



Glyphosate and AMPA Accumulation in *Camassia Quamash*
Bulbs of Coast Salish Prairies

CAMASSIA QUAMASH

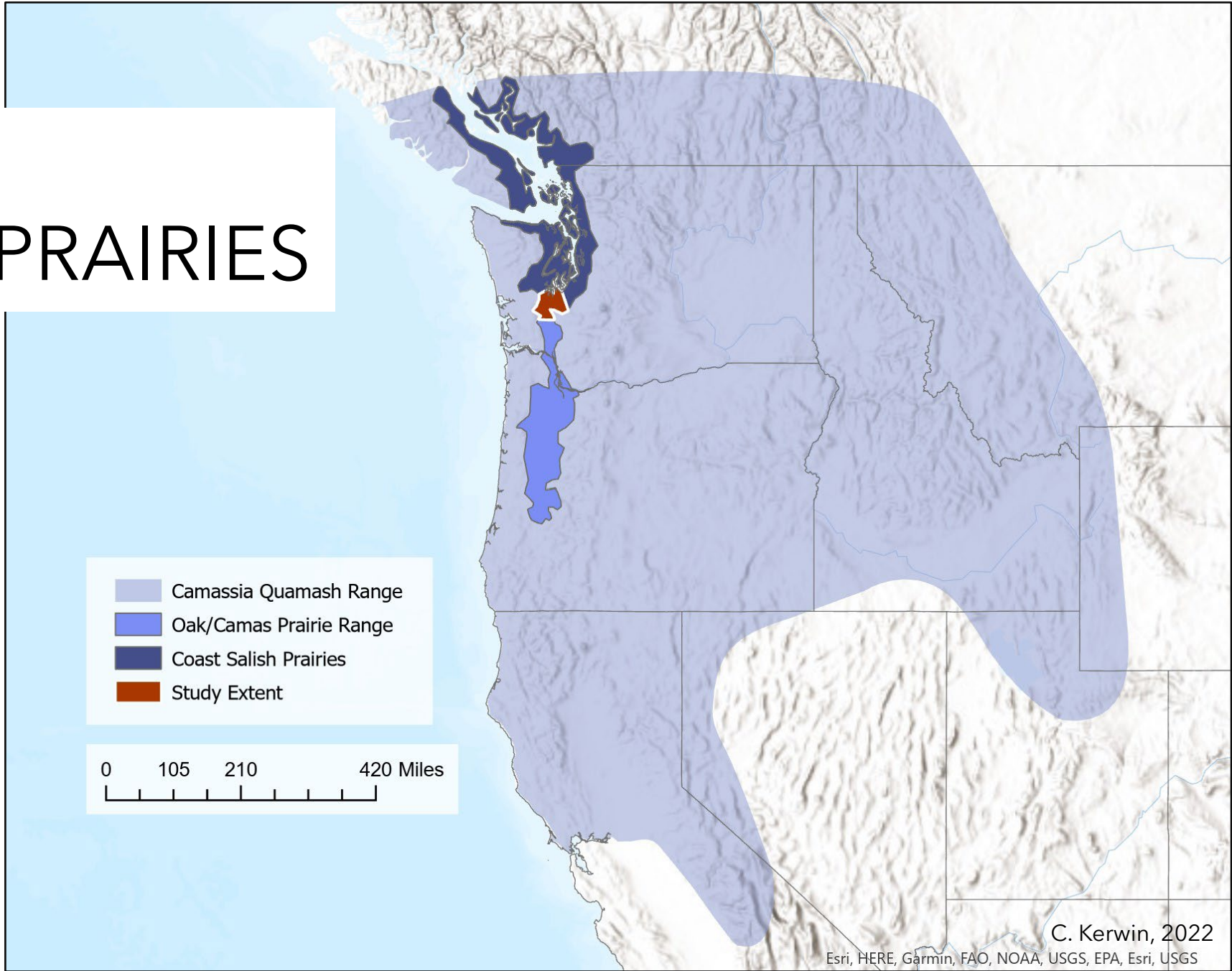


C. Kerwin, 2022



Glacial Heritage Preserve: C. Kerwin, 2021

CAMAS AND COAST SALISH PRAIRIES



PRAIRIE RESTORATION

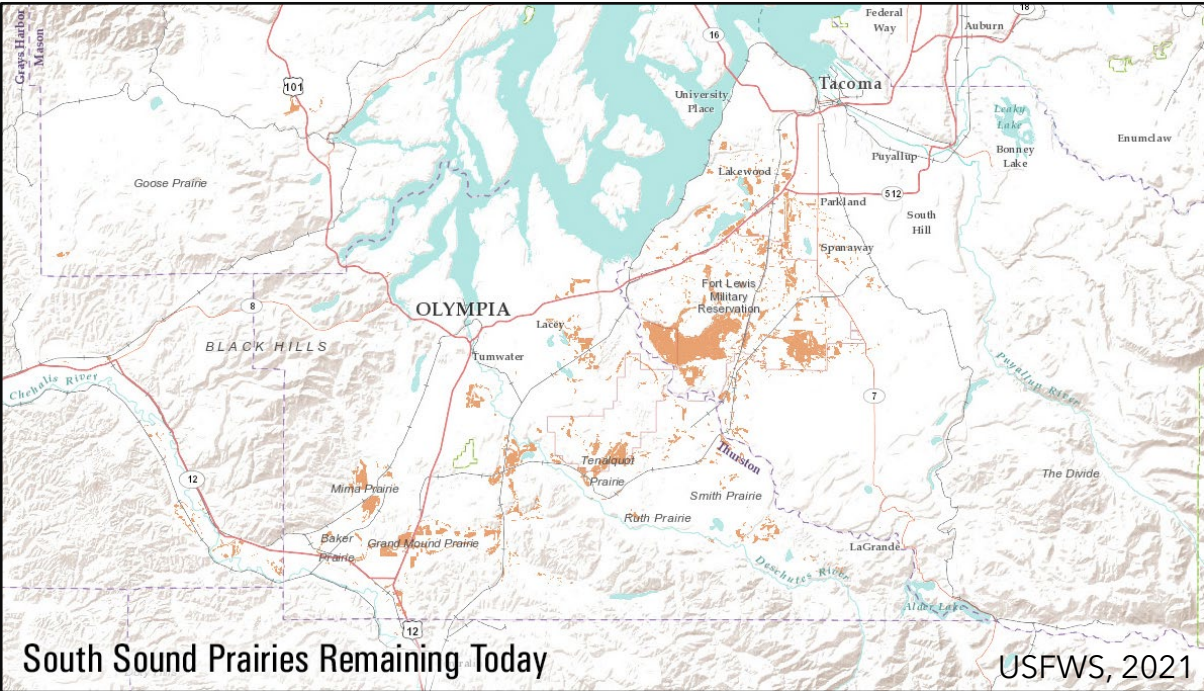


C. Kerwin, 2021



Historic Extent of South Sound Prairies

USFWS, 2021



South Sound Prairies Remaining Today

USFWS, 2021

GLYPHOSATE-BASED HERBICIDES

#1 Herbicide Used in Restoration

Highly effective and used in-tandem with other methods

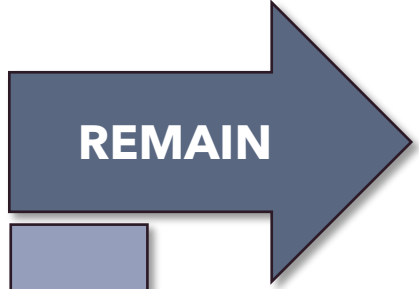
Kills through shikimate pathway disruption

Metabolite: Aminomethylphosphonic acid (AMPA)

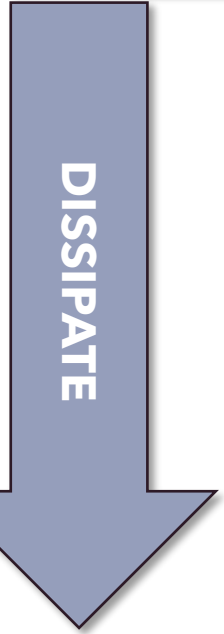
Risk of overspray and accumulation in off-target, native plants



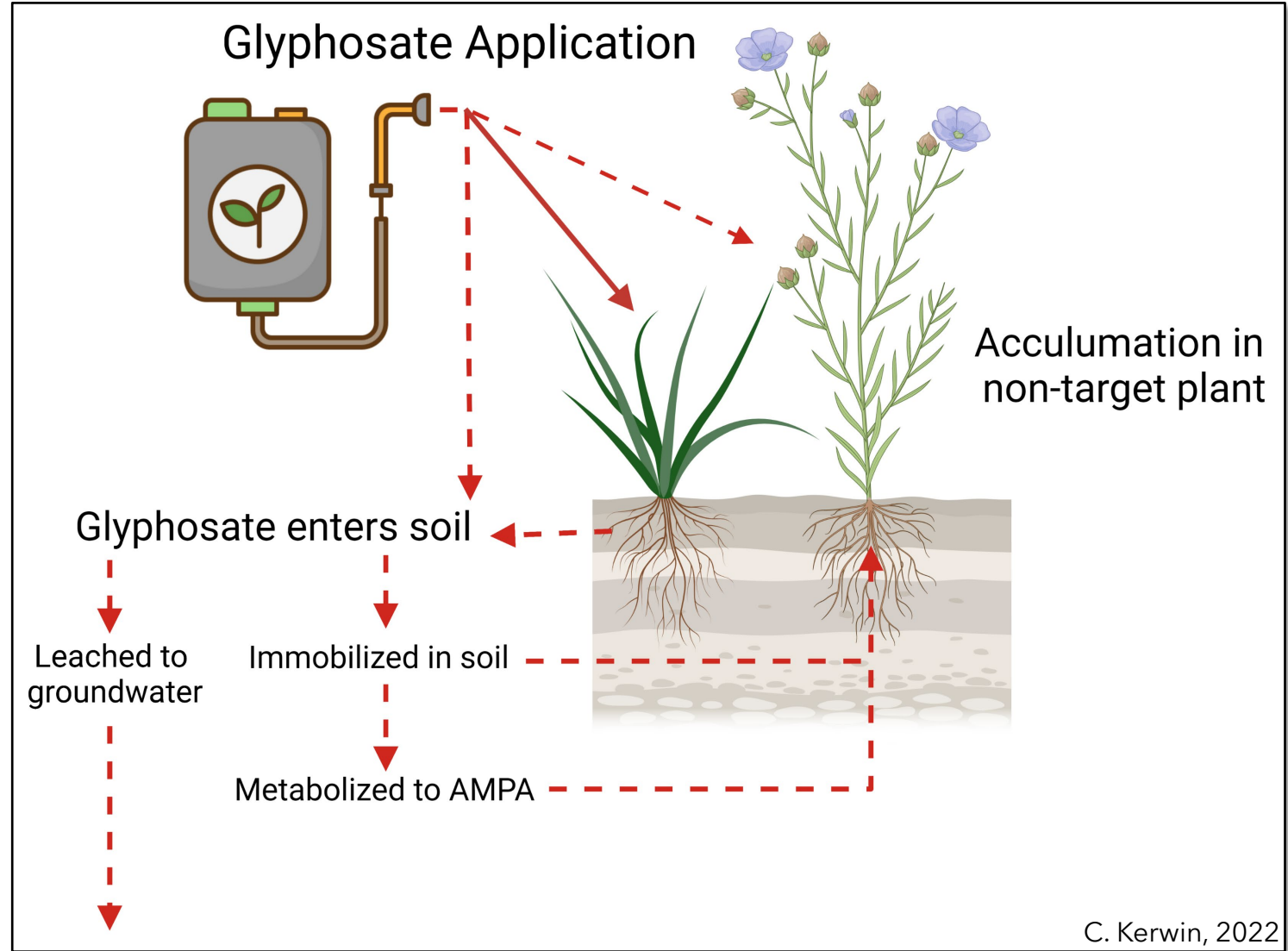
HOW GLYPHOSATE ENTERS PLANTS



- + **Clay**
- + **Organic Matter**
- + Iron
- + CEC
- **pH**

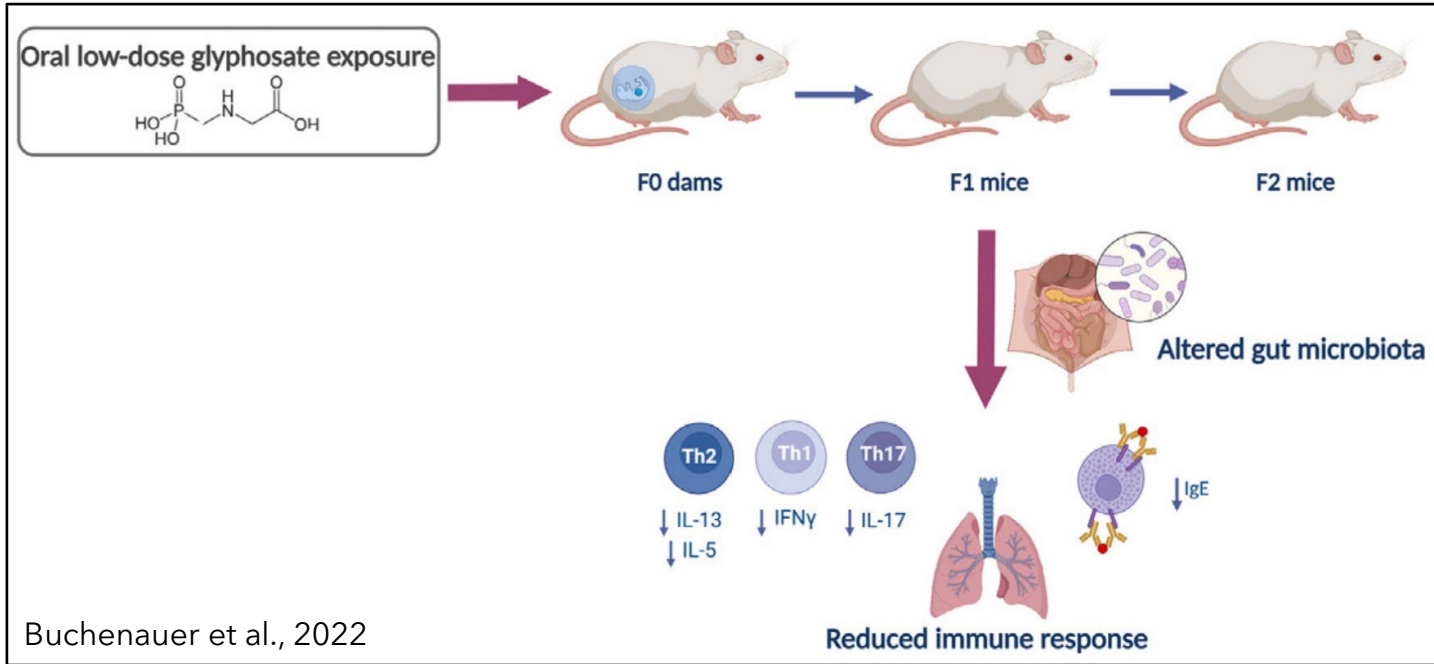


- + Phosphorous
- + **Drainage**
- + **Precipitation**
- + **Time**



HEALTH CONCERNS

Shikimate pathway in gut microbiome bacteria



METHODS

How does the legacy of glyphosate application affect glyphosate and AMPA accumulation in camas bulbs?



Site Selection:

- 1- Culturally Significant
- 2- Traditional Harvest
- 3- Low Air-Drift Risk

Sample Date:

Marion Prairie: 6/5/2023

- 17 months post-treatment

Scatter Creek: 6/6/2023

- 5 months post-treatment

West Rocky: 6/6/2023

- 4.5 months post-treatment

METHODS: EXPERIMENTAL DESIGN

Experimental Design:

- 6 sites
 - 5 plots
 - 8 bulb samples from each
 - 1 soil sample from each
- **Total:**
 - **30 composite bulb samples**
 - **30 soil samples**

Plots:

- 1m x 1m
- 30m (100ft) apart

Plants: Variety of ages



Camas Data:

- Glyphosate
- AMPA
- Weight

Soil Data:

- PH Level
- Clay Content
- Organic Matter
- Web Soil Survey

Weather Data:

- Temperature
- Precipitation

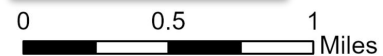
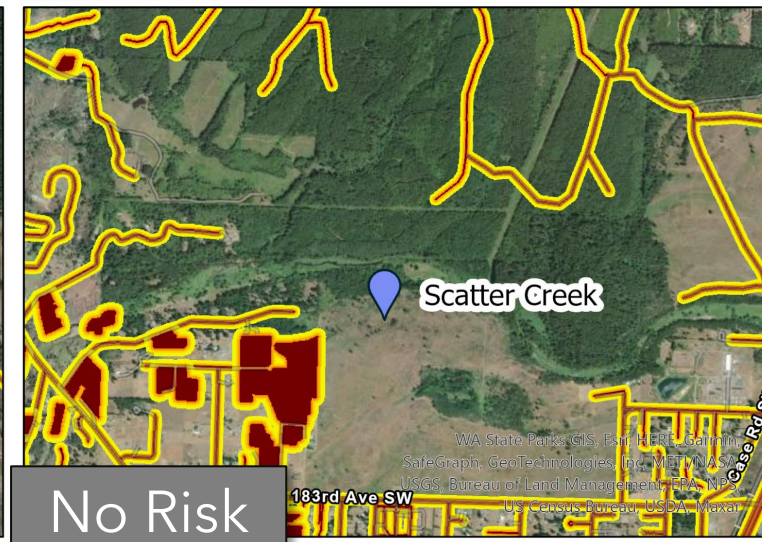
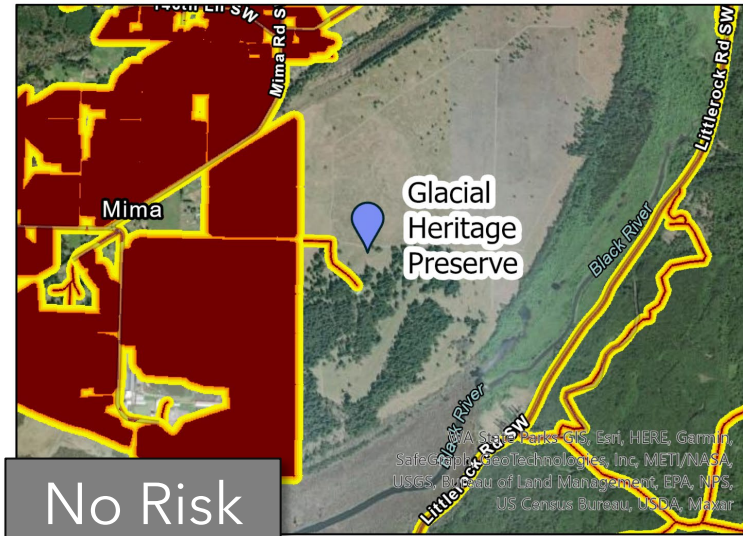
AIR DRIFT RISK: GIS ANALYSIS

Glyphosate Air-drift

Risk Level

- Very High
- High
- Medium
- Low
- Very Low

Sample Sites



RESULTS: SOIL CHARACTERISTICS

Top 10cm:

- Low pH
- Very low clay %
- High organic matter %

Web Soil Survey:

- "somewhat excessively drained"
- Sandy-skeletal
- Andisols and Inceptisols

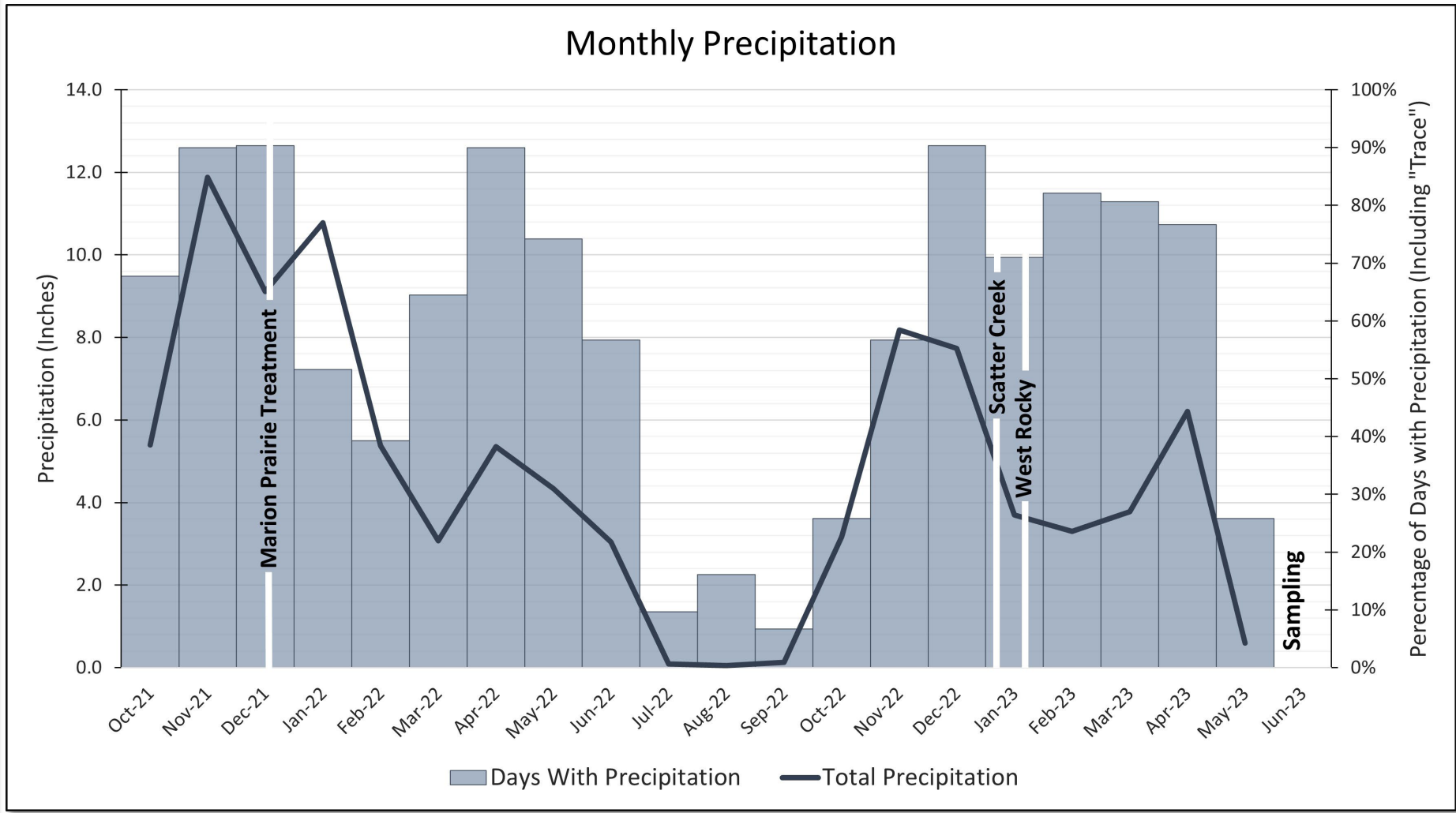
Site Characteristics Results

Type	Site	Camas Bulb Weight (g)	Soil pH	Soil Clay Content (%)	Soil Organic Matter (%)
Treated	Marion Prairie	1.40 ± 0.24	5.22 ± 0.07	2.34 ± 1.08	28.68 ± 2.17
	Scatter Creek	2.28 ± 0.30	4.83 ± 0.08	0.27 ± 0.27	23.61 ± 1.13
	West Rocky	3.02 ± 0.98	5.29 ± 0.11	5.31 ± 0.76	18.62 ± 1.9
	Average	2.23 ± 0.98	5.11 ± 0.06	2.64 ± 0.69	23.64 ± 1.46
Control	The Prairie at the Mouth of the Black River	3.33 ± 0.03	5.02 ± 0.08	3.7 ± 0.86	37.74 ± 2.72
	Glacial Heritage	1.30 ± 0.08	5.12 ± 0.05	2.4 ± 1.21	32.27 ± 1.73
	Secena Prairie	2.10 ± 0.44	5.33 ± 0.08	3.73 ± 0.95	21.63 ± 1.95
	Average	2.28 ± 1.04	5.15 ± 0.05	3.28 ± 0.48	30.55 ± 2.21
All Sites	Average	2.25 ± 0.19	5.13 ± 0.04	2.96 ± 0.44	27.09 ± 1.42

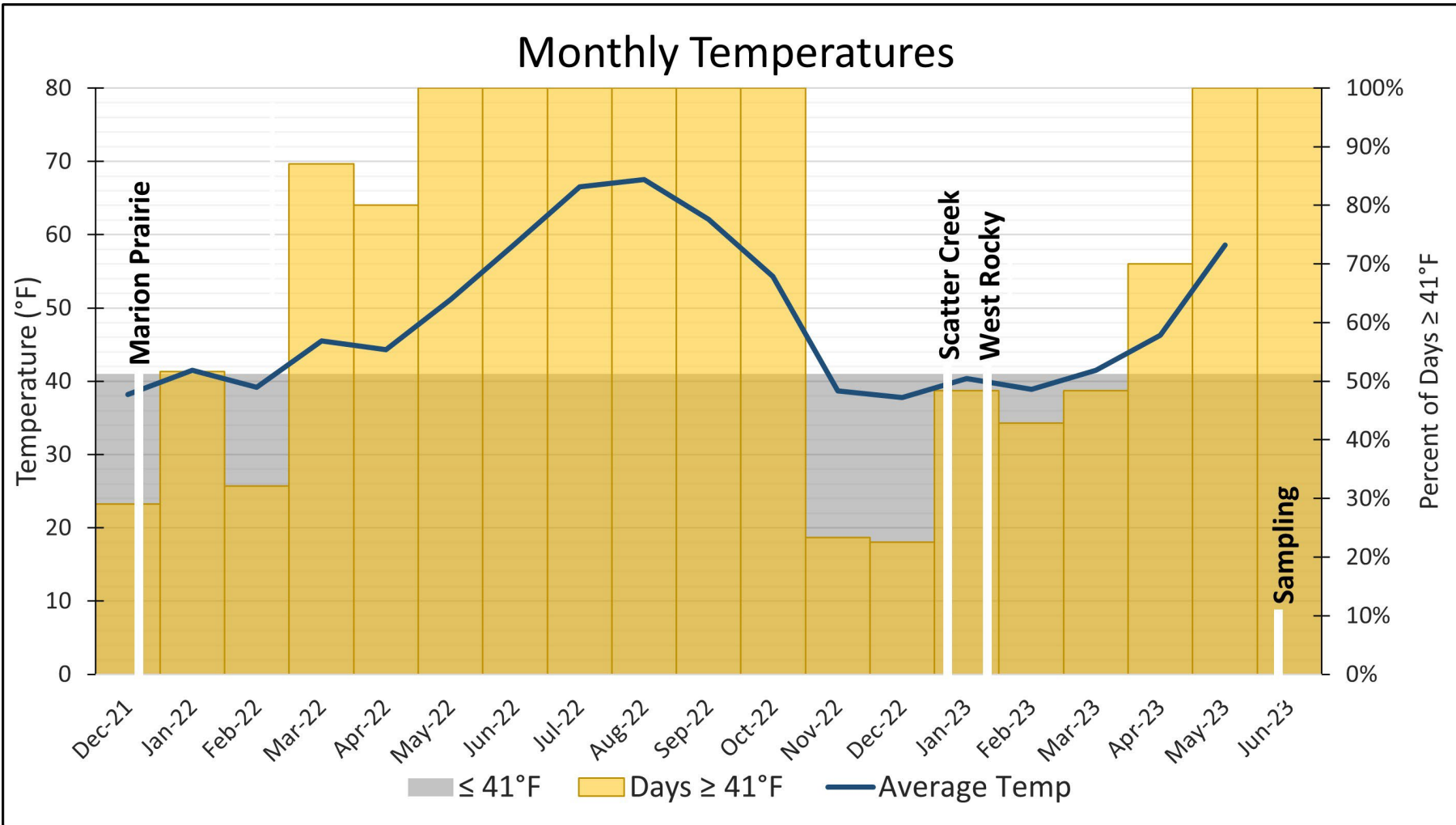
RESULTS: WEATHER AND CLIMATE

Precipitation Since Treatment:

- Marion Prairie: → 69.1 in
- Scatter Creek: → 17.5 in
- West Rocky: → 14 in



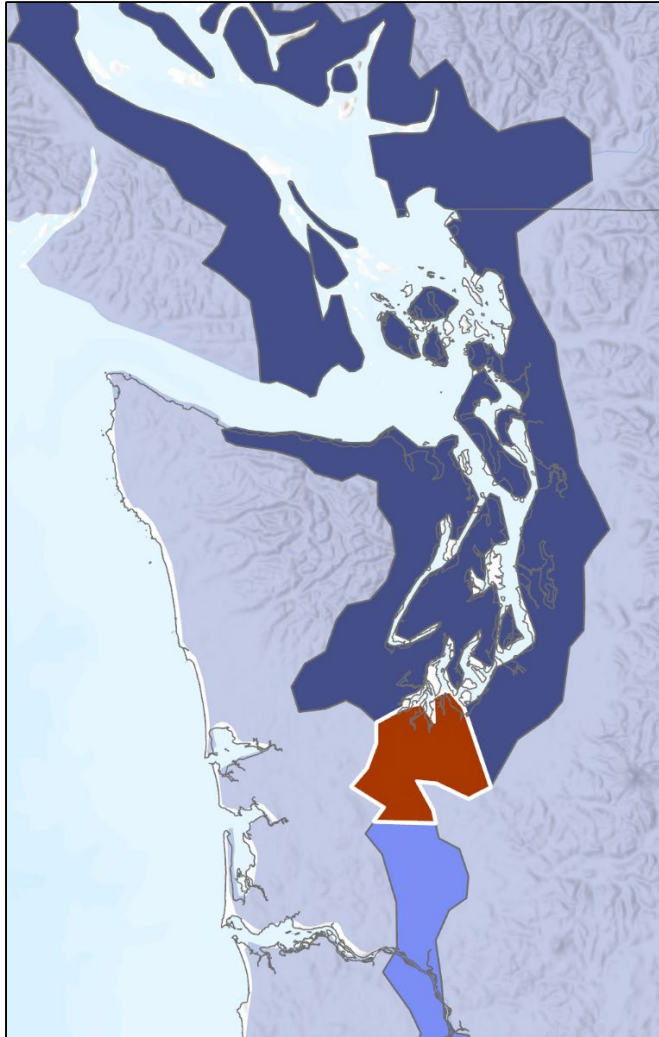
RESULTS: WEATHER AND CLIMATE



Months of Ideal Mineralization Temperatures:

- Marion Prairie: → 10 months
- Scatter Creek: → 2 months
- West Rocky: → 1.75 months

RESULTS: ALL BULBS



4.5 months after 0.96% glyphosate treatment
17 months after 2.5% glyphosate treatment

No detectable glyphosate ($<0.01 \pm 0.0024$ mg/kg)

No detectable AMPA ($<0.01 \pm 0.00238$ mg/kg)

IMPLICATIONS

Soil Characteristics

- Mobile in soil
- Drainage

Climate

- Mild, wet winters

Application Timing

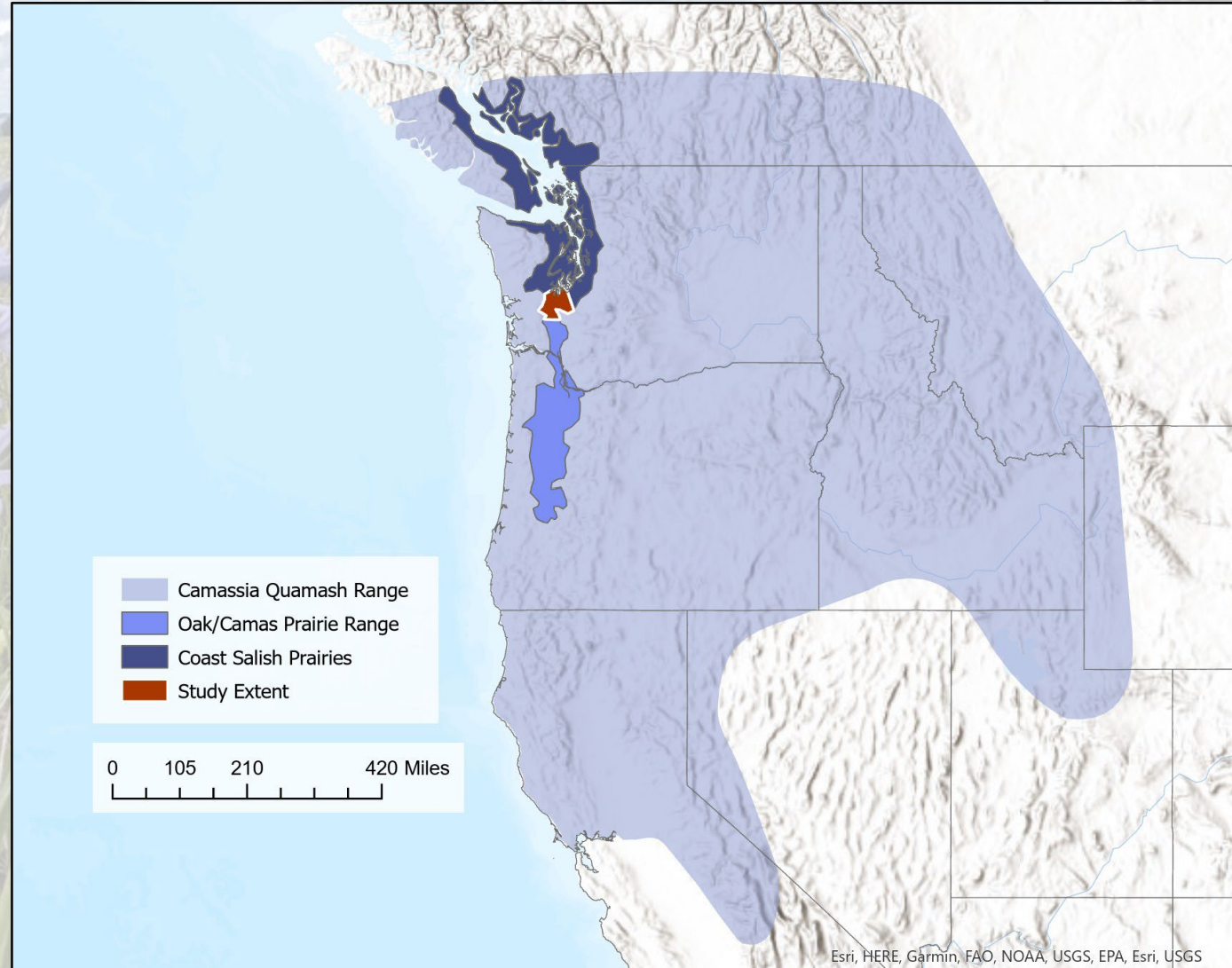
- Rainy season
- Camas dormancy

No risk of consuming glyphosate or AMPA 4.5 months after a 0.96% glyphosate treatment and 17 months after a 2.5% glyphosate treatment

Did glyphosate and AMPA leached from soil before it could be absorbed by camas roots?

FURTHER RESEARCH

- Other regions, climates, soils?
- Other species of *Camassia*?
- Other herbicides and concentrations?
- Different application timing?
- Other plants?
- Heavy metals?



ACKNOWLEDGEMENTS:

Camas and Coast Salish Prairies

Landcestors

Chehalis Tribe

Washington Native Plant Society

TESC Thesis Fund

Dr. Sarah Hamman

Sources and Image Credits:

Barnett, J. A., Josephson, J. K., Bandy, M. L., Haskey, N., Gibon, J., Chiang, H., & Gibson, D. L. (2023). A55 YOU ARE WHAT YOUR GREAT, GREAT GRANDPARENTS PARENTS ATE: PRE-NATAL GLYPHOSATE EXPOSURE INDUCES DYSBIOSIS, METABOLIC DYSFUNCTION AND BEHAVIOURAL ABNORMALITIES THREE GENERATIONS AFTER EXPOSURE. *Journal of the Canadian Association of Gastroenterology*, 6(Supplement_1), 30-31. <https://doi.org/10.1093/jcag/gwac036.055>

Botten, N., Wood, L. J., & Werner, J. R. (2021). Glyphosate remains in forest plant tissues for a decade or more. *Forest Ecology and Management*, 493, 119259. <https://doi.org/10.1016/j.foreco.2021.119259>

Buchenauer, L., Junge, K. M., Haange, S.-B., Simon, J. C., von Bergen, M., Hoh, A.-L., Aust, G., Zenclussen, A. C., Stangl, G. I., & Polte, T. (2022). Glyphosate differentially affects the allergic immune response across generations in mice. *Science of The Total Environment*, 850, 157973. <https://doi.org/10.1016/j.scitotenv.2022.157973>

Severn, J. (2023, May 19). *Camas is blooming, foragers delight and history of this prairie based plant*. The JOLT News Organization, A 501(c)(3) Nonprofit Organization. <https://www.thejoltnews.com/stories/camas-is-blooming-foragers-delight-and-history-of-this-prairie-based-plant,10624>

World of ATVs. (2023). *UTV and ATV Sprayer Buyer's Guide*. World of ATVs. <https://www.world-of-atvs.com/atv-sprayer.html>

USFWS. (2019). *Disappearing Prairies of the South Sound, Washington*. United States Department of Fish and Wildlife Services. <https://www.fws.gov/media/disappearing-prairies-south-sound-washington>

Wood, L. J. (2019). The presence of glyphosate in forest plants with different life strategies one year after application. *Canadian Journal of Forest Research*, 49(6), 586-594. <https://doi.org/10.1139/cjfr-2018-0331>