

Use of genotyping-by-sequencing data to develop a high-throughput and multi-functional set of genetic markers for conservation applications in Pacific lamprey

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Dave Herasimtschuk © FI

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Hess *et al.* (in review) Molecular Ecology Resources

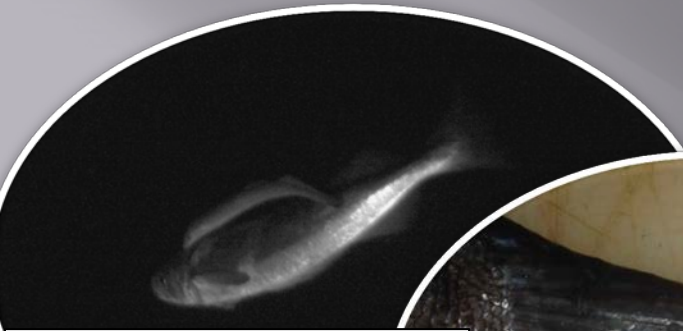
Adults return to freshwater, overwinter, and construct redds for spawning.



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Pacific lamprey Life cycle

Adults spend
3 years in ocean
feeding parasitically



Ammocoetes filter feed
7 years in the stream



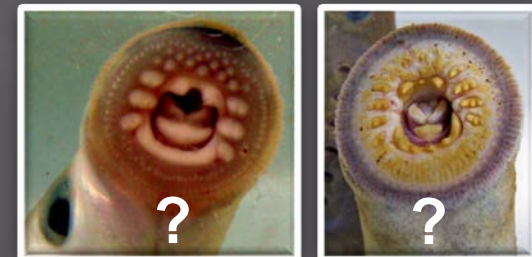
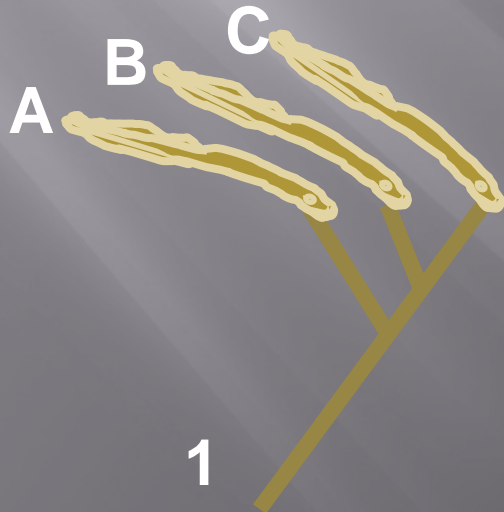
Macrothemia:
migrate to sea

Marker Development & Marker Versatility

Objectives:

Develop 96 multi-functional SNP assays from a total of 4,439 quality filtered RAD-seq loci:

- 1) Characterizing neutral and adaptive variation
- 2) Parentage analysis
- 3) Species identification



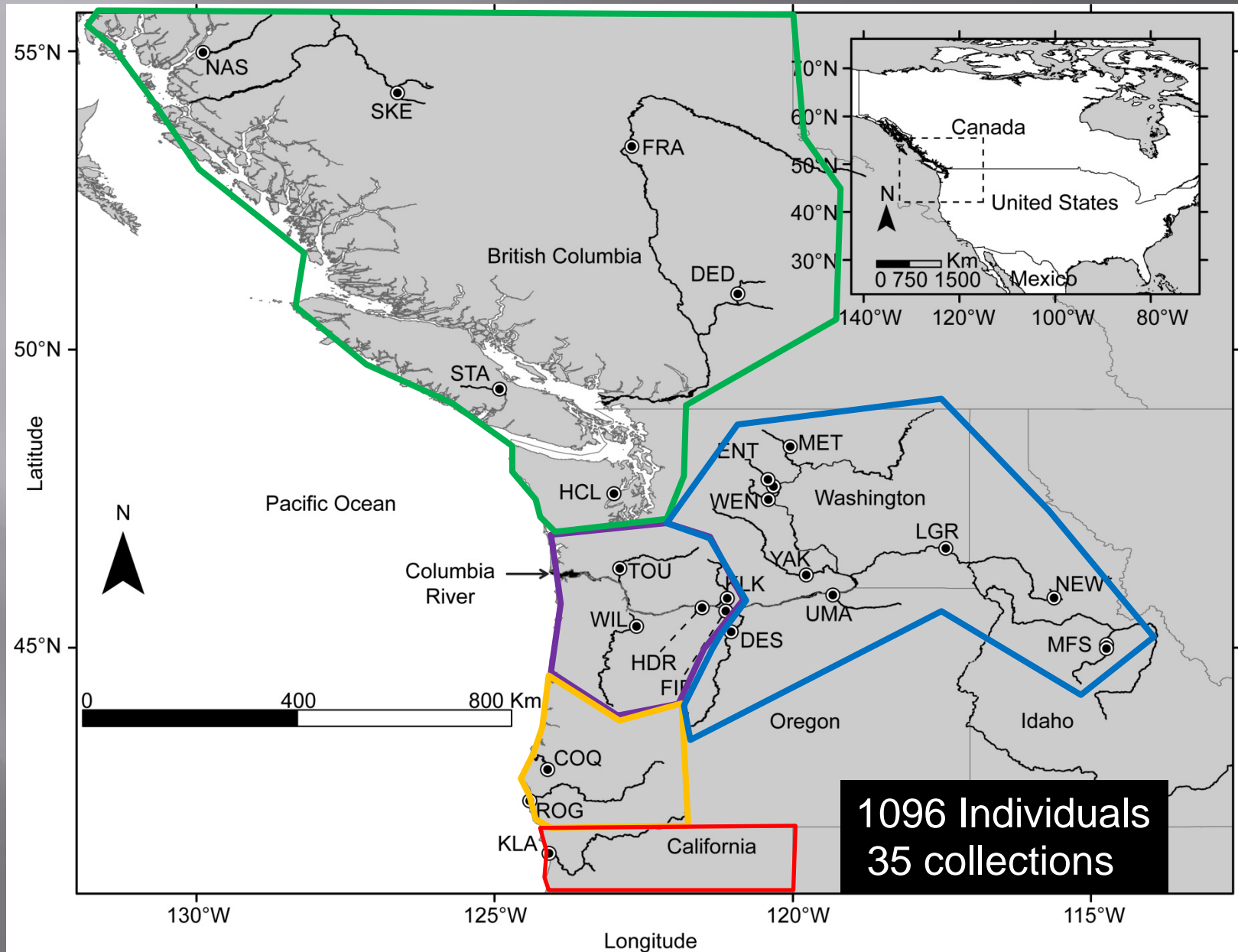
Demonstration of Marker Versatility

Apply these 96 markers to address conservation directives:

- 1) link genotypes with phenotypes (i.e. adult migratory traits)
- 2) validate reproductive success of a translocation
- 3) identify species of early life stages of lamprey

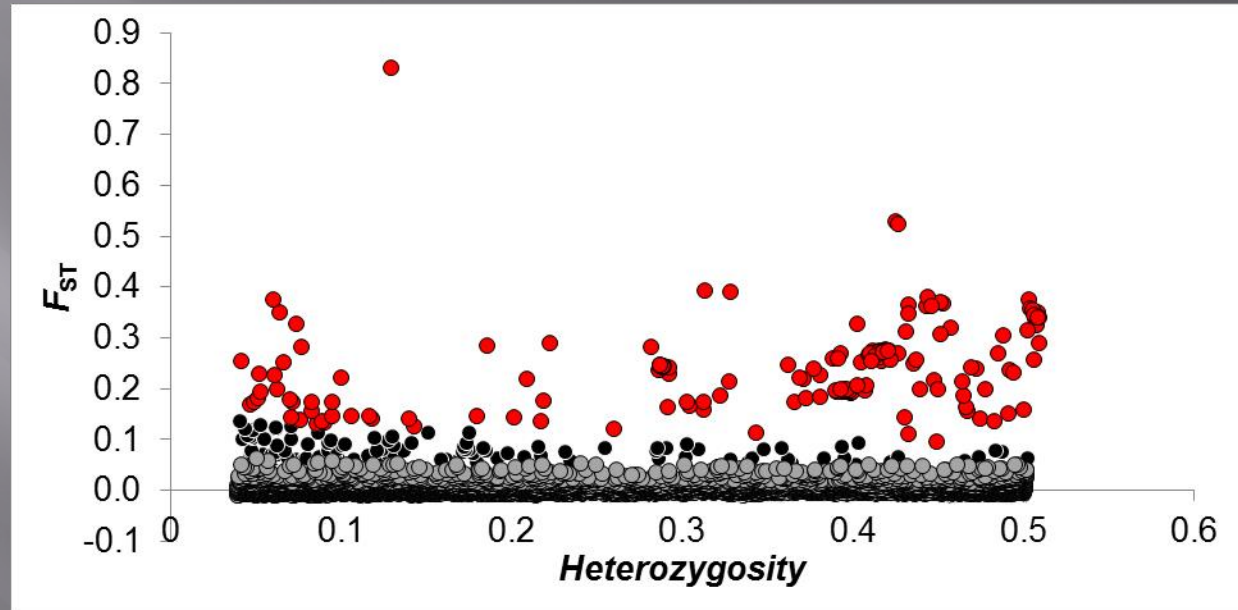


Pacific lamprey study area



Selection of a 96 panel of SNPs

N = 4,439 SNPs



Hess *et al.* (2013) Population genomics of Pacific lamprey. *Molecular Ecology*, 22, 2898-29916

Quality-filtered SNPs: 4,439
Putatively neutral SNPs: 4,068
Adaptive SNPs: 162

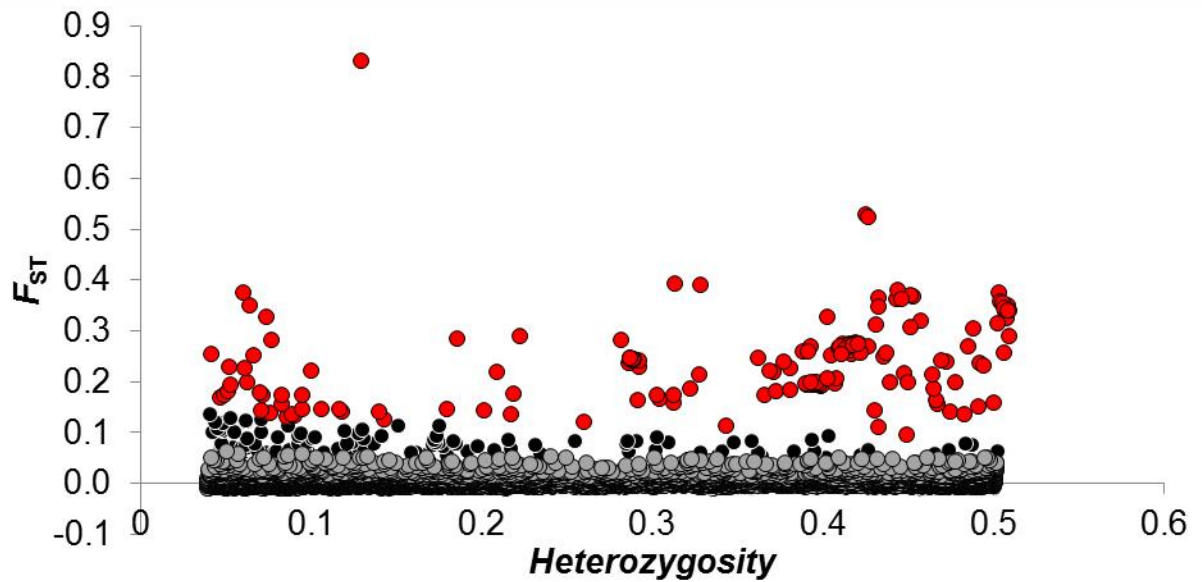
Pacific lamprey: lack of natal homing



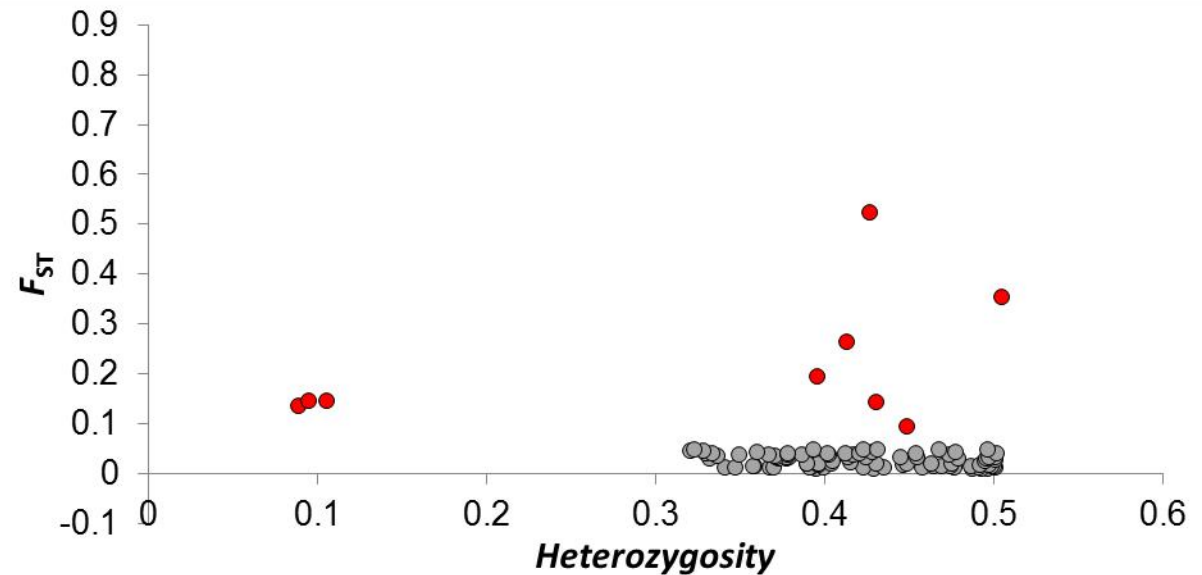
Yun SS, et al. (2011)
Canadian Journal of Fisheries and Aquatic Sciences, 68, 2194-2203.

Selection of a 96 panel of SNPs

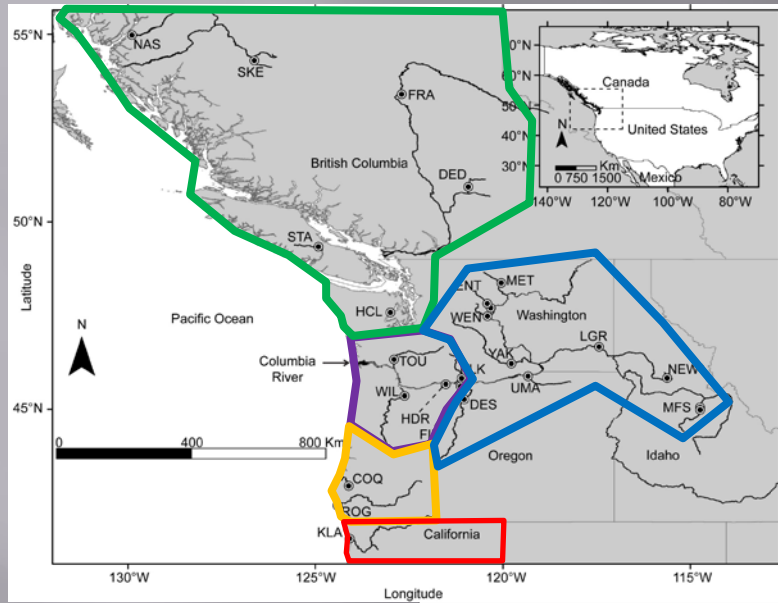
N = 4,439 SNPs



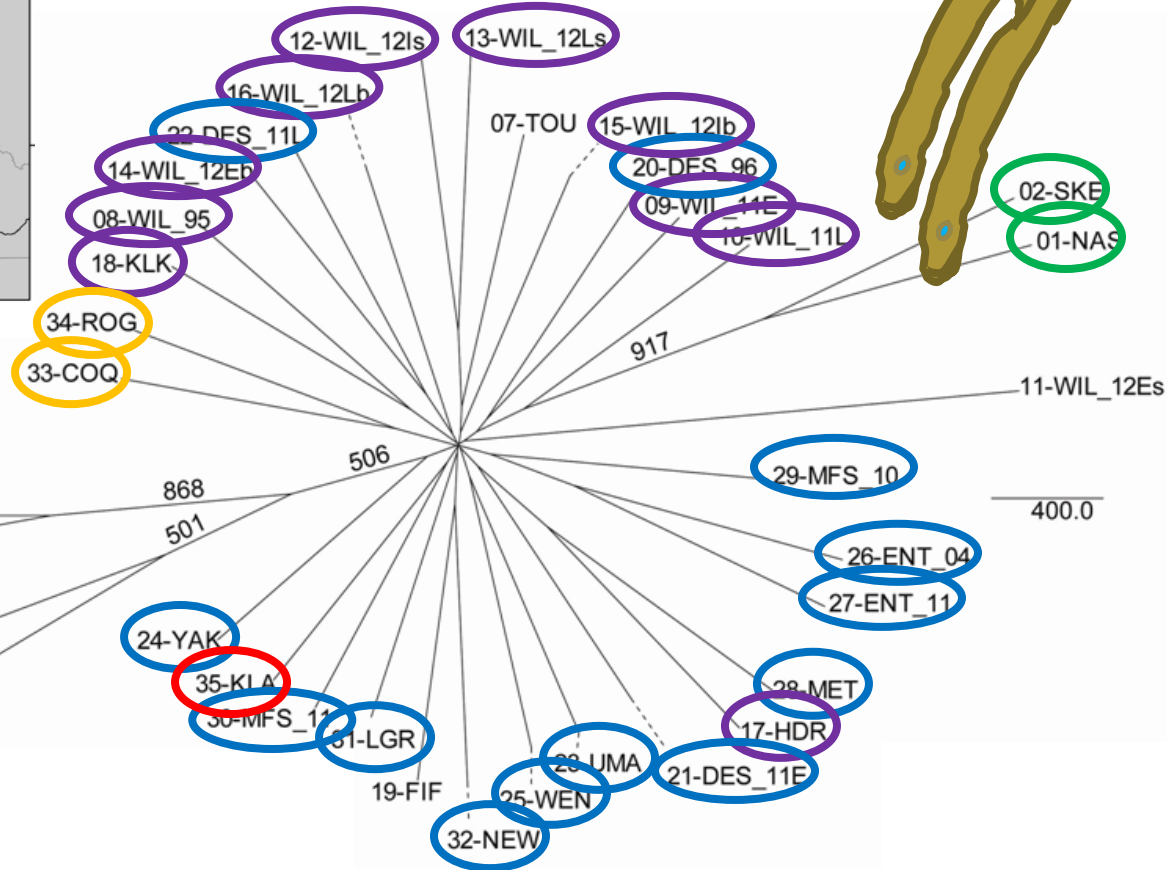
N = 94 SNPs



Population structure (neutral)

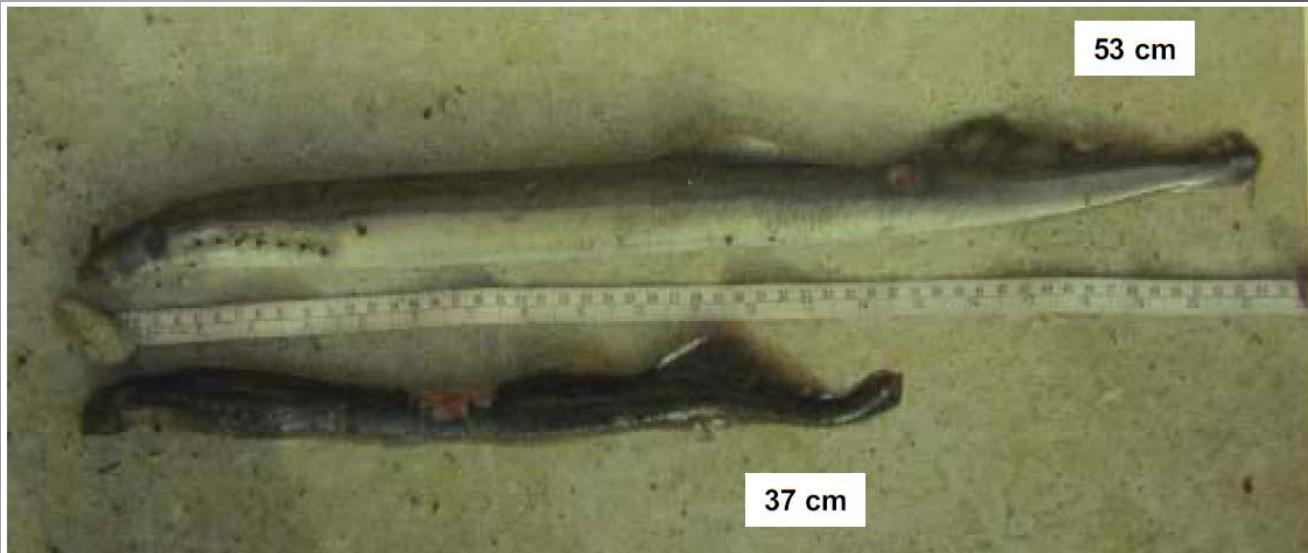


85 putatively neutral SNPs



Nei's (1972) genetic distance
1000 bootstraps

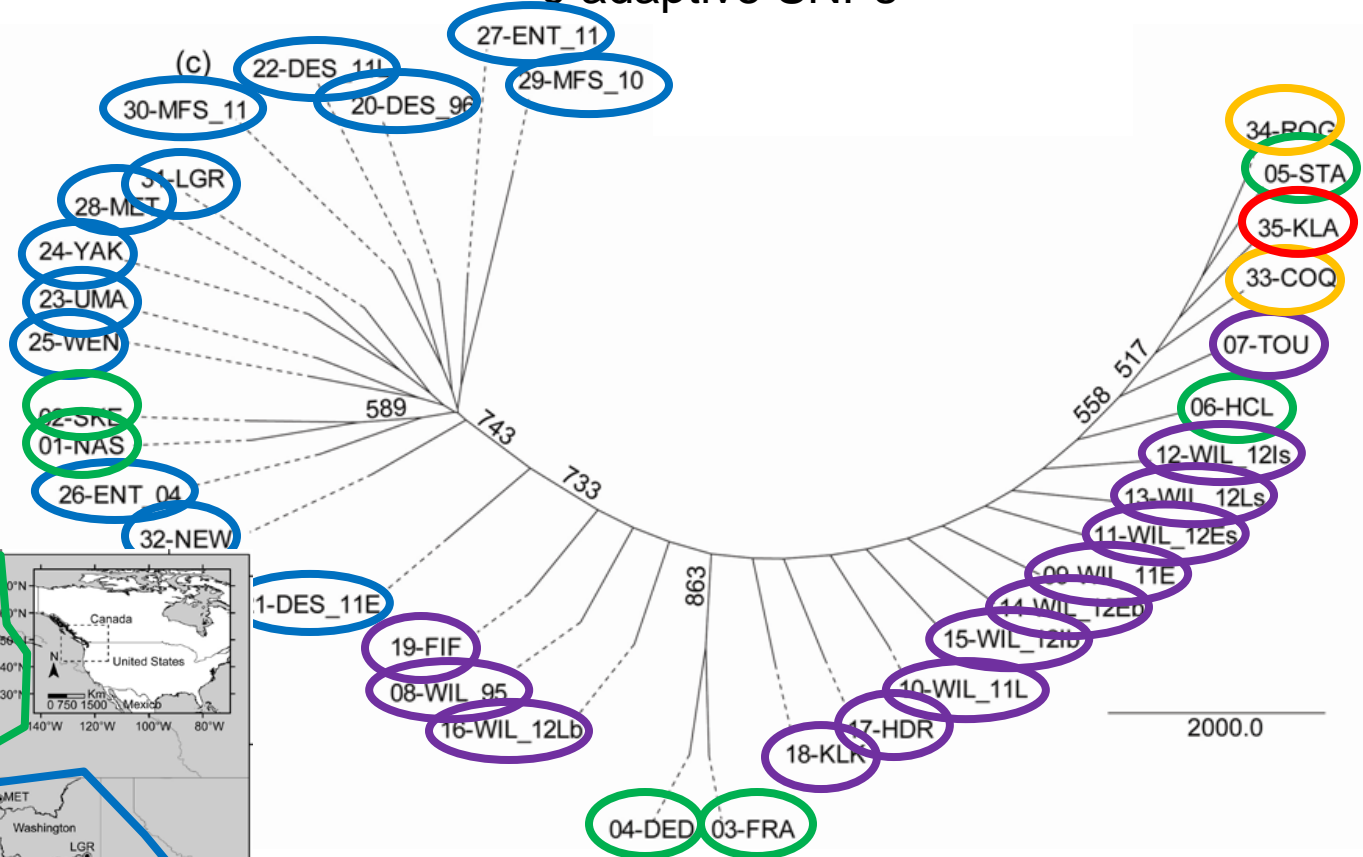
Dwarf Pacific lamprey



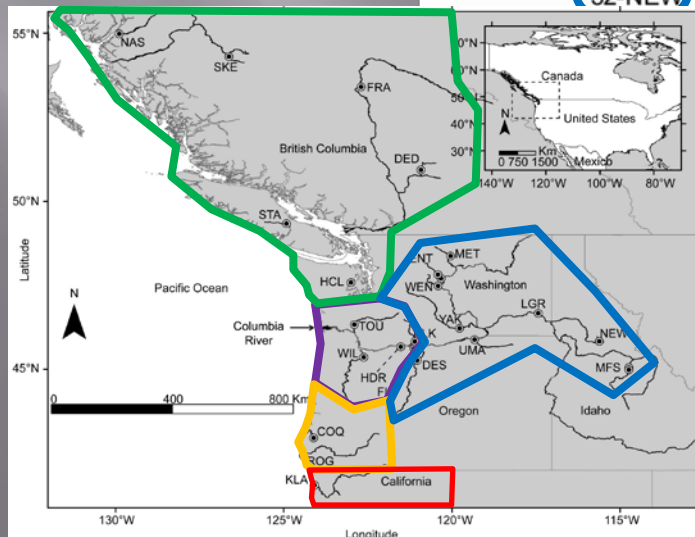
Beamish, RJ (1980) Canadian Journal of Fisheries and Aquatic Sciences, 37:1906-1923.
Kostow, K. (2002) Oregon Department of Fish and Wildlife.

Population structure (adaptive)

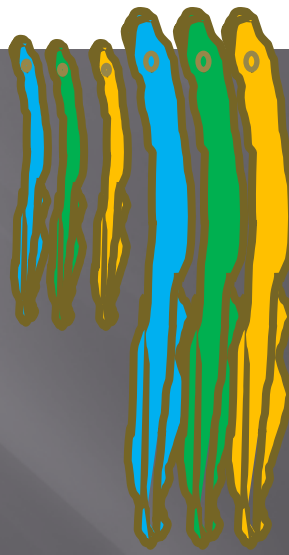
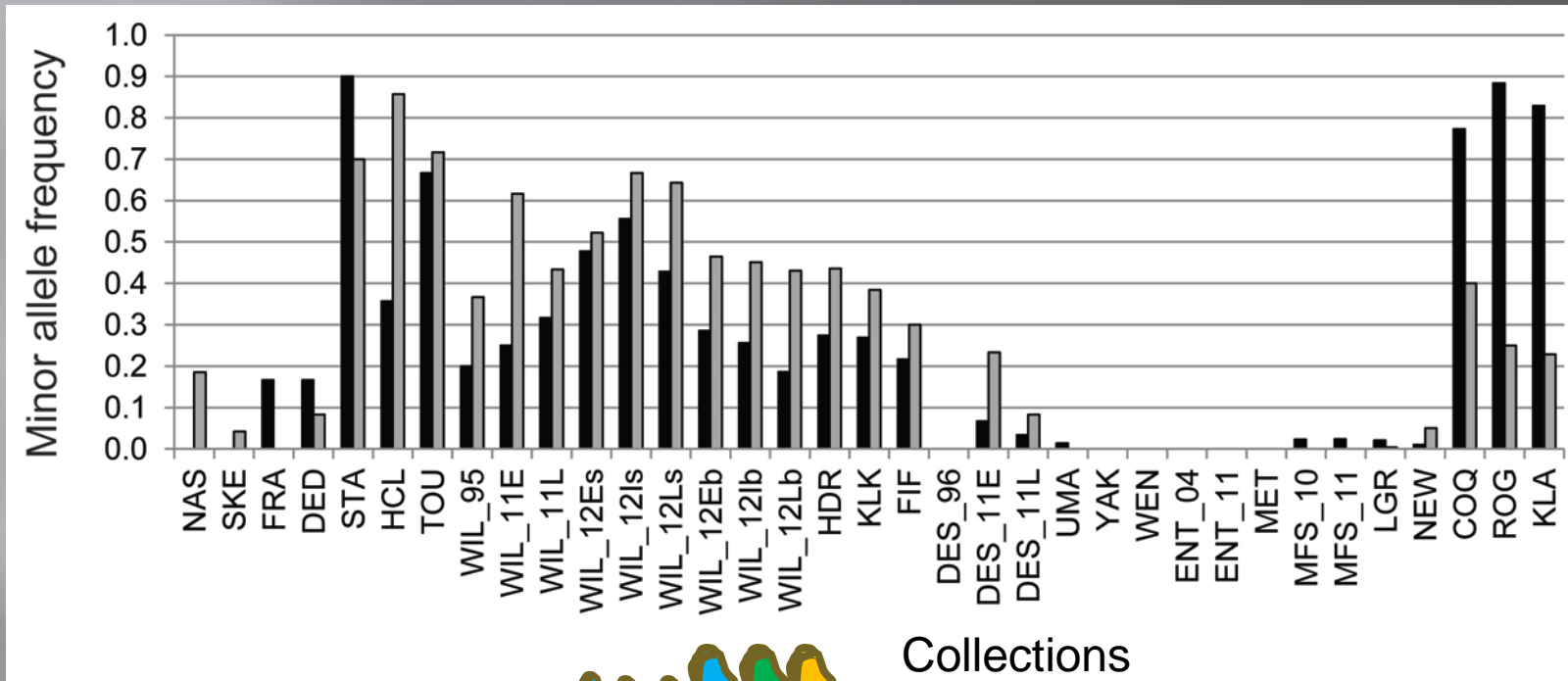
9 adaptive SNPs



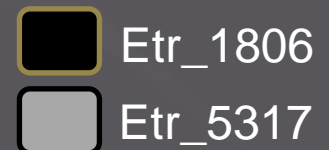
Nei's (1972) genetic distance
1000 bootstraps



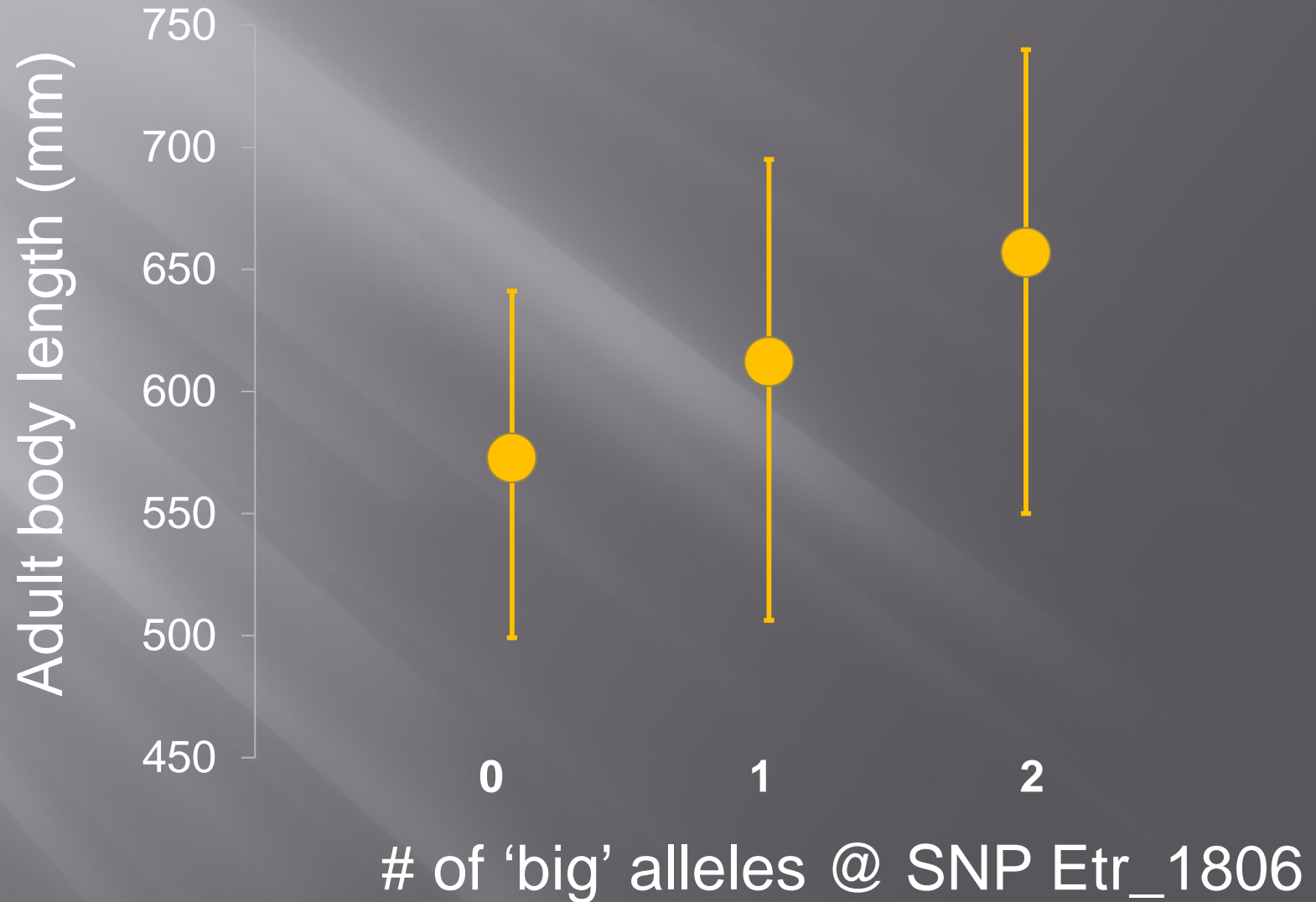
Characterize adaptive variation



Adaptive SNP loci



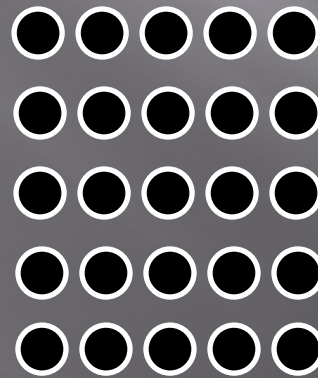
Characterize adaptive variation application: Link genotype with phenotype- adult length



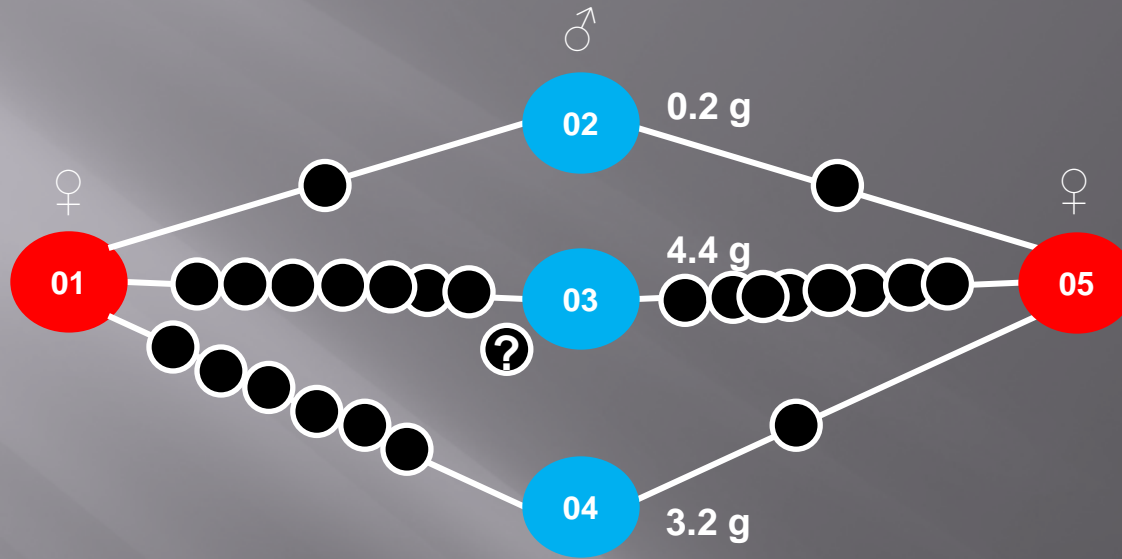
Parentage analysis



Rearing study:
Known parents
and their offspring

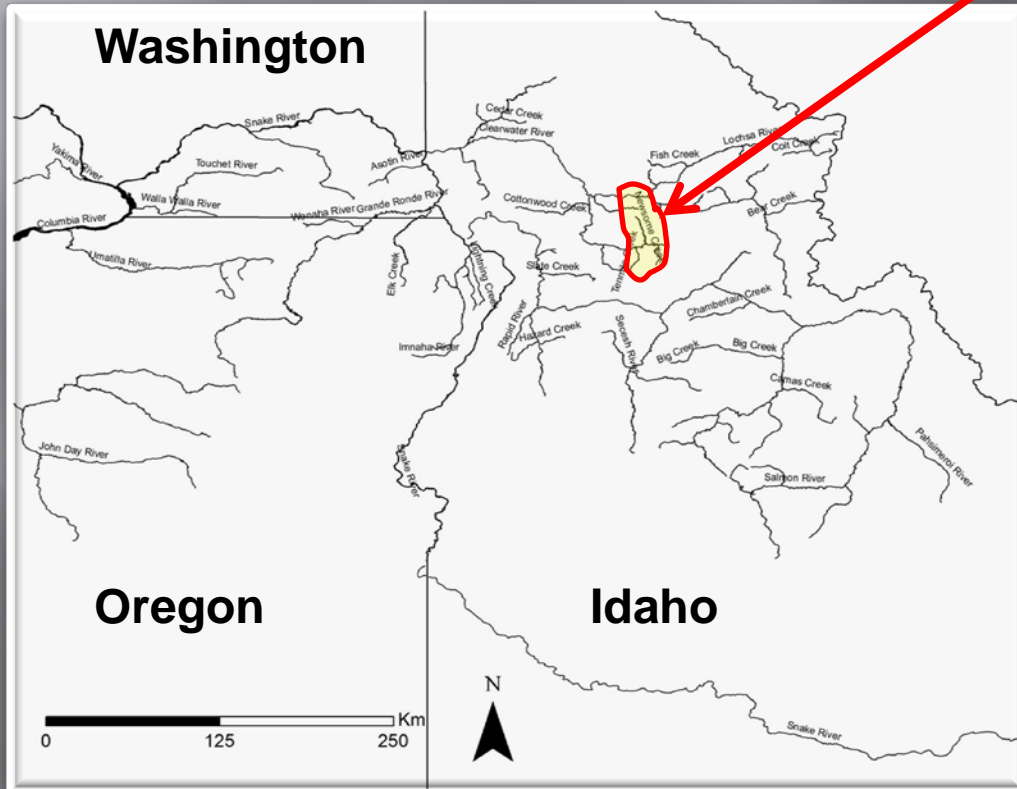


Parentage analysis



Rearing study:
Known parents
and their offspring

Parentage analysis application part 1: validate reproductive success of a translocation



Newsome Cr. Translocation:
2007-2012 (~50 adults per year)

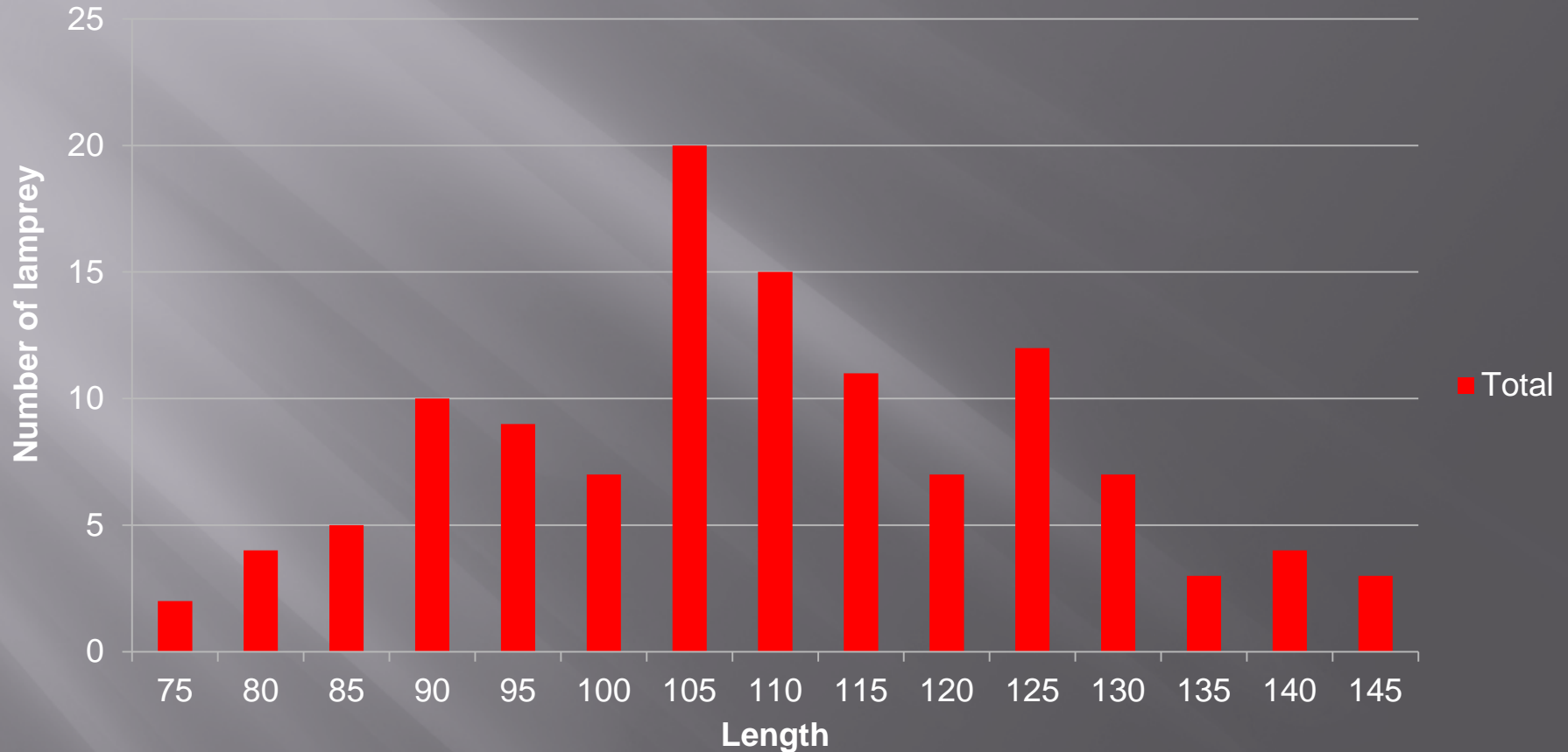
Parents genotyped
2007- 50 adults
2008- 6 adults
2009- 4 adults

Juvenile collections
2009- 18 larvae (Electrofishing)
2012- 119 larvae (Screw trap)



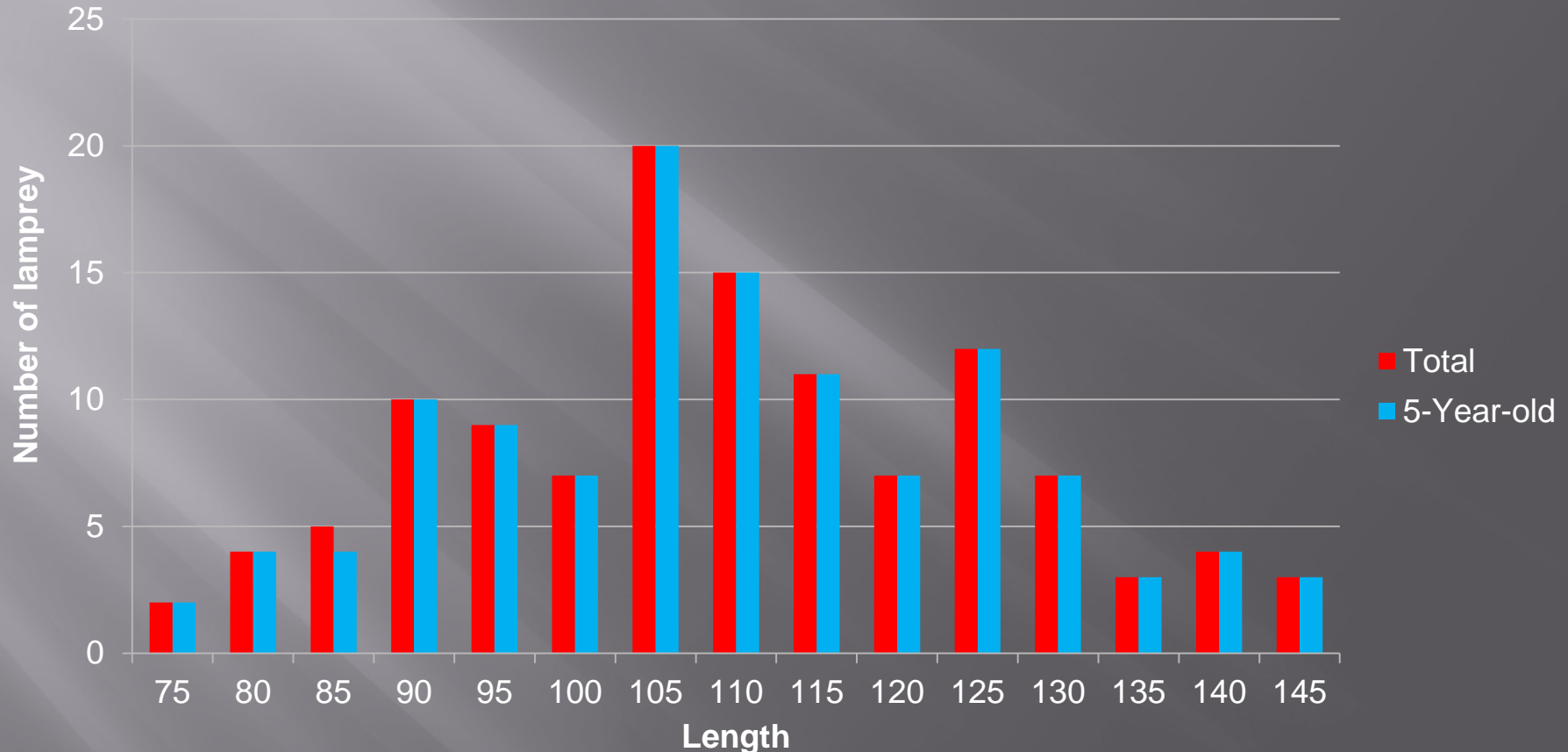
Parentage analysis application part 1: validate reproductive success of a translocation

Length distribution of Newsome Cr. lamprey from screw trap in 2012

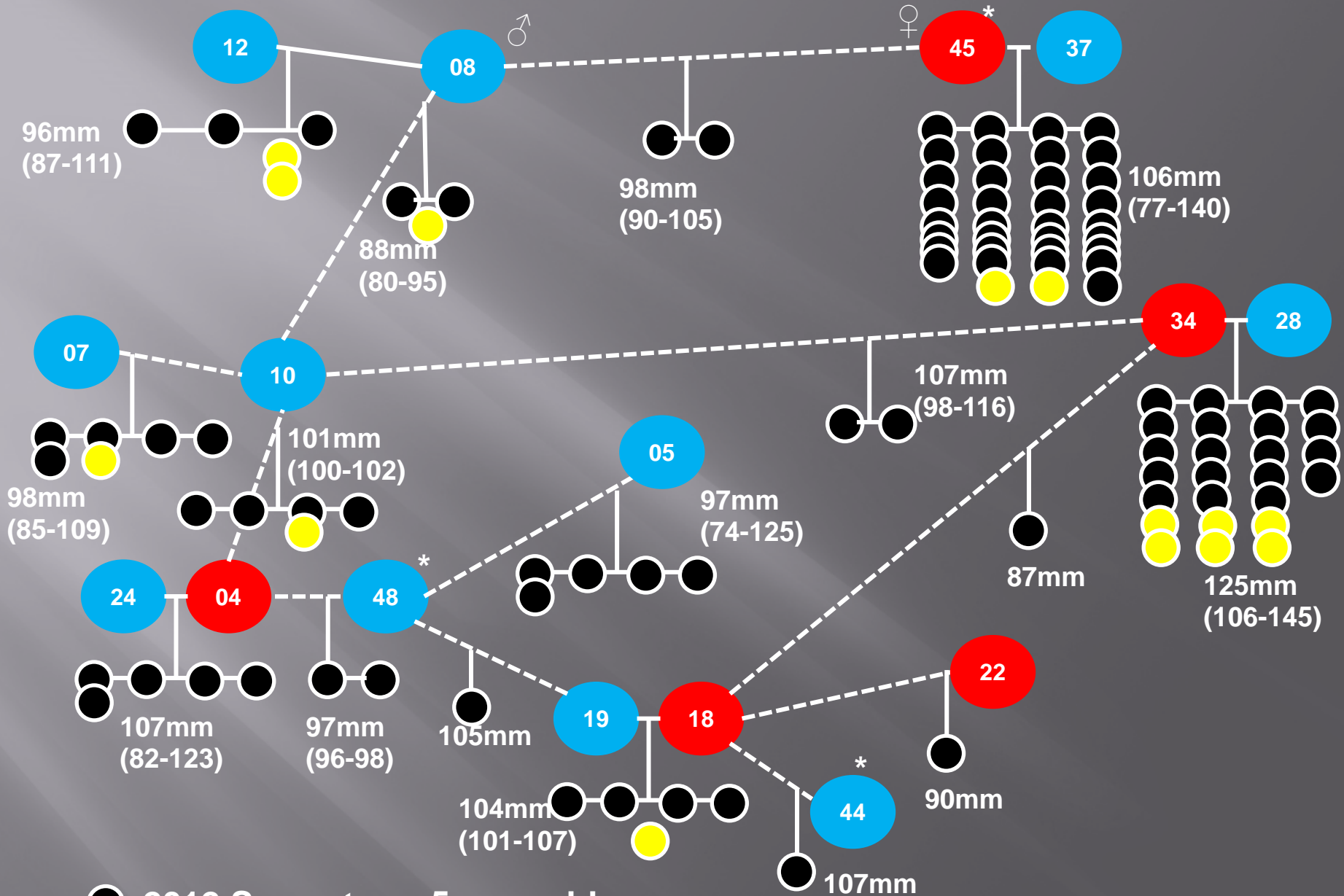


Parentage analysis application part 1: validate reproductive success of a translocation

Length distribution of Newsome Cr. lamprey from screw trap in 2012



N=119 larvae genotyped
N=118 Assigned to 2007 parents
(5-year-olds)

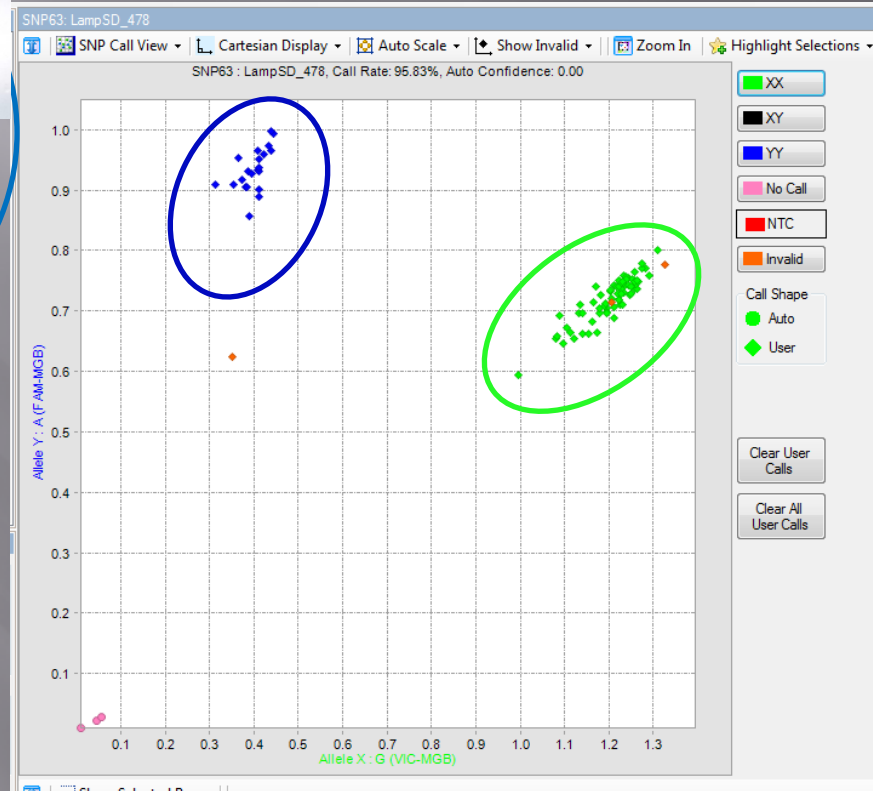


27 of 50 (54%) translocated adults confirmed as spawners!

Species identification



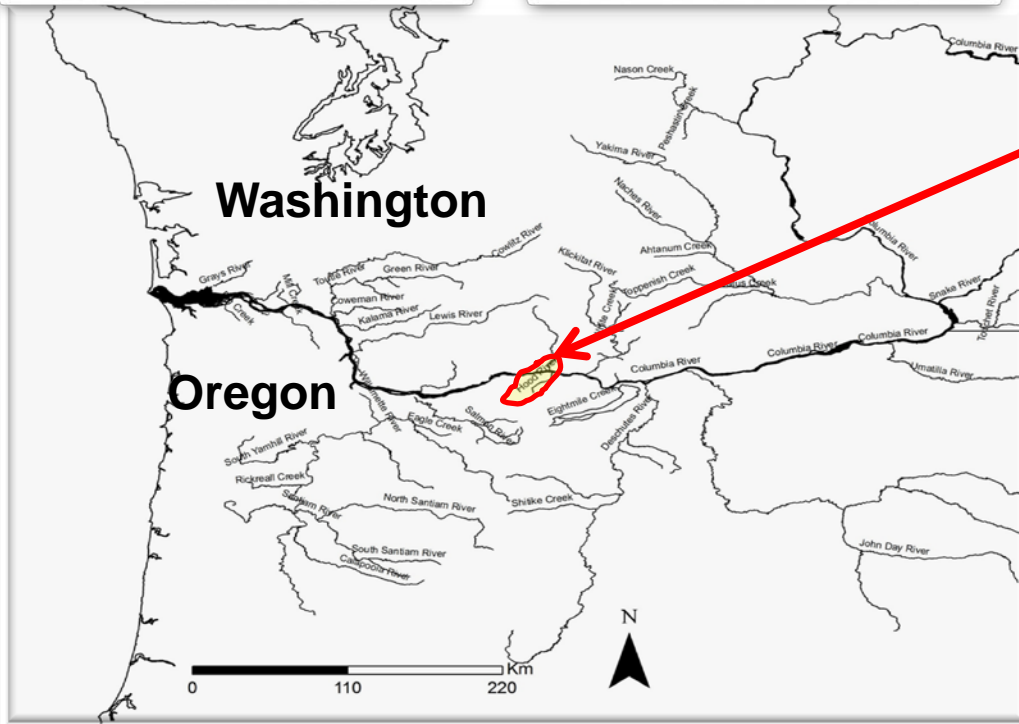
Entosphenus tridentatus
N=1121, 100%



Lampetra
Sp.
N=92, 100%

Raw data from SNP diagnostic marker:
LampSD_478

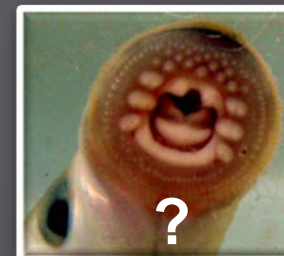
Species identification application: Document a recent natural reintroduction of Pacific lamprey from 0-yr larvae



**Hood R. Natural Reintroduction:
2012 (~60 0-year ammocoetes)**

**Above and below
Powerdale Dam site
(dam removed in 2010)**

**59 out of 60 identified as
Pacific lamprey**



Concluding remarks

- 1) Marker associated with adult length can differentiate Pacific lamprey from interior Columbia R. versus lower Columbia R.
- 2) Pacific lamprey translocation success verified! AND - multiple mating + outmigration initiated at age 5.
- 3) Natural reintroduction possible with improvement to habitat.
- 4) Large scale parentage analysis will be used to track translocations, and markers will be used to estimate effective # spawners.

Acknowledgements

Nick Hoffman; Lori Maxwell; Travis Jacobsen:
laboratory experts

Ben Hecht; Mike Miller: RAD-seq gurus

Pacific lamprey collections: John Crandall,
Elmer Crow, Joyce Faler, Leo Grandmontagne,
Michael Hayes, Don Ignace, Patrick Luke, R.D.
Nelle, Matt Powell, Bob Rose, Christian Smith,
Greg Tamblyn, and Eric Taylor.

BPA: Funding

Questions?



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Jeremy Monroe

Parentage analysis application part 2: estimate effective number of spawners



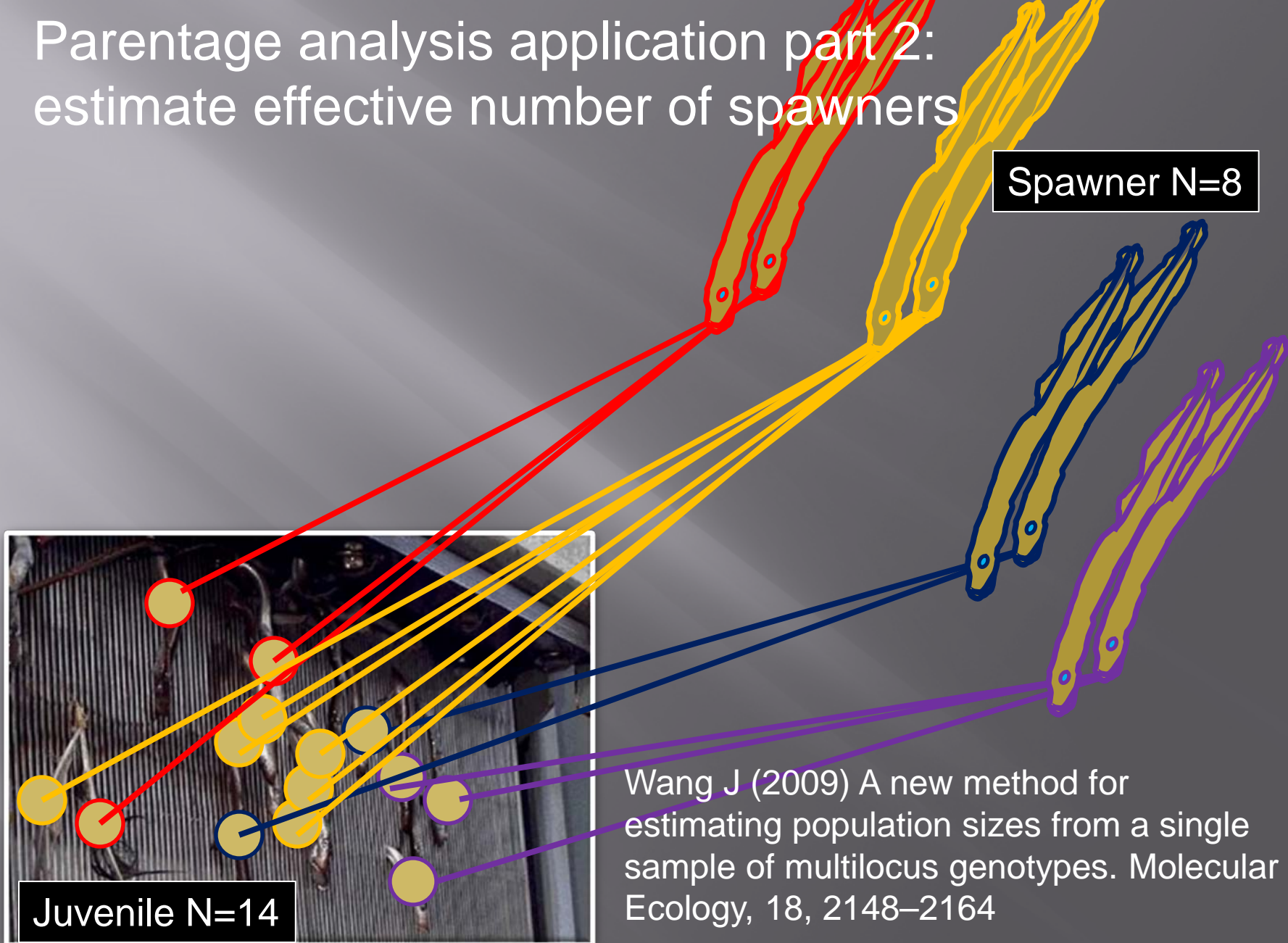
Juvenile lamprey impinged on turbine intake screen

Parentage analysis application part 2: estimate effective number of spawners



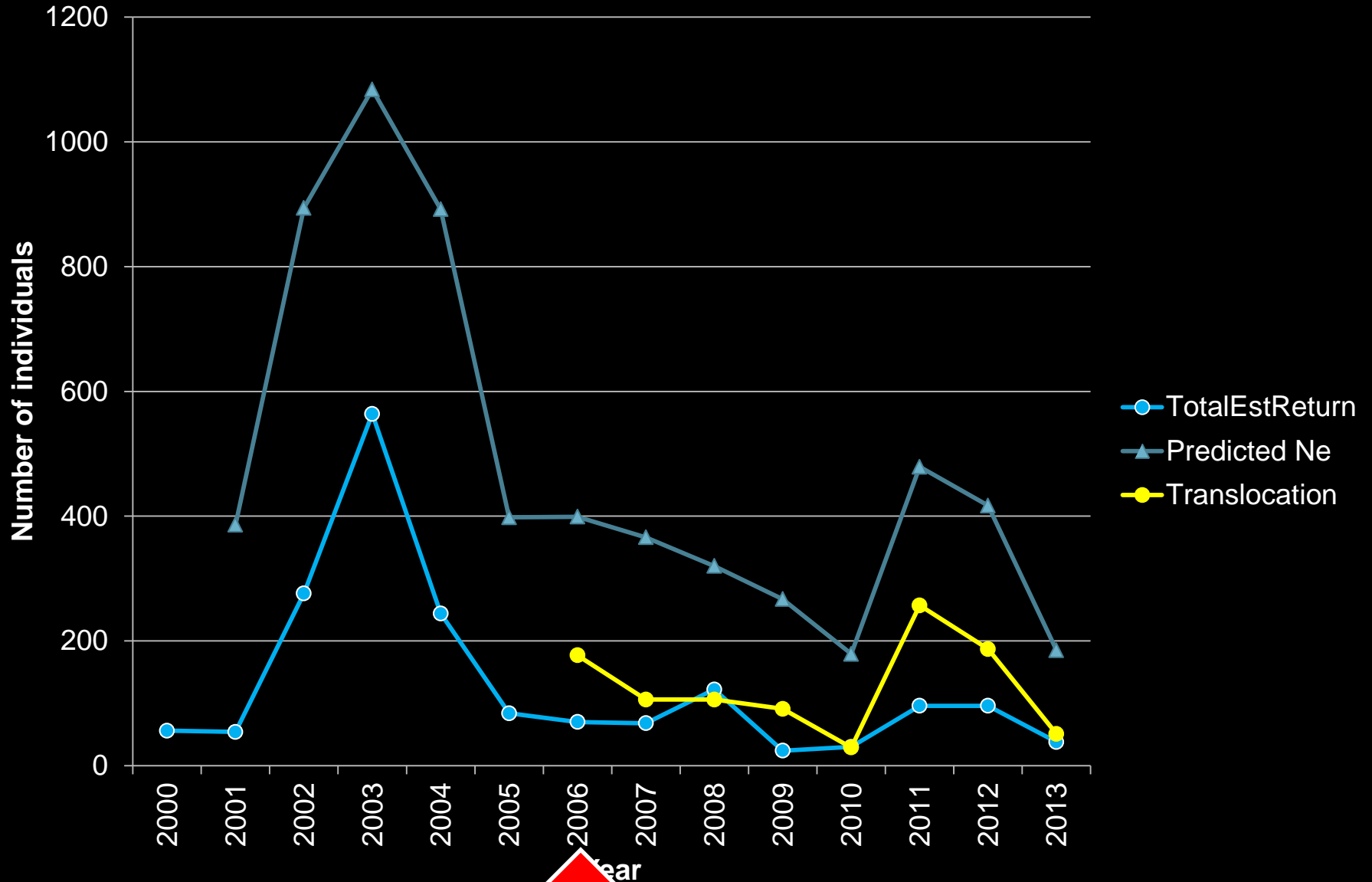
Juvenile lamprey impinged on turbine intake screen

Parentage analysis application part 2: estimate effective number of spawners



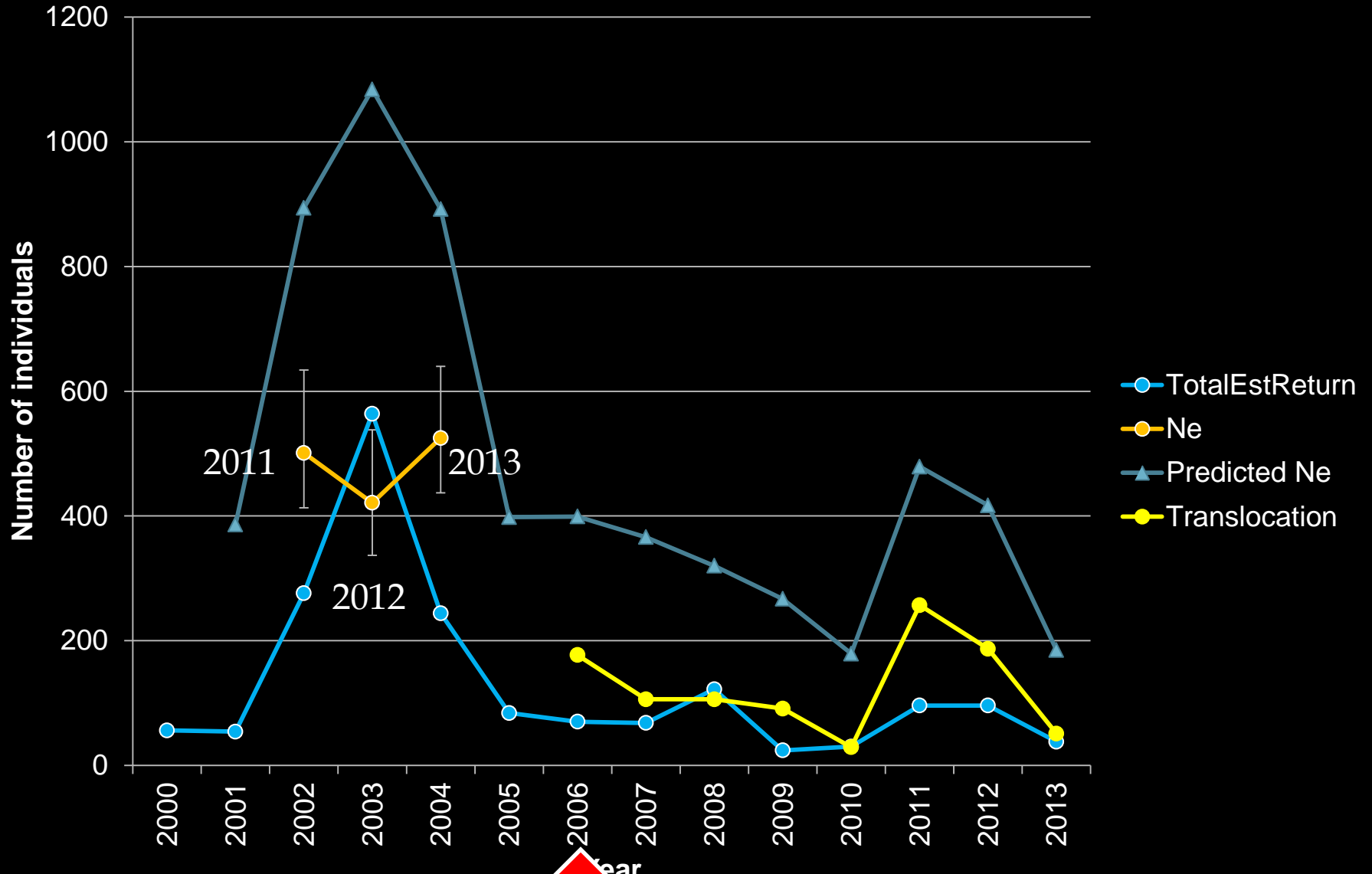
Juvenile lamprey impinged on turbine intake screen

Lower Granite Dam- Pacific lamprey abundance



Translocations begin in Snake River

Lower Granite Dam- Pacific lamprey abundance



Translocations begin in Snake River

Species diagnostic markers

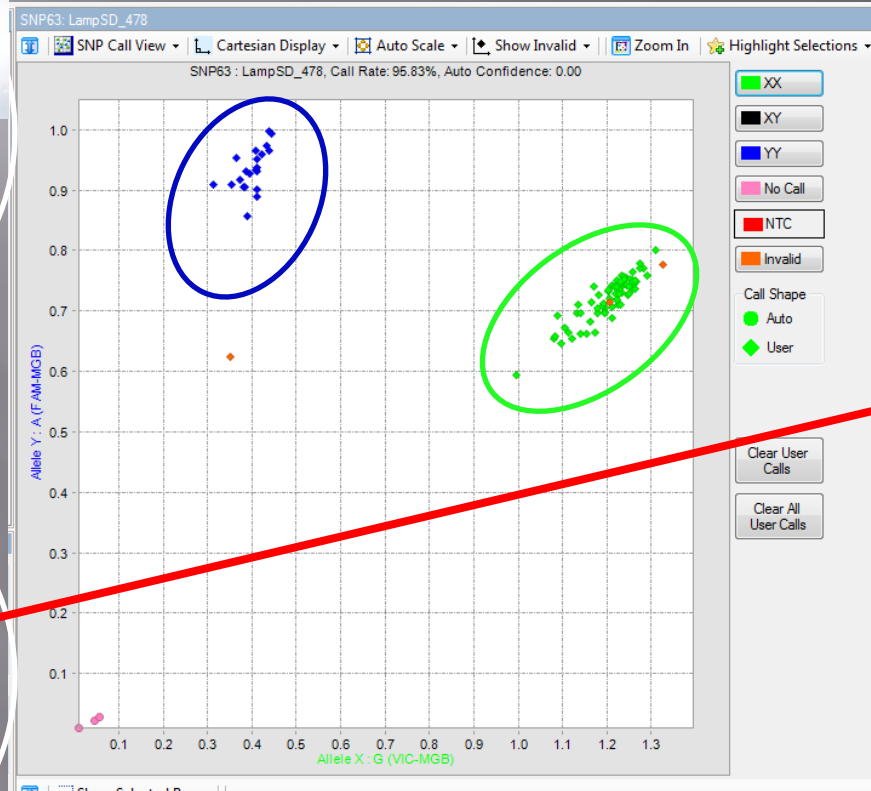
LampSD_478



Entosphenus tridentatus
N=958, 100%



Lampetra
Sp.
N=132, 100%



LampSD_802



Lampetra richardsoni
N=103, 96%

Lampetra pacifica
N=30, 100%