

# Current Status of Herbicides for Controlling Invasive Knotweeds in the United States

Tim Miller

WSU Mount Vernon NWREC



# Herbicide Trials for Knotweed Control

- North American herbicide trials
  - Ahrens (1975) showed positive results from **foliar glyphosate**
  - Trial by Jennings and Fawcett (1977) tested **foliar** and **cut stem** applications of **glyphosate** and **triclopyr**

# Herbicide Trials for Knotweed Control

- North American herbicide trials
  - Trial by Scott and Marrs (1985) used two applications of fosamine, glyphosate, simazine, triclopyr, and picloram
    - Picloram was by far the most effective, although glyphosate rate was probably too low (2 lbs ae/a)
  - Trial by Figueroa (1989) used 2,4-D, clopyralid, dicamba, glyphosate, imazapyr, and metsulfuron
    - Imazapyr, clopyralid, and glyphosate reduced stem number and height by more than 50% by one year after treatment
    - Only imazapyr maintained control (up to five years)

# Herbicide Trials for Knotweed Control

- More recent trials
  - Crockett (2003) reported on work involving **injection of glyphosate** concentrate
    - 5 ml full-strength product into lower stem
    - 10 ml 50% product in water
  - Volmer (2006) reported on tests with **imazapyr** and **glyphosate**
    - Excellent control from **0.75 to 1.5%**
  - Trials by Skibo (2006) showed some activity with **mesotrione**

# Greenhouse Trial, 2003-04

- Knotweed plant material
  - Bohemian and giant knotweed shoots (Mount Vernon)
  - Himalayan knotweed shoots (Cape Disappointment)
  - Giant knotweed seedlings (Big Quilcene River)
  - Two separate populations of Bohemian knotweed seedlings (Japanese knotweed female parent, unknown male parent; Acme and Marblemount)

# Greenhouse Trial, 2003-04

## Materials and Methods

- Foliar treatments of **glyphosate** (Aquamaster), **triclopyr** (Garlon 3A or Renovate), or **imazapyr** (Arsenal or Habitat) applied in summer
  - 0.5% each
  - 1% each
  - 0.5% each in 2-way combinations
  - 0.3% each in 3-way combination
- All plants **cut** three weeks after treatment and **re-growth monitored**

Giant  
seedling



←  
Bohemian  
transplants





Untreated



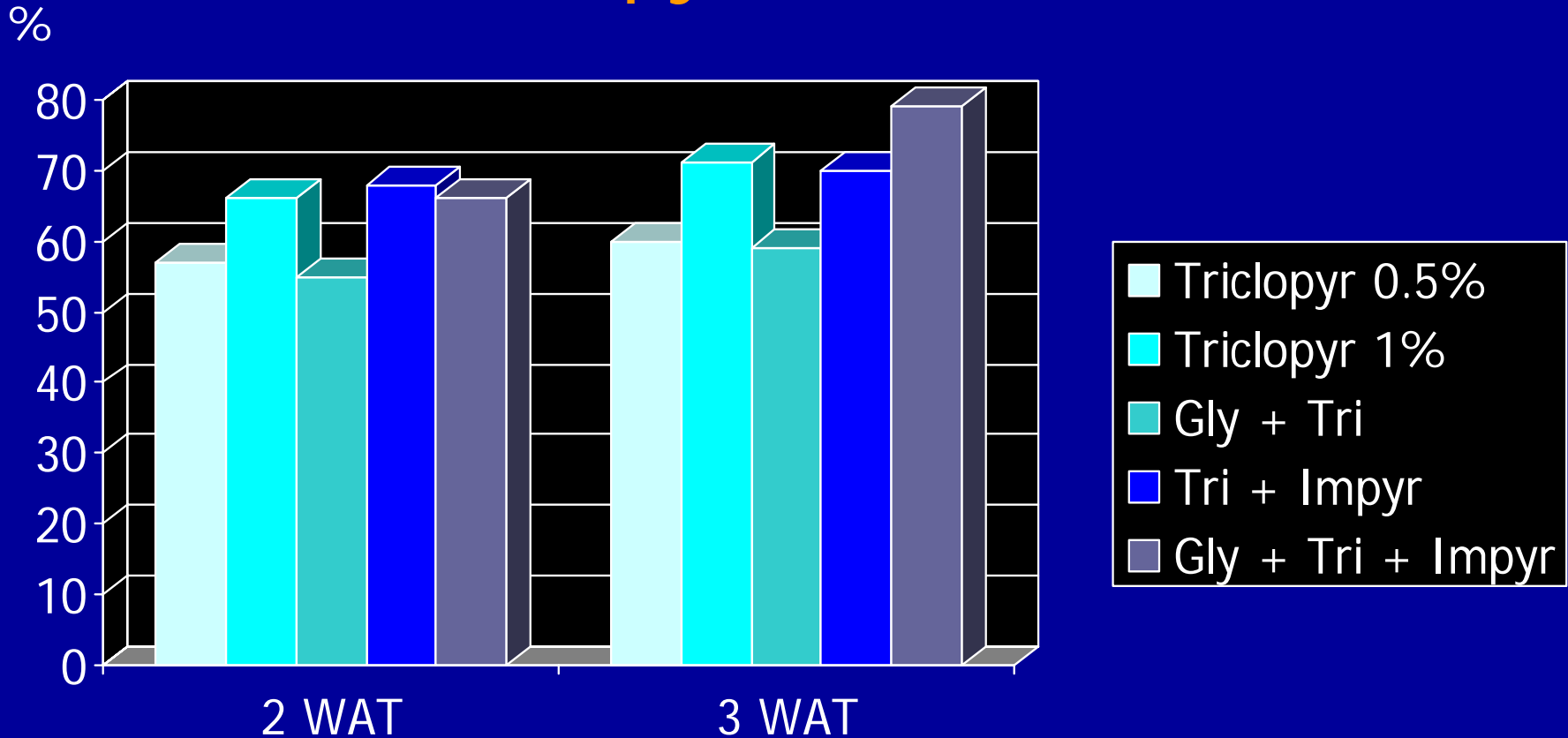
Three weeks after  
triclopyr at 1%





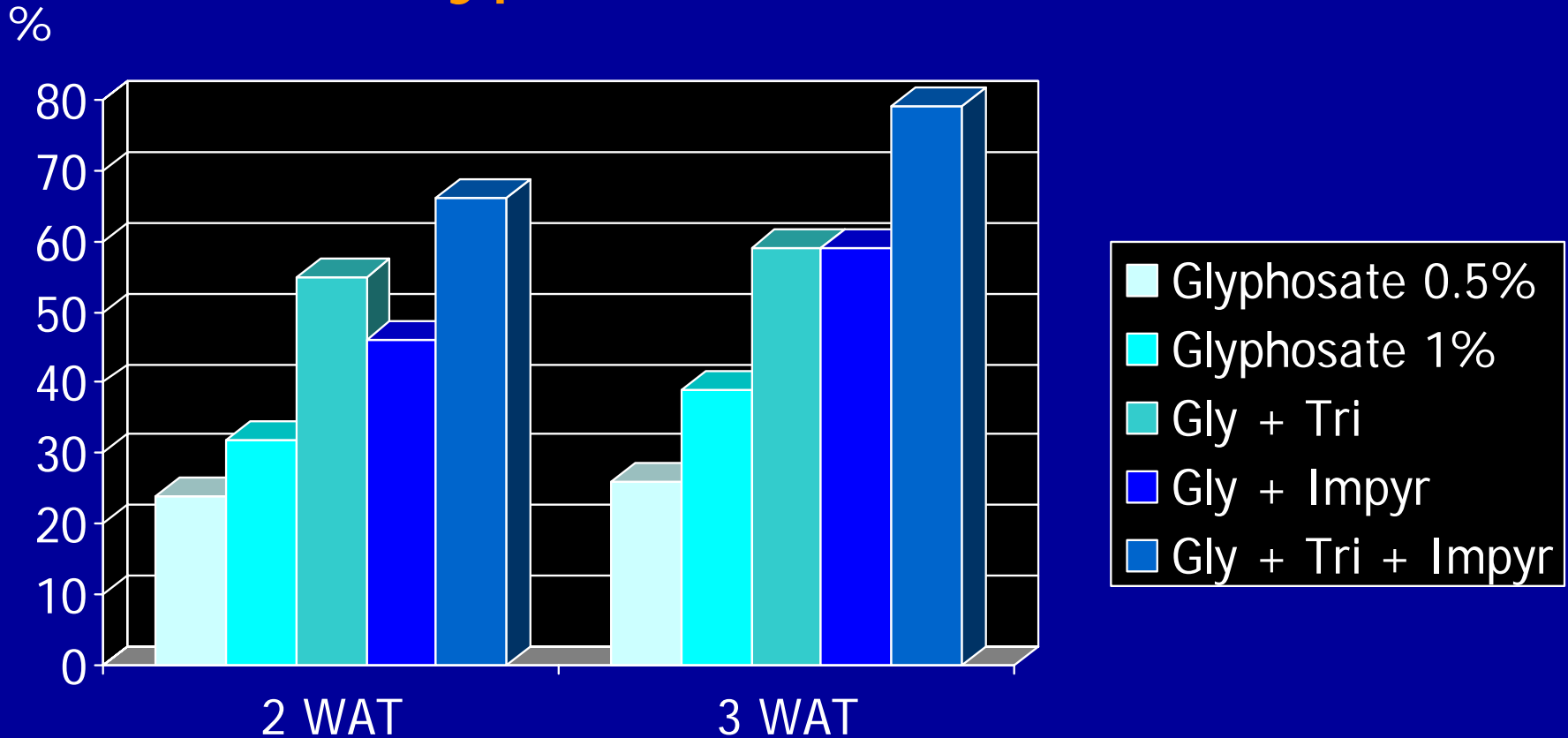
# Early Bohemian Knotweed Injury

Triclopyr, 2003-04



# Early Bohemian Knotweed Injury

## Glyphosate, 2003-04





Before and after clipping



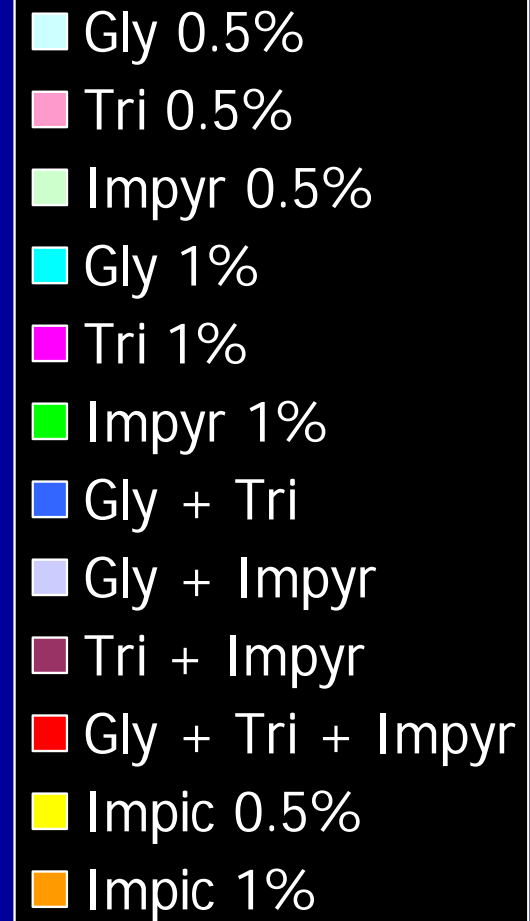
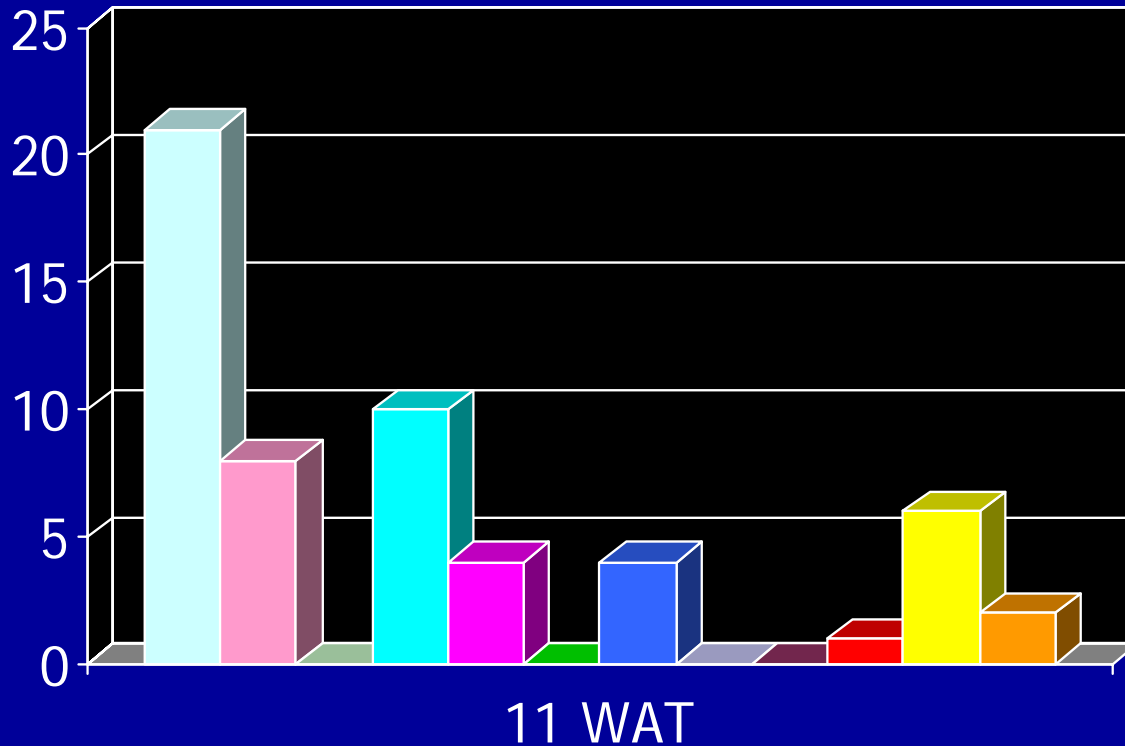
## Bohemian knotweed re-growth

Eleven weeks  
after glyphosate  
at 0.5% (eight  
weeks after  
clipping)

# Bohemian Knotweed Re-growth

## 2003-04

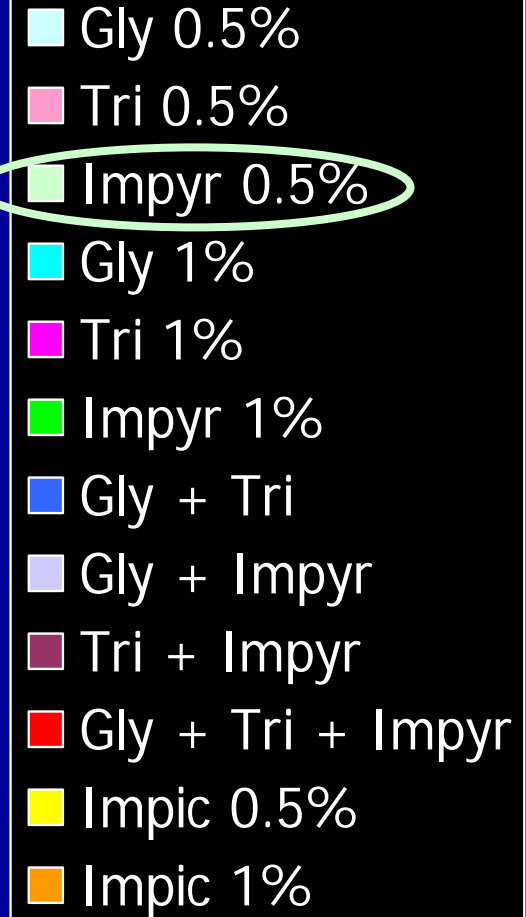
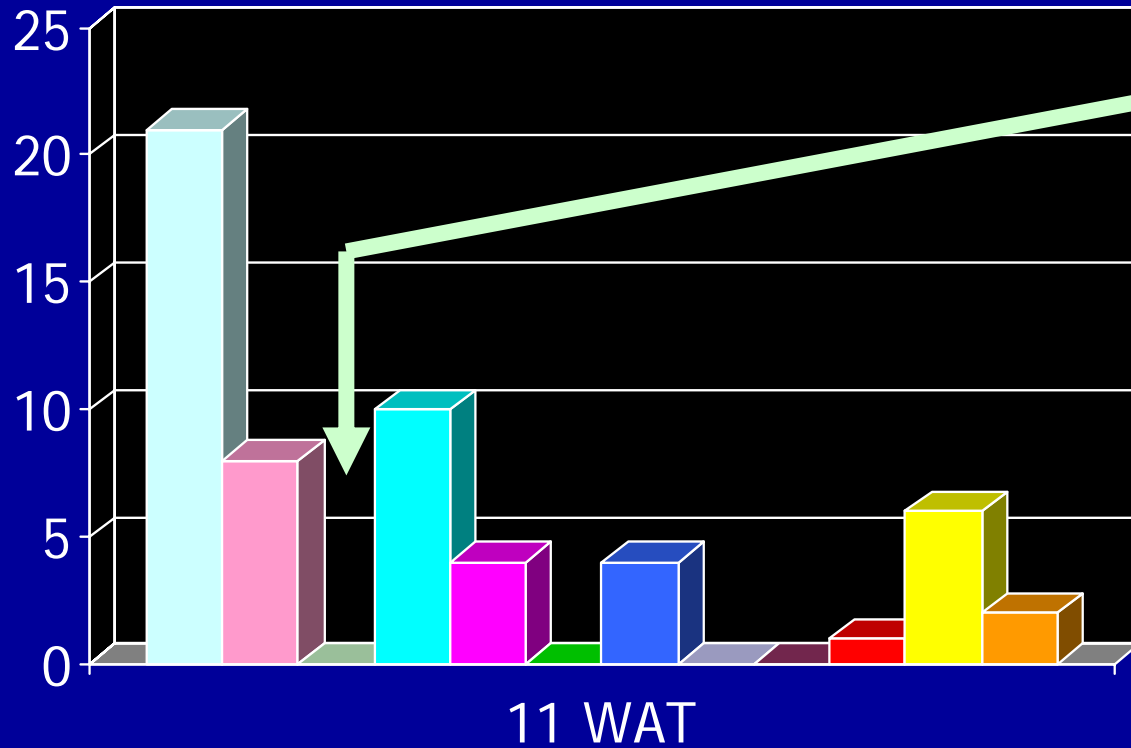
% re-growth (check = 100%)



# Bohemian Knotweed Re-growth

## 2003-04

% re-growth (check = 100%)

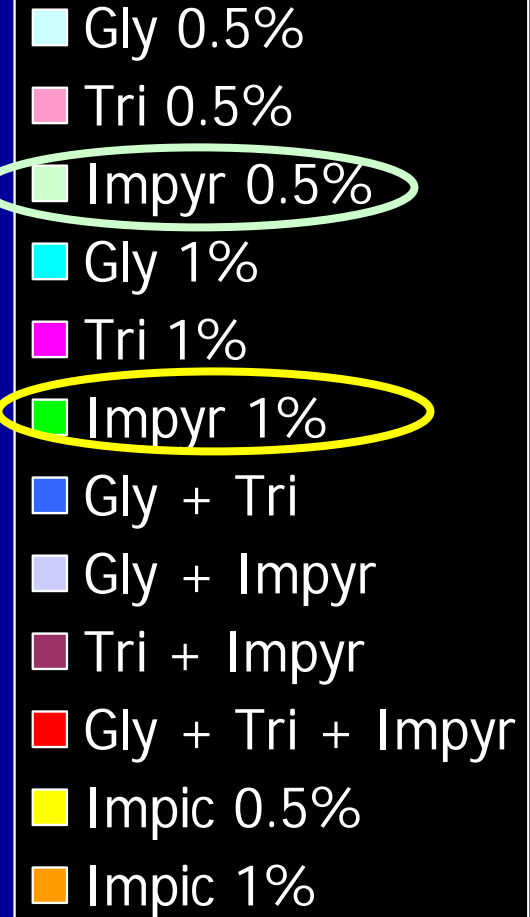
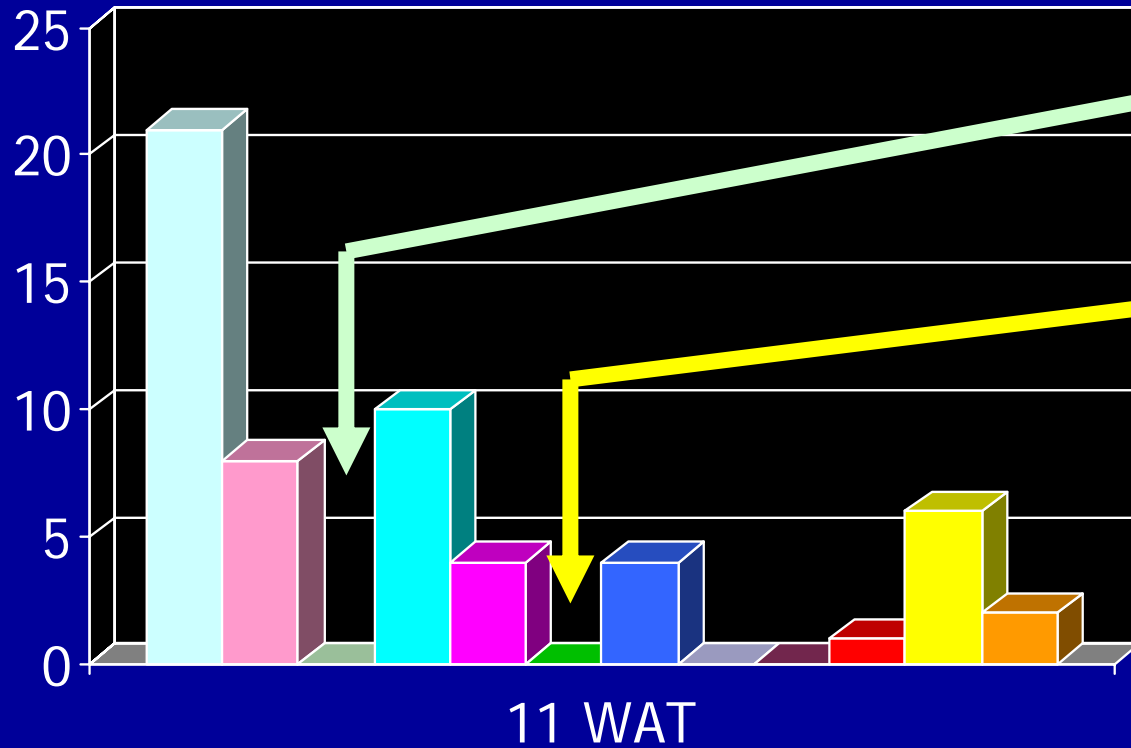




# Bohemian Knotweed Re-growth

## 2003-04

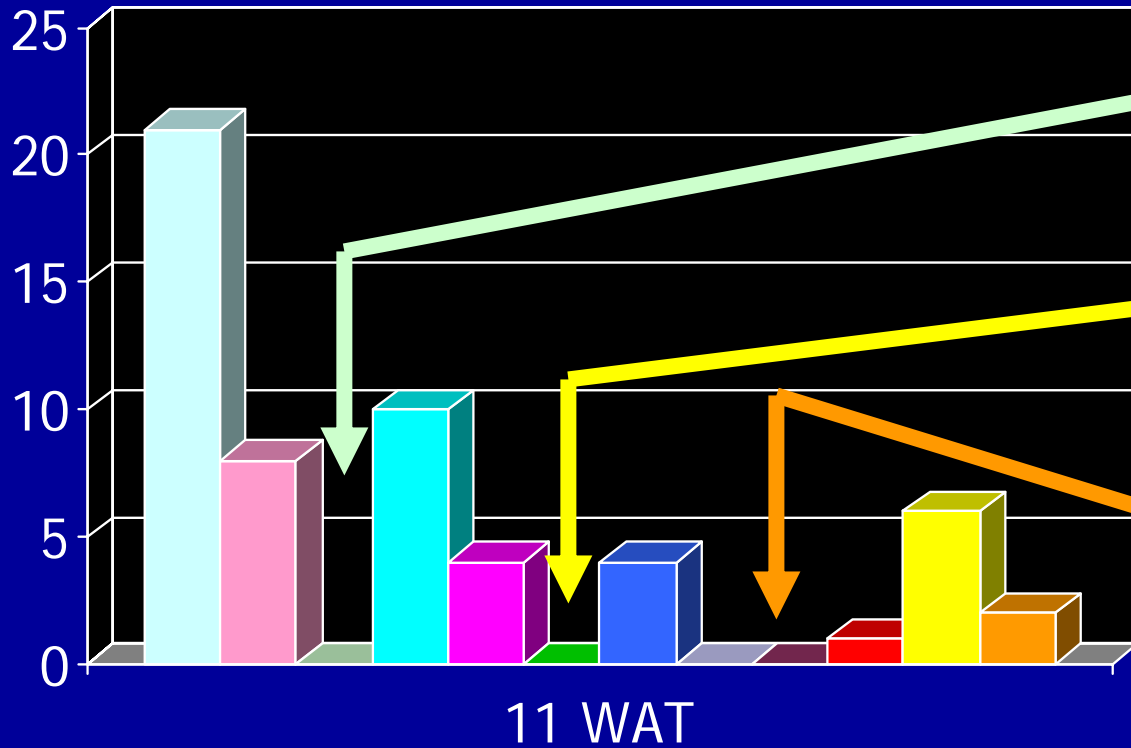
% re-growth (check = 100%)



# Bohemian Knotweed Re-growth

## 2003-04

% re-growth (check = 100%)



- Gly 0.5%
- Tri 0.5%
- Impyr 0.5%
- Gly 1%
- Tri 1%
- Impyr 1%
- Gly + Tri
- Gly + Impyr
- Tri + Impyr
- Gly + Tri + Impyr
- Impic 0.5%
- Impic 1%

# Field Knotweed Trials



# Field Trials, 2003-05

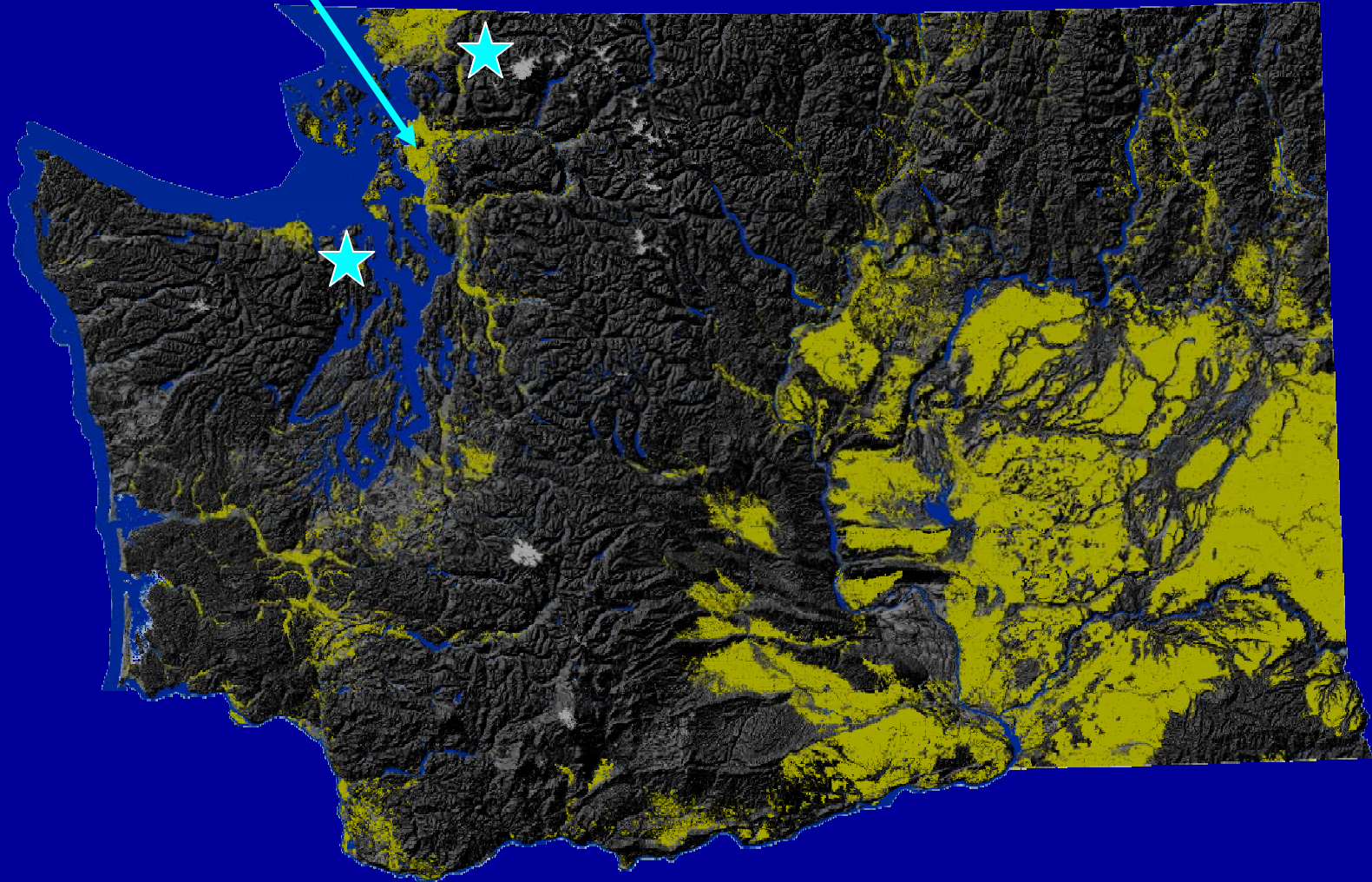
## Materials and Methods

- **Giant knotweed** (Big Quilcene River, Jefferson County, WA; Cathy Lucero, co-investigator)
  - Treated at **early flowering**
- **Bohemian knotweed** (Hutchinson Creek, Whatcom County, WA; Laurel Baldwin, co-investigator)
  - Treated at **early flowering** or **after petal fall**
- Each trial was **two years** long



# Knotweed Field Sites

WSU NWREC

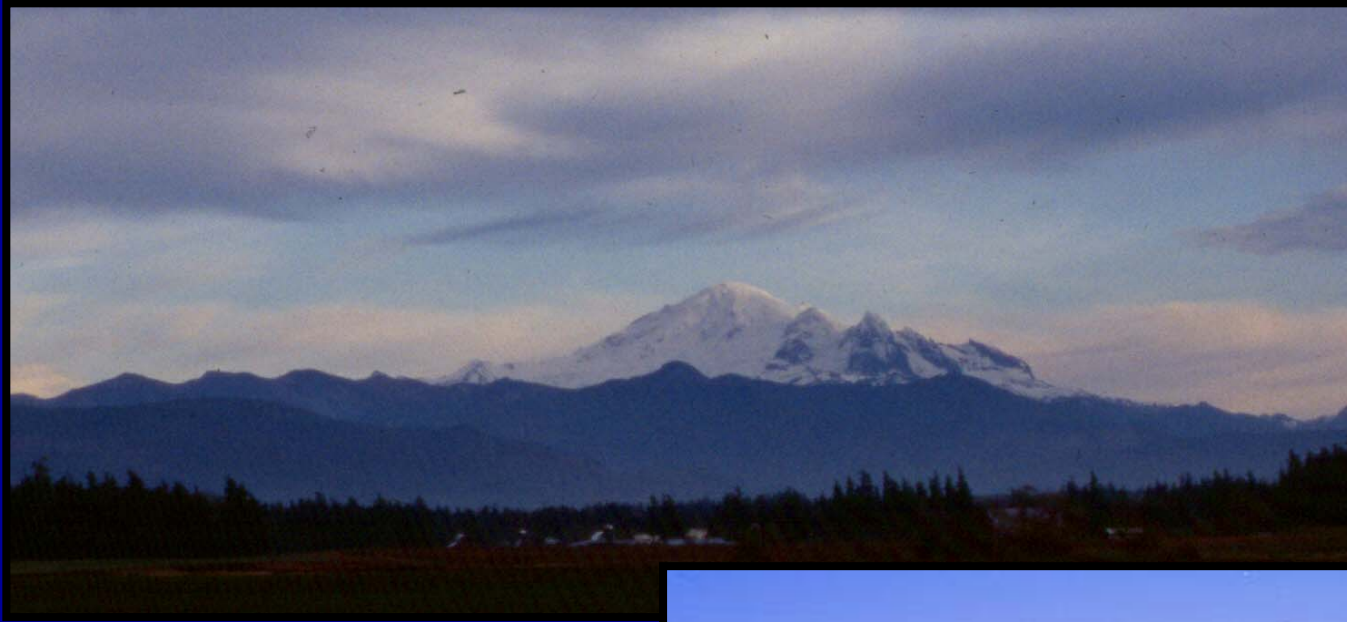




Plots near  
Hutchinson  
Creek







Plots near  
Hutchinson  
Creek



Plots near  
Big Quilcene  
River

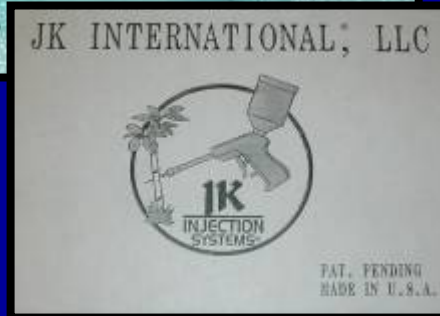


# Field Trials, 2003-05

## Materials and Methods

- Herbicides tested were **glyphosate**, **triclopyr**, or **imazapyr**
  - 33% herbicide **wiped** on lower three feet of intact stems
  - 33% herbicide **wiped** on stems cut at three feet
  - Stem **injection** of 2.5 or 5 mls of full strength herbicide
- Plots were **circular**, measuring **1 m in diameter**, 4 replicates

# Knotweed injection



# New Knotweed Shoot Growth

## Second Year Data, April

- No differences in control between species
- All three herbicides killed the crowns of treated stems, although wipe treatments (non-cut canes) were less effective
- No treatment effect on early spring growth (likely due to undergrowth of rhizomes originating from outside the plot)
- Early-bloom treatments in the field injured Bohemian knotweed more quickly than did post-bloom treatments, but there was no difference in stem kill by April



# New Knotweed Shoot Growth

## Second Year Data, August

- Still **no major treatment differences** between giant and Bohemian knotweed
- Still **no differences** in number of **stems** in treated plots
  - Control of **knotweed crowns** remained excellent for all treatments (except herbicide wipe)
- Herbicide **symptoms** were apparent up to **four feet** away from the application point
  - Most symptoms on knotweed, but **other species showed symptoms**
  - 22 incidences of 144 possible (**15%**)

# Non-Target Symptomology

- Blackberry, 2 incidences (imazapyr)
- Red alder, 1 incidence (imazapyr)
- Reed canarygrass, 7 incidences (imazapyr)
- Salmonberry, 8 incidences (imazapyr and glyphosate)
- Snowberry, 4 incidences (imazapyr and triclopyr)





# Greenhouse Symptomology Trial 2005

- Investigating the potential for glyphosate injury to non-target plants
  - Salmonberry (*Rubus spectabilis*) or thimbleberry (*R. parviflorus*) potted in sand along with knotweed
  - Knotweed treatments
    - Spray over pots (2%)
    - Leaf wipe (33% solution)
    - Injection (full-strength product)

# Greenhouse Symptomology Trial 2005

- **Overspray** (2% glyphosate)
  - Average knotweed control **81%**
    - Nearly complete control of **giant** (100%) and **Himalayan** (98%)
    - **Bohemian** control only 68%
  - Average injury to salmonberry and thimbleberry **68%**

# Greenhouse Symptomology Trial 2005

- Leaf wipe (33% solution)
  - Average knotweed control 89%
    - Nearly complete control of Bohemian (83%), giant (98%), and Himalayan (98%)
  - Average injury to salmonberry and thimbleberry 13%

# Greenhouse Symptomology Trial 2005

- **Injection** (up to 5 ml glyphosate)
  - Average knotweed control **88%**
    - Nearly complete control of **Bohemian** and **giant** (88 and 100%, respectively)
    - Could not inject **Himalayan**, but small drops of glyphosate enough to provide 63% control
  - Average injury to salmonberry and thimbleberry **26%**

# Injection Problems

Small diameter canes can't be injected



Photos by Cathy Lucero, Clallam County  
Noxious Weed Control Board

Canes may  
split during  
injection



# More Field Trials

- Bohemian knotweed (Mount Vernon)
  - 2005 (aminopyralid, imazapyr, glyphosate, and triclopyr)
    - One site treated at full bloom
    - Second site mowed in mid-summer, re-growth treated when about three to four feet tall
  - 2006 (aminopyralid, imazapyr, glyphosate)
    - Stems bent and herbicides applied after ten days
- Bohemian knotweed (Pacific county, Kim Patten)
  - 2005 and 2006 tests involving application timing with aminopyralid, imazapyr, glyphosate, and triclopyr





Aminopyralid **does show activity**, but still need fine-tuning of **rates** and **tank mix partners**



# How Should Symptomatic Plants be Re-treated?







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# Field Knotweed Control Projects, Southwestern Washington, 2004-05

- \$250K in funding from legislature for **knotweed control work** in southwestern Washington from July 1, 2004 to June 30, 2005
  - Some \$ to me to **estimate control** from the various treatments

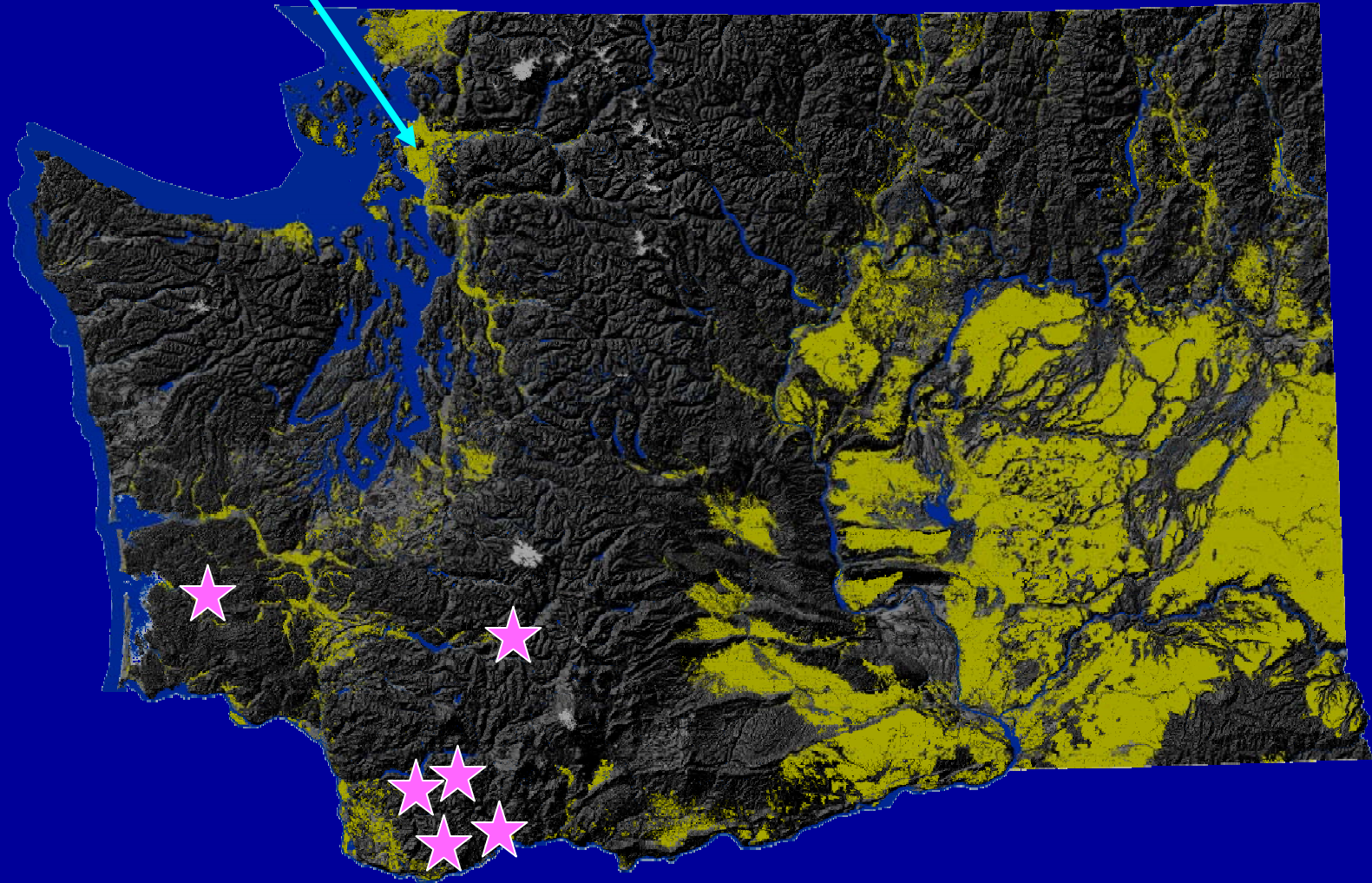
## Overview of six project sites and knotweed control strategies

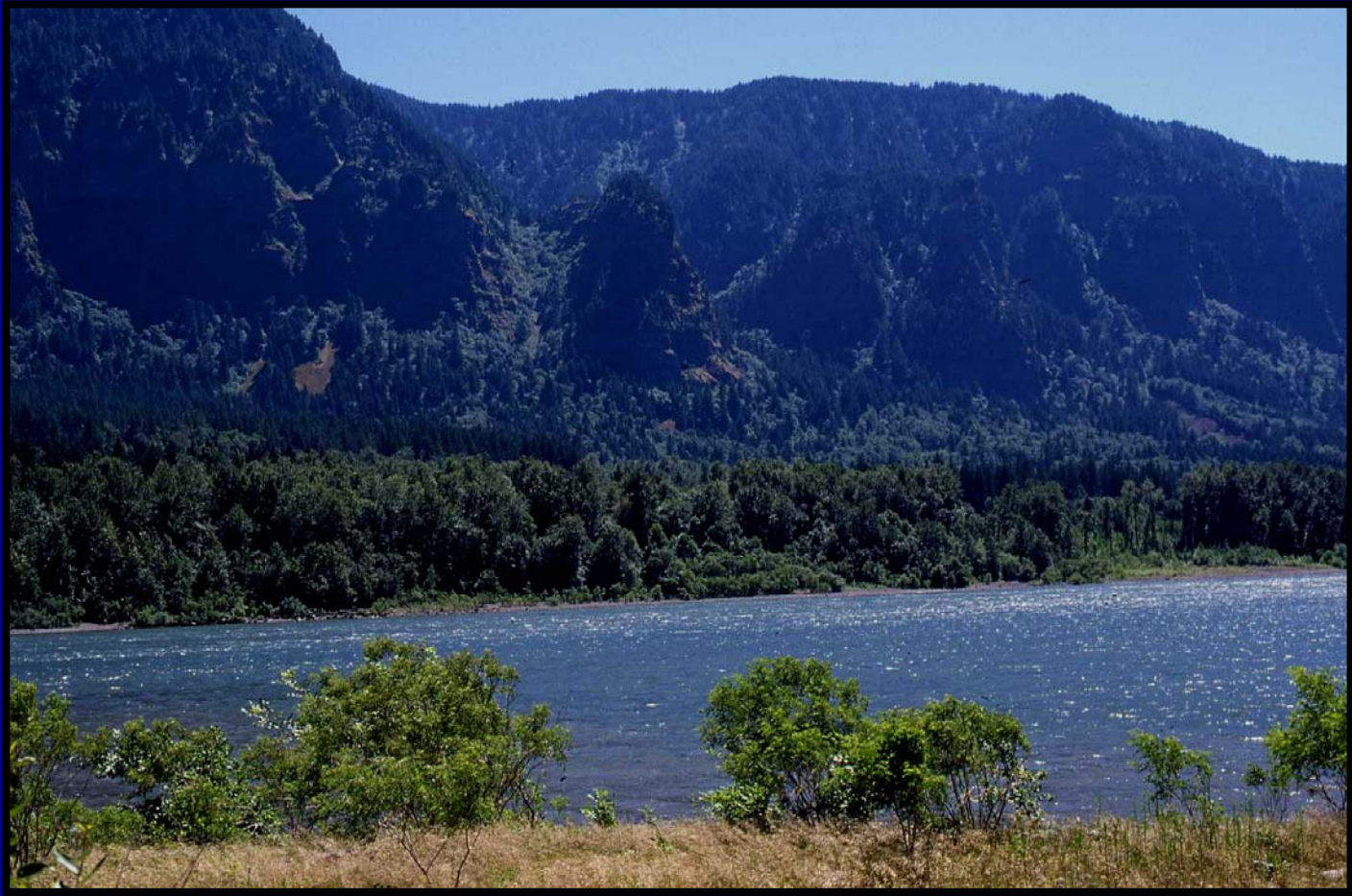
Project Location	Treatment site	Knotweed species	Treatment
Clark	Upper East Fork Lewis River	Bohemian	Injection, 5 mls Aquamaster per stem
Clark	Lower East Fork Lewis River	Bohemian	Foliar, 1.5% Habitat
Lewis	Upper Cowlitz River	Bohemian	Foliar, 1.5% Aquamaster + 0.75% Habitat
Pacific	Willapa River	Bohemian	Foliar, 2% Aquamaster + 0.5% Habitat
Skamania	Washougal River	Japanese (?)	Injection, 5 mls Aquamaster per stem
WA State Parks	Beacon Rock	Japanese (?)	Injection, 5 mls Aquamaster per stem



# Southwest Knotweed Field Sites

WSU NWREC

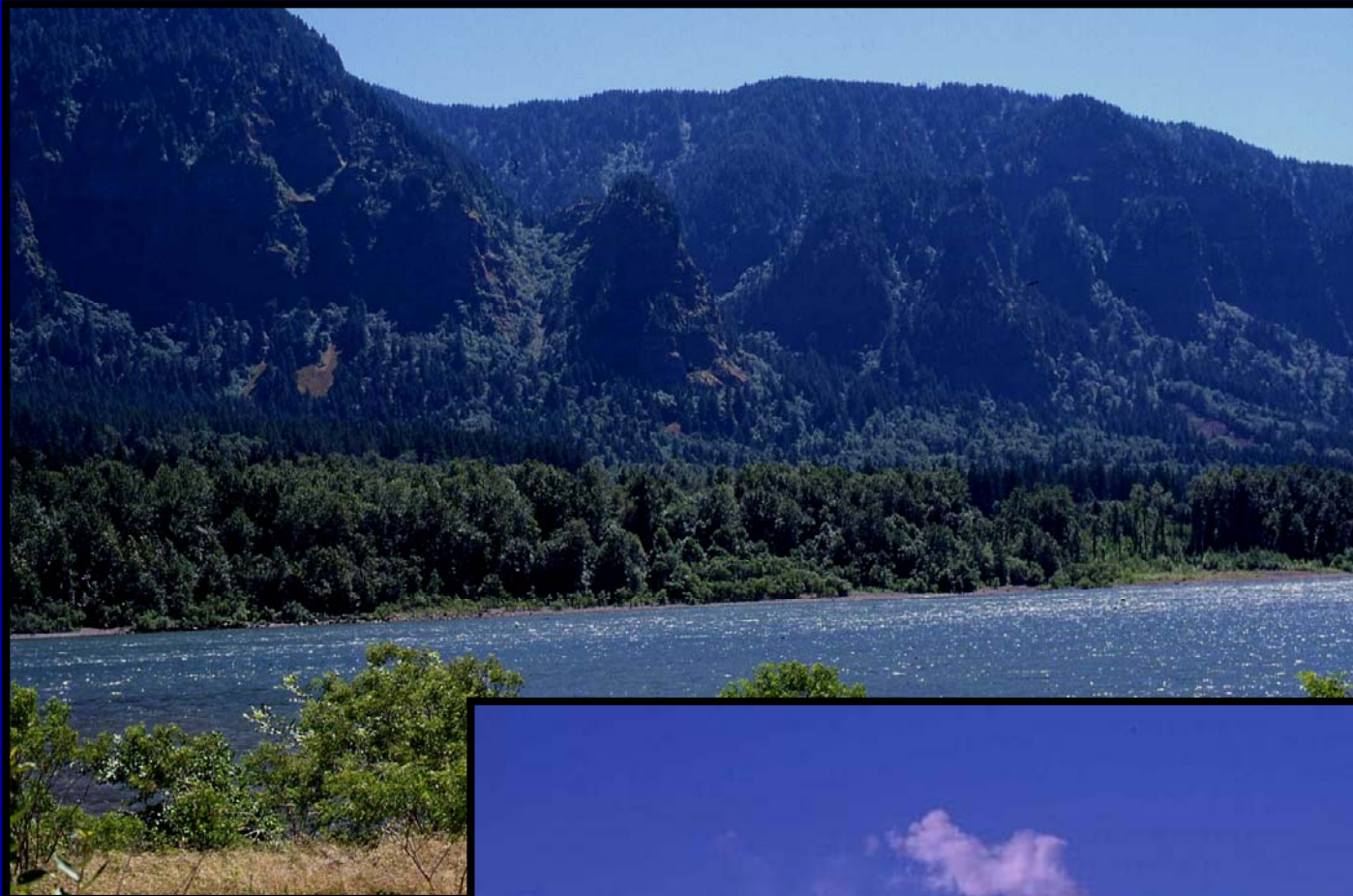




View to  
the south







View to  
the south



View to  
the  
Northwest





View  
to the  
north







View  
to the  
north



View to  
the south





# Results of Treatments

## Knotweed in June, 2005

- Visual knotweed control ranged from 88 to 94%
  - No significant differences between sites, but trend toward better control with imazapyr
- Stem numbers were reduced 63 to 80%
  - Estimated 17,000 to 33,500 stems per acre before treatment and 4,600 to 10,800 after treatment
- Stem height ranged from 10 to 20 inches tall
  - Expected height 72 inches (72 to 86% reduction)

# Results of Treatments

June, 2005

- Injury to **non-target vegetation** among all treatments was **< 10%**
  - No apparent correlation between injury and application type or herbicide choice
- All new shoots in treated areas were from rhizomes/crown (**no seedlings were found**)
- **Very little plant growth** in any plot
  - Probably speaks more to competitive ability of these knotweeds prior to treatment than by the herbicides killing other species
  - Allelopathy?