The Spatial Structure of a Bohemian Knotweed (*Polygonum x bohemicum*) Infestation on the Hoh River, Washington, USA – An Assessment of Spatial Data

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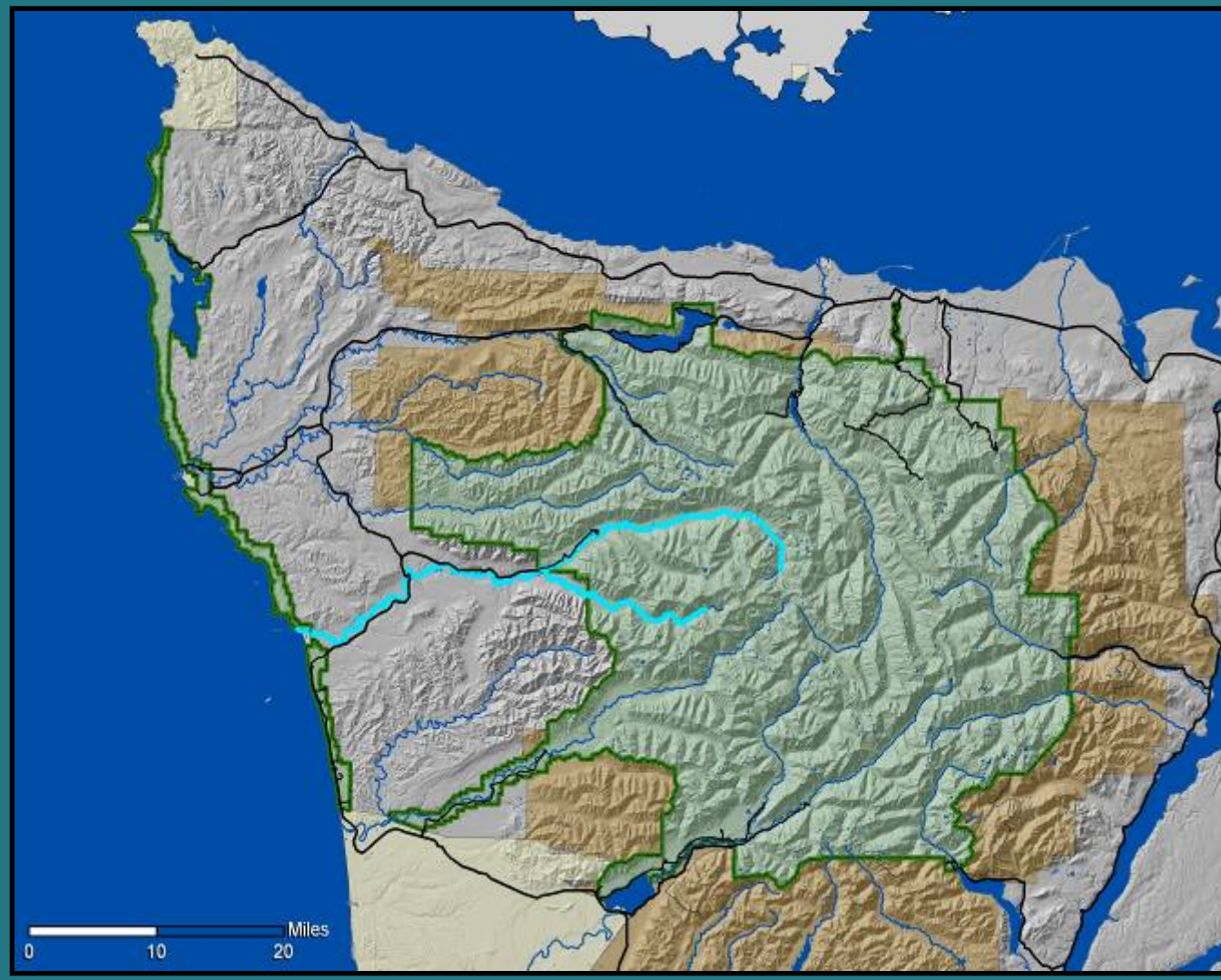
Hoh River

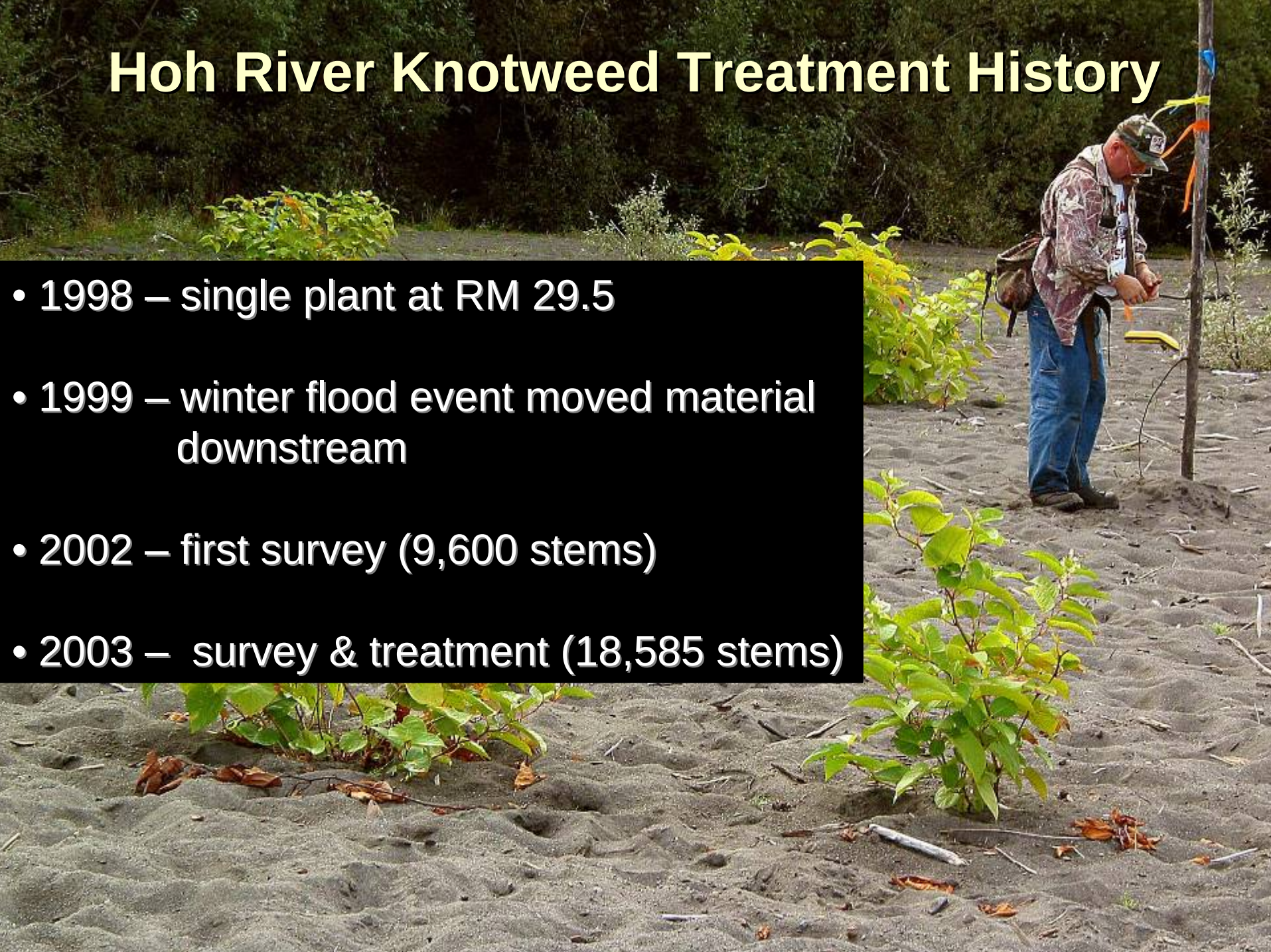
- 25 miles – OLYM
  30 miles – to coast

- species
  - bull trout (T&E)
  - 7 salmon runs

- 76% of precipitation from Oct. - April



Hoh River Knotweed Treatment History



- 1998 – single plant at RM 29.5
- 1999 – winter flood event moved material downstream
- 2002 – first survey (9,600 stems)
- 2003 – survey & treatment (18,585 stems)

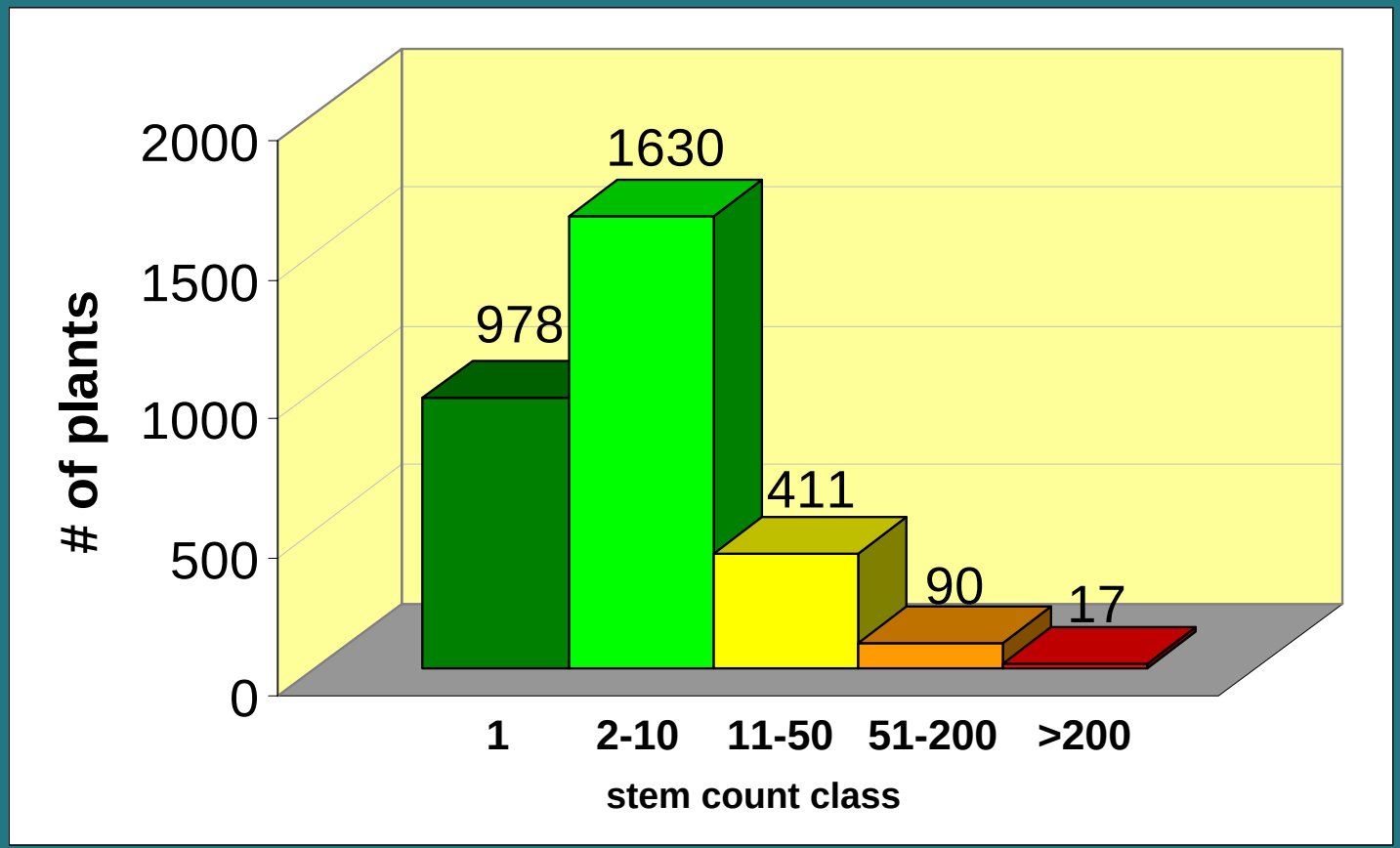
Hoh River Knotweed Treatment History

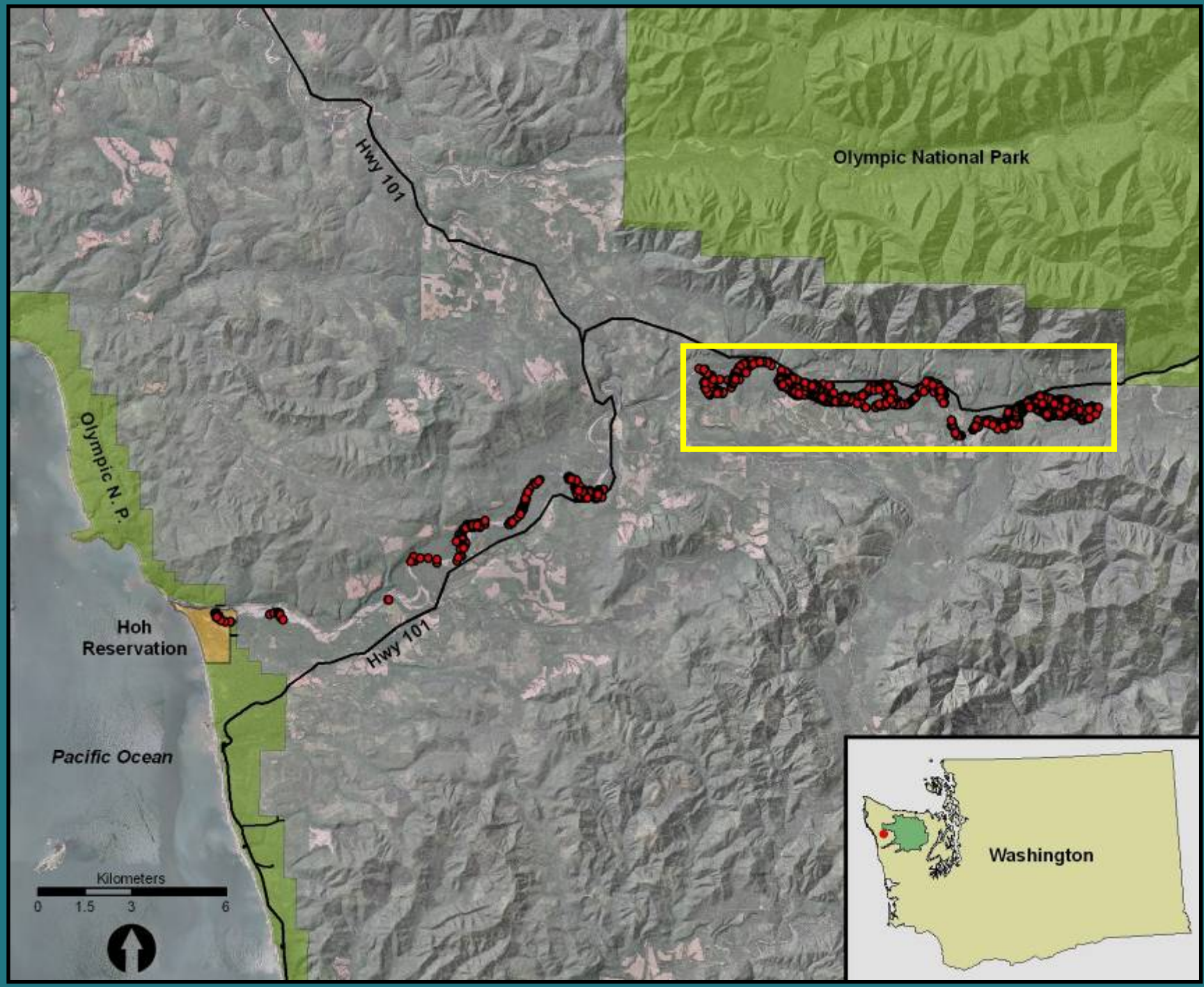
- 2004 - the entire river corridor from RM 29.5 to the mouth was mapped and treated.

- Treatments consisted of stem injection, foliar application, and a combination of injection & foliar spray

Hoh River Knotweed Treatment History

- 2003-2005: treated 3,126 plants [39,581 stems]




Olympic National Park
Hwy 101
Olympic N. P.
Hoh
Reservation
Hwy 101
Pacific Ocean
Kilometers
0
1.5
3
6
Washington

General Question

How useful are our spatial data?

GIS analysis?

adequately capture what we want to know?

Project Questions

- What are the spatial distribution patterns of knotweed plants over time?
- At what spatial scales does knotweed clustering occur?
- What are the temporal and spatial relationships between knotweed ramets and parent plants?

Methodology

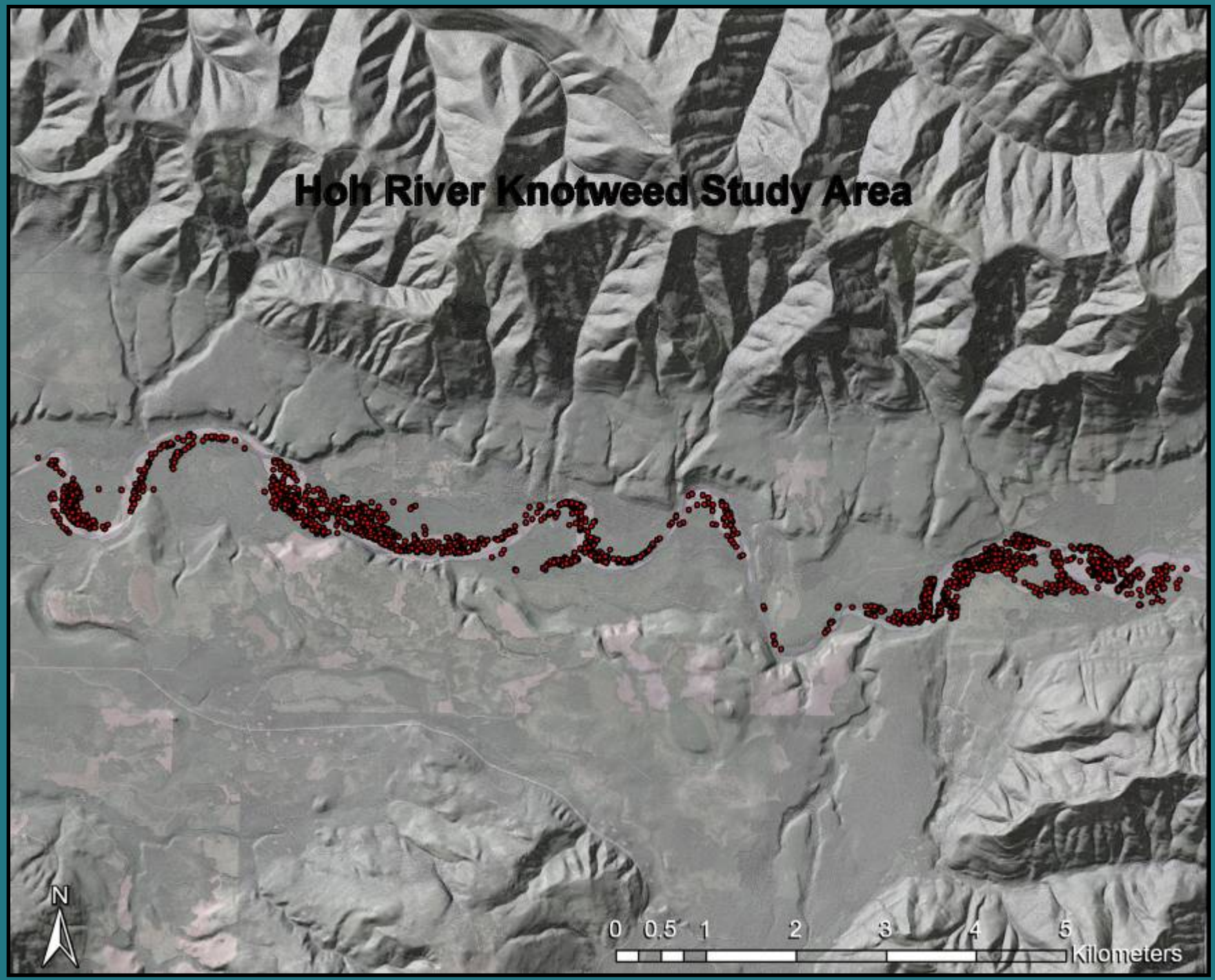
- Limited study to 2003, 2004, and 2005 data collected in the upper reach of the infestation:
  - most thoroughly & consistently surveyed area
  - plants well established
  - 18 km (11 river miles)

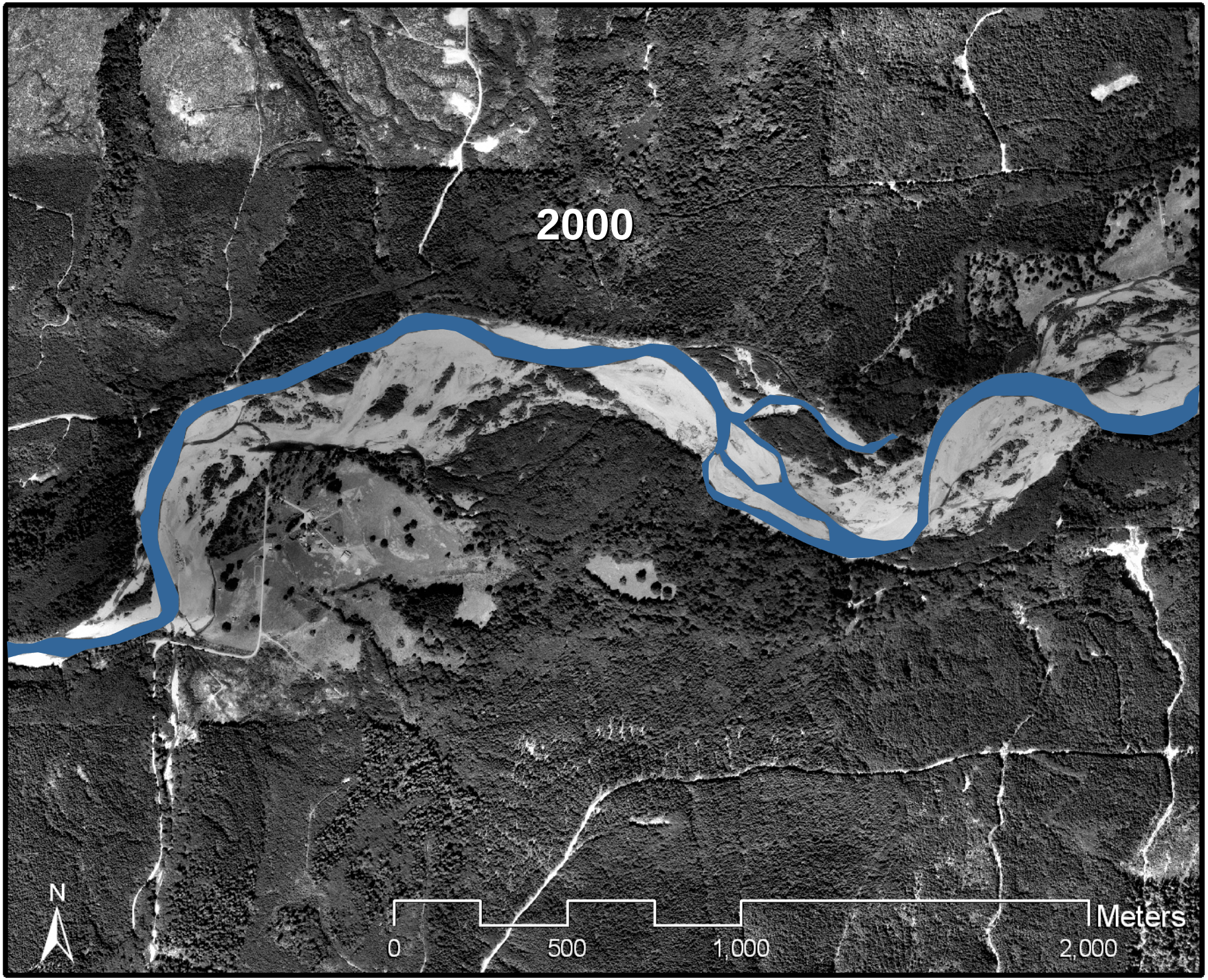
- Database field of interest: knotweed growth-form
  - ramet, genet, or cluster

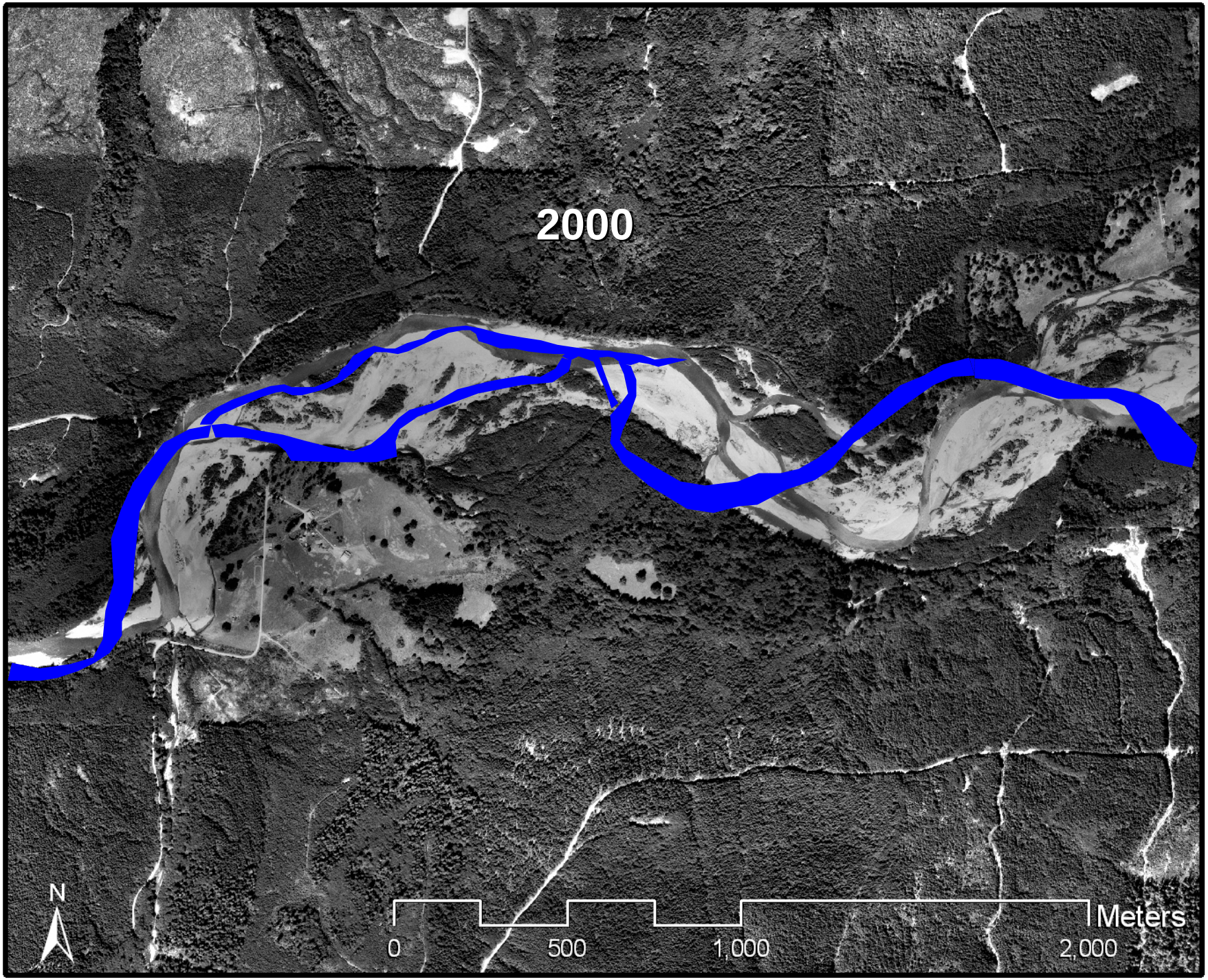
Growth-forms

cluster

genet


Hoh River Knotweed Study Area
N
0 0.5 1 2 3 4 5
Kilometers


2000
N
0
500
1,000
2,000
Meters


2000
N
0
500
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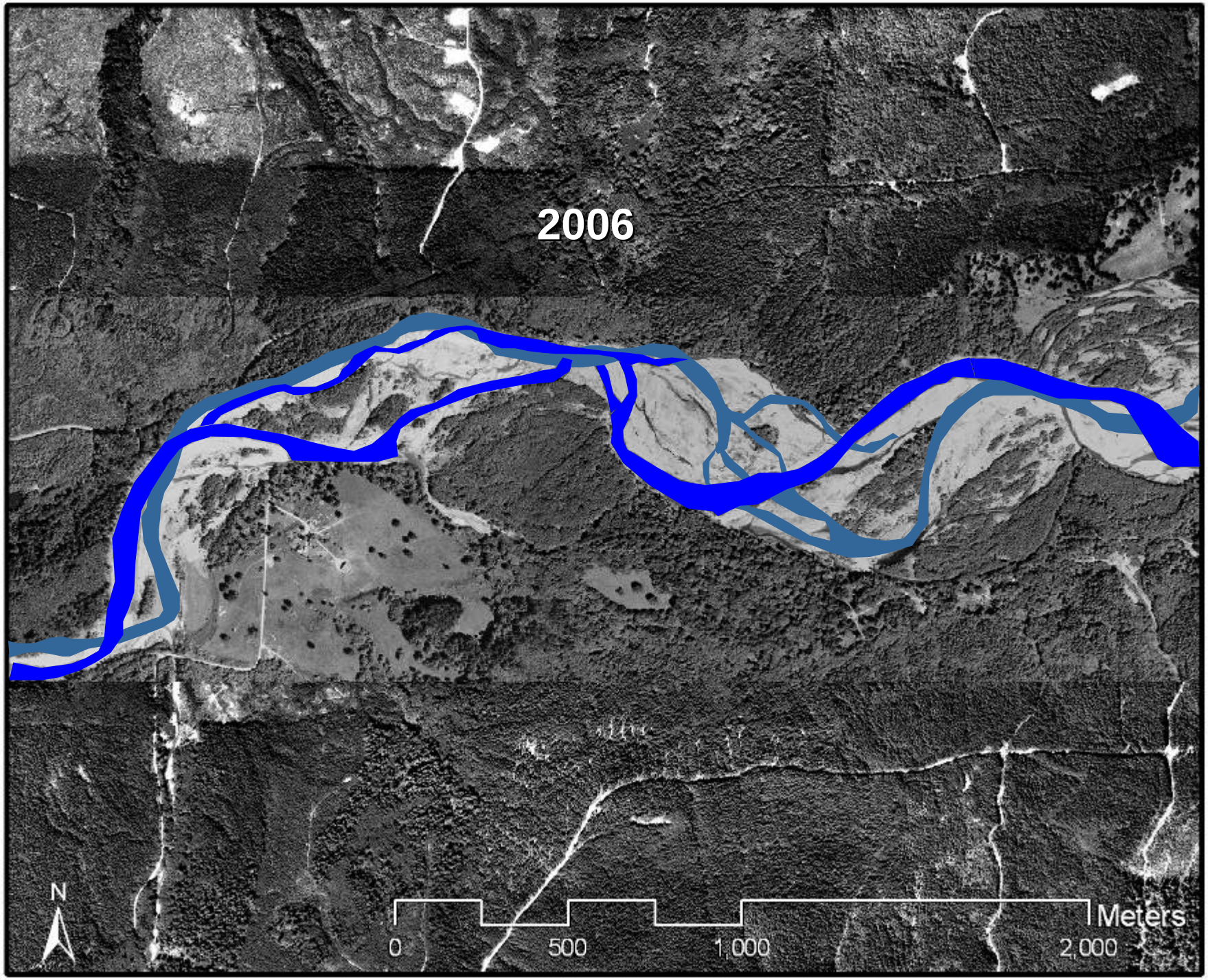
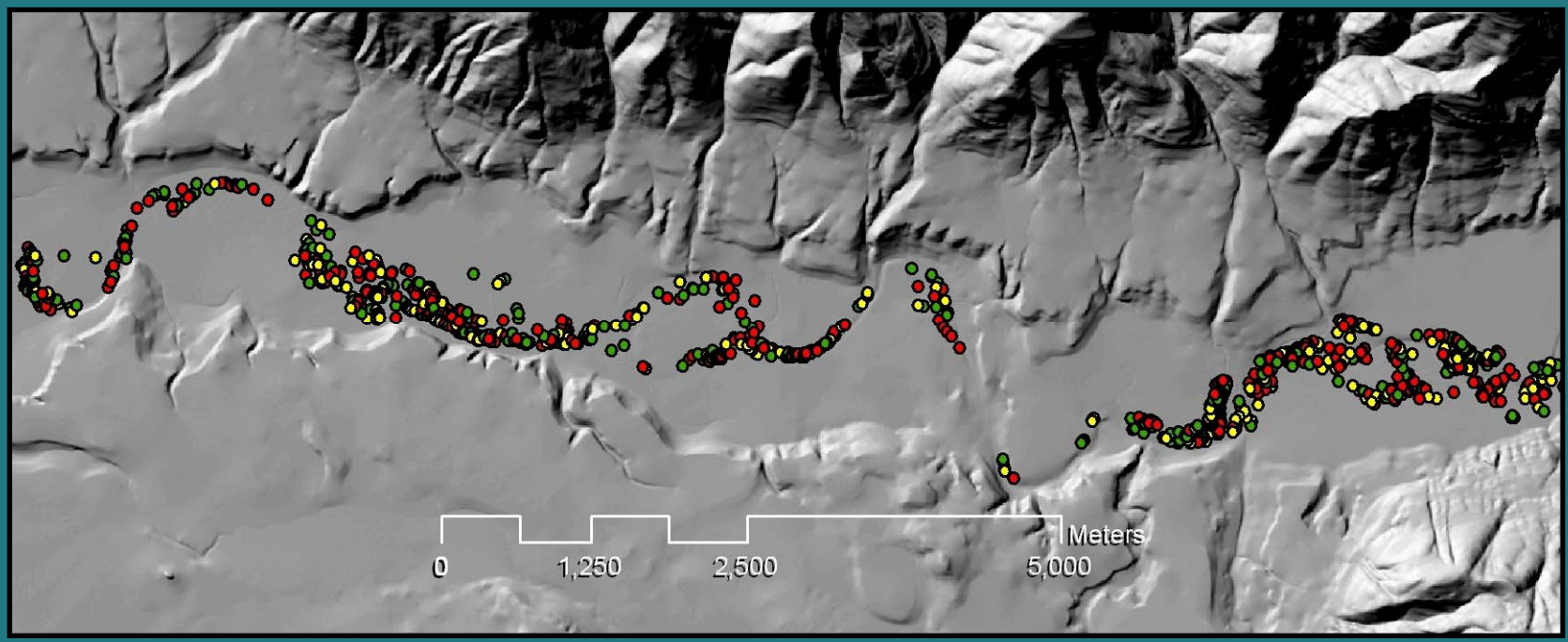
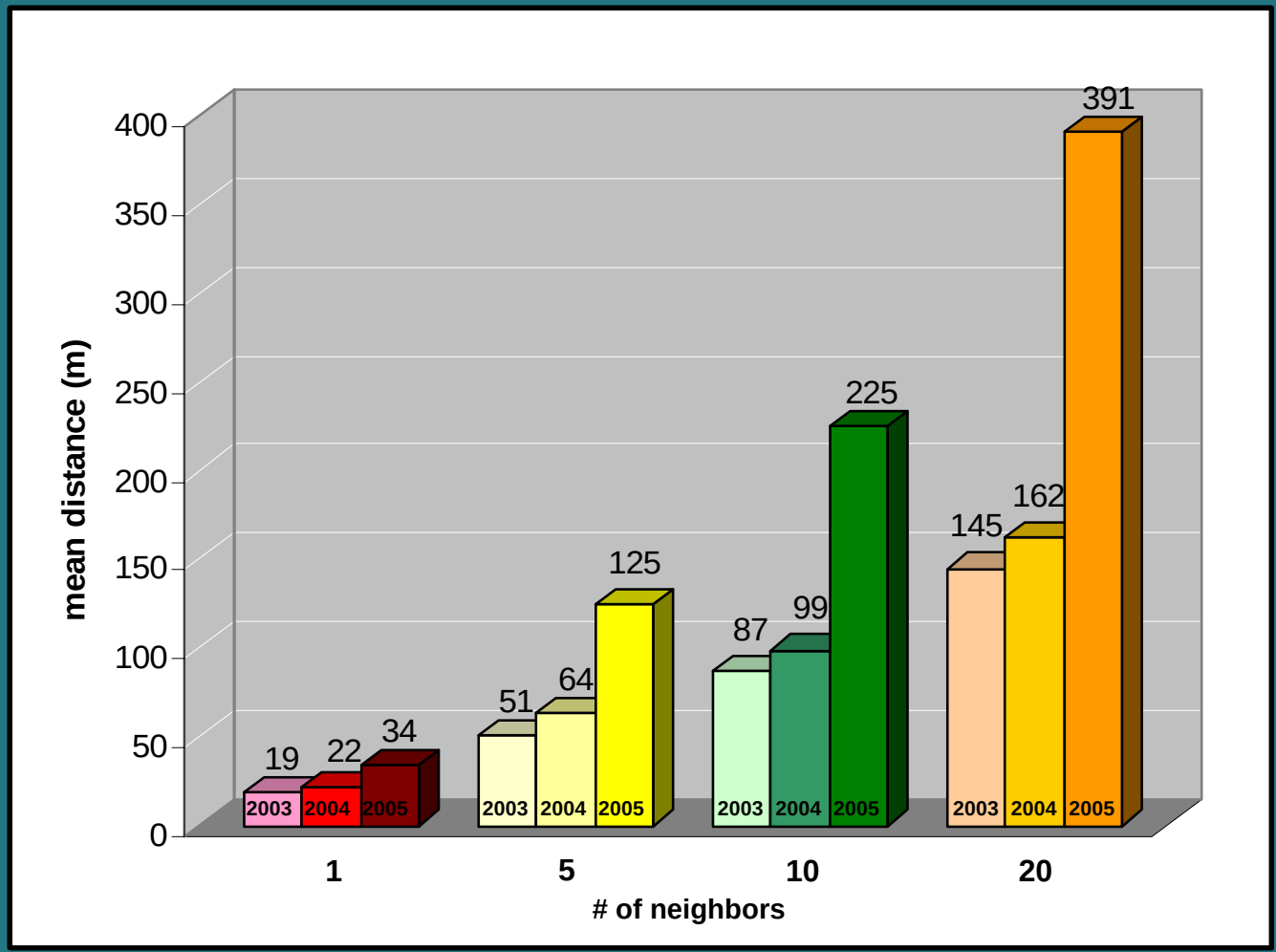

2006
N
0
500
1,000
2,000
Meters

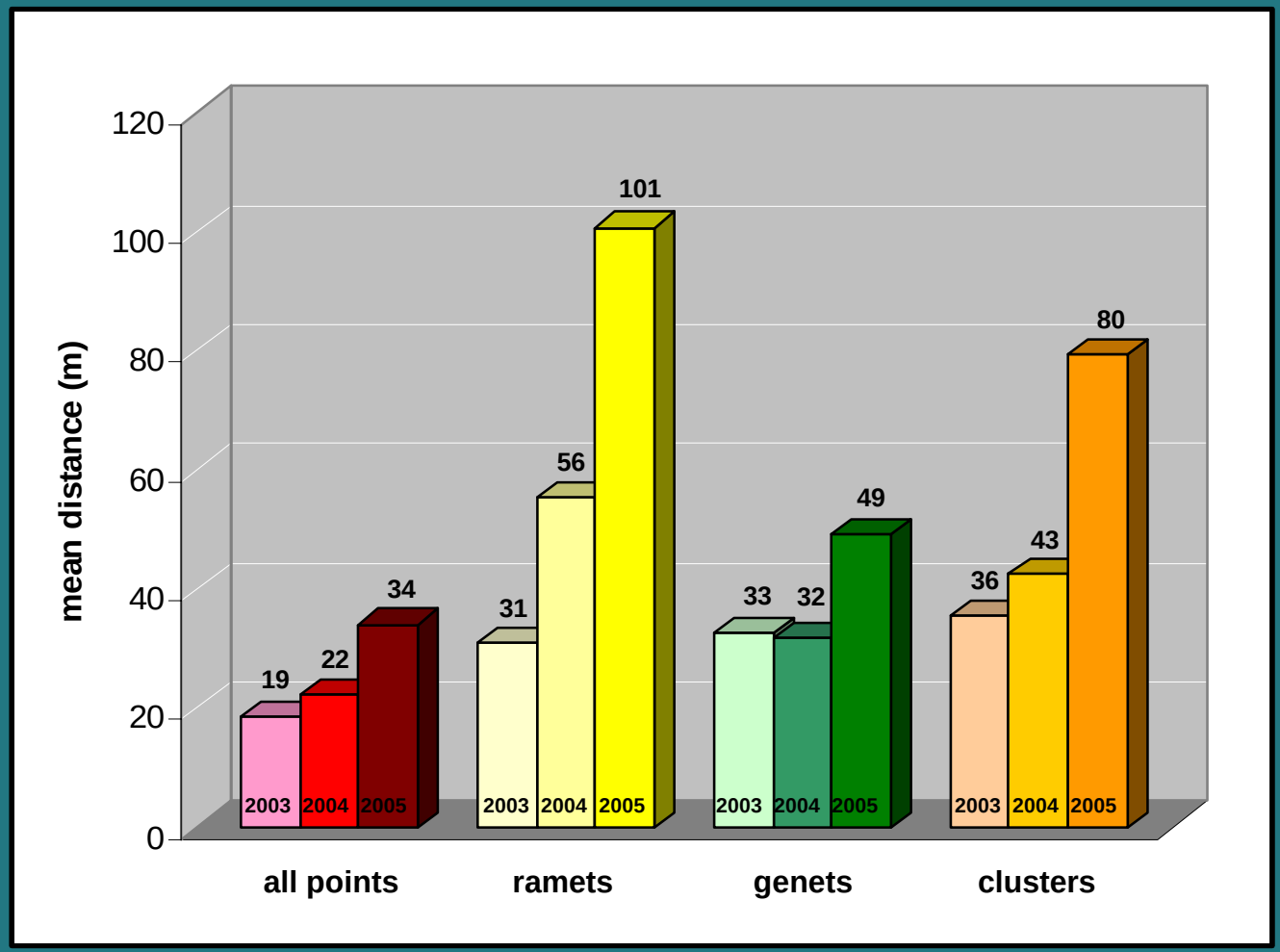
What are the spatial distribution patterns of knotweed plants?



Nearest Neighbor Analysis of GPS Points
of Neighbors

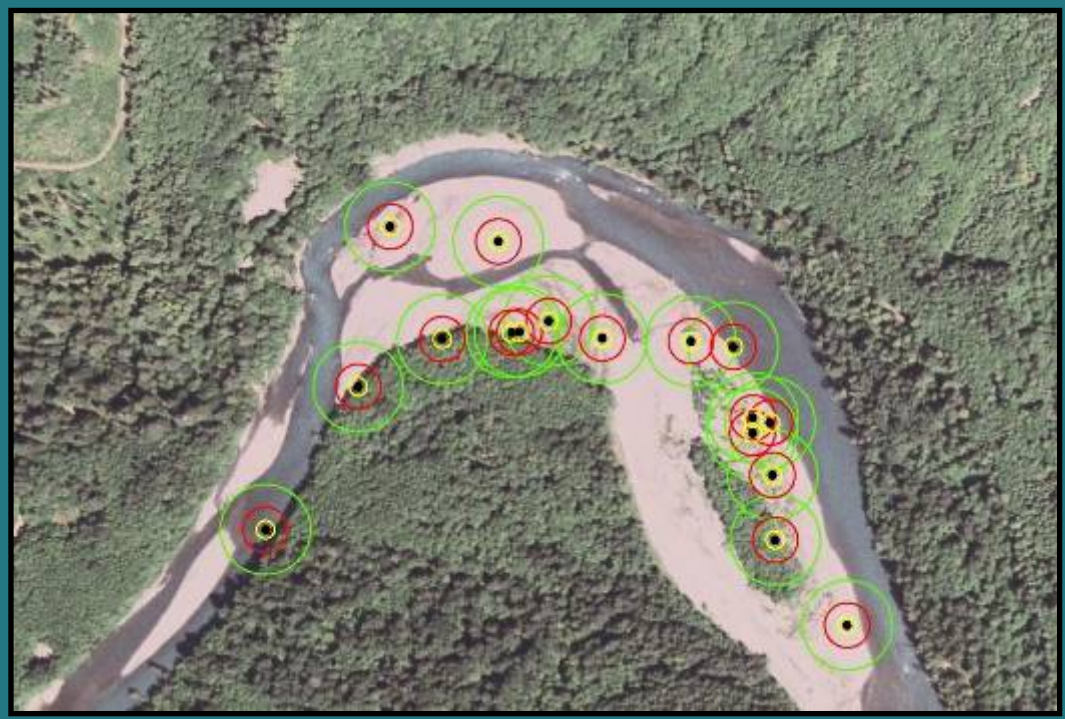


Nearest Neighbor Analysis of GPS Points by Growth-form



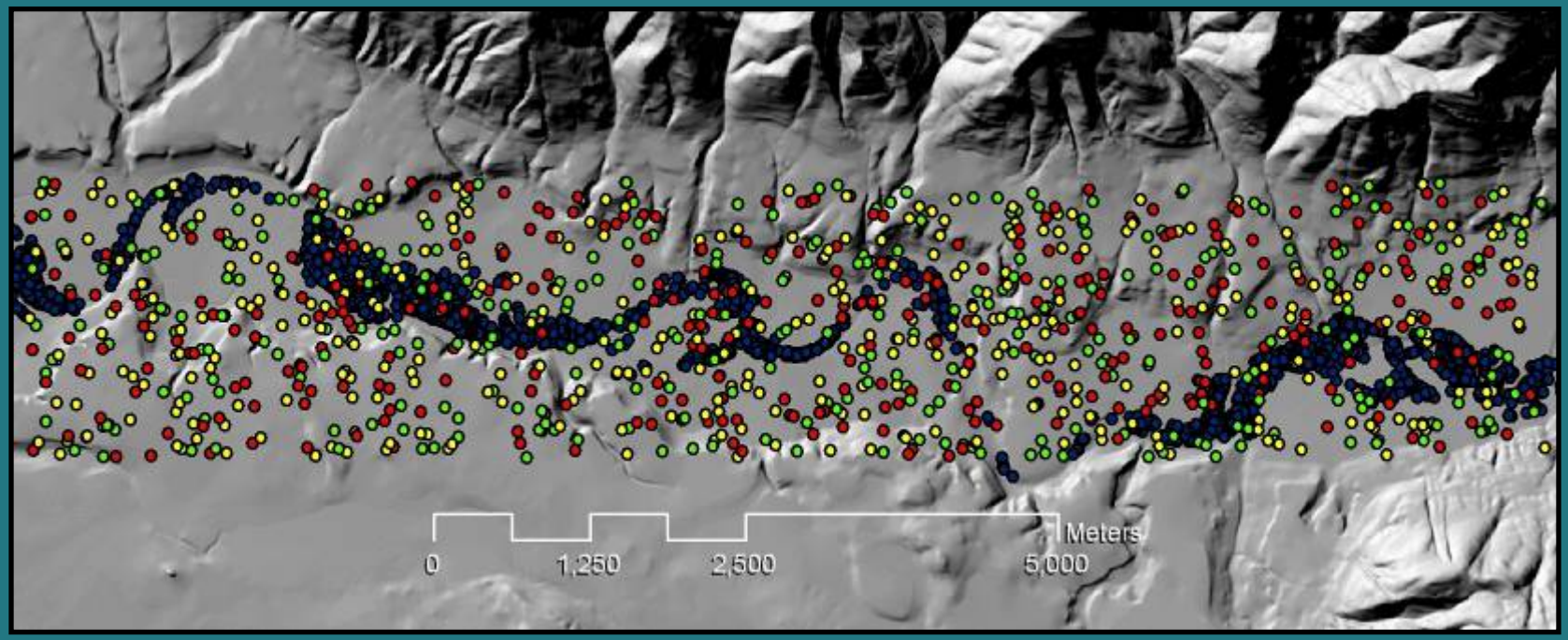
At what spatial scales does knotweed clustering occur?

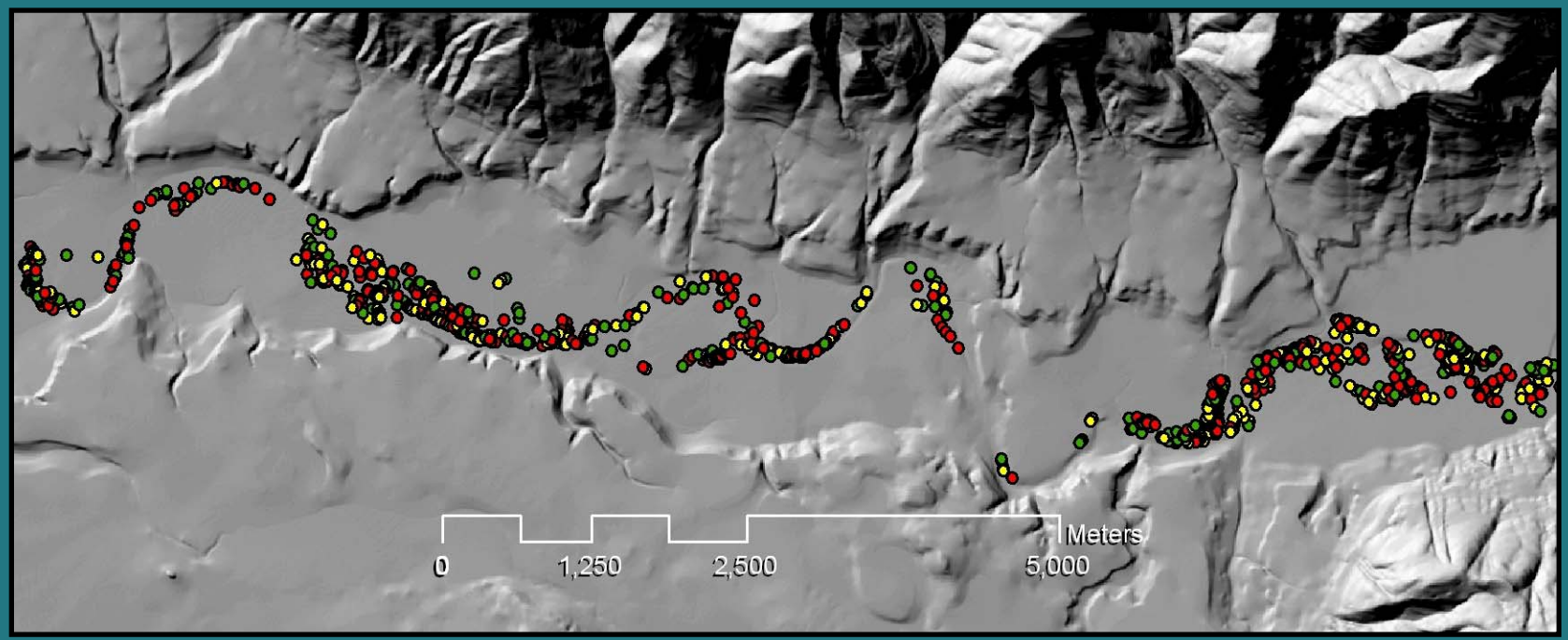
What are the temporal and spatial relationships between growth-forms?

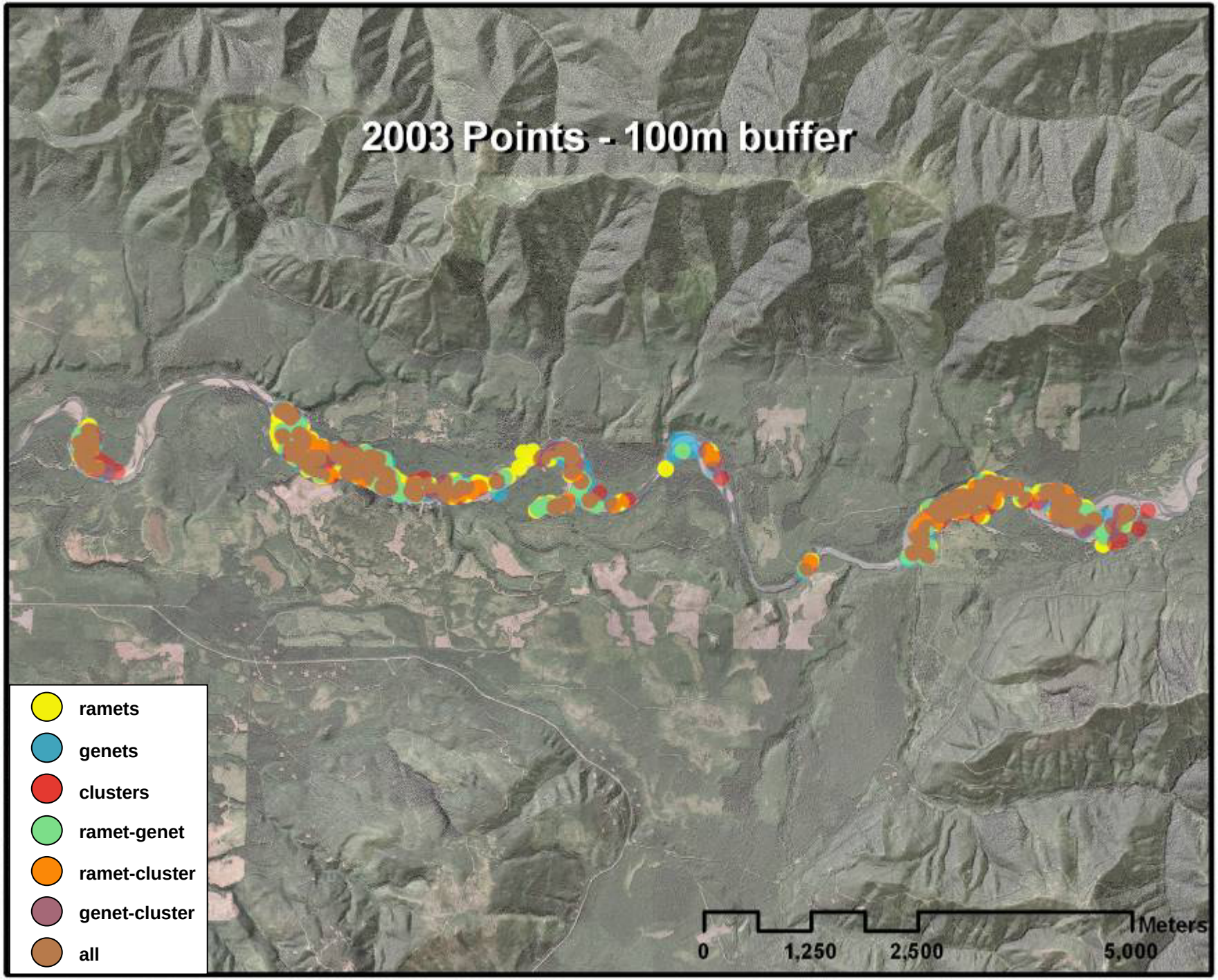


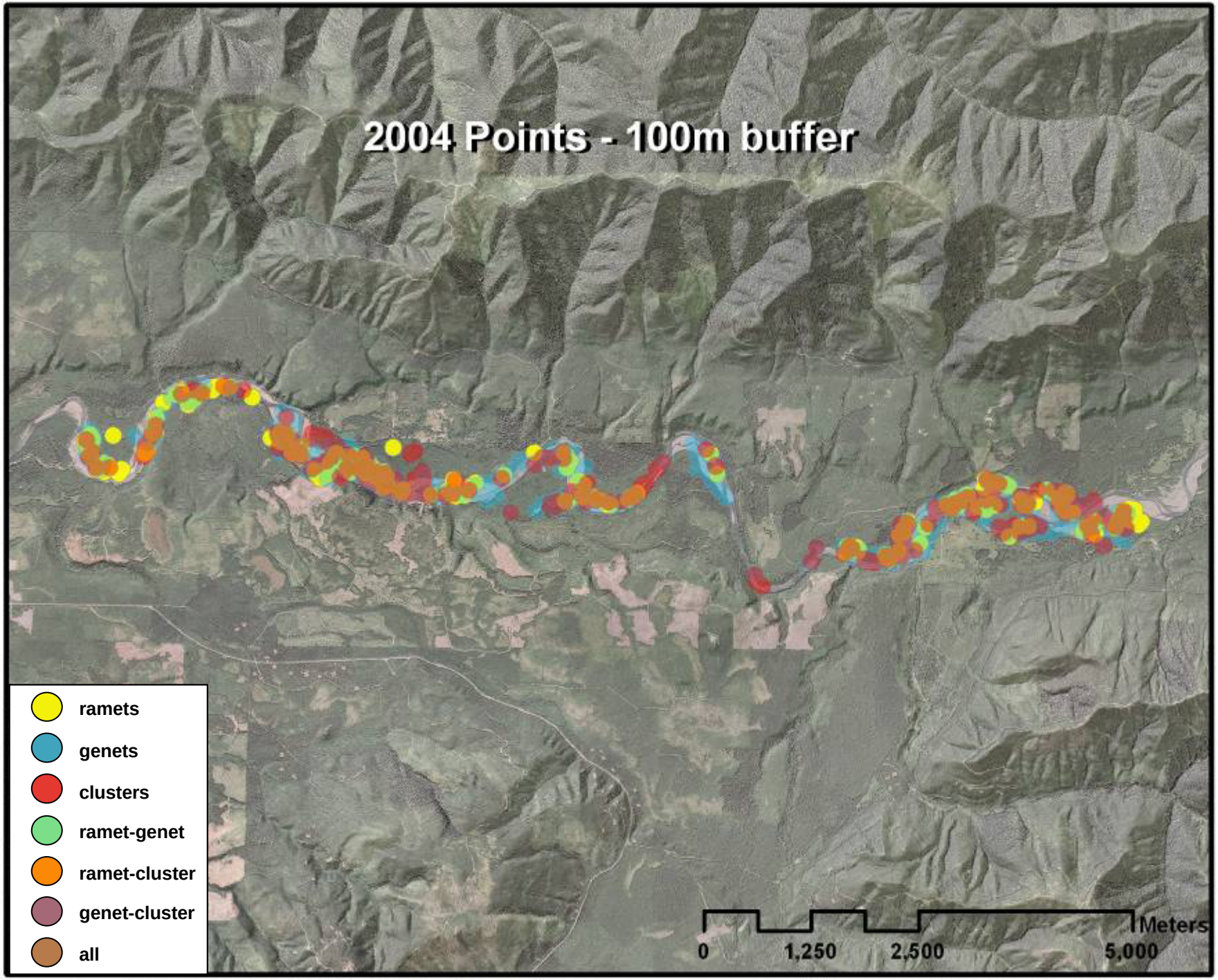
M Function

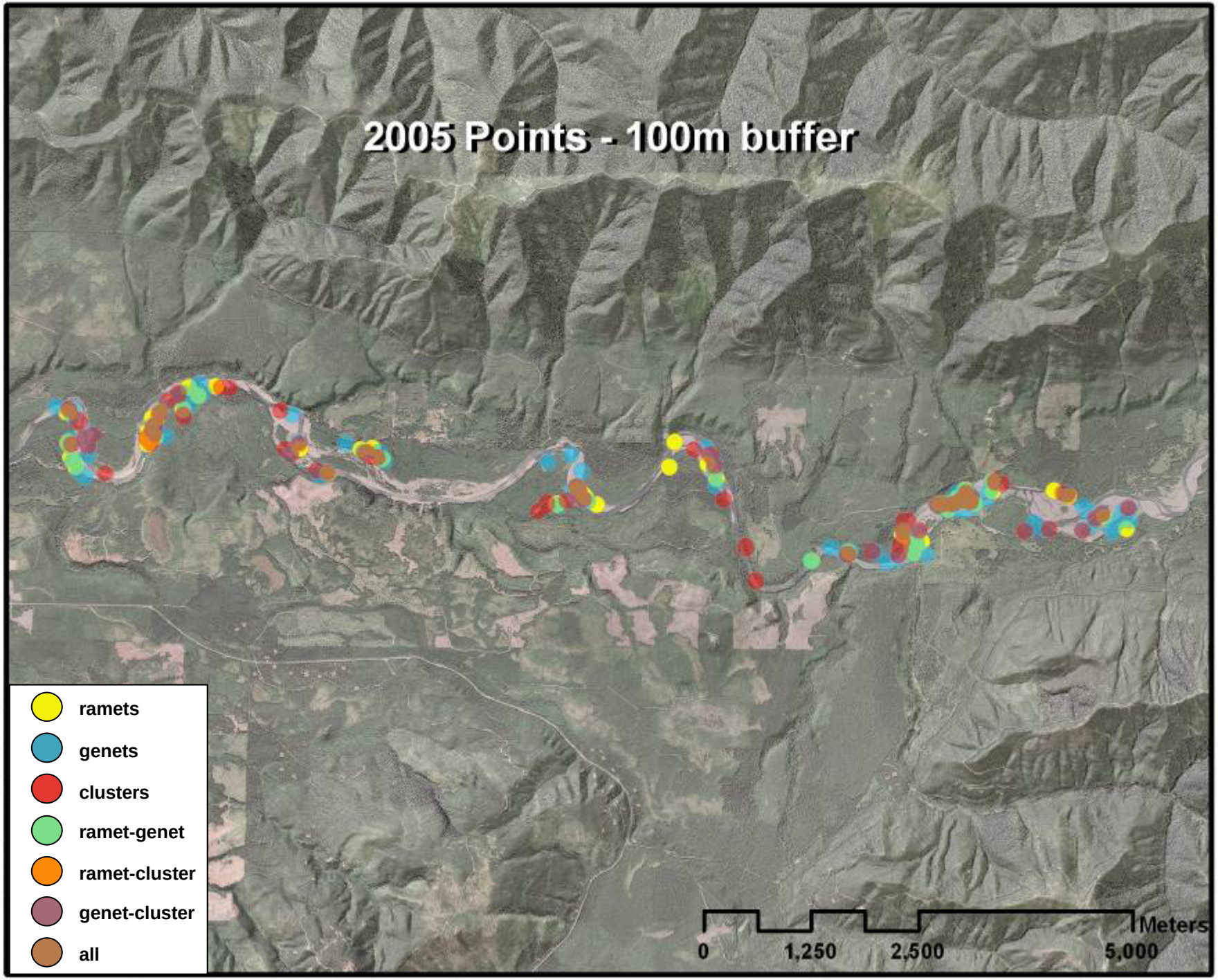
- Modification of Ripley's *K* Function
- Tests for spatial autocorrelation simultaneously across spatial scales [100m radius, 5m increments]
- Does not assume spatial homogeneity; null hypothesis is not complete spatial randomness, but rather a random distribution based on the heterogeneous distribution of test points; Monte Carlo simulations are used to develop confidence intervals


0
1,250
2,500
5,000
Meters


0
1,250
2,500
5,000
Meters


2003 Points - 100m buffer
ramets
genets
clusters
ramet-genet
ramet-cluster
genet-cluster
all
0
1,250
2,500
5,000
Meters


2004 Points - 100m buffer
ramets
genets
clusters
ramet-genet
ramet-cluster
genet-cluster
all
0
1,250
2,500
5,000
Meters


2005 Points - 100m buffer
ramets
genets
clusters
ramet-genet
ramet-cluster
genet-cluster
all
0
1,250
2,500
5,000
Meters

M Function Results

***M* Function Results by Year Within Each Growth-form Class.**

Growth-form	2003	2004	2005
ramet	20m, $M = 1.33$	60m, $M = 1.69$	45m, $M = 3.77$
genet	45m, $M = 1.71$	50m, $M = 1.25$	40m, $M = 2.69$
cluster	15m, $M = 1.68$	30m, $M = 1.58$	20m, $M = 4.12$

M Function Results

***M* Function Results by Year For Growth-forms in Other Neighborhoods.**

Growth-form	Neighborhood	2003	2004	2005
genet	**ramet**	40m, $M = 1.33$	35m, $M = 1.05$	40m, $M = 2.99$
cluster	**ramet**	45m , $M = 1.27$	35m, $M = 1.15$	45m, $M = 3.30$
cluster	**genet**	40m, $M = 1.20$	30m, $M = 1.23$	15m, $M = 2.16$

Growth-form – Neighbor Relationships

Growth-form Neighbor Distances.

pairing		number of interactions	mean number of neighbors	max. number of neighbors	mean neighbor distance (m)
genet - ramet					
	2003	338	7.4	23	60.4
	2004	477	3.1	12	59.3
	2005	111	2.9	8	58.2
cluster - ramet					
	2003	303	7.5	23	61.8
	2004	245	3.2	11	57.2
	2005	50	2.7	7	58.6
cluster - genet					
	2003	293	6.4	17	60.4
	2004	295	9.7	32	58.3
	2005	63	3.7	21	53.9

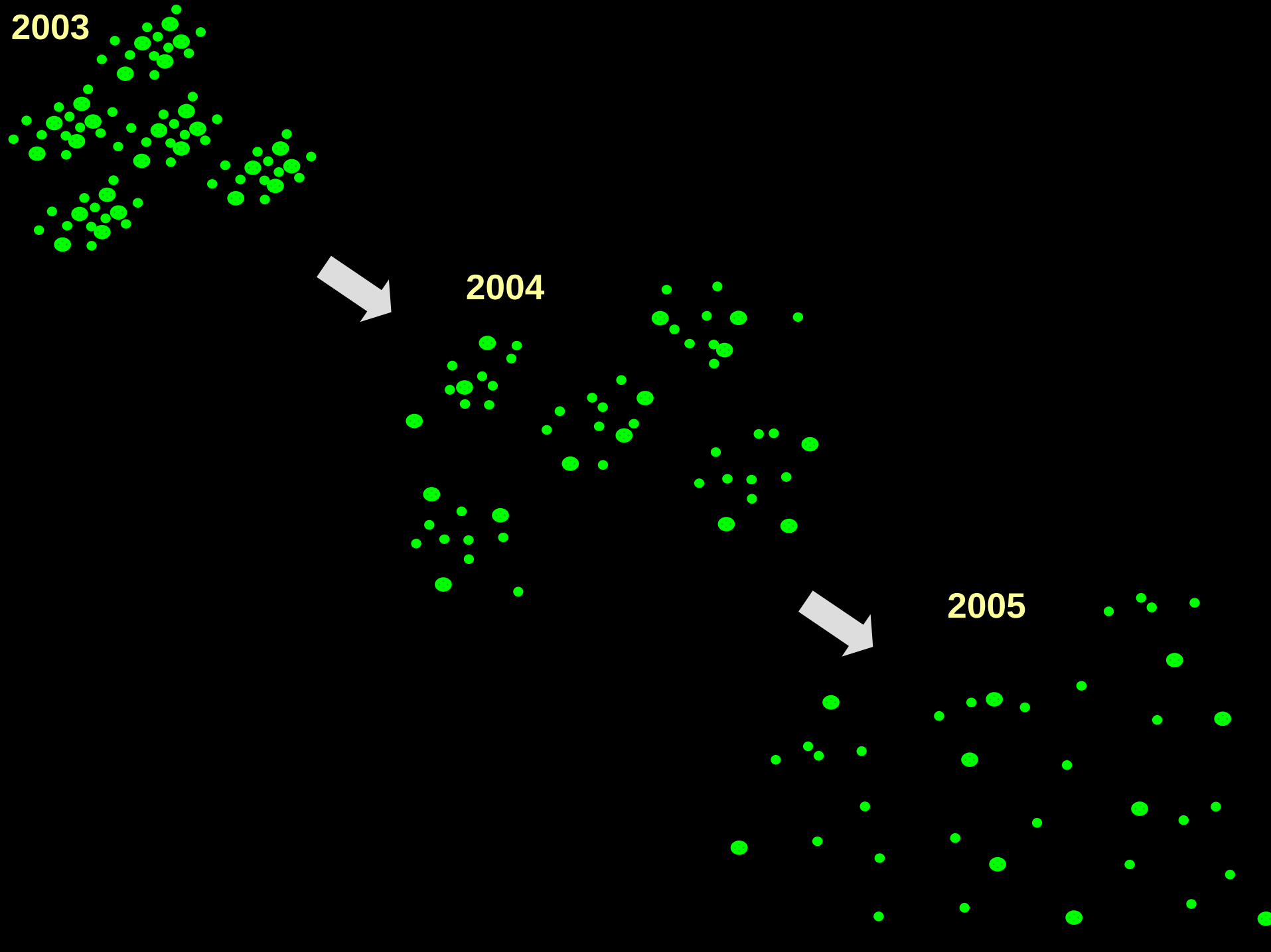
Summary

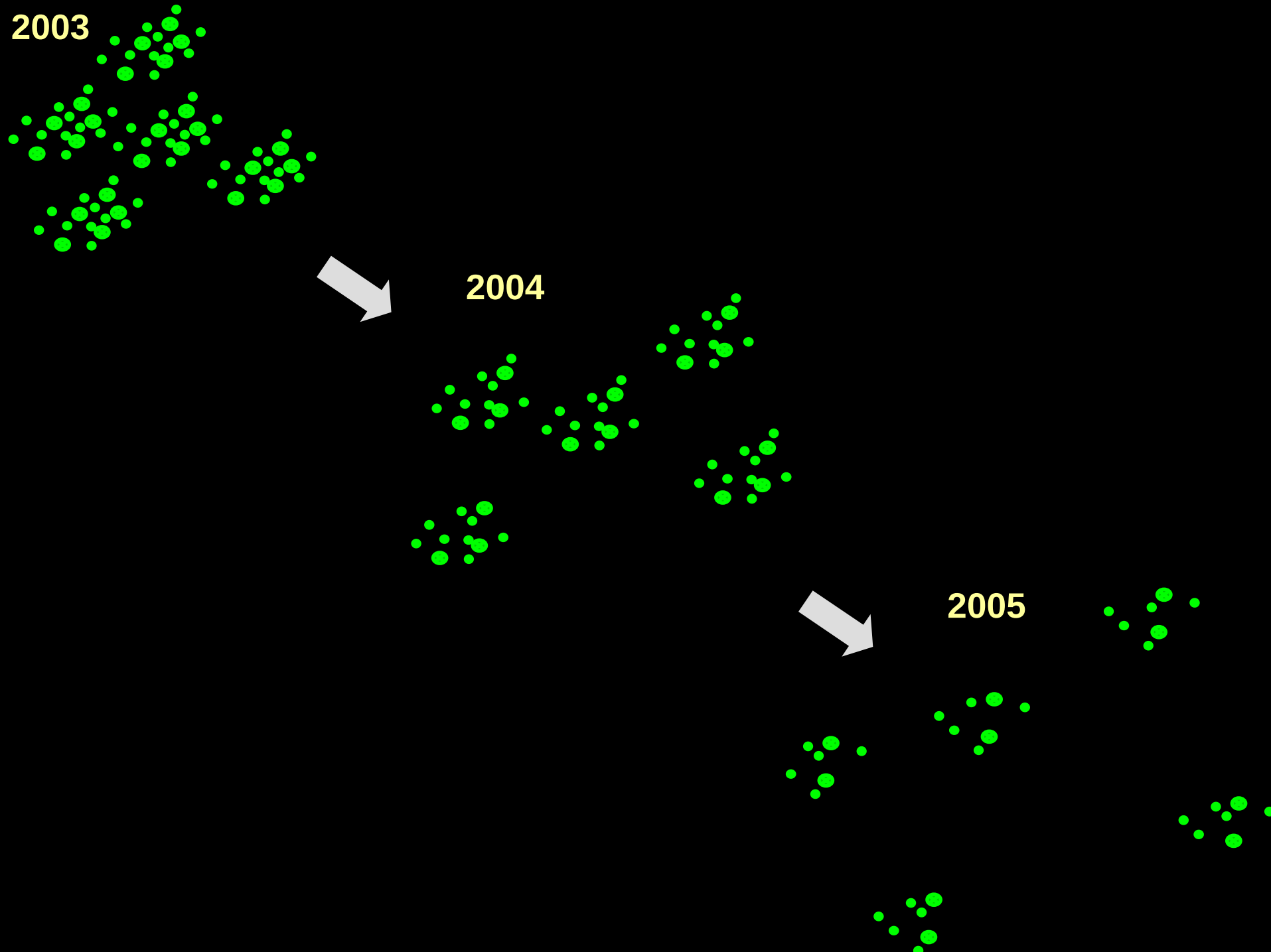
- Knotweed points clustered by year. Corroborates field observations that stream channel migration plays a significant role in distribution patterns.
- Spatial scales that captured maximum densities varied year-to-year within growth-form classes.

Summary

- Mean number of ramets around genets and clusters decreased. However, mean distance between these growth-forms was relatively constant.

- The average nearest neighbor distance steadily increased from 2003 - 2005. However, the incidence of significant spatial clustering suggests that the increase was driven more by the spatial segregation of knotweed “neighborhoods”, than individual plants.


2003
2004
2005


2003
2004
2005

Implications for Management

- Treatments
  - knotweed maintained spatial associations
  - distribution heavily influenced by…?

- Data Analysis
  - GIS & spatial statistics are powerful tools
    - ID and quantify “hidden” relationships
    - be wary of casual use of statistical procedures

Acknowledgements

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Clallam Co. NWB
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NPS
USFS
Quileute Nation
Makah Nation
Jamestown S'Klallam Tribe
10,000 Years Institute


Questions?

Spatial Analysis Software

ArcGIS – point distance

http://www.esri.com/software/arcgis/index.html

CrimeStat III – nearest neighbor analysis

CrimeStat III: A Spatial Statistics Program for the Analysis of Crime Incident Locations. Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC, November 2004.

http://www.icpsr.umich.edu/NACJD/crimestat.html/

Ripley – *M* function

Marcon, E., Puech, F., 2003. "Evaluating the Geographic Concentration of Industries Using Distance-Based Methods", *Journal of Economic Geography*, 3:4, 409-428.

http://e.marcon.free.fr/download/MeasuresOfTheGeographicConcentrationOfIndustries-ImprovingDistanceBasedMethods.pdf

http://e.marcon.free.fr/Ripley