Welcome and thank you for visiting the River to River CWMA’s 2016 WPF workshop presentations. This is one in a series of five presentations that were presented in different locations across the River to River region in the spring of 2016.

This presentation is on herbicide considerations such as safety, effectiveness against target species, and other factors when deciding when and how to use herbicides to treat invasive species.
“In general for work in natural areas, it is best to select compounds that are effective against the weed, not likely to drift, leach to groundwater or wash into streams, nontoxic to people and other organisms, not persistent in the environment, and easy to apply. In some circumstances, a single application of a more toxic or persistent chemical that kills the weed, however, may be preferable to a less persistent, less toxic compound that must be applied repeatedly. Strive to do the job with the smallest total negative impact to the environment.” (p. 5.4, Tu, et al. 2001)
Signal Words

- **DANGER** signals that the pesticide is highly toxic. A taste to a teaspoonful taken by mouth could kill an average sized adult. Any product which is highly toxic orally, dermally, or through inhalation or causes severe eye and skin burning will be labeled "DANGER."

- **WARNING** signals that the product is moderately toxic. As little as a teaspoonful to a tablespoonful by mouth could kill the average sized adult. Any product which is moderately toxic orally, dermally, or through inhalation or causes moderate eye and skin irritation will be labeled "WARNING."

- **CAUTION** signals that the product is slightly toxic. An ounce to more than a pint taken by mouth could kill the average adult. Any product which is slightly toxic orally, dermally, or through inhalation or causes slight eye and skin irritation will be labeled "CAUTION."

Rindels, S. 1994
Degradation refers to the breakdown of the chemical(s) in the herbicide to simpler chemical compounds or elements. This does not necessarily mean they break down to more benign chemicals. In some cases, the resultant chemical may be more toxic or harmful than the original. Photodegradation is the breakdown of a chemical by sunlight, microbial degradation is when soil microbes break down a chemical, and chemical decomposition is the separation of a chemical compound into simpler compounds by chemical reactions. A lack of chemical degradation is chemical persistence.

Immobilization and adsorption are ways in which a chemical compound do not break down, but instead are immobilized typically either in plant material or soil particles. In this process, the chemical binds to soil or plant matter and does not move through the environment or degrade into other compounds. A persistent chemical that adsorbs to plant material can be problematic if the plant material is then spread in different areas and the chemical is still active. In that case, the active chemical may be taken up by plants in the new area.

Movement refers to movement of the herbicide after introduction to the environment. This is most often accomplished by being dissolved or suspended in

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water and then moving with water over the surface or through groundwater.

Volatilization is when herbicides become gaseous and move through the air. This can lead to human and environmental health concerns as well as non-target impacts. The only two herbicides discussed in this presentation with volatilization concerns are 2, 4-d and triclopyr ester.
These are some of the most commonly used herbicides in natural areas management. Discussion of an herbicide or brand of herbicide is not an endorsement. Always select an herbicide based on individual, species, and site needs and requirements and always follow label instructions...it’s the law.
Probably the most widely used herbicide on the planet. Since it is broad-spectrum, it can be effective at controlling most woody and herbaceous species at various rates and with different application methods depending on species and location, although some species are now resistant. There are many different formulations and care should be taken to read the label of the formulation you choose. One consideration is the use of glyphosate in areas with hard water. Hard water can decrease the efficacy of glyphosate, but that can be counteracted by the addition of ammonium sulfate.
Different formulations of herbicides can vary significantly. Be sure to check the label for use requirements and limitations. One major difference is between aquatic-safe glyphosate and glyphosate that is NOT aquatic safe. Glyphosate itself is relatively non-toxic to animals, but the surfactants and other additives in some formulations can be toxic to aquatic species.

Often, the rate of active ingredient varies from one formulation to the next, so never assume the rate you used from one brand of glyphosate will translate to the rate you would use for a different brand of glyphosate. Always check the label.
Relatively non-toxic to animals, but some recent studies have shown some formulations with glyphosate as the active ingredient have been shown to be carcinogenic. Those studies were conducted on formulations not available in the US, and the results are disputed.
Another commonly used herbicide in natural areas. There are many different trade names, but there are also two more broad formulations, triclopyr ester (an acid), and triclopyr amine (a salt), just as 2, 4d, and herbicide we will examine next, also has these same two broad formulations. Both are selective and act on broadleaf plants.

Ester formulations tend to have a greater tendency to volatilize, especially in hot dry weather, so care needs to be taken. Also, ester formulations tend to be more active in plants because they are more soluble in the plant’s cuticle compared to amine formulations.
Similar to triclopyr, 2, 4d has two main broad formulations, an ester and an amine. Similar to glyphosate, 2, 4d can have formulations that are aquatic safe, and some formulations that are not aquatic safe. 2, 4d is also selective against broadleaf plants and generally should not harm most grasses with a couple exceptions.

Ester formulations tend to have a greater tendency to volatilize, especially in hot dry weather, so care needs to be taken. Also, ester formulations tend to be more active in plants because they are more soluble in the plant’s cuticle compared to amine formulations.

Also beware that one formulation can cause severe eye damage. Always check and follow label instructions.
Sethoxydim is a grass-specific herbicide and is widely used against a suite of invasive grasses. This herbicide is moderately to slightly toxic to aquatic species and can be highly mobile in the environment. There are currently no grass-specific herbicides that are labeled as aquatic safe, so if you need to treat a grass in or near water with herbicides, then you will have to use a broad-spectrum herbicide.
Clethodim is gaining momentum as a more popular choice for grass-specific herbicide treatments because it is generally less expensive and more widely available than sethoxydim. It also appears to be more active and show results more rapidly than sethoxydim. Less is known about the environmental fate of this herbicide, but it is believed to be similar to that of sethoxydim because they are chemically related.
Clopyralid is a specialty herbicide that acts on groups of species instead of the more broad categories of broad-leaf or grass-specific. In addition to generally not harming grasses, clopyralid also does little harm to mustards and other groups of broad-leaved plants including many trees, which makes it useful in foliar treatments of vines such as kudzu (although care needs to be taken when spraying kudzu not to overspray onto adjacent soybean fields!). While more specific herbicides such as this can be desirable for their specificity, clopyralid can be highly mobile in the environment and may contaminate water and harm non-target species. In addition, clopyralid can cause severe eye damage, but it is otherwise non-toxic to vertebrates. Always read and follow the label instructions.
Herbicide Safety

- PPE
  - Legal requirement found in any herbicide label
  - At least consists of long sleeved shirt and long pants, chemical-resistant gloves, shoes plus socks
  - Some herbicides also include eye protection
  - Some herbicides not covered here include greater protections, always read and follow label instructions
  - Wash and launder PPE equipment separately from other clothing
What’s wrong with this picture?

No gloves, no long-sleaved shirt, no eye protection.
Correct PPE
Herbicide Safety

- Spills
  - Limit spills by handling herbicide containers carefully
  - Carry absorbent material to contain spills
  - If spill does occur try to contain it as much as possible and prevent further spilling
    - Avoid direct skin contact when working with herbicide spills
  - Contact supervisor and proper authorities if spill is large or dangerous
  - Always follow label instructions
Herbicide Safety

- **Reduce exposure**
  - Check all equipment to make sure no leaks exist before using.
    - This is particularly important for backpack sprayers
    - Check for signs of degradation in equipment
    - Do not use faulty equipment, instead report them to applicator
  - Be careful of any hoses or other parts of the equipment that might get caught and tear
  - Always wear PPE when using herbicides or handling spray equipment filled with herbicide
  - Carry a change of clothes in case herbicide contaminated clothing
Herbicide Safety

- Reduce Exposure
  - Don’t make applications upwind of where you are standing
  - Using rubber boots instead of leather or other material can also help reduce exposure
  - Don’t walk through a recently treated area (especially true with foliar applications)
  - Consider using herbicide dye to more easily recognize exposure
  - Don’t spray herbicide over your head
  - Always follow label instructions
Safety

- Take care not to overheat on hot days
- Be careful of typical hazards when working in the field
  - Poison ivy
  - Dehydration
  - Ticks/chiggers
  - Snakes
  - Loose rocks, old wells, etc.
- Be careful when working with other people, particularly with power tools
Wait for Operator to Clear the Area
An electronic copy of the herbicide label is handy to have on your smartphone in the field instead of carrying a hard copy. You can also more easily search for specific information in the label if you have an electronic copy.
The next several slides show an example herbicide label and the type of information you will find on this and other labels.
Specimen Label

Rodeo Herbicide

For control of annual and perennial weeds and woody plants in forests, non-crop sites, and in and around aquatic sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression and grazed areas on these sites.

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Precautions and Precauciones

Hazard to Humans and Domestic Animals

Harmful if Inhaled
Avoid breathing spray mist. Remove contaminated clothing and wash before reuse. Wash thoroughly with soap and water after handling.

PPE Requirements
(You must follow these requirements when applying this particular herbicide)

Description of Herbicide Use
(Tells you what type of species and what locations it is legal to apply this herbicide)

Hazard Statement
(Volunteers can only apply herbicides labeled as 'Caution')
Cautionary statements

(To avoid unintended injury to desirable plants)
### Moving Sites
This product may be used to control the stand of grass and weeds in and around aquatic sites and in moving water sites such as:
- Canals
- Marshes
- Reservoirs
- Lakefronts
- Forests
- Reservoirs
- Ponds
- Ponds
- Stormwater Treatment Facilities
- Seaweed
- Aquatic Plant Areas
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### Aquatic Sites
This product may be applied to emergent weeds in all bodies of water, including wet and dry areas of water bodies. Always follow the label directions for use in aquatic areas. Aquatic sites are present in the moving water area and are part of the moving water system. Read and observe the following directions:
- This product does not control plants which are completely submerged or have a majority of the foliage under water.
- There is no restriction on the use of herbicides for irrigation, rainwater or domestic purposes.
- The product is designed for application to public water. Private or non-public water use may be restricted by state or municipality regulations.
- The product is not recommended for use in areas where a state or local water use permit is required.
- To be used only by or under the direct supervision of a state-licensed pesticide applicator, a state-licensed or state-approved pesticide applicator, or a state-approved pesticide applicator.
- Do not apply or store the product in containers that have been used for any other product, including chemical waste or disposal.
- Do not apply the product to water bodies that are subject to state or local water use permits.

### Forestry Sites and Utility Rights of Way
- Forests and utility rights-of-way shall use a method of application that is similar to those used in aquatic areas.
- Site-specific control recommendations chart (Label gives specific control recommendations for certain sites)

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**Wetland/aquatic information**

(If you herbicides in or near water, it is crucial that you use a product labeled for use in aquatic areas. This section gives specific information about this type of application.)
Mixing Information
(Important information on which other herbicides are compatible with this specific herbicide and what rates to use and how to mix them correctly)
Wetland/aquatic information
(If you herbicides in or near water, it is crucial that you use a product labeled for use in aquatic areas. This section gives specific information about this type of application)

Information on cut stump treatments
(Specific information on the rates and methods used for this application type)
Consider using alternative methods, or methods/techniques/strategies that minimize the use and risk of using herbicides. See the presentation in this series on Strategies and Techniques or management guides for more information.

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<th>Conclusions</th>
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<tr>
<td>• Always follow label instructions, it's the law</td>
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<tr>
<td>• Many considerations need to be taken into account when choosing which herbicide is best for you, the species being treated, and your site(s)</td>
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<tr>
<td>• Human safety and the safety of the environment are of utmost importance, and many unintentional impacts can be avoided with proper use</td>
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<tr>
<td>• Consider alternative treatments, or complementary treatments to herbicide use, as part of an integrated pest management strategy</td>
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There are numerous sources of information online regarding herbicides and their use. It is highly encouraged that you research more on your own to determine the best choice(s) for you.

References

- Many informational resources are available online. It is highly recommended that you research an herbicide before deciding to purchase and use it in the field.
- Herbicide references:
References

- Glyphosate references:

- Clethodim References

- Sethoxydim References

- 2, 4d References
  - [http://www.fs.fed.us/foresthealth/pesticide/pdfs/093o06_24d.pdf](http://www.fs.fed.us/foresthealth/pesticide/pdfs/093o06_24d.pdf)

- Triclopyr References
  - [http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-25-03aTriclopyr.pdf](http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-25-03aTriclopyr.pdf)