Weed Management

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This presentation is Weed Management for Master Gardeners. My name is Tim Miller, Extension Weed Scientist at Washington State University Mount Vernon. During the next several minutes we will be discussing what weeds are, the attributes that make them weedy, and how weeds go about their business in making your gardening more difficult.

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My first question to you is, what is a weed? Definitions vary and weeds are sometimes called names that I can't use in polite company. Emerson commented that "a weed is a plant whose virtues have yet to be discovered." The common definition is a plant out of place – you've maybe used that yourself. A plant that we don't happen to like because it is not attractive or because it is poisonous or smelly or spiny or whatever. Such definitions take into account how these plants affect people. And the term "weed" certainly conjures up that negative image. But I argue against the strictly human-centered definition. If people disappeared tomorrow, there would still be plants whose growth and development could be called weedy. Let me tell you what I mean.

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Weeds are plants that exhibit, by their nature, certain characteristics. Weeds are competitive. What they want, they take. They excel at taking up space, nutrients, water, and sunlight very quickly, more quickly than do most other plant species. Weeds are invasive. These are plant species that just don't stay in one place. They colonize new locations, constantly spreading from site to site to site. Weeds are persistent. Once they are established at a particular location they are very difficult to get rid of. Where one plant grew in one season, the next year there are dozens or hundreds. Can you name a plant that willingly gives up its ground? If so, it probably isn't a weed. Weeds are pernicious. Now pernicious is an old-fashioned word, but I think that it is a word that perfectly describes a plant's negative attitude from a human beings perspective. Pernicious means having an evil intent. This is the effect that weeds have on humans. They interfere with what we want to do with the land and must therefore be managed if our plants are to be successful.

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So how do weeds do their thing? What makes a weed species weedy? What are those characteristics that we need to think about? Well, first of all, weeds grow in a lot of different habitats. These plants don't need specific environmental conditions to really thrive. They are open-minded and they grow well under widely varying conditions. Think of common lambsquarters, for example. Now common lambsquarters is a plant that

grows in every state of the Union, including Alaska and Hawaii. It is a European plant but it has moved itself here and has made itself quite at home. It grows in gardens, annually cultivated fields, waste areas, vacant lots, road sides, range lands; you get the idea. Many other weed species are able to do the very same thing, so they are very widely adapted. Weeds are always able to exploit a weakness, too, they are able to emerge rapidly and grow very quickly, often better than the plants that we are trying to grow.

Weeds are quick to reproduce themselves, often in a matter of days. This includes production of seeds as well as spreading vegetatively to form new shoots, crowns, and things like this from roots and other structures that we will talk about shortly. Weeds can often make a lot of seeds in a short amount of time. Remember that common lambsquarters that we talked about just a minute ago? Well, common lambsquarters is capable of producing 72,000 seeds in a single growing season. One plant - 72,000 seeds! You know, it is kind of like the plant is betting that at least a few of those hundred seedlings or so that will germinate in the spring will survive to mature and produce a new crop of seeds. And when those seeds drop to the ground, well, basically that keeps the species alive and well year after year after year.

Weed seeds are able to disperse themselves widely. A good weed just doesn't stay put and while some seeds do just drop directly to the ground underneath the mother plant, most are able to travel far and wide using different strategies. Some seeds fly in the air, some float in the water, some hitch a ride on fur, feathers, or clothing. Some are moved by machinery, some by vehicles, some are eaten by animals only to be excreted with waste only days or even weeks later. So these plants get around in a lot of different ways and those seeds are the main reason why.

Now finally, weed seeds rarely all germinate at the same time. Most seeds are born dormant, allowing a certain number of seeds to survive in soil for an extended period of time. How long? How about forty years for our friend common lambsquarters. So that lambsquarters that is growing in your garden right now may have come from a seed produced during the Nixon Administration. It will be around for a while. These are all characteristics that make those plants difficult to manage.

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So how do we classify weeds? Well, there's a number of different ways really, sometimes we classify plants and weeds by their origin; where they are from. Sometimes we look at what a plant looks like; its morphology and we classify a weed that way. Often, and I think the most relevant way, is by life cycle; how the plant does its job from year to year to year. We'll talk about each of these.

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First of all the weed origin; where these plants came from. Some plants are native to the site where they are growing currently. In this particular case, look at the slide of the

horsetail – the bright green in the center upper portion of the slide. Horsetail is native to northern climates throughout the world. In other words, across Canada, northern tier of the United States, as well as in Siberia and places like that. So this plant grew up here, developed here, and we're just trying to grow things in the same place that it just happens to like to grow in. Consequently, it's not something that we are ever going to get rid of, it's always going to be here, and it's been here for 350 million years, so I don't think we are going to get rid of it anytime soon.

We also have the introduced species; often times these are introductions that are by accident. Look on the right side of the screen; you'll see Canada thistle growing there. Canada thistle is an introduced species from Europe and Asia. It came here accidentally, probably in a seed lot of wheat or something like that, that was brought from the old country and planted in the new country, and made itself rapidly at home and has basically spread throughout that same climate we were just talking about for the horsetail - the northern tier of the United States, into Canada, and places like that.

The last little category here, the one that is showing you the photo here as an escaped ornamental would be the photo in the center lower part of the slide; this is really one plant. What you are seeing there is an entire landscape that is covered by Kudzu – the plant that ate the south. It was brought in purposefully by weed scientists, like me, who are looking for new types of plants that could be productive, grow very strongly, and produce a lot of forage for animals and things like this. Well, this was brought in, on purpose, as a forage type of plant and it promptly made itself at home and well, history is pretty clear on what Kudzu can really do. So this plant is one of the cases where it was brought in on purpose, as an ornamental, and spread from there. Unfortunately, many of our noxious weeds fall into this category and these are the ones that people like us, Master Gardeners, can sometimes, we help the situation along, unfortunately.

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Most weeds are really not native, however. If we look at the list of weeds, this was put together by a weed scientist named Holm back in the 1950s, and the number of species, I think is illustrative of some of the ideas that we have been talking about as far as the introduced species. Now most of the species on Holm's list, 25 of them, came to the U.S. from Europe. And then actually, you see more than in the U.S. These are species that are weedy in world agriculture. 25 of those species came from Europe; another 17 species from Central and South America, 14 from Asia, 11 from Africa, 5 species are from where we call cosmopolitan – well, that just means that they grew in other places, different continents at the same time, so you can't really narrow them down that much -- much like horsetail, for instance -- and then from North America only about 4 species. So, I think that we are not doing our job here in North America -- we need to spread some weed species around the world so that we get better notoriety. I think what this kind of shows, however, is that many of the weed species developed in adaptation in some of the crops we are actually growing. Think of Europe. Many of the cereal grains came to us from Europe and so consequently, many of the weed species that grew up with wheat, for instance, probably have continued to grow with wheat. And

so when wheat grows somewhere, then those weeds have kind of hitched their way over and become weedy in agriculture.

Asia, Africa, Central and South America often are tropical regions and consequently many of the species that are weedy under those conditions are weedy in all those locations. So think of rice production, think of banana production, other subtropical and tropical fruits and vegetables; very much similar kind of conditions over widespread parts of the U.S. and excuse me, of the world.

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What about morphology? Let's talk about morphology just for a second. In the big world of botany, there are really two kinds of plants. Or one of the ways you can split them up is by how many cotyledons they actually produce. Think of these two categories as being monocots (monocotyledons) and dicots (dicotyledons). Monocots have a single seed leaf, or one cotyledon. It comes up from the seed, and this seed pushes this cotyledon up through the soil in a kind of soda straw kind of growth and the first leaf comes out of that seed leaf, the cotyledon. These include plants like grasses, like sedges, lilies, things like this.

We also have dicots, which have two seed leaves, di-cotyledons. Nearly all plant families; at least most of the weeds are dicots. Dicots typically have broad leaves and they grow a little bit different than a grass does. A typical meristem is located higher up on the plant, usually at the tips of the branches. Whereas with a grass, it is down near the soil level, so grasses can handle certain types of grazing, for instance, that a dicot would not be able to handle very well.

There are also consequences to these plant types in that they act differently with herbicides and other types of control mechanisms that we might employ to try to control these particular plants.

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Now remember that we were talking about the third way to classify plants as being the life cycle - how the plant actually goes from seed to another seed. I like to think in terms like this, because many weed species fall into a category and the management of the particular types of weeds will be the same. In other words, let's consider the annuals; these are plants that live essentially one year. They go from seed to seed within twelve months.

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Okay, so look at this flow chart. If you look on the left hand side, this is the life cycle of an annual that will germinate in the spring, and it goes through a vegetative growth period, then it flowers in the summer, sets seeds, then dies in the fall. This is typically called a summer annual weed or a summer annual plant in general. Many of our crop

plants, for instance, are summer annuals. If you look on the right hand side of the slide, this flowchart represents what is called a winter annual. Usually winter annuals will germinate in the fall, and they will grow during the winter time, or at least hang in through the winter time, and start growing again in the very early spring. Typically, winter annuals will flower and set seed and die very, very early in the year. Usually they are dying by the onset of summer. Consequently they do their job very early in the growing season. That is the winter annual.

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Some common winter annuals we have in Washington, particularly in western Washington, but also in the rest of the state in central and eastern Washington, are depicted here. Common chickweed is located on the left-hand side of the slide. Henbit is on the right-hand lower section. Western bittercress, also called shotweed, is in the center lower section and common groundsel – the upper view of the weed is on this slide. All of these weeds are winter annuals. Remember, winter annuals germinate in the fall, survive the winter and if the winter is mild, they will continue to grow all winter long. And then they will set seed and start sending those seeds out and around all over the place, typically in April to May, and sometimes in June.

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Contrast that with the summer annuals. Summer annuals, again, will germinate in the spring, grow during the summer; and die in the fall. Here are some very common summer annuals. Common lambsquarters, the one we have been talking about quite a bit, is in the center lower portion of the slide. Barnyardgrass is the upper weed that you can see here. Pigweed is on the lower right-hand side and some of the smartweeds are on the lower left-hand side.

These weeds are really more common in central Washington and eastern Washington than they are in western Washington. Think of the climate that we have in western Washington. Very mellow conditions, very cool conditions, but not that cold during the wintertime. Consequently, our climate in western Washington favors the winter annuals and they become more problematic probably in western Washington than they do in other parts of the state. Summer annuals like warm conditions. They like the heat of the summer, they enjoy having those kinds of conditions and consequently, they do best in our climates in central Washington or in eastern Washington. They do very well under those conditions. Consequently, the environment is really telling these plants which part of the state they may enjoy growing in. And, consequently, they become more dominant in those kinds of environments.

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So my question to you is, when do you suppose is the best time to control an annual?

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Well, I think the best time to control an annual is when they are very small, they're wee little bitty. When they are very young, helpless, little plants. I say kill them early, kill them often. So for an annual, if you've got a very small plant, it has very little chance of surviving any type of control activity, that's when you want to hit them. Hit them when they are young and defenseless; when they are small.

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Here's a nice official chart that I've got for you – this bar chart. The numbers are made up, but it gives you the idea of how things work. If you look at the seedling time, the percent of control that you can achieve with, say, a cultivation is usually quite high. Seedlings are easier to kill. Notice what happens as the growth stage advances through the vegetative stage of growth, the flowering stage of growth, and then finally in the mature stage of growth. Controlling those plants becomes increasingly more difficult the older they get. This is regardless of the type of herbicide or the type of hoeing that you are going to be doing. All of these control efforts are easier when you apply them to seedlings than to mature weeds. At least as far as the annuals are concerned.

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The second life cycle of weeds I want to talk about includes the biennials. A biennial is a plant that takes two years to grow from seed to produce another seed.

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OK, let's look at this flow chart for the biennial plants. Notice first of all that on the right hand side is where you have the biennial life cycle, if you will. The seed germinates and you get this vegetative growth the first year. Usually it ends up with the first year being done in the fall where you have this plant forming what's called a rosette. It is kind of a tangle of leaves; it is low growing and strictly vegetative type of plant that first year. During the course of the winter, something magical happens to the plant. It encounters low light, typically very short days, cool temperatures, and these things taken together do what is called vernalize that plant. It basically makes the plant move from a vegetative stage of growth to a reproductive stage of growth. The second year, the plant then, it starts to grow fairly early in the year, sends up a seed stalk, it flowers, and the seeds are mature, and then that biennial dies. So it takes it two years to go from a seed, through that first year of vegetative growth, into the second year of reproductive growth and then the seed is produced. So two full years, a biennium.

If you look at this flow chart, in a lot of ways a winter annual can be compared to a biennial. You also get fall germination in one calendar year, goes through the winter and in the next year it produces a seed stalk and then it dies. Keep in mind, however, that winter annuals do this within twelve months. The other thing to consider is that winter annuals don't have this vernalization requirement. It doesn't have the same requirement for those short days, cool conditions that the biennial has to move from vegetative to reproductive growth. Typically a winter annual, if the weather is nice enough, it will do the whole thing within two months. Sometimes winter annuals survive the winter and in fact grow all winter; often they do that in western Washington. So you do see the cases where winter annuals don't have that requirement for vernalization. So that's the big difference between those two types.

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Here's some examples of fairly common biennials that we have in Washington. Look at tansy ragwort, up in the upper part of the slide. This is the rosette stage of tansy ragwort; later on it produces yellow flowers during that second year, which then lead to airborne weed seeds that blow all over the place.

Common mullein is in the lower left-hand part of the slide. It is the very soft plant. It is often called "wild Charmin" because it has that, well you know why. The common mullein typically, as here in this slide, a rosette the first year; the second year it forms big long seed stalks that are sometimes 5 to 6 feet tall. You frequently see it on the road shoulders in central and eastern Washington.

Common burdock is in the center lower portion of the slide. It's this burr-like production. These are the seed pods, inside each of those are a few seeds. The whole structure of that burr is like Velcro. It actually sticks to clothing and things like this and then those seeds basically move wherever the burr goes.

Look at bull thistle; it's on the right-hand side. First year vegetative rosette; here you are seeing a seed head just before flowering. So that would be a second year plant. It's already been vernalized and is doing its thing. So, consequently, we do have a few of these. Notice that many of the biennials, however, aren't as big a problem in annually cultivated ground, giving us an inkling that perhaps cultivation would be a good way to control a biennial.

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Okay, my question now is, when do you suppose the best time is to control a biennial?

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Well the answer is - the same as for an annual. When they are small, when they are wee little bitty. Get them when they are young and helpless. Don't let them grow up and get tough. Kill them. Kill them early and often.

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Now if you look at this, you'll notice this chart is very similar to it was for annuals. No expense was spared for making this chart, I'll tell you. But notice that it is slightly different. The seedlings are still the easiest to control for a biennial. The rosette, however, is still often very easy to control, provided it hasn't been vernalized. Once it becomes vernalized, that plant becomes more and more difficult to control, finally being that mature plant. If we mow that plant off, never let it flower, never let it make seed, that biennial can live beyond two years. It may stay vegetative until the third year if we continue to mow it off. As long as it has root reserves to continue to survive, if it doesn't make seed, it may not die. So biennials can live beyond what they are typically thought to live.

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The last major life cycle I want to talk about are the perennials. These are plants that live on and on and on.

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Here's a good flow chart for what a perennial might do. If you look on the left-hand side of the screen, you'll see first-year plants. So typically they germinate, go through the vegetative growth and regrowth, and do their thing. Often times they can flower that first year and set seed, but many times they don't. Often times these perennials have to kind of grow up and go through this juvenile period as a seedling before they can go into the reproductive stage. It's not necessarily tied to winter conditions or the same thing we were talking about with biennials; rather it's more of a maturity kind of thing that many perennials have to go through. Think of apple trees, for instance, they often have juvenile periods of 7, 8, 9 years if you are trying to grow them from seedling. Many of the ornamental types of perennials have this same kind of attribute, so often times you don't see the flowering plants until the second or third or fourth year. What's interesting about perennials, and what makes them different, is that they typically have these overwintering structures. They may have roots that overwinter, or they may have buds. On certain types of perennials, buds above ground that overwinter and then they start growing again and basically go on and on and on until something kills them off.

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There are generally two types of perennials, at least the way we think of them in the weed world. First of all, there are the simple perennials. These are the perennials that basically grow and do their thing, but don't tend to spread except by seed. Dandelion, which you probably recognize from this photo, I suspect everybody in the room knows dandelion – down in the lower left. Plantain is another very common turf weed. It is in the lower right-hand section. English lawn daisy is in the center right-hand part of the screen. Scotch broom would be something that is most familiar to people in western Washington. It's a woody perennial. But all of these have in common the fact that they

just spread by seed. They don't really spread clonally. Now they will spread to an extent. They do get smaller plants that grow next to them. Not necessarily from seed, but from the root forming a crown of the plant and then the crown tends to expand with time so the plants get bigger. And they may have some short growth, but typically the seed is how these plants get along.

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The second type of perennial, these are the ones that are generally more weedy than the simple perennials, these include the creeping perennials. These are perennials that spread themselves, not just by seed, but also vegetatively. They produce structures that allow that plant to colonize new areas and to continue to spread, sometimes very rapidly within a site. Think of Canada thistle, which is in the lower right-hand section, we saw a picture of that earlier; here is a close-up of the flowers. Quackgrass is in the upper center part of the slide. You see those structures coming out of the root crowns; those white long rhizomes that help that plant to colonize new sites. Horsetail and stinging nettle in the upper right-hand section; two plants that I am sure many of you are familiar with. Especially the stinging nettle, because it's really kind of an obnoxious plant and it kind of hurts when you touch that plant. Both of them tend to spread through creeping roots.

Think also of Japanese knotweed; down in the lower left-hand section of the slide. Japanese knotweed and related knotweeds, such as Bohemian knotweed and giant knotweed, do colonize sites, but they spread almost exclusively through rhizomes and a series of crowns. They can make seed, but for the most part these plants don't spread by seed. So the creeping perennials often times are more difficult to control because of that vegetative growth of theirs and because they typically are very well connected as a huge root system.

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Question to you, then. "When is the best time to control a perennial?"

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Well you are right! When they are small. You can kill them when they are wee little bitty! That's a very good thing to do. Kill them early; kill them often! Now perennials, however, most of the time we are dealing with perennials, we are not dealing with seedlings. No, what we are dealing with is an established perennial that's been there since, oh man, a long time. Since Columbus, maybe. These things have been around for a very very long time on this particular piece of ground. Consequently, controlling them when they're small may not be the best time. Let's talk about that.

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Notice my graph has changed a little bit. Now this is the growth stage; think of it as

going from one end of the growing season to the other. Now clearly on the left-hand side, you see the seedling weeds are very easy to control and the same is true with perennials. If you actually have a true seedling with cotyledons, you can kill a perennial early and when it's very very small, it's quite easy to control.

Now the next few of these, from vegetative all the way over to regrowth, is more of a growing season kind of thing. Think of a perennial plant as starting to grow in the spring time and then dying off, or dying back anyway, in the fall. Notice that there are two circled areas here; the first circled area is the bud, the early flowering, and late flowering timing of perennial weed control. Now what the plant is doing at that point is, it has become self sufficient. In other words it's making lots of sugar through photosynthesis during these timings. Notice what happened in the vegetative stage of growth immediately to the left of these circled bars - control is more difficult in the vegetative stage of growth. Think of asparagus. When you are out picking asparagus, what are you doing? You are cutting off shoots from a perennial plant early on in the growing season, so that asparagus plant hasn't put a lot of energy into those shoots. The shoots are growing rapidly, but for the most part, they are living on the root system. If we remove those shoots, say we clip them off and eat them, what does the plant do? Does it die? No, it sends up new shoots to take the place of the ones we've taken. This plant can do this for quite some time and the level of control we see is usually quite limited. It is the same with many of the weeds. If we remove those early vegetative shoots, we are really not hurting that plant very much and it will just send up new shoots.

Now, however, if we wait until bud stage of growth, early flowering and late flowering, we are taking quite a good source of photosynthesis, or photosynthates that are made during photosynthesis, that feed the root system. If we remove those plants, we're taking that plant's main ability to feed its root system and it has already spent a lot of energy growing that shoot, and then we remove it. It has to grow them back, and it will grow them back, but each time we let it grow a little bit more than say, just a small shoot, we are taxing that root system a little bit more. And when we remove it, then we are removing its ability to feed itself. So generally speaking, with these perennials, don't try to remove them when they are too small, wait until they are a little bit bigger. The same is true with herbicides. Herbicides work best in that bud, early flowering and late flowering stage of growth for perennials. So keep that in mind.

Now notice on the far right-hand side of the chart, I also have regrowth circled. Many perennial weeds green up in the fall, or stay green through the fall. They have done their seeding for the year; they've already done their growth and development for the year. What that plant is doing now is getting ready for winter. It's putting as much sugar as it possibly can in the roots, it doesn't have to feed new shoot growth, it doesn't have to feed developing seeds or fruits or whatever. It's putting all that energy into the root system so it can survive the winter and start growing rapidly the following spring. Many of our crop plants do the same thing. Think of turf, for instance. If you take care of your turf in the fall, then you have faster growing turf later on in the spring time. That's why we fertilize and do some things in the fall, because that plant is getting ready for winter and we want it to survive winter well. The weeds are doing the same thing.

Consequently, during this regrowth stage that's not a bad time to apply some herbicides as well. Herbicide will move with the photosynthate of the plant, and during that regrowth most of the photosynthate is moving down, south in the plant if you will, down into the roots and that's what we really want the herbicide to do.

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Now, I've used the term several times, and I want to kind of flesh it out a little bit more for you - vegetative reproduction. Some perennial plants, those creeping perennials that I was talking about, do spread vegetatively. In other words, they don't have to go to seed, they don't have to do all that; they just produce new clones of themselves. Think of when you are getting a houseplant, for instance. Let's say that a friend of yours has a houseplant growing you really like. What do you do? Do you wait for it to go to seed and then get some seeds from them? No, usually you take a little shoot that comes off, you pinch it off, put it in glass of water and put it on the window sill. Eventually it starts making roots and then you can transplant it. It's a great way to propagate certain perennial types of houseplants. Well, these weeds are doing the same thing; it's a clonal reproduction. Sometimes it's by roots. If you look at the center photo, that's Canada thistle, and notice what's going on with those three shoots coming off this horizontal root. Down about 8 to 12 inches, this horizontal root of the Canada thistle is growing and all along that root you see upright shoots coming off of that. So everywhere that root goes, you are going to see new shoots.

Think of stolons. On the right-hand side of this you see this white clover that has basically a stem that is lying flat on the ground and it makes not only flowers, but also leaves. And all along there, it will root at the nodes and so it is forming new plants as it continues to spread while it is prostrate on the ground.

Think of rhizomes. Rhizomes are similar to stolons in that they are stem material, but they are actually growing underground as opposed to on the surface of the ground. They look a lot like roots, but rhizomes are stem material. They have nodes just like stems do and they have adventitious roots and new shoots that come off of that. This particular photo is of reed canary grass and you can see the rhizomes, kind of pinkish in color, growing from that crown. As those rhizomes grow they typically will aim sideways and the will eventually poke up through the ground and form a new crown, sometimes many feet away from the mother plant.

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Here are some other structures by which perennial plants spread themselves vegetatively. Think of tubers, down in the lower right-hand corner. This one happens to be yellow nutsedge; but we are very familiar with tuber production on potatoes -- same kind of structure. Now actually, a tuber is also stem material. It is not a root, it is stem material. It has nodes and each one of the eyes of the potato is actually a bud on that plant, it's very similar to a leaf bud or an axillary bud on an aboveground stem. So these tubers, then, have all these latent buds on the surface of them so that when conditions

are right and the hormones release those buds to start growing, you get new shoots from that. The shoots are growing from a nice starchy tuber which provides a lot of energy, so typically these plants grow and develop quite nicely.

If you look on the left-hand side, you see a series of bulbs. If you've ever lived in the southeast United State, you know what I'm talking about. Sometimes when you mow a lawn down there, it smells like a well-tossed salad because there is so much wild garlic in the lawn, it just perfumes the air every time. This is a picture of wild garlic and anybody who has grown garlic in your garden knows how these small bulbs form right beside the growth plate of this bulbous plant and you do get lots of new bulbs produced. Now these typically just make a cluster of wild garlic and it tends to grow out slowly that way. But if you ever cultivate the ground, you move those bulbs around and then suddenly you find wild garlic growing everywhere. Same is true for many of our perennial bulb plants, if we till the soil, we move it around. Think back to the rhizomatous roots, they do the same thing. If we were to cut that root or rhizome into pieces, say with a rototiller, we are just spreading that root piece or that rhizome piece at various different places. Each one of those – even a ¼ inch of that root or rhizome -- is enough to produce a new plant. Same is true with these bulbs. Each one of those mini bulblets is able to produce a new plant. Same is true with a tuber if we were to cut it into pieces. That's how we propagate potatoes, in fact, we cut it into pieces. If we did that with cultivation, we would spread those tuber pieces all over and get new shoots as a result of that.

In the upper right-hand part of this is Bohemian knotweed and you can see that it is rooting at the node. This is a stem piece that was broken off, and that node, the little raised section there, has produced that new shoot with new roots that basically is a brand new plant and ready to start growing and doing its thing. Now, these vegetative shoots are usually much more robust and much quicker growing than if this plant reproduced itself by seeds; so vegetative reproduction can really offer a plant a lot of benefit in that those plants are able to colonize a new site very rapidly, with lots of energy and do their thing that way.

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Break Time

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Okay, the next portion of this, and we are going to kind of go through this step by step, are different strategies that we might employ to try to control weeds better. This is the list, and we will be going through each one individually, but they include prevention, mechanical control, cultural control, biological control, and chemical control. Let's talk about each one of these.

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The first major strategy for weed control is prevention. We want to avoid establishment of these new plants somewhere else. Often times this takes the form of a regulatory or statutory weed control. We say “it’s against the law for these weeds to be moved around” and by golly, that’s how it works. Well, unfortunately, plants can’t read and so typically they don’t pay any attention to it. However, we can constrain people to do the right thing sometimes. Seed laws are generally those types of laws that say “if I am buying a particular lot of seed, then I don’t have any noxious weeds or any other weed seeds in that seed lot.” These seed laws are generally agriculturally based, but if you have ever planted lawn seed, for instance, or tried to seed a new lawn, you’ve probably gotten seed that has been tested for not only germination percentage, but also for content – whatever is in there. It also gets tested for disease and some other things that perhaps we would not want to introduce when we add seed to our lawns or other places.

Noxious weeds are those weeds that are declared by statute to be objectionable species and that are required by law to be controlled. There are a number of noxious weeds in every state; in Washington we have quite a few at different levels. We have a class A weed, a class B weed and a class C weed that are set up in these categories to set up different levels or different types of control efforts.

The quarantine is the third method that is used, at least in the state of Washington, to prevent movement of noxious weeds, or propagules, from one site to another. Sometimes a quarantine would be a particular species of plant, for instance Japanese knotweed. We have a quarantine in Washington that nurseries can’t sell Japanese knotweed, in order to prevent it from moving to new locations. These types of quarantines are also sometimes used on nurseries if, for instance their containerized plants, of say Douglas fir or rhododendron, are infested with, say yellow nutsedge. That would be the gift that keeps on giving - if I take this plant and I plant it in my yard, then I have not only planted a rhododendron, but I have also planted a yellow nutsedge or horsetail or some of these other types of weedy problems. Consequently, these regulatory laws are there to protect people who haven’t got the weed, from getting the weed.

Think of sanitation. By this I mean the bark that you are buying from the nursery down the street. Is the bark really free of other things? Are horsetail plants growing in that nice pile and then when it gets sent to your place, then suddenly you have moved the horsetail from where it was into your yard. Think of gravel. Think of top soil. It is very important that you make sure, and you as the buyer, make sure that you are not transporting weeds from where they are currently located in those sources and bring them directly to your house.

You also want to prevent seed production of these pioneer plants that start showing up; in particular the perennial weeds. As you know, perennial weeds are very difficult to control. So if you can prevent them from establishing themselves and starting to make

seed and these other vegetative propagules that we were just talking about, then you are miles ahead as far as preventing that plant from becoming a problem in the future. The effort is much less for prevention than it is for later trying to clean up the problem.

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Okay, let's talk about mechanical control. Mechanical control is taking hand A, wrapping it around plant B, and pulling and repeating over and over again, because mechanical control is very specific in what it does. Notice there are many different type of mechanical controls or strategies or different ways of employing mechanical control. The most common one is that hand pulling or hoeing or somehow removing that plant and allowing it to then desiccate in the sun. Hand pulling, as we said before, is usually best employed when those plants are very young. In fact, cotyledon-stage plants are the easiest to hand pull because they are very easy to pull up and they are very easy to desiccate. They will always die. If we are hoeing, you want to hoe very shallowly because you don't want to bring seed up from below. What you want to do is remove the weeds that are at the surface of the soil and then keeping them there.

Tillage is the second method of weed control that is commonly used in agriculture, but also in gardening. Think of this as being your vegetable garden where you are out there cultivating between things, actually rooting up plants, using usually some type of power equipment that is going to work for you. Tillage is very commonly used on annuals and is very effective on annuals. But, as we were talking about with these vegetative perennials, particularly those with underground structures that allow that plant to move around, tillage can be very counterproductive in that you are spreading the plant more than you are controlling it.

Mowing is also a very common method of mechanical control, particularly on those dicots; remember those are the plants that have the growing points fairly high up on the plant. Every time you mow a plant, it's going to have to then regrow itself in order to get from that vegetative state of growth to the reproductive stage of growth. The more frequent the mowing, the more likely it is that you can prevent seed production on that plant. Now plants don't just allow you to do that, however; many of you have noticed that after you've mowed a few times, then the plants form a very low growing plant but still try to flower just below the blade level of your lawn mower. Weeds are very good at doing this kind of thing, so you have to be on guard against them. The other thing to consider is that most grasses, the weedy grasses, don't respond very well to mowing. In other words, you don't kill them by mowing. A lot of broadleaves are the same way; particularly those perennial broadleaves, creeping perennials like buttercup, for instance, or Canada thistle. You can mow them as much as you'd like and you will still have those weeds persisting in your lawn.

Think of mulches. I've got a slide later on where I'll show you different mulches, but mulches are essentially mechanical control because what you are doing is preventing sunlight from getting to the soil surface or getting to the plant itself if you put it on thickly enough. The idea of a mulch is that if a seed is near the surface of the soil and gets

exposed to light, then it's much more likely to germinate and grow. If a seed is buried deeply in the soil, for instance, it's not going to germinate and grow. Because even a seed knows if it is buried deeply, it doesn't have the energy to make it up to the surface of the soil, so it will just lie there dormant. If we use a mulch, say a bark mulch, or even newspaper or things like that, what we are doing is preventing sunlight from getting to the soil surface and that stops the seed germination process. What we would really like to do is to employ these mulches before the seeds actually germinate. We want to keep the seeds as seeds and not as plants because plants sometimes can find their way through mulches.

So if we are dealing with winter annual weeds, things that germinate in the fall, it makes sense that you will want to do you mulching in the fall before those seeds germinate. If you are dealing with summer annual weeds, you'll probably want to mulch in the springtime when the bulk of those seeds start to germinate. So mulches are really kind of flavored differently depending on the type of weed we are trying to control.

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Think of the perennials, can you mulch your way away from Canada thistle and things like that? Well, if you have a loose mulch, you probably can't get there. If I am using bark or sawdust or even gravel or pebbles, or pumice; putting it out on top of an established perennial like Canada thistle or horsetail, you'll find that that plant is quite able to grow up through just about any depth of mulch you want to put because it's got the root system already there and it's able to do that. So mulches generally work best on annual weeds or from seeds of a biennial plant. Keep in mind, though, that the mulch itself can become a really nice bedding area for certain weeds. So the weeds that blow into a mulch during the growing season could germinate and grow in the mulch the following year. So, mulches don't last forever. Occasionally you have to scrape them out and put on new mulches.

Keep in mind, too that mulches, if applied too deeply around ornamental perennials, can have detrimental effects on those perennials as well. Particularly if the root system needs to be fully aerated for that perennial plant. Think of a rhododendron. Too much mulch can be a real problem underneath a rhododendron because it is much more prone to wet soil conditions, low oxygen down there which generally leads to more disease and other issues that plant just does not like. Consequently, you need to be aware of how the mulch will work and what type of weed you are trying to control. If you are trying to control established perennial weeds, you have to use a mulch that will stop that shoot from coming up. Either a plastic type of mulch or a landscape barrier; something that is physically strong enough to prevent emergence of that shoot. Those types of mulches are often buried fairly deeply in the soil and then topped, using a loose mulch to make it more attractive.

Fire and flaming is also another method of weed control that can be effective. Think of fire as a way to remove a plant that has already been growing; think of flaming as a way to kill a very small plant using propane flame. The idea with flaming is that you get a

very small plant, expose it to a lot of heat, which basically melts the cuticle of that seedling, explodes the cells that are there, and renders that plant dead. If, however, the plant is too well rooted and has quite a lot of root system down below, flaming will not be very effective because that plant will grow back from the root. Flaming is much like hoeing or hand pulling where the plant breaks off and leaves the roots present in the soil. Those types of plants will grow back from that. So flaming is best employed against young annual weeds at the time they are still cotyledons, up to about 3 leaves. Fire as in roadside burnings and things like this generally only work if you are trying to clear the area for a different type of application of a herbicide, for instance. Fire is not often a good thing to do and almost never is good to do in the landscape because fire tends to burn things, like, I don't know, your house. So you need to be aware of where your using fire and I would say you are much better off using flaming as a technique as opposed to actually consuming that plant with fire.

I do mention flood here because flooding can sometimes be used to control weed species; particularly terrestrial weed species. Unfortunately, the water has to be in place for sometimes up to 2 months before you actually get weed control. Now think about that - if you're flooding your garden for 2 months, you can really get rid of those annual weeds that are problematic for you. But maintaining a flood stage in your backyard garden is probably not the easiest thing to do and probably not the best thing to do for you. So, consequently flood is not used very commonly. In fact, flood, usually in the context we experience it in Washington, is that the flood brings more weed species in because these are brief moments where the weeds can move via water from places where they are to places where they ain't, which may be your garden and your lawn.

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Here's a photo of gravel and bark as they might be used in a landscape. Now, I have these photos here for a couple of reasons. First of all, you need to think about the landscape design. Bark can be very attractive, but there are some problems with it. If you look at the left-hand photo, there are a couple of things that jump out at you. First of all, they have used gravel and bark, kind of mixed together, which initially looks very nice. Unfortunately, these mulches tend to mix together a little bit more thoroughly as time goes on, as you walk thru there, and things like this. Look also at the hillside that we are dealing with bark on. Now, bark generally doesn't stay at the top of a hill because it floats, and as we get moisture moving down that hillside, that bark will move from the uphill to the downhill. Consequently, it requires a lot of maintenance to maintain this kind of site in a pretty nature such as this.

Now the slide on the right-hand side shows that the gravel really is used on this kind of waterway, which can be an effective way to use gravel. And the bark is augmenting that from the sides where the water is probably not going to be moving quite so much. It is next to a sidewalk, which can be an attractive way to use bark mulch, but remember that it's not going to stay put there, either. The other location that might not be good to use a lot of gravel, would be, I don't know, a school perhaps where there's a lot of

young children who like to throw rocks. Just keep that in mind anytime you're putting out these kinds of sites.

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The second major type of strategy for weed control is the cultural method of weed control. We talked about mechanical, let's talk about cultural. Crop rotation is frequently practiced for disease management but it also can be something to consider for controlling weeds as well. Many weeds like to grow in a similar type of condition that the crop grows in. In other words, if I am growing beans or squash or corn or some of these less hardy vegetables in my garden, it is very likely I am going to be seeing the summer annual types of weeds become more problematic in those kinds of settings. You are going to see late season germinating things like common lambsquarter, like red pigweed, like barnyardgrass be more problematic in those later season vegetables. The reason is because they germinate under the same kind of conditions that the seeds that we plant as garden plants will be germinating in. The winter annuals will be controlled by cultivation, usually that last seedbed you are preparing will remove a lot of those winter annual seeds, or weeds that have already started germinating and started to do their thing. Consequently, that summer annual crop will then lead to summer annual weeds. The same is true for the winter annual or the early planted types of crops. Think of crops like lettuce, like carrots, like radishes planted very early in the season. Consequently, we don't have the same period of time for controlling those early germinating weeds; which are usually winter annuals that like to grow under those same kind of conditions. The summer annual weeds are at a disadvantage when we're growing an early season vegetable crop; because that crop is already there, it's growing up and shading the soil surface at the time when those germinating seeds would normally be germinating. If you have a lot of shade there from the crop itself, then you're going to see less germination from those summer annual weeds. Consequentially, by using crop rotation, not with a mind so much for which particular vegetable, but more on the mind toward what type of vegetable, early season or late season kind of vegetable. You can get some weed control from that decision-making process.

A second method of cultural weed control, things we do managerially, is to use cover cropping. I've got a few slides of cover crop I want to show you later on, so I'll kind of delay this, but for now keep in mind that cover cropping can be a useful way to approach weed control.

Planting dates also can be a useful method to basically select what types of weeds you are trying to manage against. Early season transplantings may be a good way to approach controlling summer annual weeds. Get the plants out there growing earlier, then that's going to take care of those summer annuals because they just won't germinate on you. The reverse is also true, if you go to a little bit later season of planting, you can get that extra cultivation in or some other type of weed management, even hand pulling, before you actually plant the crop that you are trying to grow. The same is true for ornamentals in this case, because you may move your planting dates

based on when you can last cultivate the soil or when you want to get soil covered by a certain time frame during the course of the year.

Watering and fertilizer management, we don't think of that as being weed management but in a way it is. If you're careful with your watering, if you put the water out at a certain time, you may see some weed management as a result. Seeds of weeds need to have water. If we go to a drip irrigation or some kind of a soaker hose-friendly kind of crop, chances are good that between the rows, areas that stay dry, you're not going to see much in the way of seed germination. So the way you water in a garden or an ornamental area may have good dividends to pay as far as weed management. Fertilizers, much the same way, we want the fertilizer to go to our crop plants or ornamental plants, not to the weeds. So placement of fertilizer can be a useful tool for making sure the weeds are not growing at a time that we don't want them to be growing.

Now, I have allelopathy here. Allelopathy is chemical warfare, if you will, that is being waged by a plant. The plant produces certain chemicals that stop or somehow damage the growth of other plants. These allele chemicals are produced either as the plant is growing or as leaf material or as root material starts to decay after the plant dies. Often it is used in the way of cover crops, so I'll use that as the segue to move into the discussion of cover crops.

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Think of cover crops as one plant fighting against another plant. Here are a few photos of different cover crops that frequently are used in agriculture and to a lesser extent in garden situations. Buckwheat is located on the lower left-hand corner. This is a very fast growing plant that likes warm conditions and is very frost tender. In other words, if you plant it in the fall, it will die very quickly after the first frost. The idea of buckwheat is that you can get a very dense planting and hopefully it will winterkill before it makes seed because then the buckwheat could become a weed in its own right.

I also have mustard in here. Mustard is a very commonly used cover crop in that it has glucosinolates, which are sulfur-bearing product, or sulfur-bearing molecules, in the leaf material itself. As this plant is incorporated into the soil it releases a volatile gas that is very effective at killing not only weed seeds, and weed seedlings, but also disease pathogens and certain insect types that may be overwintering in the soil. So mustard may have a role to play in your garden area. The problem with mustard is you have to seed it fairly early – usually August time frame and in the warmest parts of the state, in September time frame – in order to get big enough to incorporate it later in the year. Sometimes if the conditions are too cool, it doesn't produce very much and then the mustard itself does not provide that much competition with other weed species.

My other two shots here are of vetch, in the upper right-hand corner, and then winter wheat in the lower right-hand corner. Those crops also need to have fairly warm conditions in order to grow and compete well with weeds. If they don't get started rapidly, if the weeds are growing as fast as these cover crops, as they frequently do in

western Washington in the late fall and on into the winter, then the weeds are not controlled very well. This is why I have the question mark on weed suppression.

The first bullet I have up there is nutrient scavenging and I think that is one of the major benefits of having a cover crop in your garden. You do get some weed suppression, it's better than having bare soil, but one of the major plusses is that you are tying up that nitrogen which would otherwise be leached out of the soil and lost to your garden. You are tying it up in these cover crop plant materials. You want it in the cover crop; you don't want it in the weeds. So that's the whole idea of a cover crop.

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Now also, cultural weed control would include using a ground cover. Ground cover is one weed to replace another, in some cases. And this photo, this is English ivy really kind of going crazy on a landscape in western Washington. English ivy generally minds its own business much better in central Washington and eastern Washington than it does in western Washington. Consequently, a ground cover in Moses Lake with English ivy may be a very effective ground cover in that it competes well with the weeds and doesn't become a weed in its own right. If I am doing this, however, in Mt Vernon, where I am, then English ivy can be a big problem even by itself and so you need to be sure that the ground cover you choose to compete with your weeds doesn't become a problem in its own right.

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Biological control is another method of weed control that generally doesn't work all that great for the backyard homeowner. Biological control generally is set up on very large populations of very widespread weeds. The idea is that if we can't control it ourselves, if it costs too much, or if there's just too much area, then perhaps the biological enemies for these plants can do the job for us. The idea is that wherever this weed came from it had natural enemies that prevented it from being a big problem in its home country. When it was introduced into the United States, for instance, then that weed did not have those natural enemies eating on it. Consequently, it's able to grow and develop very rapidly and produce itself very effectively because it doesn't have anything that's really slowing it down. The idea of bio-control is that we go to the place where this plant is native, find the animals, insects, diseases that might be eating on that plant and keeping it from becoming weedy in its native country, and then releasing them in the new country where this plant is becoming epidemic.

This only works with lots of testing. We need to be very sure that what we grabbed in, say Japan, to release on Japanese knotweed in the United States does not then go to related plants and become a pest on related plants like rhubarb. We don't want to bring in a new pest that we are going to have to try to control in other ways. We want an insect, in fact, that is going to die before it eats anything else. The testing that gets done on bio-control does insure that is the case.

In the lower right-hand part of the slide here, I show you a picture of a cinnabar moth larva, the caterpillar, eating tansy ragwort, a noxious weed in the state of Washington. These moths were not native to the United States, but were brought to the United States and released specifically to control this species. Consequently, the insect is doing a pretty good job of defoliating these plants and that means fewer seed are produced and sometimes, in fact, these early rosettes are killed over the course of the winter through pretty efficient feeding by these cinnabar moths.

I have a picture here of goats. Goats are a commonly used type of thing for controlling many broadleaf species, particularly the difficult perennial species that become problematic. Here they are using the goats to control Himalaya blackberry in western Washington. The goats typically feed more on these broadleaf forbs than they do on grasses; consequently, the weed species that are broadleaf forbs are susceptible to selective grazing through goats. Now goats aren't the end all of things, if they are not managed properly goats will eat the good things as well as the bad things. And keep in mind when you are dealing with a perennial weed, the goats will remove it, much like you spending the time to cut down a bunch of branches of say, like a blackberry. If that's all you do, that blackberry will grow back and be quite as happy as it was before. So goats have to be used in a systematic way in order to really reduce these populations of the perennials.

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The next strategy of weed management involves chemical control - using an herbicide to control particular weed species. Now, I don't have enough time in this forum to talk about all of the different strategies involved with chemicals or using herbicides, different weed management techniques and such as that, but I do want to talk to you about several assumptions that are made and different information about the herbicides that you might find useful as you use products in your back yards. First of all, the concept of selectivity. The idea here is that not every herbicide kills every weed species. What it does is control different types of weeds. Remember back when we were talking about monocots versus dicots? Let's use that as one of the selective methods by which weeds can be controlled with herbicides. A common selective herbicide would be 2,4-D or some other product that is used for, say, dandelion control in grass. It is selective in that it controls the broadleaf weeds, the dandelions, while not injuring the monocot, or the grass species that we have planted there in our lawn. That selectivity is important because as much as you would like to kill the grass, you will not be able to kill it using Weed-B-Gon or some other product that has 2,4-D in it. So that is the selectivity of that particular herbicide.

A different herbicide may be very non-selective. For example, glyphosate or Round-Up is a non-selective herbicide. This particular product kills just about anything that it comes in contact with, if you are a plant. So if you spray a broadleaf weed, you can kill it; if you spray your grass, you can kill it or severely injure it. So the idea of a non-selective product is that you can get total vegetation control but on the other hand, you have to be very careful where you are applying it if you want to use it in a selective way,

in other words, kill a broadleaf weed and not kill something that you want to keep. So that is an important concept based on the herbicide that you select.

Placement is another thing to consider. Many of our herbicides are granular products that are only useful once they get into the soil. Most granular products are also pre-emergence products, meaning that you have to get the herbicide there before the weed seeds germinate. So placement in this case means putting that herbicide where those weed seeds are going to germinate, which is about the top half-inch of the soil surface. If you're applying a granular product, then, like Preen, the idea would be to place the product on the soil surface at the proper rate, rake it into the soil or irrigate it into the soil so the herbicide is present before those weed seeds start to germinate and grow. If the weed seeds have already germinated, then you are not going to get control. If the herbicide is placed too deeply in the soil, you may have diluted the herbicide to the point where it is not going to control the species as it would at the proper rate. Or if it is left on the surface, many times these products will just evaporate from the granule and end up not controlling any weeds at all. So you can see that placement plays a very important role in the activity of a product like Preen or Casoron.

Timing is also alluded to in that placement. When I mention pre-emergence timing, that herbicide has to be done before the seeds germinate. Other types of herbicides need to be applied post-emergence, after the emergence of the weed from the soil surface. So those products need to come in contact with weeds or shoots or stems or some other material in order to be absorbed into the plant and kill it. If I apply certain post-emergence products before the weeds come out of the ground, for example glyphosate, then I will not control those weeds. Even if they germinate the next day, glyphosate does not control that plant. Similarly, if I apply a pre-emergence product like Preen to a weed that is already up and growing, I won't control it with that product either, because the roots are already down deeper than that herbicide is going to be causing an effect. Consequently, timing is going to be very important depending on herbicide choice as well.

Mode of action can be important because this is how the herbicide actually kills a weed. We do have resistant species, meaning that certain weed species are not killed by a mode of action that used to provide some level of control. That being said, it is important to mix and match your modes of action. Look for things that have different modes of action in order to get a better level of weed control than you would get otherwise. So these combinations are maybe some ways to approach weed management in a way that will give you better weed control as a whole.

It also plays into the spectrum of activity, meaning that certain herbicides will kill certain weeds very nicely but won't kill other species, regardless of how much product you put on. The spectrum of activity is well known for all of the herbicides, so it is important to know what the weed is that you want to kill and then match the herbicide to that particular species. If you don't know what the weed is, then you are going to have a hard time killing it because you may not be selecting the proper product to do the job.

So all of these factors play a role in chemical control, but I think that it is most important for you to realize is that chemical control is something that you will be doing once you have a better idea of how these herbicides actually work. This is good basic information for you. If you want more information, it is probably best to talk to the Extension Agricultural Educator or other type of person who has a particular knowledge base on these particular products.

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Now, integrated weed management is kind of the combination of all these different strategies we've been talking about for the last several minutes. Integrated weed management is combining two or more of these strategies to work in concert with each other; either at the same time, or in combination or sequence, so that you are hitting the weed in a number of different susceptible stages. To work best, it's always good to know what species you are dealing with. Now, I spent quite a bit of time on the lifecycle: annual, vs. biennials, vs. perennials. It is important to know that because certain strategies lend themselves to certain lifecycles. For example, cultivation lends itself well to annual weeds but not so much to those creeping perennials we were talking about. Growth habit can play a role in that depending on how tall that weed is, certain management strategies will be more effective. If I try to control a plantain with a lawn mower, I think we'll find it doesn't do a very good job because the plantain is much lower than where you will be mowing that lawn. How the plant disperses its weeds, or moves itself around, is also a factor to consider. If the weeds are primarily annuals that need that weed dispersal, like a dandelion that will blow it all over the place, then perhaps we are going to not use a lawn mower, for example, to try to control dandelions. Because, again, we are not only not cutting the leaves, we are also knocking those seed heads off and having them blow all over the place.

So it's important to know the targeted weeds and then select strategies that will be effective against them. It is very important, too, to not let new invading weed species get themselves established. Remember all the dormant seeds, the number of seeds that a weed can produce. These are very important concepts to keep in mind because prevention is always easier to do than cleaning that plant later on when you have thousands of them instead of just one or two plants. So it is important to then strategize these weed management strategies so that you have good weed control.

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So which management should I use? There are some things you should think about. What is the general climate of the weather at the time that you are doing the applications? For example, if it's in western Washington, and you are trying to control early germinating seeds or winter annuals, the rainfall in western Washington will often preclude the use of a herbicide, for example. If that's precluded, then you need to use other strategies that will be effective. Think about tillage, if you can use tillage at a time when the soils are very wet. Perhaps you would be better off using a flame or some

other mechanical method of weed control, or a hoe, where you can cut those plants off. So that will be an important thing to consider.

What about the soil factors? Are you dealing with sandy conditions, or are you dealing with very clay-like, or high organic matter conditions? These will play a role, not only on herbicides, but also on mechanical weed control. There is a certain amount of cultural weed control that you can do on sandy conditions, for example, that you couldn't do on a clay soil. Think about the timing of putting transplants out in your vegetable garden. If the soil is saturated and very wet, and very dense, that transplanting may not work very well and that could favor the weed species that could be coming up when your crop plants are not doing so well.

You have to consider what is growing around you, particularly in areas that are more natural areas, such as stream sides and places like this. They will also have a preclusion against using certain herbicides, for example, if that vegetation is sensitive to that herbicide. Perhaps you are dealing with a wetland; under those conditions one of the worst things you can do is probably go in there and try to cultivate it. Because you cause more damage that you would if you were using it on a more well-drained site. So it's important to think about the surrounding vegetation as well as the site that the vegetation is growing on.

Keep in mind, too, about that weed biology. What type of perennial are we are dealing with? Are we dealing with a creeping perennial? If so, you have to be careful about cultivation. If we are dealing with an annual that produces weed seeds very early in the spring, perhaps we are better off using a mulch and not letting it get started in the first place. So there are different things to consider as you develop your integrated weed management strategy.

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A stale seedbed is a good integrated strategy for those areas where you are going to use annually planted crops, such as a vegetable garden or an ornamental garden where you are putting out bedding plants, for example. If you've got bare soil, remember that bare soil has full sun exposure and that is the big key for seeds to germinate. So those weed seeds, as in the photo here with the common lambsquarters seeds, are going crazy. Because it's bare soil, they'll germinate and you will get a massive flush of weeds. The idea of the stale seedbed, then, is to allow that process to occur. Those seeds are going to germinate one way or another. Get them all to germinate at the same time, then you can kill them off with a herbicide such as glyphosate; or flame as in this photo; or shallow tillage prior to planting. You don't want to do deep tillage because then you will bring up ungerminated seed from deeper in the soil profile (those seeds that didn't germinate because they know that they are deeply buried – they don't want to germinate unless they are close to the surface where the sun can get to them). So if I use a shallow tillage, I can kill the seeds on the top of the soil and then because I've killed them with another method and I haven't moved the soil around, almost all of the seed has been exhausted in that top half-inch of the soil. You will still get a few seeds

that germinate; there are some dormant seeds in there that may overcome dormancy during the course of the growing season. But sometimes you can get up to 60-70% weed control just from a single operation and that is where a stale seedbed can really pay you some benefit.

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Here's another integrative method that you may not think of as an integrative method. A high density planting of bedding annual plants, such as these flowers here, could be used in a cultural method of weed control. Because you are planting at a very high density, what you are doing is taking the space that would otherwise be taken over by weeds. If there is something physically growing there; it is shading the surface; and absorbing that space and stealing sun, and nutrients, and water from those weed seeds instead of the other way around. And also because this particular planting has bark mulch in those areas where you don't have anything planted, you are using a mechanical method of weed control at the same time. So, what you are doing in those places is keeping the sun from getting to the soil surface, again, stopping those seeds from germinating. So you have basically a cultural method, high density planting, coupled with mechanical weed control, bark mulch, is a truly integrative method of weed control.

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There's one more thing I want to talk about on these weed management types of areas and that's to use thresholds. Now, commonly thresholds are used for public sites, like school districts and parks, and places like that. But often, even for backyard weed control or lawn weed control, you might want to consider thresholds before initiating a control strategy. Threshold is the point at which you declare you are going to be doing some level of weed management. It may be species-specific. In other words, based on the species of weeds that are present, you may or may not initiate control. For example, if I have a common dandelion, I may not be overly worried about it. There is a lot of dandelion out there that's fairly innocuous vs. a Canada thistle, which is very spiny and nasty to deal with -- particularly if you are walking barefoot in a turf. Consequently, I may want to have a very low threshold for Canada thistle, but a very high threshold for common dandelion. In other words, there needs to be a lot of common dandelion before I initiate control measures, whereas with Canada thistle, I might initiate that control at a much lower population.

We can also be site-specific. Different sites do allow different levels of management to occur. For example, if I have a lawn, I may not mind so much a certain amount of weeds out there in my lawn. At some point I will want to do some weed management; but if it's just mostly grass I may be perfectly happy to allow things to grow normally without employing any weed management beyond the typical mowing heights. However in a vegetable garden, I am going to have a very low tolerance for weeds. My vegetables, for me, are very important and I'm not going to allow weeds to start taking away some of the benefits I get from a vegetable garden. So I am going to have a very

low threshold in my vegetable garden. So you can see that these different sites would have different levels of thresholds, depending on just the site itself.

More commonly, I think we deal with combinations where we are dealing with a specific species of weed as well as the particular situation where that weed may be found. Let me give you an example of that. White clover in a lawn typically is not a big issue for most people. It's green, it grows, it's not so bad – so if I have a bluegrass lawn with white clover in it, I might say I am not going to try to control the white clover at all. Or maybe when it gets up to over half the lawn is white clover, then I might contemplate doing some level of weed control. Now if I run a daycare, however, I might have a completely different idea based on that same situation. White clover, as you know, certainly attracts bees, and bees and kids just don't get along -- particularly barefoot kids running around in the grass. Consequently, under those kind of conditions, I may say that white clover in my lawn is completely unacceptable. Maybe I would do some kind of weed control based on a very low threshold of white clover in that lawn in that particular situation. So you can see that maybe this threshold can be a powerful way for you to use to decide when to initial control and to do that exercise before you actually have the problem.

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The last thing I want to mention is that it is important for you to know the species that you are dealing with. There are a number of different publications out there; you have probably seen many of these that are on the screen right now, *Weeds of the West* being the most commonly purchased weed identification guide that I think is anywhere in the state of Washington. *Weeds of the West* is very good as far as having photos of a lot of the very common weeds. But keep in mind *Weeds of the West* was developed for all the western states. There are going to be many weeds in there that don't fit our particular climate patterns. For example, there are going to be weeds in *Weeds of the West* that may be at sites that are very cool and damp and if I live in Yakima, they may not very well describe the weeds that I am talking about. If I happen to be in Renton, Washington and I've got some very damp conditions, there are some desert species that are listed in the *Weeds of the West* that will never ever grow in Renton. So you need to keep that in mind that it was developed for a different purpose. However, many of the common species, remember weeds are pretty open minded about where they grow, they have a wide range of conditions that they can grow in. So you'll find that many of the weeds in *Weeds of the West* are problems wherever we happen to be anywhere in the state of Washington.

Another book is *Aquatic and Riparian Weeds of the West* this is a fairly recent edition that came out of the University of California and it specifically is dealing with aquatic and riparian weeds – those that are growing on riversides or in some cases along the banks of ponds and lakes. If you are dealing with those kinds of conditions this could be an invaluable resource. You will probably want to have it for your Master Gardener library.

The book I use a lot is *Plants of the Pacific Northwest Coast.* I find it a very good match to what we have here in Mt. Vernon. So if you are living in western Washington, this would be a very volume to have. It also covers a lot species you would have more inland so if you are in extreme eastern Washington or in northeastern or southeastern Washington, it may have a good fit for some of the higher elevations as well. So I would consider getting that book. The plus of that book is that it also has a lot of native species and many times you as a Master Gardener will be asked to identify this plant that comes in, sometimes that is a native plant and sometimes it is nice to be able to identify it using a different guide book.

The other two books here are *Garden Wise* books. These are published by the Washington State Noxious Weed Control Board and there is a eastern Washington and a western Washington edition. These are books that have in them, instead of the weeds necessarily, they have alternatives for garden-type ornamentals that can be invasive. In other words, if I want to use something like a butterfly bush for attracting butterflies or for the visual impact of those beautiful flowers, it may be that I want to select something else to use instead of that butterfly bush and *Garden Wise* can help me do that. *Garden Wise* suggests alternative, noninvasive type plants that achieve the same visual effect. If you don't have *Garden Wise*, check into getting copies of that for your Master Gardener Library.

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In conclusion then, I hope you learned a little bit about the way I think about weeds and the way I think about weed control. If you have questions on any of these, refer back to the Master Gardener Handbook as there is a full chapter on what we have covered in very brief detail here on this slide set and the chapter goes into great detail about most of these concepts . Good luck and good weeding out there!