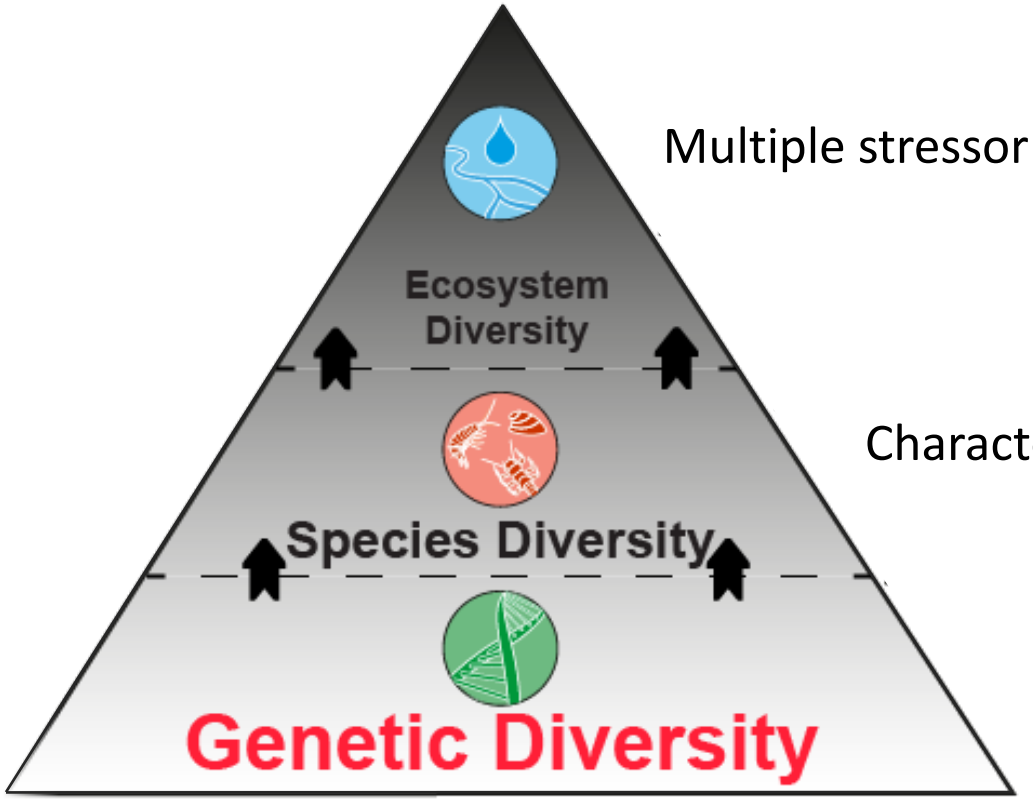
# From genes to ecosystems

**Integrating genetic diversity to study freshwater ecosystems under stress**

Jeremy ‘Jay’ Piggott

GeneStream




Multiple stressor impacts on ecosystem diversity

Characterization of species diversity

Genetic diversity and connectivity of populations

# GeneStream

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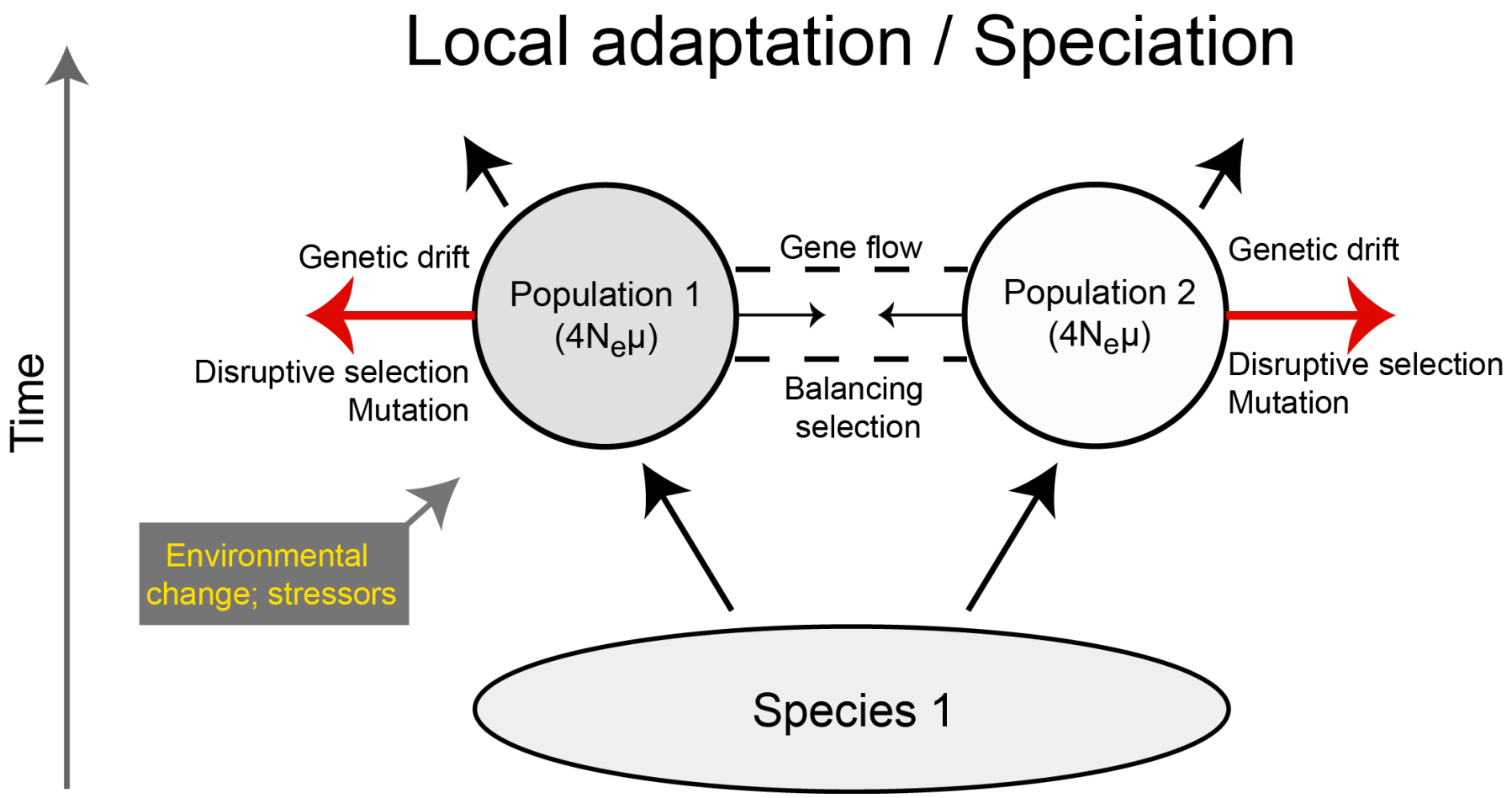
AKADEMIE WISSENSCHAFTEN UND KÜNSTE NORDRHEIN-WESTFALEN

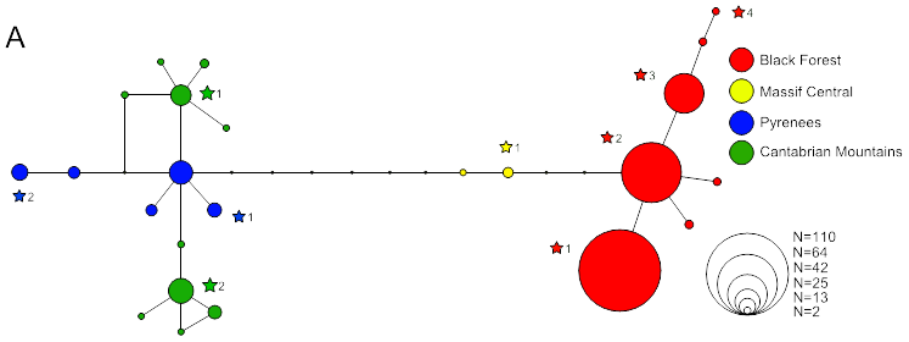
# Background


Local adaptation / Speciation
Time
Genetic drift
Disruptive selection
Mutation
Population 1
($4N_e\mu$)
Gene flow
Balancing
selection
Population 2
($4N_e\mu$)
Genetic drift
Disruptive selection
Mutation
Environmental
change; stressors
Species 1

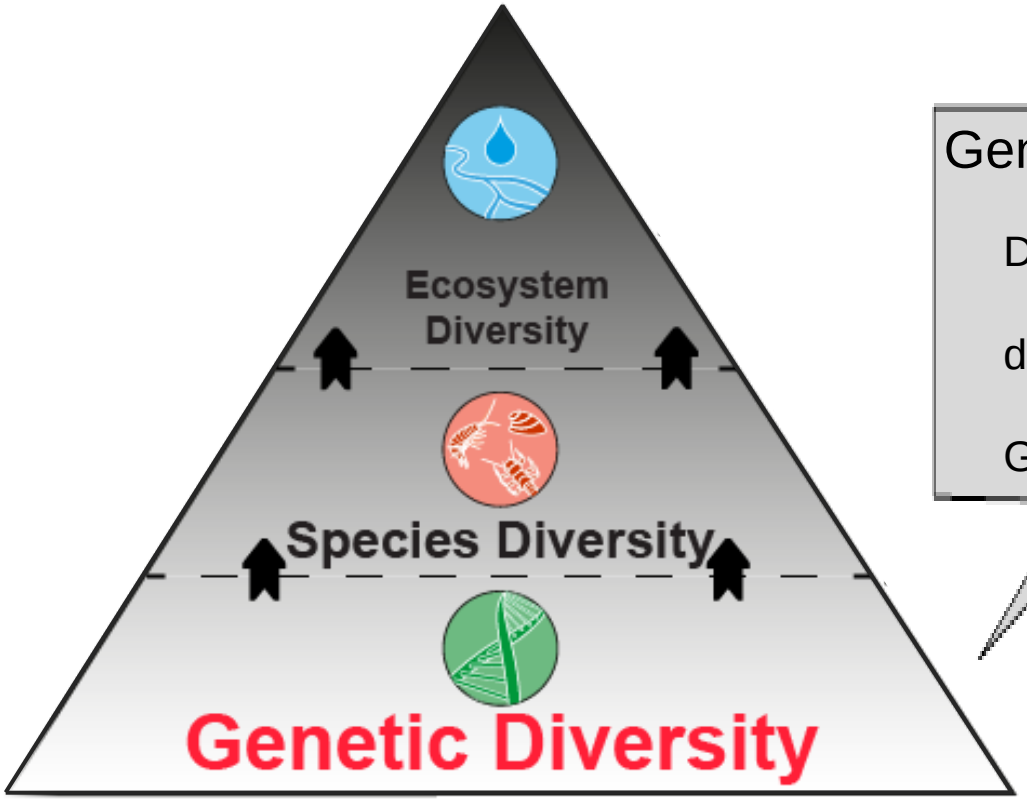
# Background

**We are using molecular genetics to**

- ...assess species diversity with greater precision
- ...understand patterns of gene flow
- ...disentangle the roles of random genetic drift and selection in speciation / adaptation processes
- ...assess the effects of stressors on the genetic diversity of species


# Genetic diversity




Genetic Diversity and Connectivity

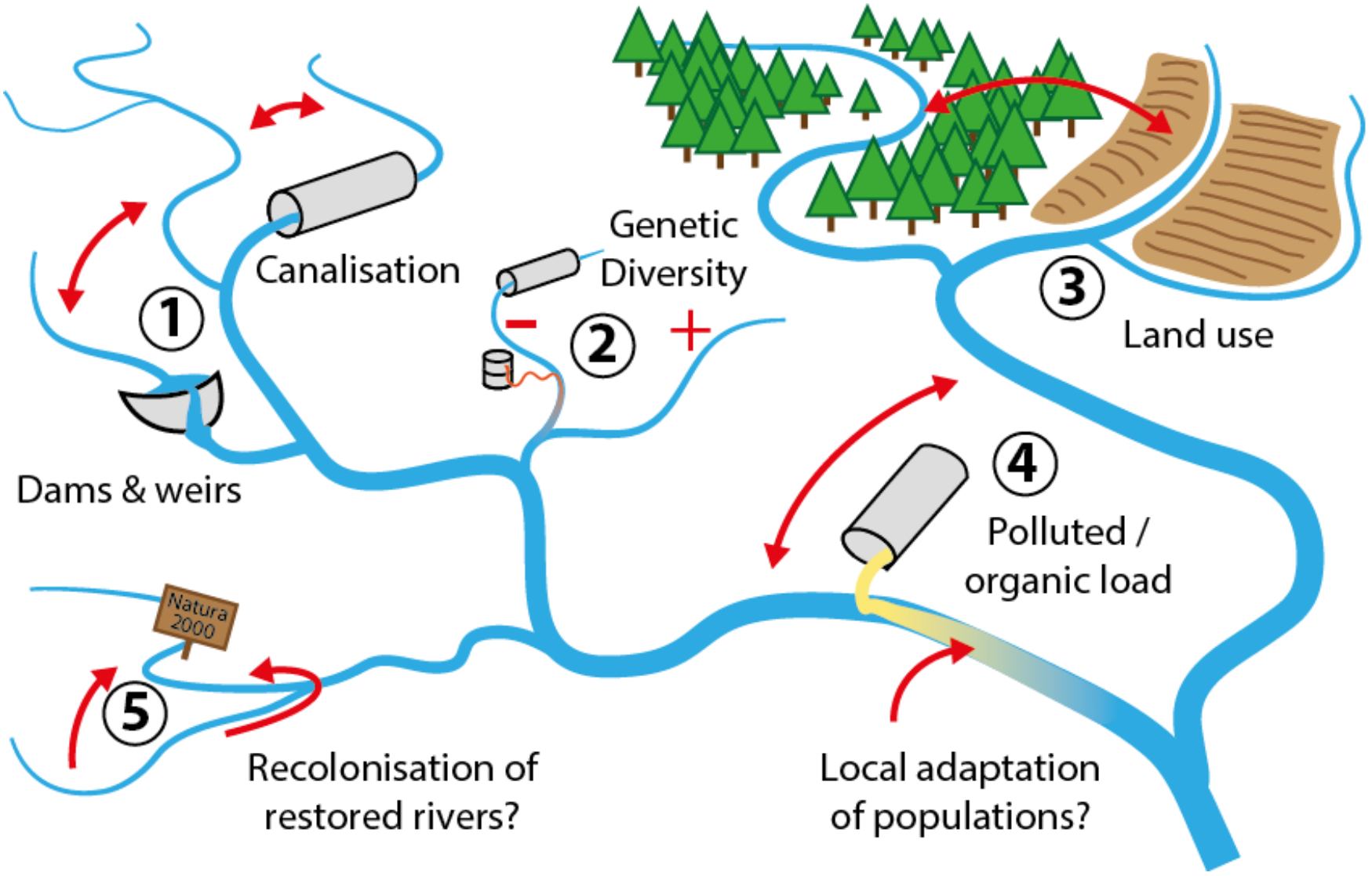
- DNA Barcoding
- ddRAD Sequencing
- Genome Sequencing

Martina Weiss,

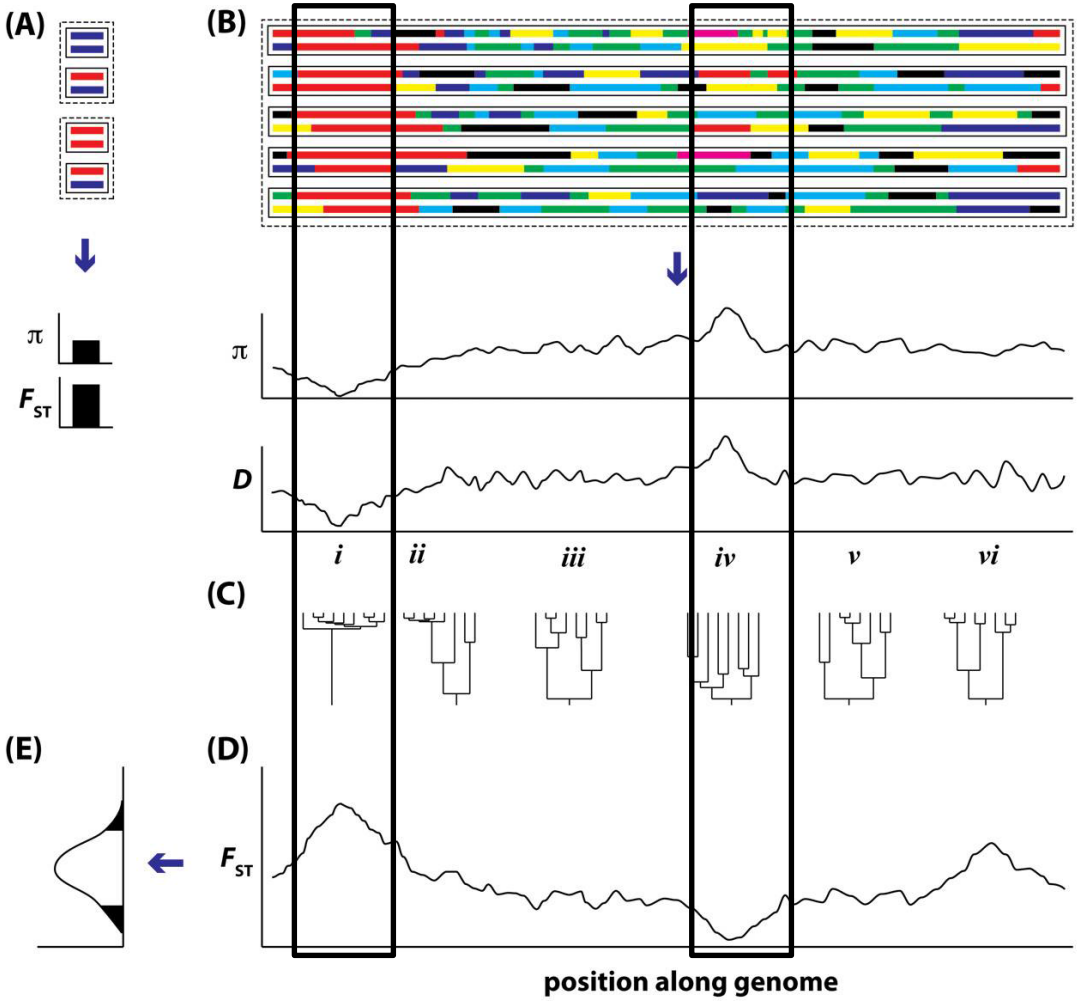
Hannah Schweyen,

Jan Macher

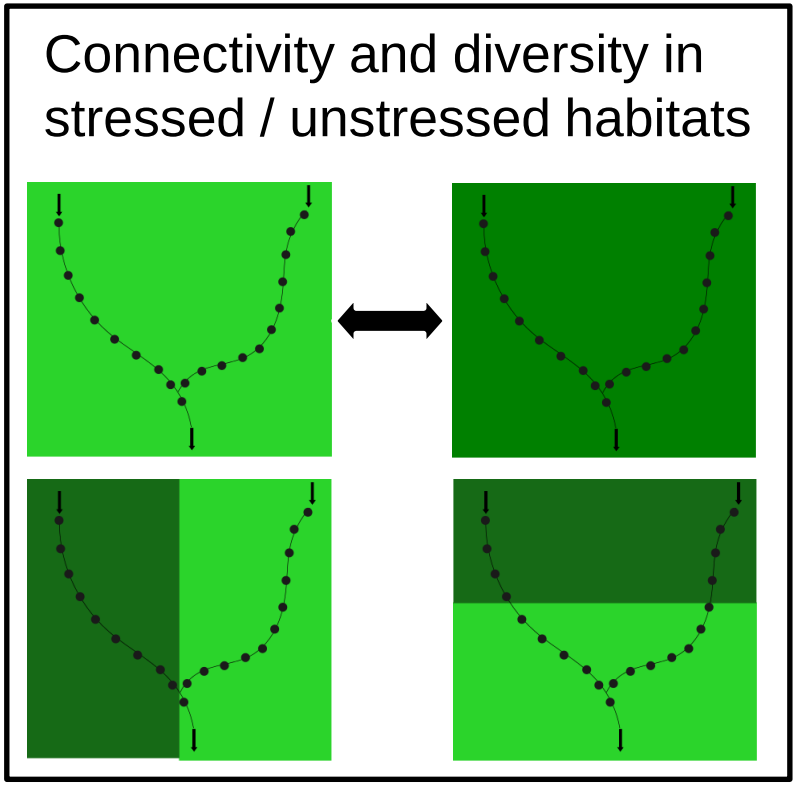
# Genetic diversity

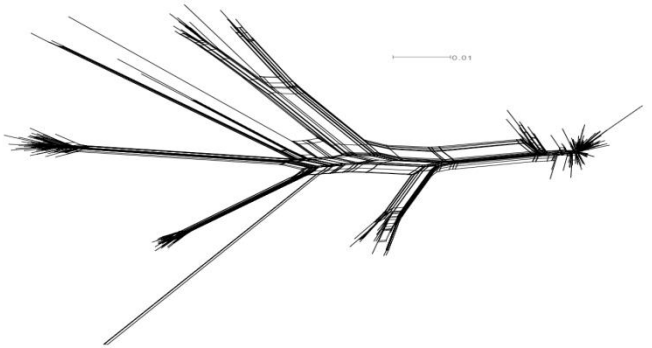


# Genetic diversity and connectivity




Hohenlohe *et al.* 2010

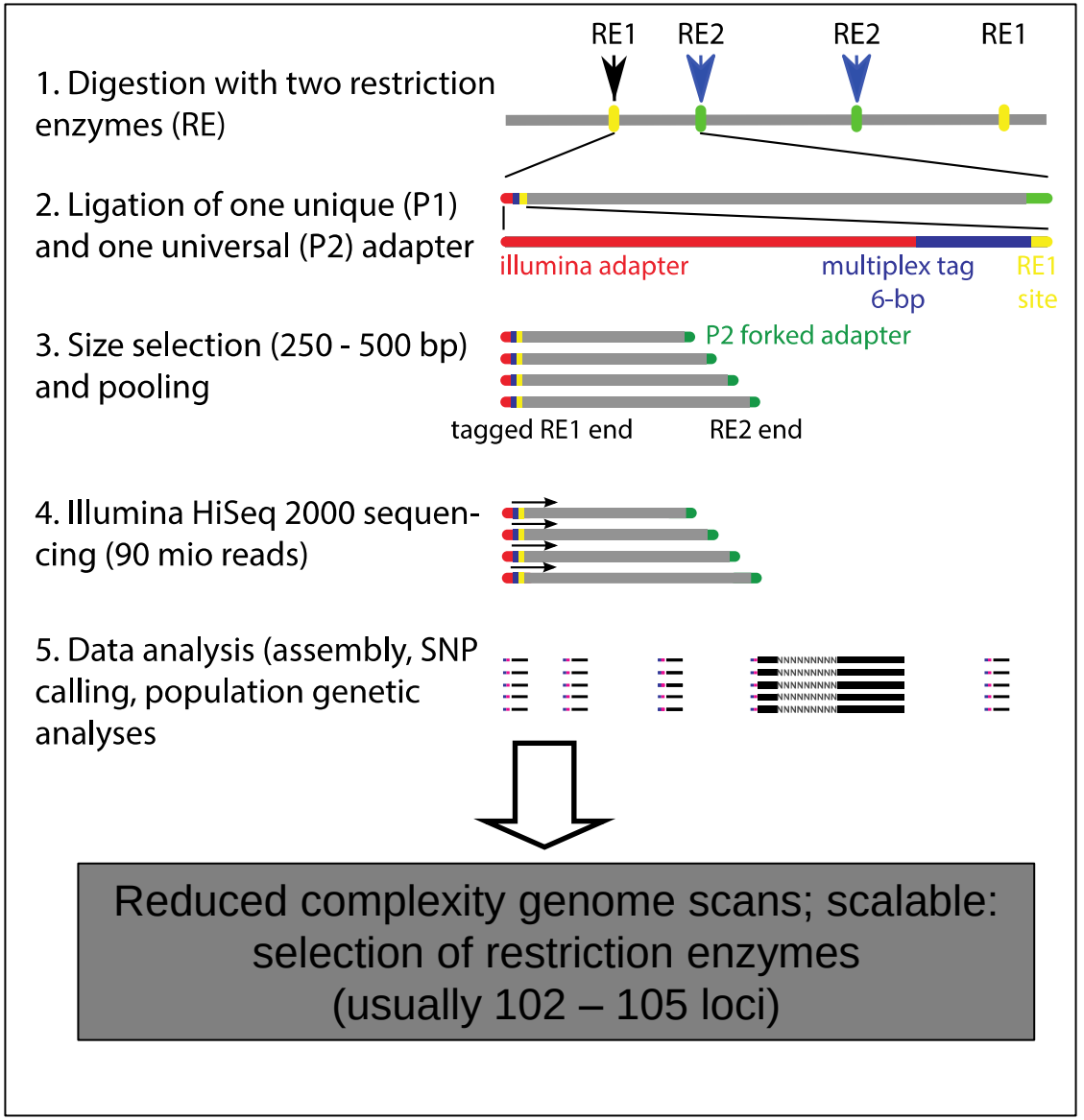


# Genetic diversity and connectivity

- “Next generation sequencing“ (NGS) offers new tools for analyzing loci across the genome even in non-model species

- RAD-seq (Restriction-site associated DNA sequencing)




mod. after Rowe et al. 2011

# RAD sequencing

Population genetic analyses of poorly studied freshwater insect species with:

a) one mitochondrial gene (CO1)

- (658 bp Folmer region)

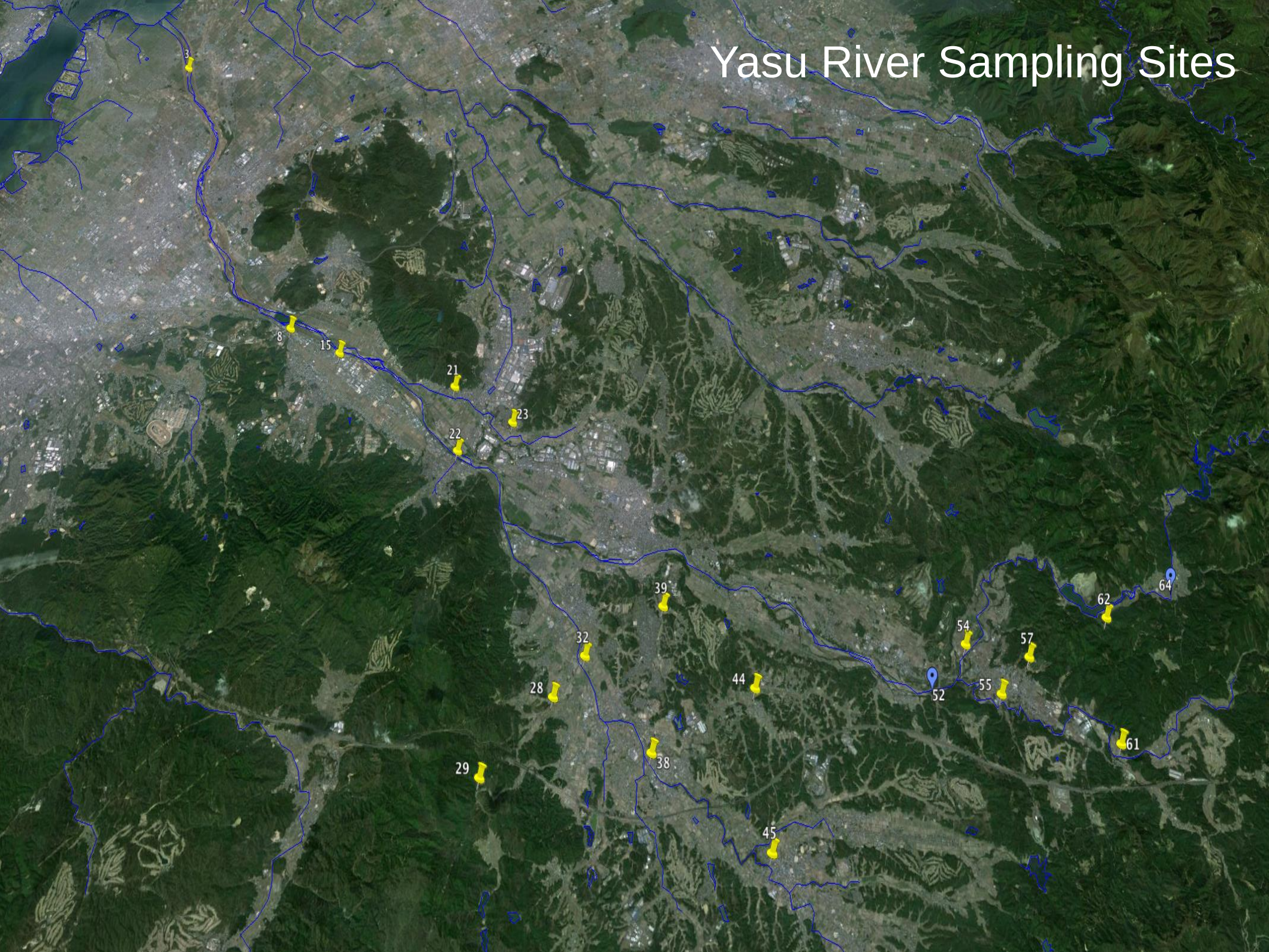
b) thousands of RAD-loci (few spec.)

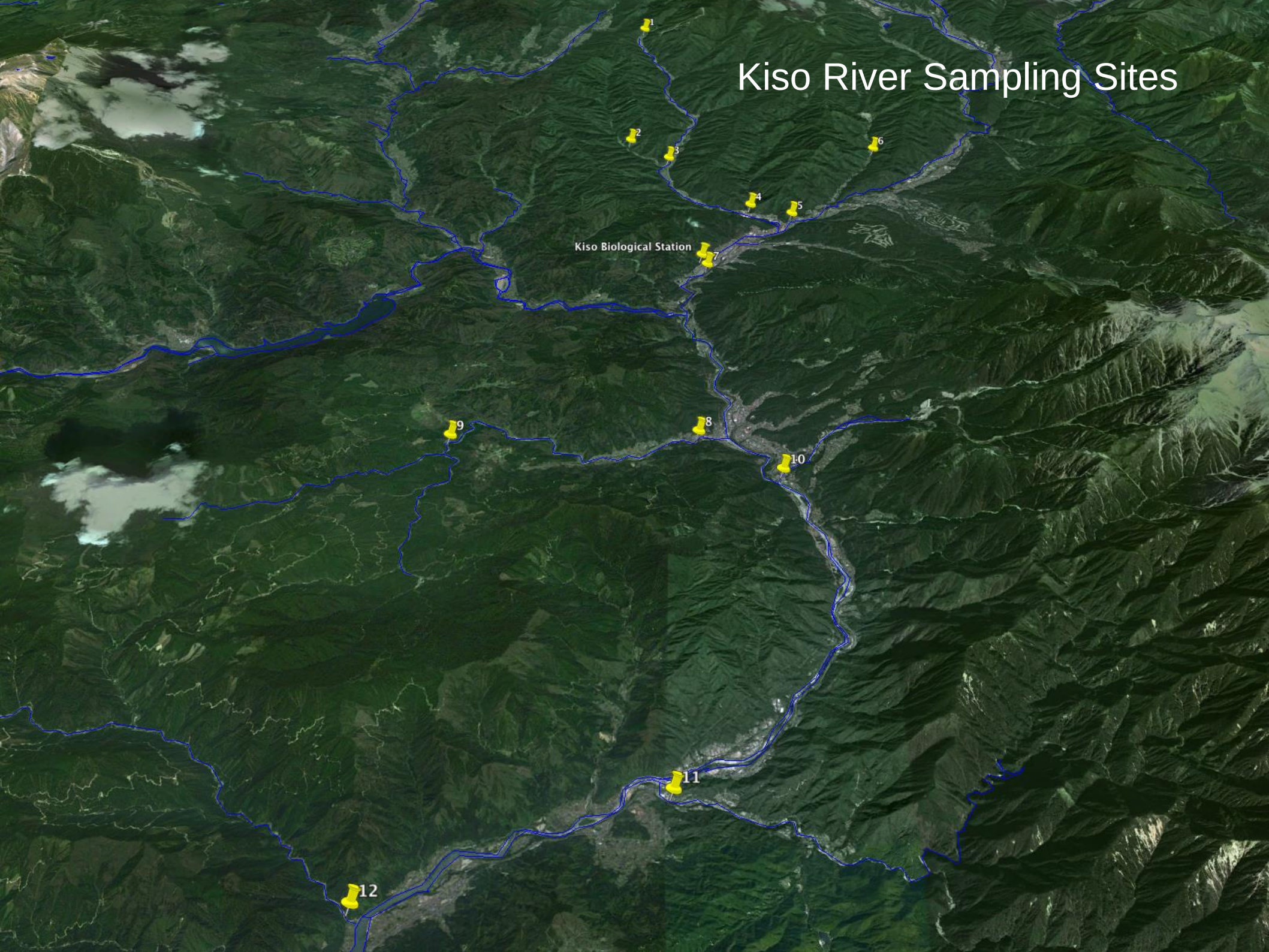
- ddRAD (1.9 million reads per specimen on average)
- >13,000 loci (>16,000 SNPs)

- Phylogenetic networks +

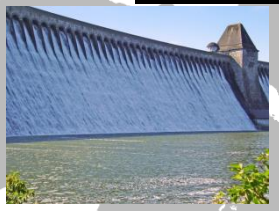
  Permutation tests

*Hydropsychidae orientalis* & *Cheumatopsyche brevilineata* (Trichoptera)

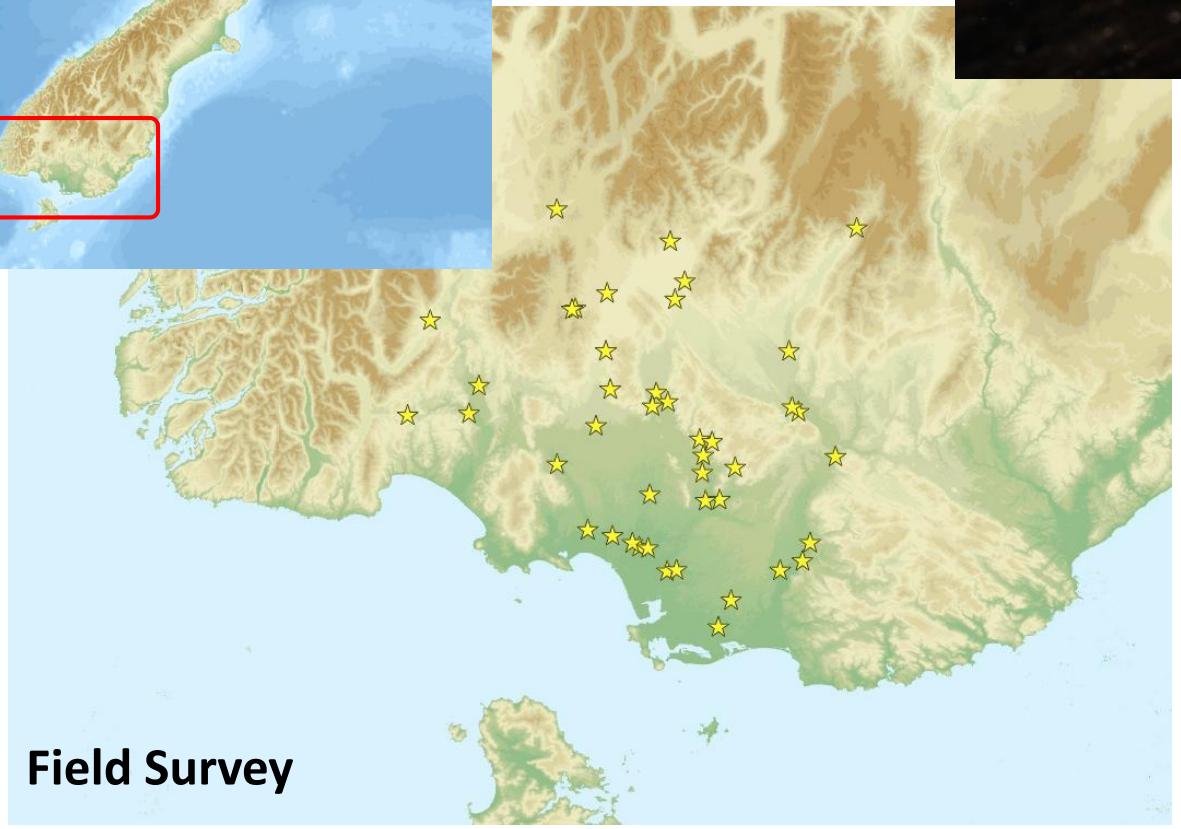

Yasu River Sampling Sites
3
8
15
21
23
22
39
32
28
29
38
44
45
52
54
55
57
62
64
61


Kiso River Sampling Sites
1
2
3
4
5
6
7
Kiso Biological Station
8
9
10
11
12

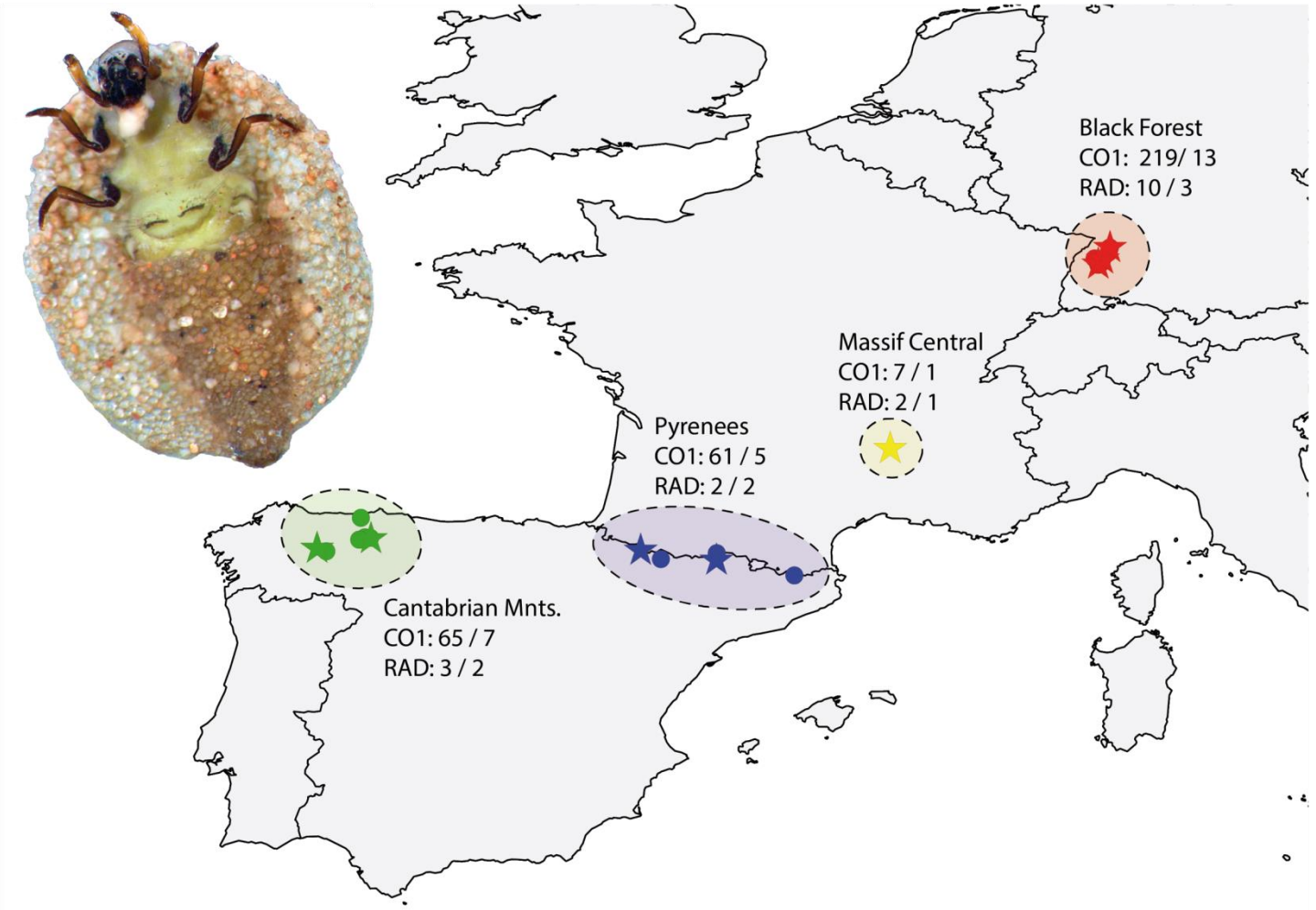
# Genetic diversity and connectivity




***Deleatidium* (Ephemeroptera)**

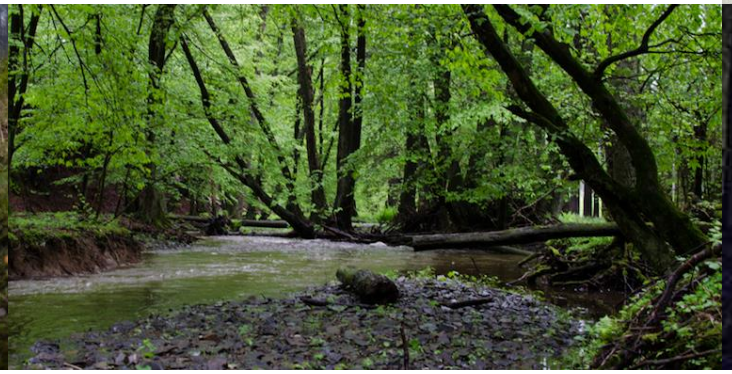


## *Thremma gallicum* (Trichoptera)



# Genetic diversity and connectivity : Summary

- Population genomic approaches (RAD) provide the necessary resolution to study genetic diversity and connectivity in “natural“ and stressed environments
- Few specimens needed
- Costs per basepair very low



GeneStream

# From genes to ecosystems

**What is the benefit of integrating the level of genetic diversity to study freshwater ecosystems under stress?**

- Faster, more complete and reliable identification of true species diversity in assessment / conservation programs
- DNA Metabarcoding for assessments: Possible and affordable!
- Evaluation of the impact of stressors on all levels (loss of genotypes)
- Linking ecosystem functioning to individual genotypes provides unique insights into ecosystem processes

# Thank you!