Utilizing Clethodim to Naturally Regenerate Emergent Wetlands and Promote Pollinator Habitat in Early Phases of Woody Riparian Establishment

Blaine Kisler
Natural Areas Field Inspector
Clark County Noxious Weed Management

Clark County's Legacy Lands Program

- Established in 1985 as a means of protecting lands within the county that are highly valued for habitat, scenic corridors, low-impact recreation, and other qualities that enhance the local environment. The program, also referred to as Conservation Futures, works with public agencies, non-profit conservation organizations, private landowners, and the community to establish, restore, and maintain an interconnected system of parks, natural areas, trails, and open spaces
- Actively maintains 4,262 and acquired over 5,556 acres
- Partnership with Clark County Clean Water's Reforestation Program
- Special thanks to Washington Conservation Corps', Aquatic Invasive Species program!

Overview

- Why we started using grass specific herbicides
- Reed canary grass overview
  - How history, biology, and climate combine to make a bad plant the worst in PNW intertidal wetlands and low gradient riparian forests
  - Control strategies
- Introduction to grass specific herbicides
  - Mode of Action
  - Labeled site uses and restrictions
  - EPA Human Health Risk Assessment & Toxicity
  - Aquatic Glyphosate VS Clethodim
    - Pounds active ingredient/acre
    - Brief toxicity comparison
  - Rates and Mixing
- Test site methods, results, and notes
    - Vancouver Lake; 3 acres
    - Salmon Creek; 7 acres
    - East Fork Lewis River; 21.5 acres

Why did we start using grass specific?

- A huge false brome infestation at Camp Bonneville
  - Fall applications not as effective as Willamette Valley
    - We don’t seem to get a consistent fall green up period, inconsistent kill
    - Washington class A = must prevent from seeding
  - Needed something that wouldn’t create gaps for other weeds
    - Hole effect
      - If not false brome, what else?
        - Annual and biennial weeds, sometimes worse
      - Native woody species and herbaceous perennials taking a huge hit
  - False brome hiding in native vegetation surrounding old patches, reseeding holes

Executive Summary of Existing RCG control Research

- Dr. Craig A. Annen says it best in his 2016 “A Multiple-Method Systems Approach to Reversing Reed Canarygrass Invasions”
  - The subject of 913 peer reviewed studies from 311 different scientific journals totaling over 9,400 printed pages (Craig is responsible for no less than 6 of these studies)
  - Despite this, eradication and prevention of recolonization still considered an unrealistic management goal by most
    - It is possible, just takes 5-7 consecutive growing seasons
      - Mix of mechanical, chemical, and cultural control methods tailored to specific site attributes
    - Most grad studies only last two, concluding their treatments ineffective, ironically saying more research is needed
  - This 5-7 year commitment is not viable for most land management agencies
    - 2 year grant funding timelines don’t help
  - Two surprising gaps in data
    - How long an individual can live
    - Degree of clonal integration within a stand

More From Craig A. Annen's 2016 Literature

- "Essentially, RCG (along with many other rhizomatous perennial plants) possess dormant renewal buds at all but the most distal nodes of their rhizomes. Systemic herbicides translocate along with sugars only to actively growing tissues; thus, a single systemic herbicide application is only effective at killing actively-growing distal portions of the rhizome and the target plant is able to reestablish itself from dormant buds. Multiple-year applications are required to exhaust this dormant bud renewal bank."

  Craig A. Annen, 2016

Phalaris arundinacea aka Reed canarygrass (RCG)

- Straight from the USDA Plants Database Factsheet for Reed Canarygrass, *P. arundinacea*
  - Use in PNW began late 1800's-early 1900's
  - Early European colonization, farming typically followed logging, RCG frequently used as "breaking in" crop (Wheeler 1950)
  - USDA factsheet specifically highlights issues with this species in the PNW west of the Cascades
    - Extended growing season
    - Tolerates 9 months of grazing pressure
  - "The bane of wetland restoration."
  - Seedlings exhibit much higher mortality due to interspecies competition than decreased water availability (Morrison & Molofsky 1998, 1999)

January 14th, 2025

- 10 month growing season?!

Sedimentation and mulching, RCG's one up on the competition

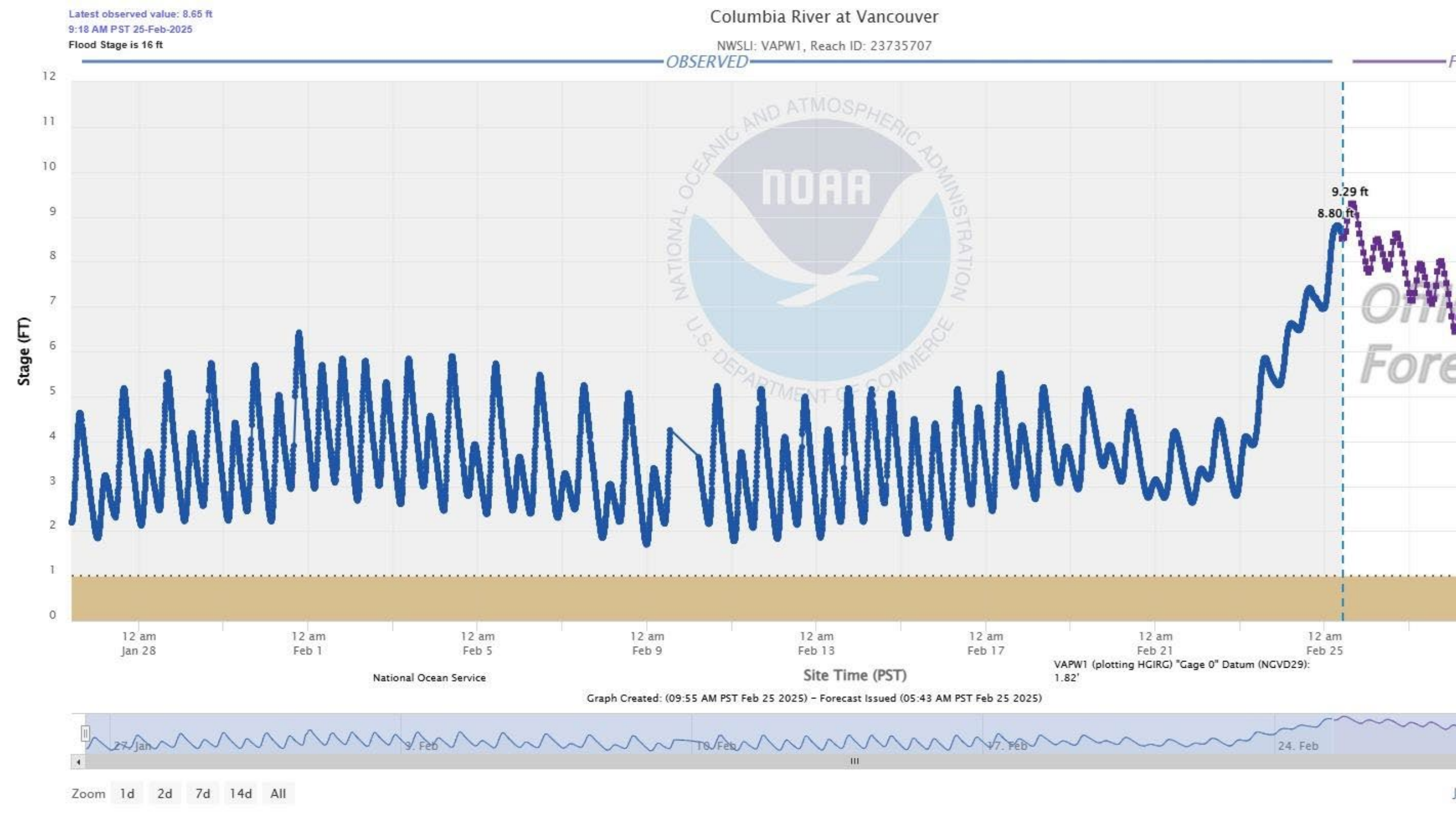
- RCG rhizome intolerant of full inundation (Hovin et al. 1973)
  - Survives on energy stored in culms (stems)
  - Culms also capable of rooting and starting new stands
- Thick RCG mats trap sediment, especially low gradient systems where flow is tidally driven
- Roots from nodes (Hovin et al. 1973) into freshly acquired sediment with no competition
- Re-roots and mulches as water recedes
- Indeterminate rhizomes grow outward until terminal bud develops a shoot (Evans and Ely 1941)
  - Unlike other rhizomatous grasses that develop shoots all along the rhizome axis.
  - Allows for rapid expansion, a single rhizome **or** stem can infest a whole drainage
- Allows for rapid colonization into areas otherwise too wet once water recedes
- Thick mulch layer covering mineral soil prevents germination of other species
- Also prevents woody rhizomatous and coppicing species from expanding underground

Mode of Action
Group 1 Herbicides; ACCase inhibitors

- ‘Grass-selective herbicides are noncompetitive inhibitors of acetyl coenzyme A carboxylase (ACCase), an allosteric enzyme that catalyzes the initial irreversible chemical reactions in fatty acid biosynthesis. In the majority of vascular plants, ACCase consists of three separate subunits, each catalyzing a sequential step of a three-part chemical reaction that converts acetyl CoA into malonyl CoA. In the Poaceae, ACCase consists of a single multienzyme complex, and only the multimeric ACCase assembly possesses a binding site for the inhibitor, rendering ACCase inhibitors truly grass-selective.’
- Craig A. Annen, 2016

Clethodim Research

- Clark County Pesticide Review Committee
- Used primarily to control grass in >100 fruit and vegetable crops and kill Roundup Ready corn
- For ‘non-planted/non-crop areas’
  - EPA has yet to define this term
  - State regulators inquiring about how to deal with end users’ interpretation of non-crop to include indoor uses for various pesticides!!
  - 2011 Archived EPA dialogue fails to set strict definition; the interpretation of using non-crop labeled herbicides to control noxious weeds in natural areas is much preferred to use of various pesticides
- Not for intertidal wetlands below mean high water mark
- Where is mean high-water mark in Clark County?
  - USGS monitoring station for Columbia at Vancouver; 0ft ~ sea level
  - During the spring freshet of 2017 (the highest levels since 1996), surface water elevation at times was over 17ft
  - Normal winter high tide 6 feet
  - Elevation at test sites ranges from 12ft-20ft above sea level


Latest observed value: 8.65 ft
9:18 AM PST 25-Feb-2025
Flood Stage is 16 ft
Columbia River at Vancouver
NWSLI: VAPW1, Reach ID: 23735707
OBSERVED
Stage (FT)
9.29 ft
8.80 ft
12 am Jan 28
12 am Feb 1
12 am Feb 5
12 am Feb 9
12 am Feb 13
12 am Feb 17
12 am Feb 21
12 am Feb 25
Site Time (PST)
National Ocean Service
VAPW1 (plotting HGIRG) "Gage 0" Datum (NGVD29): 1.82'
Graph Created: (09:55 AM PST Feb 25 2025) - Forecast Issued (05:43 AM PST Feb 25 2025)
27. Jan
3. Feb
10. Feb
17. Feb
24. Feb
Zoom 1d 2d 7d 14d All

2001 US Environmental Protection Agency Memorandum

- Subject: HED Risk Assessment: Human Health Risk Assessment for Clethodim to Support Request for New Uses of Clethodim in/on Onion (green), lettuce (leaf), Head/Stem *Brassica* Crop Subgroup 5-A (Broccoli and Cabbage), and Canola, Mustard and Flax, Seed.
- Detectable/tolerable levels in crop residue study
  - Green onion = 2ppm
  - Lettuce, Leaf = 2ppm
  - *Brassica* Head and Stem = 3ppm
- A snippet from the longest Executive Summary I've ever read:
  - 'Overall, the quality of the toxicology database for Clethodim is good and the confidence in the hazard and dose-response assessments is high. The toxicology data base is complete and there are no data gaps.'
- The EPA says very low risk for acute and chronic adverse effects to human and environmental health given current agricultural practices and use rates
  - Non-carcinogen
  - Not an endocrine disruptor
  - Doesn't bioaccumulate

Clethodim Toxicity

- Really hard to find a Clethodim product SDS that had actual toxicity values for the AI itself
  - Most SDSs for clethodim formulations only contain toxicology data for Naptha Solvent or Naphthalene
- Surprising lack of toxicological data on PAHs in general, but also ones included in clethodim products
  - Naphthalene is a probable carcinogen
  - Naphtha solvent, heavy aromatic CAS# 64742-94-5 not listed as carcinogen in most literature
    - Similar acute oral toxicity to aquatic labeled glyphosate
      - Inhalation biggest exposure route
      - Don’t swallow it, puke it up, then aspirate on the fumes
    - Agridex is a petroleum-based product
      - Lowest toxicity of any WA state approved aquatic surfactant
- Toxicology data for clethodim @ 83.3%
- Clethodim 2#AI/Gallon Formulations @ 26.4%

Ecotoxicity

- Extension Toxicology Network extoxnet.orst.edu

  - Acute avian toxicity, very low
  - Slightly toxic to freshwater fish
  - Practically non-toxic to Daphnia
  - Non-toxic to adult worker bees at the highest dose tested, 100 micrograms/bee
  - Highly mobile in soils
  - In field studies, no vertical movement of the parent compound or residues was observed below the top 20 cm of the soil
    - Attributed to rapid degradation and low use rates
  - Extoxnet says highly persistent in aquatic environments, but…
  - Half-life in simulated aquatic environments
    - "The photochemical fate of the herbicide clethodim in natural waters was investigated under simulated and natural sunlight radiation. This herbicide exhibited a rapid degradation rate in simulated aquatic environment with half-lives ranged from 27.9min to 4.6h. The commercial formulation of clethodim showed a faster degradation with half-lives from 19.3min to 1.4h." Villaverde JJ, Sevilla-Morán B, López-Goti C, Calvo L, Alonso-Prados JL, Sandín-España P. Photolysis of clethodim herbicide and a formulation in aquatic environments: Fate and ecotoxicity assessment of photoproducts by QSAR models. Sci Total Environ. 2018 Feb 15;615:643-651. doi: 10.1016/j.scitotenv.2017.09.300. Epub 2017 Oct 17. PMID: 28992491.

Aquatic Glyphosate VS Clethodim Rates For RCG Apples to Pounds of Active Ingredient (#AI) /Acre

- 2#AI/gallon Clethodim, max single application 16oz/acre up to four applications a year = 1#AI/Acre/year
- 5.4#AI/gallon Glyphosate, max broadcast application 7.5pints/acre = 5.0625#AI/acre
- Multiple treatments/year at this rate allowed on label for Aquaneat!
- Our max tested rate clethodim (2#AI/gal) = 1oz/gallon (0.78125% for all you % heads out there)
  - @ 40gallon/acre x 1oz/gallon = 40oz/acre ÷ 128oz/gal = 0.3125gal/acre x 2#AI/gallon = 0.625#AI/acre
  - Our minimum tested rate; 0.4oz/gal = 0.25#AI/acre
- Typical Aquatic Glyphosate (5.4#AI/gal) RCG rates 2.5%
  - 2.5% x 1.28oz/% = 3.2oz/gal x 40gal/acre = 128oz/acre ÷ 128oz/gal = 1gal/acre x 5.4#AI/gal = 5.4#AI/Acre!!
  - I would wager most treatments of tall RCG are over 40gal/acre
  - 40gal/acre rate base on 1-2' tall previously mowed RCG
  - If you're using the 2.5% rate to treat an acre, even at 40gallon/acre you are over the single application limit for broadcast spraying an acre!
- 5.4#AI/acre Glyphosate VS 0.625#AI/acre Clethodim
  - **21.6 : 1 ratio lowest rate tested**
  - **8.64 : 1 ratio highest rate tested**

Clark County Rate for Aquaneat RCG treatment = 2oz/gal (or 1.5625%;))

40 GPA VS 80 – 100 GPA

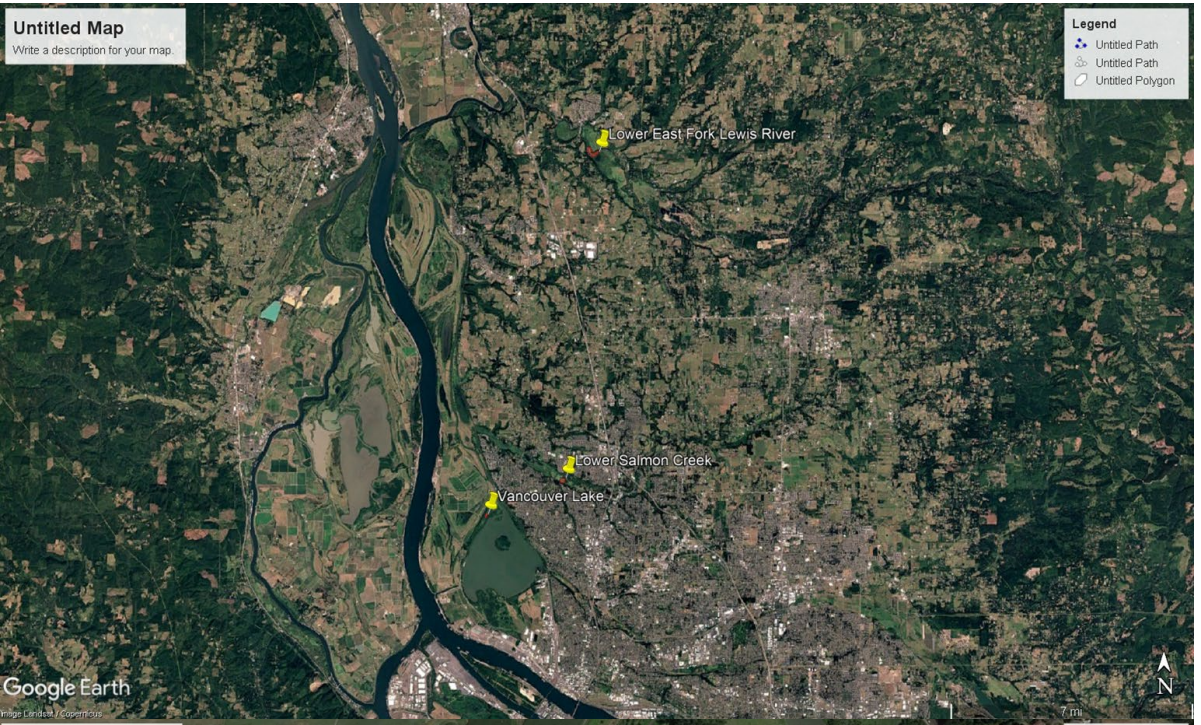
Mowing is BMP not only for reducing total chemical usage, but increasing effectiveness of herbicide

Rates & Mixing Instructions For Clethodim 2#AI/Gallon

- **READ THE LABEL!!!**
- **0.25#AI/acre/application**
- **1#AI/acre/year**
- Broadcast rate (max /application rate for non-crop areas)
  - 0.4oz/Gallon Clethodim **2# AI/Gallon**
  - @ 40 GPA = 0.25#AI/acre
  - 4 applications spaced at minimum 14 days for total 1#AI/Acre/year
- Spot treatment
  - Ranges from 0.8-1oz/gallon Clethodim 2#AI/gallon depending on what % of site is being treated
  - </=50% treatment area @ 0.8oz/gallon
  - </=37.5% treatment area @ 1oz/gallon
  - Others conducting grass specific research go higher than 1%v/v Clethodim 2#AI/gallon
- Fill pack/tank ½-2/3 water
- 1oz/gallon Bronc Max
- Add Clethodim
- 1oz/gallon Agridex
- Fill pack/tank to full amount
- Make sure to fully agitate
- Shake packs/agitate tank if sitting for more than several minutes

Other Clethodim Notes

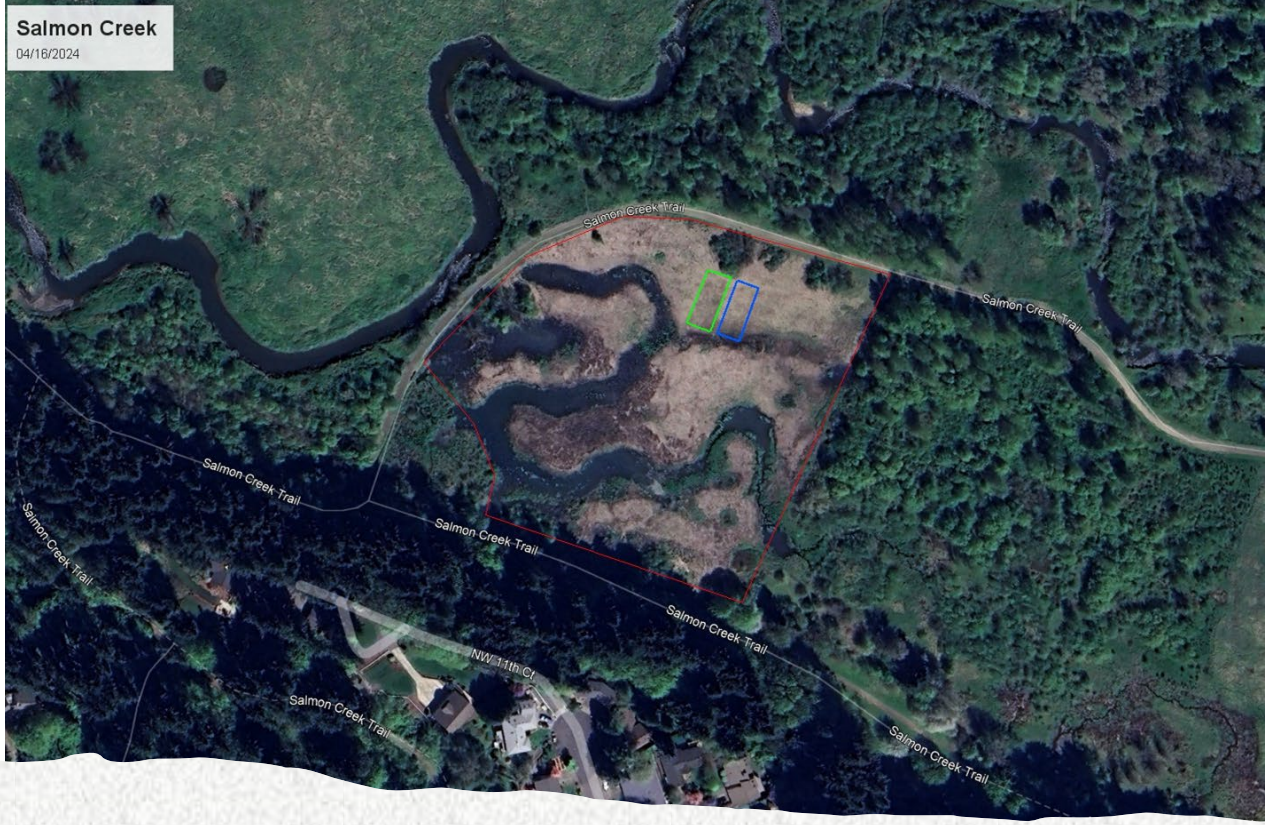
- Extremely photo volatile
  - Higher UV index = Less herbicide adsorption
- Low rate is very slow to show symptoms if you don't know what to look for
  - That doesn't mean it's not working
  - Accumulates at growth points and nodes
  - Growth arrested immediately
  - Meristems yellow within 1-2 weeks, nodes inside sheath start to yellow/necrose
  - Basal leaves can take over a month to fully necrose
- 24 hours between applying synthetic auxins (triclopyr, aminopyralid, clopyralid, etc.)
  - Vaquero label says it reduces effectiveness of grass specific
- Some damage noted on certain off target species at certain times of year, but this is attributed to AMS and higher surfactant rates in combination with younger growth
- Label does not suggest using AMS or surfactants over 0.25%v/v over certain crops to avoid injury
- Label calls for mowing or tilling of perennial grasses prior to treatment to maximize effects


Untitled Map
Write a description for your map.
Legend
Untitled Path
Untitled Path
Untitled Polygon
Lower East Fork Lewis River
Lower Salmon Creek
Vancouver Lake
Google Earth
7 mi
N


Van Lake 08/2020
Write a description for your map.
Legend
Untitled Path
Untitled Path
Untitled Polygon
Vancouver Lake
Google Earth
1000 ft
N


Salmon Creek 08/2020
Write a description for your map.
Legend
Untitled Path
Untitled Path
Untitled Polygon
Lower Salmon Creek
Google Earth
1000 ft
N


Lower EFLR 08/2020
Legend
Untitled Path
Untitled Path
Untitled Polygon
Lower East Fork Lewis River
Google Earth
1000 ft
N



Salmon Creek Reforestation Site

- 3 years site prep
  - 2022; Mow-Glyphosate
  - 2023; Clethodim or mow, Clethodim regrowth depending on growth stage and avoiding water
  - Seeded Test Plot Fall 2023
  - 2024; Clethodim/mow, clethodim regrowth
  - Installed rushes/sedges and live stakes near water and seeded ‘Upper’ portion of site

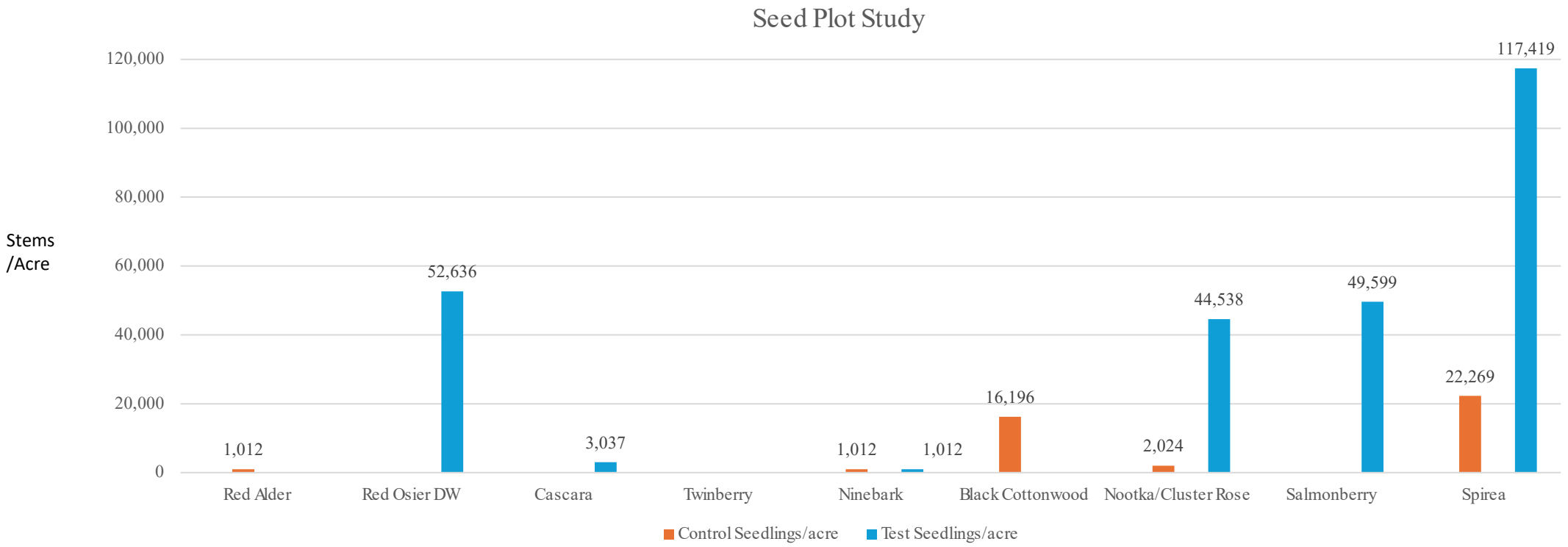
June 22nd, 2022

July 22nd, 2022

September 13th, 2022


09/19/2024

Cougar Creek @ Salmon Creek Reforestation Seed Plot Stem Counts



		Red Alder	Red Osier DW	Cascara	Twinberry	Ninebark	Black Cottonwood	Nootka/Cluster Rose	Salmonberry	Spirea
Control	Seedlings/m^3	0.25	0	0	0	0.25	4	0.5	0	5.5
	Seedlings/acre	1012	0	0	0	1012	16196	2024	0	22269
Test	Seedlings/m^3	0	13	0.75	0	0.25	0	11	12.25	29
	Seedlings/acre	0	52636	3037	0	1012	0	44538	49599	117419

Salmon Creek Takeaways

- Mowing greatly accelerated native plant recruitment from seed compared to Van Lake
- Seed plots measured early summer
  - If seed plots were measured again early fall, numbers in control plot and everywhere else onsite would have gone up exponentially!!!
  - Alder, spirea, cottonwood, everywhere, even 100 yards from nearest tree
  - Insane native sedge and rush recruitment despite apparent lack of nearby seed source
  - Cottonwoods coppicing 30+ feet from the mitigation edge
  - Pre-existing rose and spirea clumps coppicing like crazy,
  - Spirea seedlings so thick you couldn't avoid stepping on them 25 yards downstream from nearest clump
  - Deer browse is a major factor
    - Plants never shut down growth due to drought stress
  - Mystery Jewelweed **hand pulled** or would have prevented native seed recruitment and establishment
    - The most satisfying plant to hand pull
    - Surprisingly not that labor intensive
  - Decent mix of native herbaceous broad leaf species establishing, including perennials
  - Lots of broadleaf weeds
    - Canada thistle is a beast
    - Butterfly bush, Yellow flag Iris, blackberry, controlled
    - Sow thistle and other non-listed herbaceous weeds ignored


Van Lake 08/2020
Write a description for your map.
Legend
Untitled Path
Untitled Path
Untitled Polygon
Vancouver Lake

Vancouver Lake Treatments

- Initial round July 28 & 30th 2020 With Washington Conservation Corps Aquatic Invasive Species crew funded by WA Department of Natural Resources
  - Bronc Max 1oz/gallon, Aquaneat 2oz/gallon, Syl-tac EA 1oz/gallon
- 6/17, 9/16, and 9/21 2021, dry spring, low snowpack allowed for early round, September treatments for RCG that had broken out of dormancy through the summer
  - Bronc Max 1oz/gallon, Vaquero 0.5-0.67oz/gallon, Syl-tac EA 1oz/gallon
- 8/31 & 9/07 2022
  - Increased rate to 0.8oz/gallon Vaquero
  - Down to 3 days staff time
- 7/12 & 8/30 2023
  - One half day me and the Ranger
  - One half day 3 staff backpacks


November, 2020
06/24/2024

Van Lake; 5 Year Maintenance Cost Breakdown

~$7,500/acre

For 5 years maintenance

- No planting labor/Materials costs

Chemical usage;

- 1st year, 24.5lbs AI (glyphosate)
- Years 2-5 combined, 7.12lbs AI (clethodim)
- Max allowable site usage
  - 3acres*4years*1#AI/acre/year= 12#AI


East Fork Lewis
07/2014
Legend
Beaver Dam
Untitled Polygon
Beaver Dam
Beaver Dam
Beaver Dam
Beaver Dam
NW Timmen Rd
Google Earth
N
900 ft


Untitled Map
Write a description for your map.
Legend
Beaver Dam
Untitled Polygon
Beaver Dam
Beaver Dam
Beaver Dam
Beaver Dam
NW Pollock Rd
NW Pollock Rd
NW Timmen Rd
NW Spencer Rd
NW Timmen Rd
Google Earth
Image © 2025 Airbus
N
1000 ft


07/22/2024


Questions?