

# Fine-scale population genetic structure of bull trout in the Yakima basin

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Presentation to YKFP on June 18, 2009

# Format

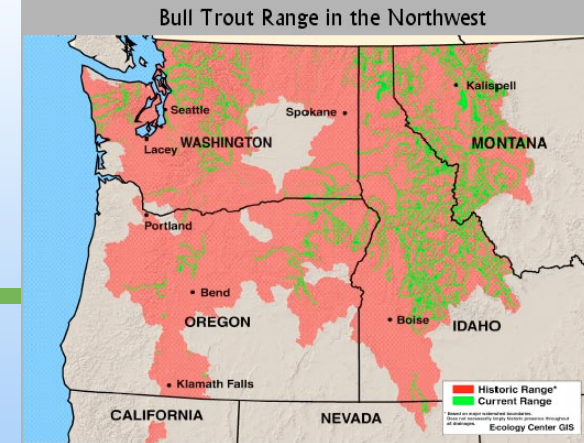


<http://www.dfw.state.or.us/swwd/trout.html>

- ▣ 1) Describe bull trout life history
- ▣ 2) Questions for study
- ▣ 3) Methods to address questions
- ▣ 4) Results

# Bull trout life history

- Considered “glacial remnants”
- Spawn and rear in cold headwaters (< 8 °C)
- Repeat spawners
- Juveniles stay in natal streams
  - Resident – remain in small streams
  - Fluvial – migrate out to mainstem rivers
  - Adfluvial – migrate out to lakes or reservoirs
  - Anadromous (amphidromous) – migrate out to saltwater but may move in and out of rivers
  - Connectivity important but disrupted in Yakima basin by irrigation impoundments and extractions



# Bull trout questions in Yakima basin

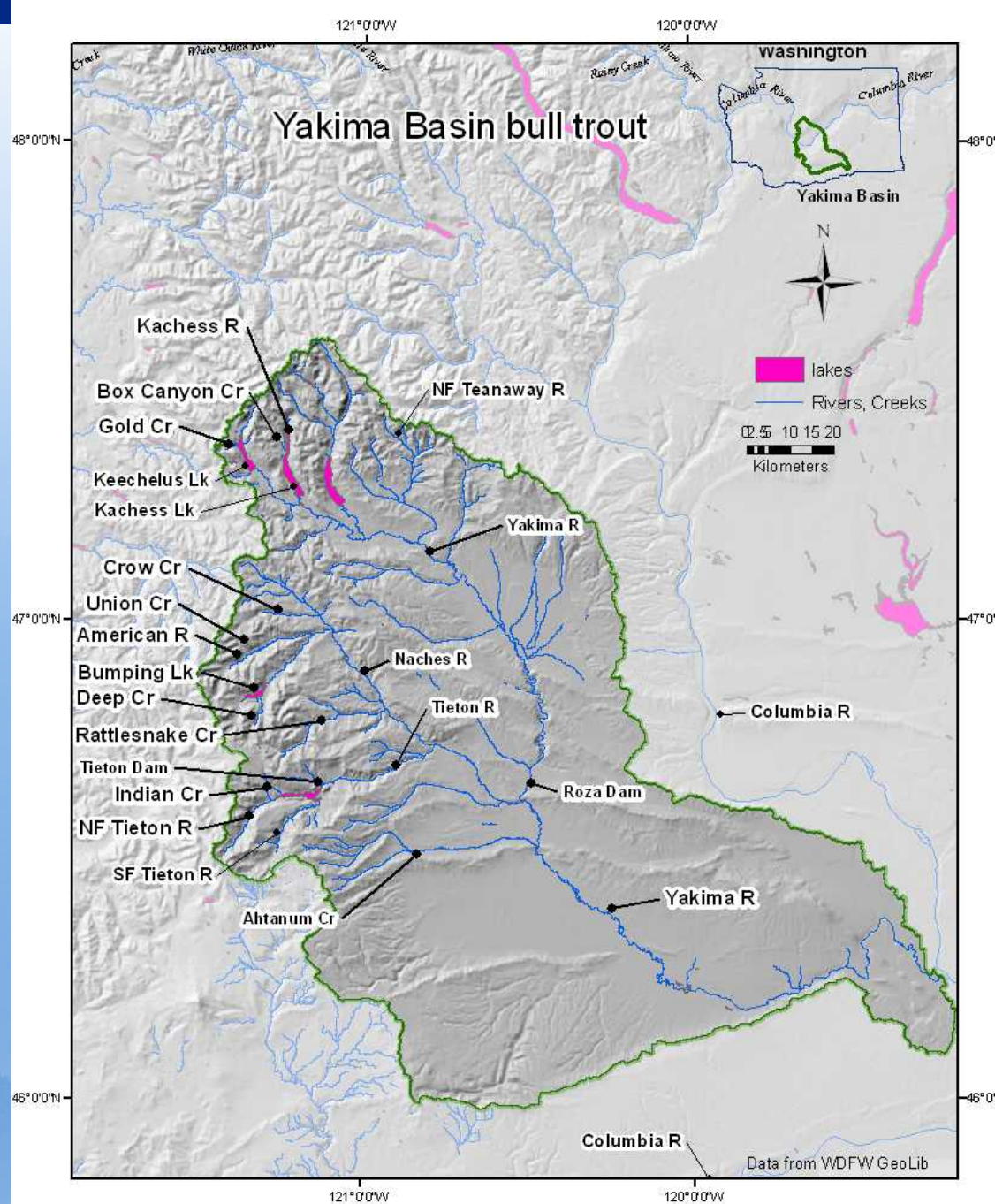
- What are the characteristics of Yakima bull trout – diversity, heterozygosity, effective population sizes?
- What are the genetic relationships among populations?
- How have dams affected connectivity?
- Where do fish go if they get over a dam?



# Map of the study area

Features affecting bull trout movement

- Dams
- Dewatered portions
- Water temperature
- Sediment load
- Culverts
- Roads
- Vehicles in river
- Cows in river and grazing
- agriculture



# Tieton Dam

Constructed in early 1900's with no fish passage – 319 feet tall  
Tieton pool formed at base



# Identify Bull trout genetically

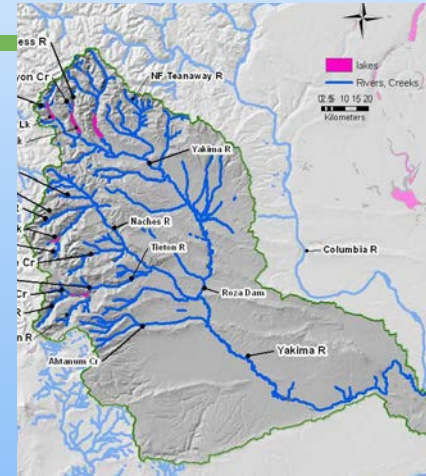
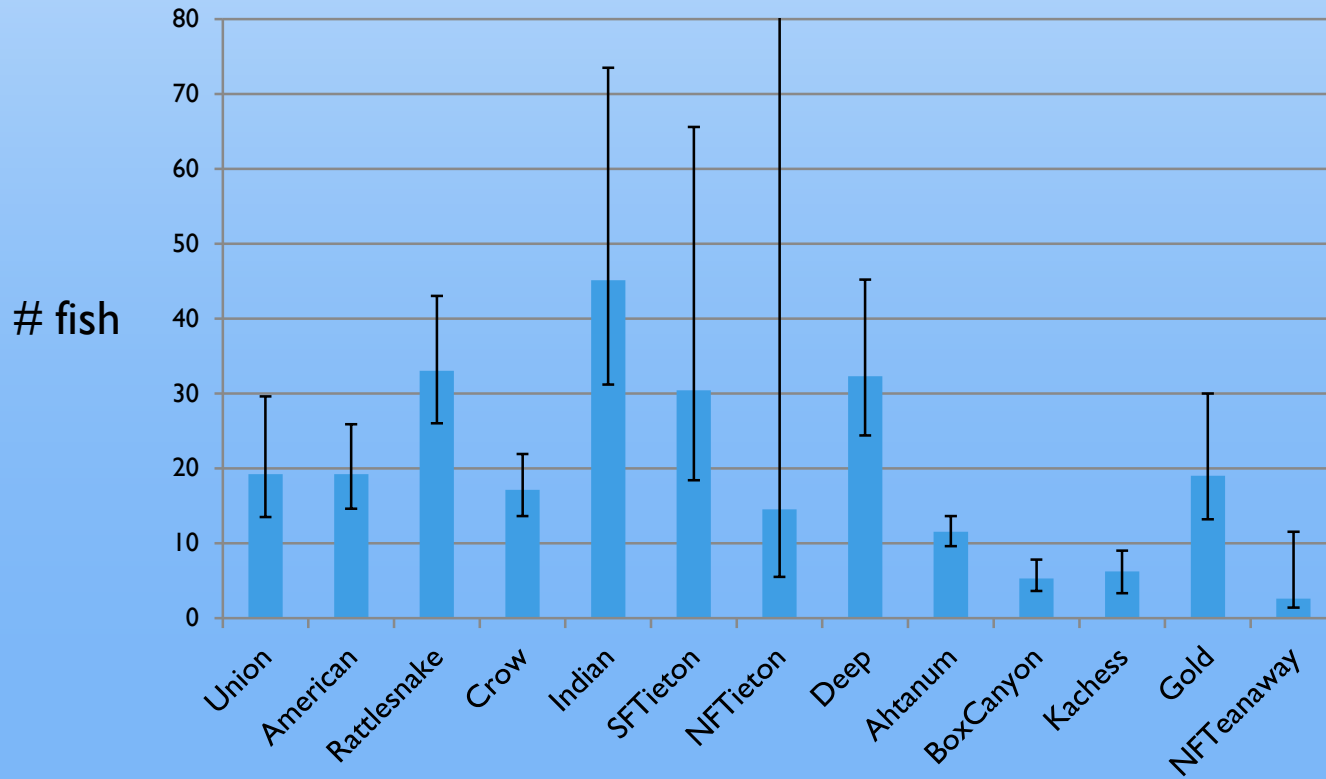


<http://www.fws.gov/pacific/bulltrout>

- Use standardized bull trout microsatellite suite
- Collaborative effort headed by USFWS, including WDFW, UBC, U of M, IDFG
- Data compatible among participating labs
- Standardized loci discriminate:
  - Local bull trout populations
  - Inland and Coastal bull trout
  - Bull trout and Dolly Varden
  - Bull trout and Brook trout
  - Identify hybrids

# Bull trout effective population sizes

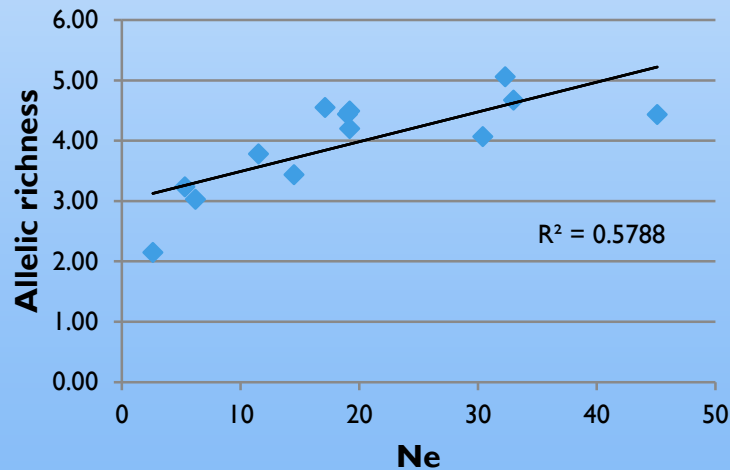
Ne and 95% CI



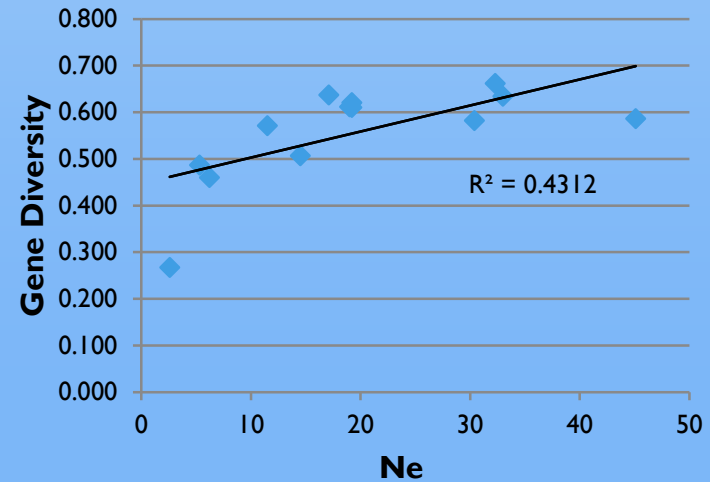


# Genetic diversity vs Ne

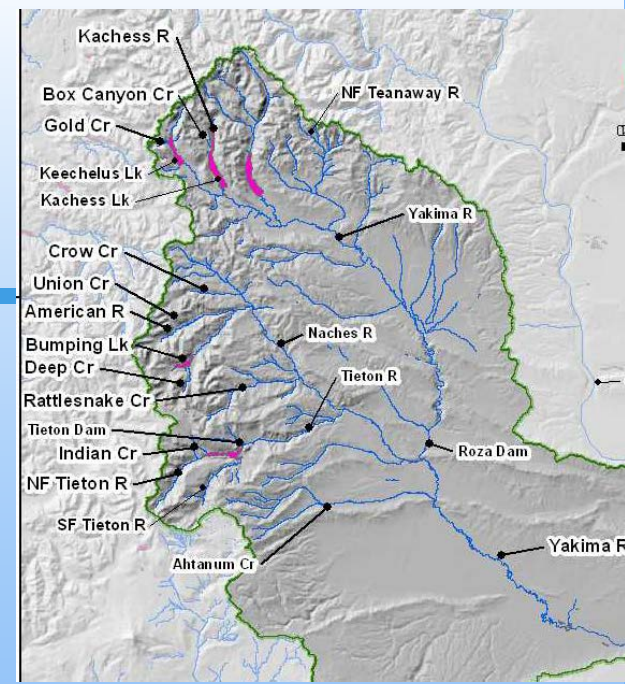
## Allelic richness vs Ne



## Heterozygosity vs Ne

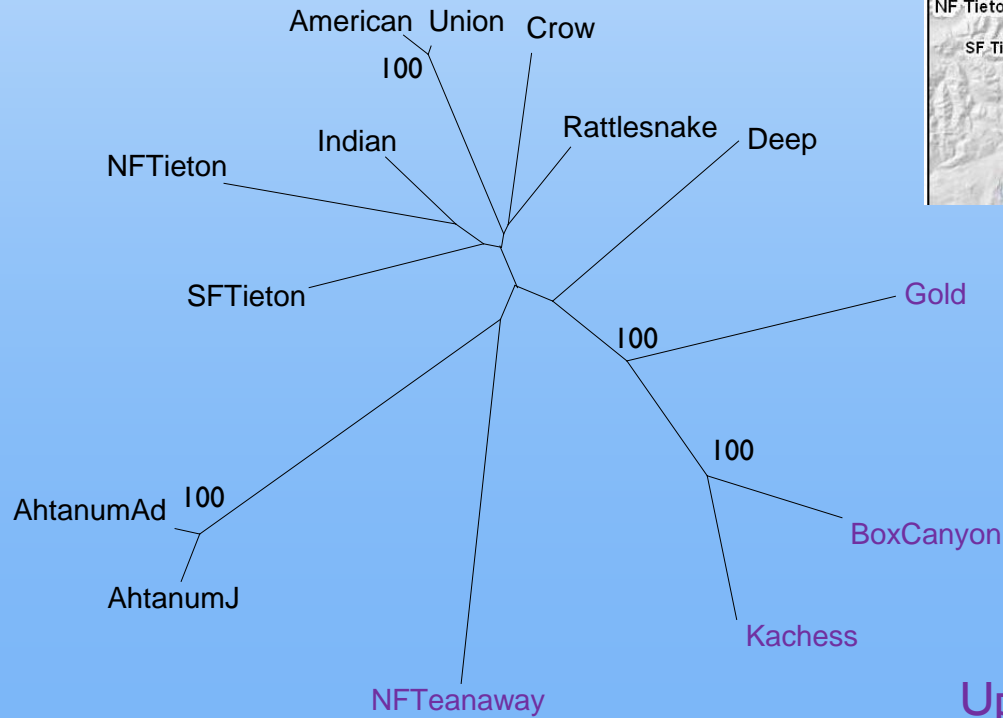


# Population structure



## Naches tributaries

## Middle Yakima

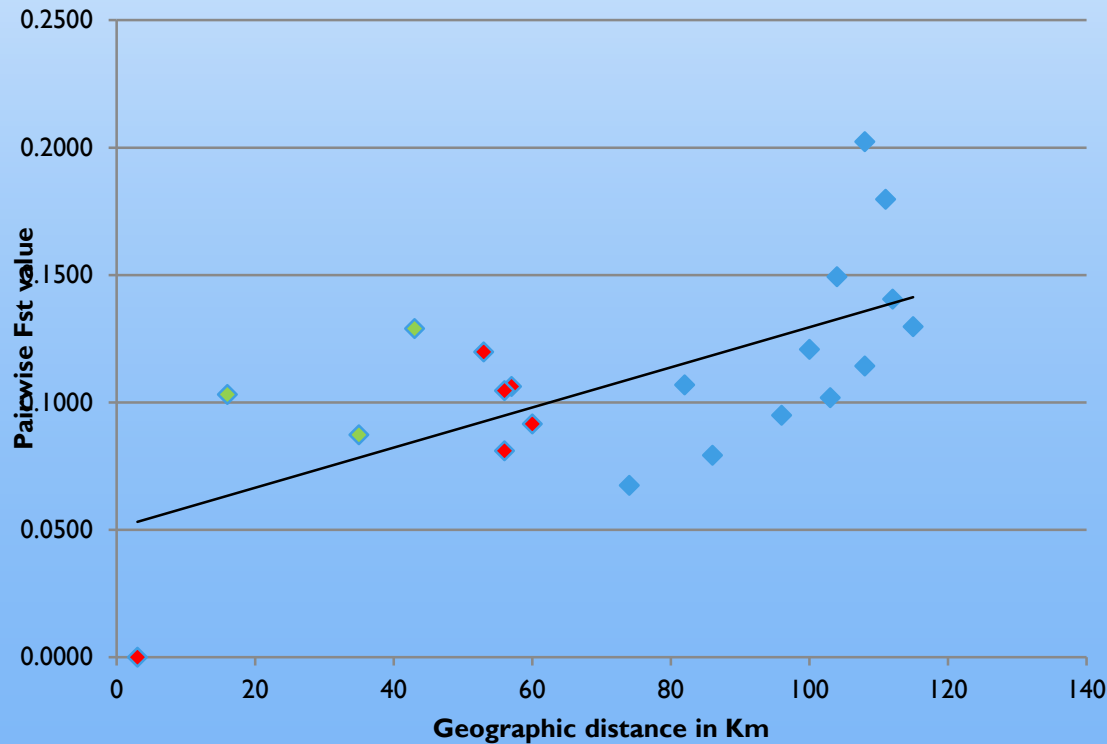


## Upper Yakima

Cavalli-Sforza and  
Edwards distances in  
Neighbor-joining tree  
1000 bootstraps

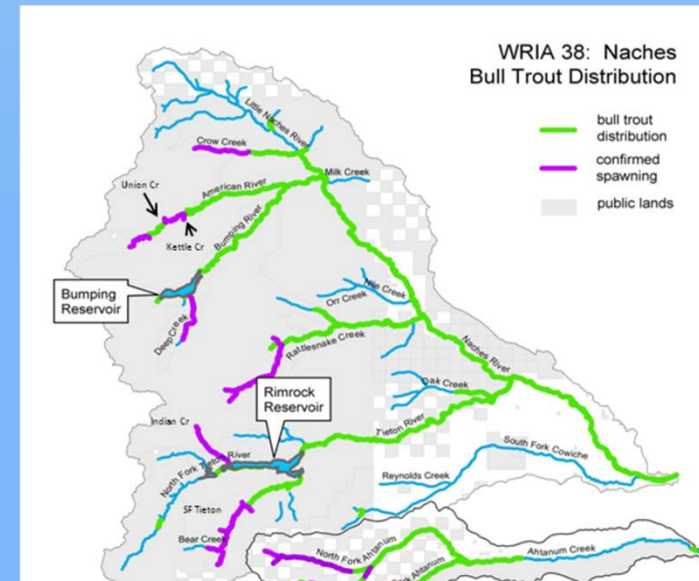
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# Isolation by distance in middle Yakima



Green – within Rimrock  
 Red – within Naches (except Deep Cr.)  
 Blue – between Rimrock and Naches

Map by Mike Mizelle



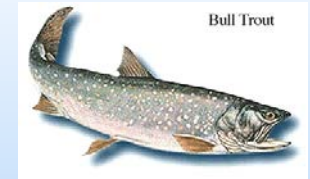
# Tieton Dam

One-way barrier since 1925 – created adfluvial habitat for Tieton populations  
Populations get bigger but lose some portion over the dam

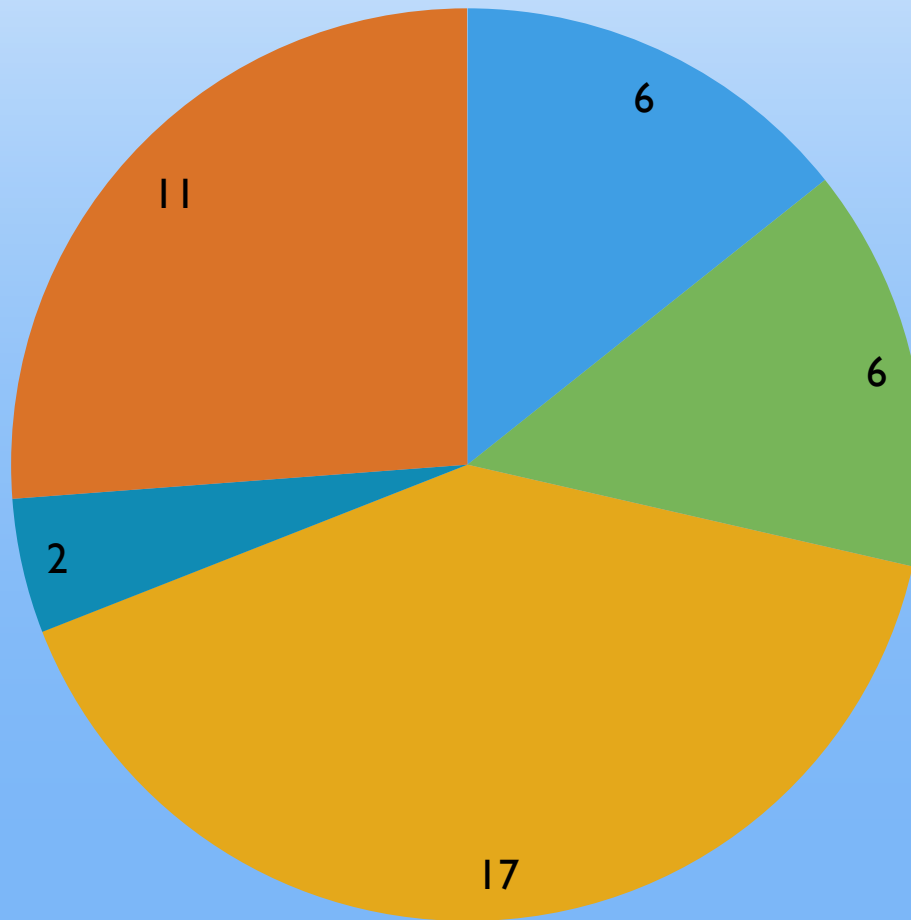


# Tieton Pool composition

- what happens to these fish?



<http://srd.alberta.ca/fishwildlife/fishingalberta/gamefish/bulltrout.aspx>



- AmUnion
- Rattlesnake
- Indian
- NF Tieton
- SF Tieton



# Self-assignment tests



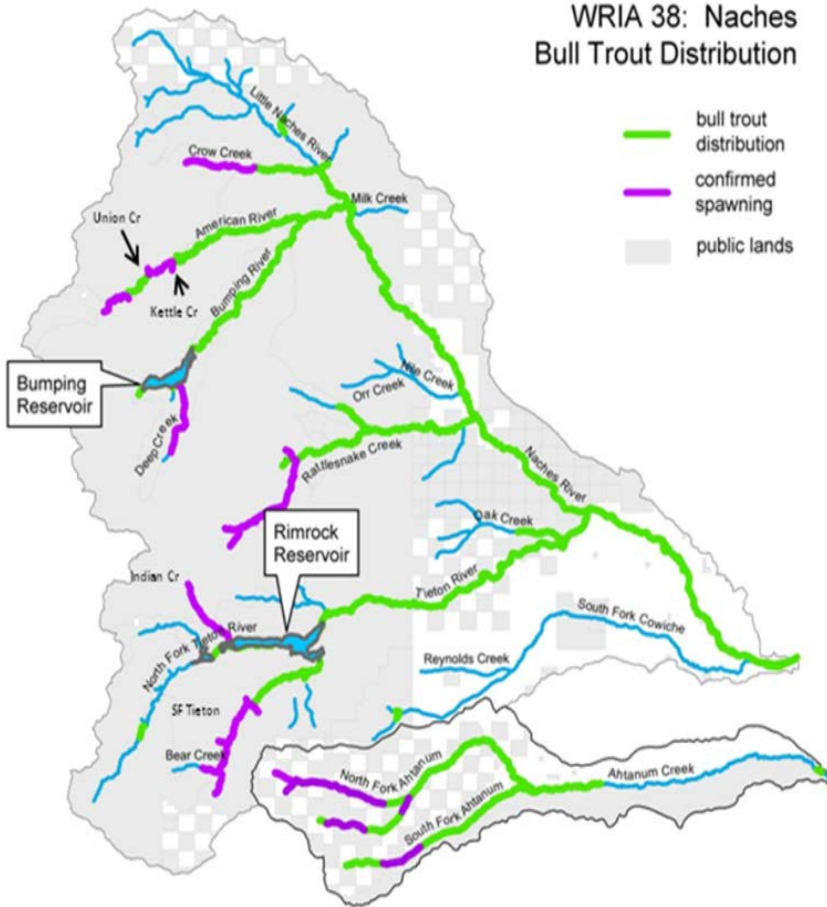
<http://www.cnr.usu.edu/wats/images/uploads/budy/bull%20trout4.jpg>

	BoxCanyon	Kachess	Gold	NFTeanaway	AmUnion	Rattlesnake	Crow	SFTieton	NFTieton	Indian	Ahtanum	Deep	N
BoxCanyon	33	1											34
Kachess		30											30
Gold			19 (1)										20
NFTeanaway				10									10
AmUnion					52								52
Rattlesnake					(1)	43 (3)		2	1				50
Crow							30						30
SFTieton								18 (2)					21
NFTieton									8 (1)				9
Indian										34			34
Ahtanum											69		69
Deep												31	31

3 adult fish sampled in the Rattlesnake spawning area came from SF Tieton and NF Tieton

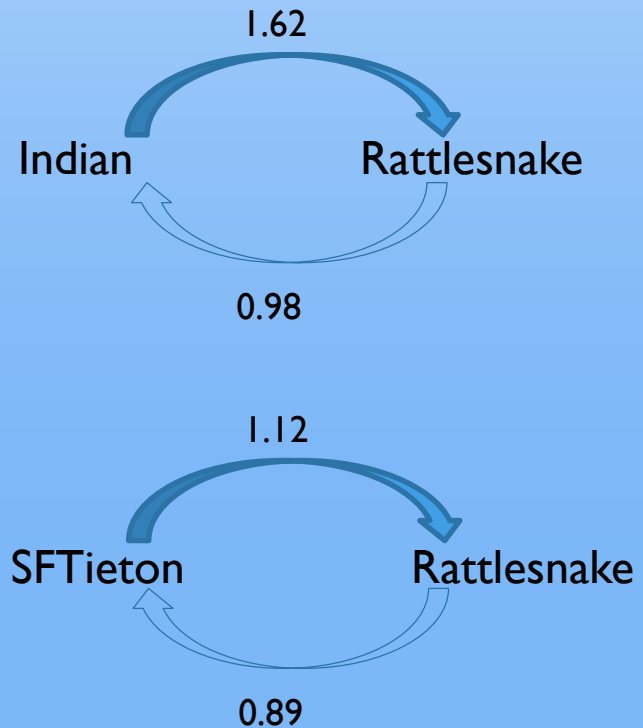
# What happens to fish after they get out of Rimrock Lake?

WRIA 38: Naches  
Bull Trout Distribution



Go to nearest spawning area?

Gene flow estimates from MIGRATE show asymmetric gene flow



# What are impacts of dams?

- Negative: fish unable to return to spawn in their natal tributary if they cross the dam
  - Lose genetic diversity?
    - Lower allelic richness than bull trout in Columbia and Snake
  - Alter genetic relationships?
    - Some of these fish go to nearby tributaries
      - SF Tieton fish in Rattlesnake
      - NF Tieton fish in Rattlesnake
      - One-way gene flow out of Tieton basin
- Positive: opportunity for bull trout in Tieton tributaries to become adfluvial
  - Grow larger – have more offspring



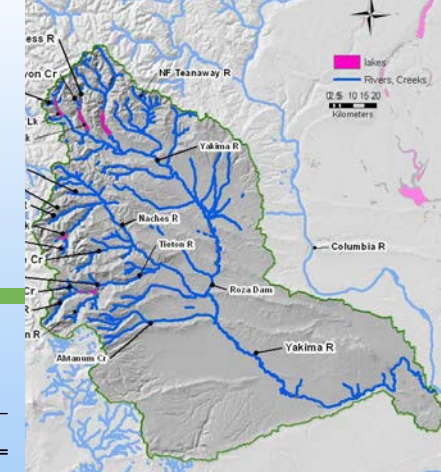
# Acknowledgements



[www.goodnaturepublishing.com](http://www.goodnaturepublishing.com)

- Thanks to all the samplers:
  - WDFW, Mike Mizelle, William Meyer, Yuki Reiss  
CWU, Yakama Nation, USFWS
- Thanks to Adrian Spidle, Judy DeLaVerne, Scott Blankenship, Anne Marshall, Todd Kassler and Ken Warheit for comments and suggestions
- Thanks to the people who post nice pictures of fish
- Funding from USFWS and WA state general funds

# Bull trout genetic statistics



	N	rich	Gene Div	LD	Ne	FIS	Pval
BoxCanyon	33	3.24	0.487	0	5.3	-0.066	0.983
Kachess	31	3.03	0.460	0 (18)	6.2	-0.062	0.958
Gold	20	4.48	0.614	1 (4)	19	0.016	0.314
NFTeanaway	10	2.15	0.268	0 (4)	2.6	0.050	0.284
American	32	4.20	0.610	2 (9)	19.2	0.027	0.167
Union	20	4.49	0.621	0 (8)	19.2	0.079	0.011
Rattlesnake	49	4.67	0.635	1 (7)	33	0.013	0.273
Crow	32	4.55	0.637	2 (11)	17.1	-0.018	0.744
SFTieton	22	4.07	0.582	0 (1)	30.4	-0.004	0.538
NFTieton	9	3.44	0.507	0 (4)	14.5	0.054	0.218
Indian	35	4.44	0.587	1 (5)	45.1	0.044	0.045
AhtanumJ	51	3.64	0.563	10 (52)	6.8	0.033	0.086
AhtanumAd	18	3.78	0.571	1 (8)	8.5	-0.025	0.724
Deep	31	5.06	0.662	0 (13)	32.3	0.072	0.003
avg		3.95	0.557			0.015	
SD		0.78	0.102			0.046	

Allelic richness = avg. number of alleles per locus

Gene Diversity = avg. heterozygosity per locus

LD = number of locus pairs in linkage (number in parenthesis is before Bonferroni corrections)

Ne = effective population size

FIS = Hardy-Weinberg equilibrium value – based on departures from expected heterozygosity

# Unknown fish assignment tests

## Baseline populations

Collection site	BoxCanyon	Kachess	Gold	NFTeanaway	AmUnion	Rattlesnake	Crow	SFTieton	NFTieton	Indian	Ahtanum	Deep
Kettle					3							
UBumpPool												1
LBumpPool					2							
KachessPool		1										
RozaDam					1					1		
WDFWsecondary		1	1									
07KachessAdult	1	2										
TietonPool					6	7		11	2	17		
NachesAdult					19	1	2					

