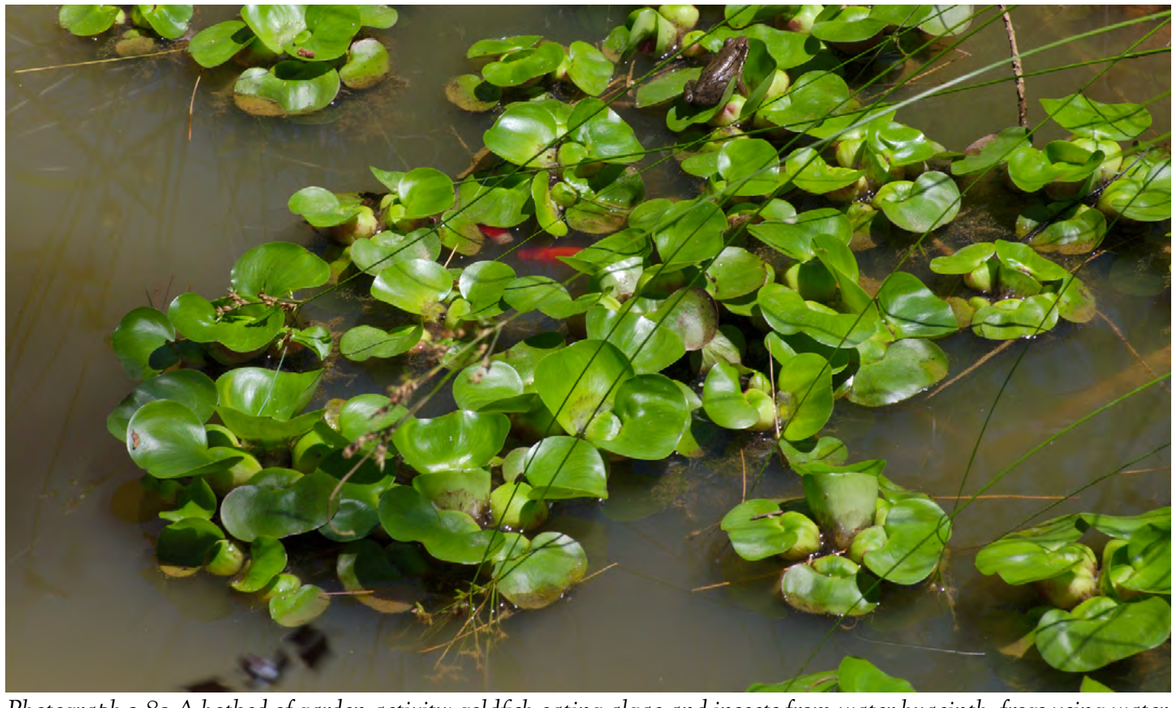
Photograph 3-78 Great blue lobelia (Lobelia siphilitica) and comfrey in two niches along the second swale. June 13th, 2012

Photograph 3-79 Small/upper pond's cool microclimate. June 13th, 2012

Photograph 3-80 Adult male Common whitetail dragonfly (Plathemis lydia) perching near the upper pond. Males use their brilliant color to warn other males that this is their territory- which can stretch for 30 meters. June 16h, 2012



Photograph 3-81 Solo bronze frog floating around the pond on a mid summers day. June 16th, 2012



Photograph 3-82 A hotbed of garden activity: goldfish eating algae and insects from water hyacinth, frogs using water hyacinth like lily pads, as a dragonfly swoops over the small pond. June 16th, 2012

Photograph 3-83 Three Zai bowls along the fence. June 13th, 2012

Photograph 3-84 Three false indigo seedlings with a June bug. June 13th, 2012

Speaking of water features, I was inspired to dig Zai bowls (mulched pits) just before leaving the country. I wish I had wanted to dig them earlier in the year! I dug small pits along the eastern fence line and filled them with wood chip mulch. I packed the chip in so that as you walked along the fence to cut back growth from entering the neighbor's yard you wouldn't sink in and twist an ankle. The bowls were attached to one another by the Type 1 Error I had made back in the beginning of 2011 by digging the overflow ditch between the upper and lower swale. In this way, if one bowl filled, then the water would be directed into the next. Turning an old problem into a solution! Eventually, these bowls will reach all the way down the length of the fence line to help absorb the shock of runoff that comes from the neighbor's lawn. I am also hoping that the amount of biological activity in these Zai bowls will help buffer any chemicals that our neighbor uses on her lawn. Perhaps they will be intercepted by the carbon filter and have time to degrade. Diverse water harvesting features, scattered throughout the garden, help add lumpy texture and create wet/dry places that otherwise would remain uniform.

False Indigo (Amorpha fruticosa) seedlings looked strong enough to be transplanted into the garden much earlier than usual: typically one would wait until they have grown for a full summer. But because I had more than one sharing a container and we can afford to pay attention to them, I transplanted them into the newly sheet mulched area. False Indigo bushes are highly attractive nitrogen fixing natives that do well with coppicing, so they are perfect for woody chop and drop. I am recommending stacking many more into the system at least for the next few years.

In the old four sisters guild, the wood chip mulch apparently didn't stop these brassica seedlings from germinating in the height of summer. Dispersed by birds in the spring, this is an example of naturalizing species in the garden. Over the course of a few years, local landraces that bear little resemblance to their parents will emerge since we plant only open pollinated species (except those Sungold Cherry tomatoes!).

Like the other native perennials we planted the first year, these echinacea plants began to reach maturity by the middle of the summer. Displaying

Photograph 3-85 Brassica seedlings sprout from seeds dispersed by the house finches in spring. June 16th, 2012

Photograph 3-86 Echinacea purpurea in full display just before my departure. Mustards flowering, without any leaves, for the second time in the middle of summer (right). Aster and lettuce blooming too (left). June 16th, 2012

exquisitely beautiful flowers, echinacea are wonderful as they require little water or care but still provide tea that is purported to help our immune system. Interestingly, they are related to sunflowers by sharing the same biological tribe: which helps explain their allure for pollinators of all stripes.

Emigrating to Europe & 2012 Conclusions

Leaving- once again- in the middle of the growing season, but this time for good, was difficult knowing that my situation in Finland would leave little room at all for the level of interaction with nature I had grown accustomed to. I was happy that I had been able to spend so much of my life interacting on a daily basis with developing ecosystem. It was very rewarding to see how the thorough application of mainframe permaculture design could swing a degraded landscape towards regeneration in such a short period of time. The decision to focus on cover cropping and building soil organic matter before the canopy closed was a good one.

The months of 2012 flew by because we simply needed to observe, adjust, and cut plants for mulch. They didn't require any additional watering, besides transplants, and the little bit we extended the garden was easily manageable. The amount of work required to keep the garden alive should have been quite low, though of course new plant growth in July and August can quickly overwhelm even the most dense cover crop if troublesome plants are not identified early.

Both the alfalfa and red clover responded very well to the chop and drop regime, as did the year old comfrey plants. A few more years of concentrating heavily on increasing the soil organic matter should prove quite fruitful. By 2013, the thick lines of comfrey dominating the swale mounds would be producing plenty of mulch for any new plantings.

The sheer amount of life that sprang up after a mild winter was bewildering. At times it was difficult to remember that we had set the stage and brought in many of the actors, as the cover crops dug deep and new arrivals poured in day after day. Although the pace will eventually slacken, it is reinforcing to see that our experience matches the models for ecosystem change.