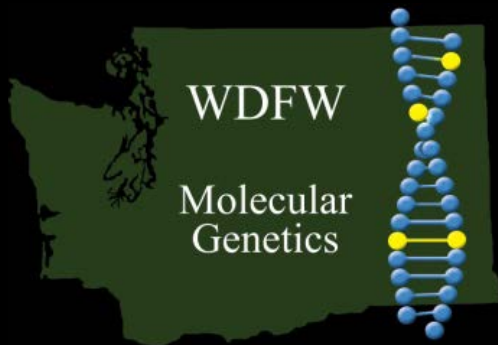


# DNA-Based Pedigree Analysis of Chinook Salmon from the Yakima River

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## Background

- Joint project between WA Department of Fish and Wildlife (WDFW) and Yakama Nation (YN)
- Project objective is to assess the relative reproductive success of Chinook in the upper Yakima River
- Collection of hatchery-origin adult males and females, jacks, and precocious male Chinook occurred at Roza Dam from 2003 – 2006
- Collection of both hatchery- and natural-origin Chinook has occurred from 2007 - present
- Genetic analysis using microsatellite DNA loci is used to determine parentage. Methodology used for the analysis is the same as we have used for the Cle Elum spawning channel

## Laboratory Methods

- DNA was extracted from fin tissue
- PCR amplification was performed using microsatellite loci
- Amplified products were run through an ABI-3730 Genetic Analyzer
- Electropherograms were scored using GENEMAPPER software v.3.7
- Data was binned using GAPS allele naming

# Laboratory Methods



## Locus Data

Locus	N Alleles	N parents Genotyped	H <sub>o</sub>	H <sub>e</sub>	Excl (1)	Excl (2)
Ogo-2	11	2,186	0.825	0.821	0.475	0.648
Ogo-4	11	2,188	0.801	0.806	0.456	0.632
Oki-100	26	2,117	0.919	0.904	0.682	0.811
Omm-1080	44	2,162	0.937	0.961	0.852	0.920
Ots-201b	29	2,118	0.915	0.904	0.679	0.809
Ots-208b	29	2,115	0.930	0.941	0.787	0.880
Ots-211	28	2,123	0.930	0.931	0.757	0.861
Ots-212	24	2,182	0.887	0.887	0.631	0.774
Ots-213	29	2,185	0.921	0.936	0.769	0.869
Ots-3M	9	2,185	0.652	0.651	0.254	0.435
Ots-9	6	2,186	0.678	0.656	0.237	0.400
Ots-G474	13	2,190	0.362	0.367	0.072	0.211
Ssa-197	25	2,180	0.902	0.906	0.683	0.812
Ssa-408	27	2,160	0.728	0.916	0.709	0.830

Excl (1) = Exclusionary ability of the locus when neither parent is known

Excl (2) = Exclusionary ability of the locus when one parent is known

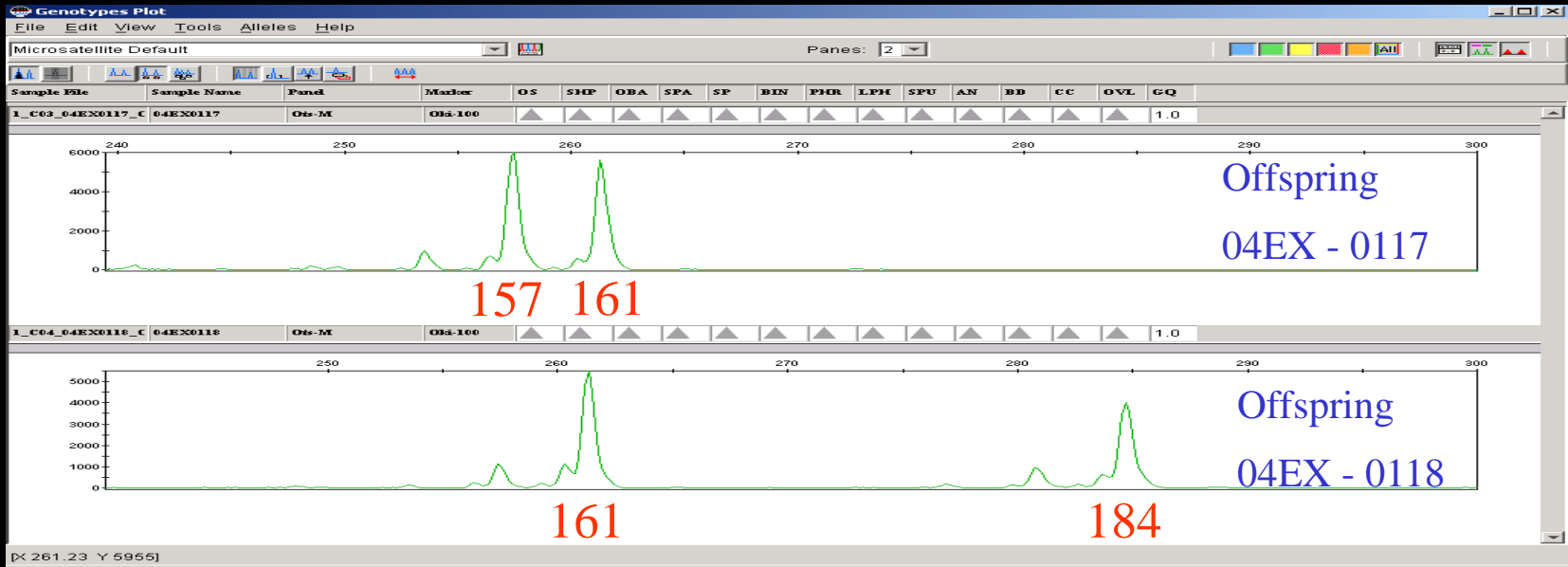
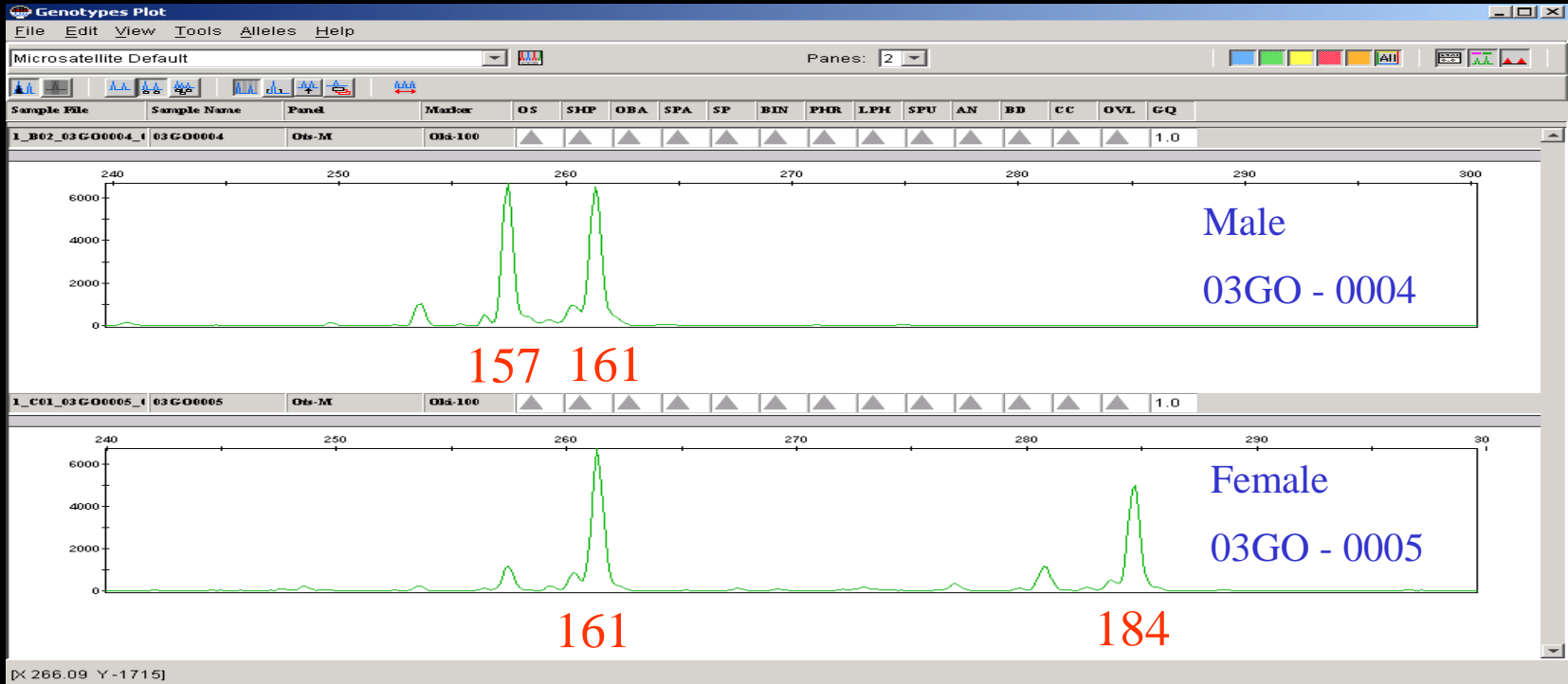
# Evaluation of Parentage Assignments

- Maximum likelihood parentage assignments performed with the program CERVUS 3.0
- Assignments for offspring were calculated for the most likely male and female parent pair. The parent pair assignment with two mismatches or less was accepted
- Individuals that did not assign to a parent pair were then analyzed for a female parent only and male parent only (assignments with zero or one mismatches were accepted)

## Causes of Mismatching

- Germ-line mutation – a parent passes a changed allele to their offspring (sequence or allele changes during replication)
- PCR error (or process error) – error introduced by poor amplification from lower quality DNA extracts
- Genotyping error – inadvertent human error and computer software error in scoring due to multiple peaks being selected

# Electropherogram – Oki-100





## Mismatching

	Oki-100	Ots-3M	Ots-213
Female – 1	100/100	100/100	100/100
Female – 2	200/200	200/200	200/200
Male – 1	120/120	120/120	120/120
Male – 2	240/240	240/240	240/240
Offspring – 1	100/120	100/120	100/120
Offspring – 2	200/240	200/240	200/240
Offspring – 3	100/120	100/120	100/240

# Chinook Adults 2003 and 2004 -

## 2003

- 2,201 – Hatchery-origin Chinook collected and analyzed  
(includes 368 jacks and 39 precocial males)
  - 0 – Natural-origin Chinook collected and analyzed
- 

- 1,151 – Hatchery-origin adult Chinook counted at Roza Dam
  - 1,133 – Hatchery-origin jacks Chinook counted at Roza Dam  
2,284
  - 784 – Natural-origin adults Chinook counted at Roza Dam
  - 774 – Natural-origin jacks Chinook counted at Roza Dam
- 

## 2004

- 2,542 / 2,160 – Hatchery-origin Chinook collected / analyzed  
(includes 20 jacks and 7 precocial males) 382 samples left to analyze
  - 0 – Natural-origin Chinook collected and analyzed
- 

- 2,985 – Hatchery-origin adult Chinook counted at Roza Dam
- 216 – Hatchery-origin jacks Chinook counted at Roza Dam  
3,201
- 7,093 – Natural-origin adults Chinook counted at Roza Dam
- 711 – Natural-origin jacks Chinook counted at Roza Dam

**Expected proportion -  
Hatchery- and Natural-origin Chinook counts 2003**

- **2,284 – Hatchery-origin Chinook counted at Roza**
  - **1,558 / 1,086 – Natural-origin Chinook counted at Roza**  
**(472 – Natural-origin Chinook brood)**
  - **$2,284 / 3,370 = 0.6777 - P$  ;  $1,086 / 3,370 = 0.3223 - Q$**
- 
- **45.9% Hatchery-origin (H X H) –  $P^2$**
  - **43.7% Hatchery & Natural-origin (H X N & N X H) –  $2PQ$**
  - **10.4% Natural-origin (N X N) -  $Q^2$**

**Expected proportion -  
Hatchery- and Natural-origin Chinook counts in 2004**

- **3,201 – Hatchery-origin Chinook count at Roza Dam**
  - **7,804 / 7,322 – Natural-origin Chinook count at Roza Dam  
(482 – Natural-origin Chinook brood)**
  - **$3,201 / 10,523 = 0.3042 - P$  ;  $7,322 / 10,523 = 0.6958 - Q$**
- 
- **9.3% Hatchery-origin (H X H) –  $P^2$**
  - **42.3% Hatchery & Natural-origin (H X N & N X H) –  $2PQ$**
  - **48.4% Natural-origin (N X N) -  $Q^2$**

## Observed returns 2007 - Hatchery- and Natural-origin Chinook

- **229 / 1,153** offspring were assigned parental pair  
Hatchery X Hatchery (**19.9%**)
- **443 / 1,153** offspring were assigned a mother only  
Hatchery X Natural (**38.4%**)
- **163 / 1,153** offspring were assigned a father only  
Natural X Hatchery (**14.1%**)
- **318 / 1,153** offspring did not assign a mother or father  
Natural X Natural (**27.6%**)

**Observed returns 2008 -  
Hatchery- and Natural-origin Chinook**

- **21 / 799 offspring were assigned parental pair  
Hatchery X Hatchery (2.6%)**
- **67 / 799 offspring were assigned a mother only  
Hatchery X Natural (8.4%)**
- **60 / 799 offspring were assigned a father only  
Natural X Hatchery (7.5%)**
- **??? / 799 offspring did not assign a mother or father  
Natural X Natural (?..??%)**

# Comparison of Expected and Observed Percentages of Hatchery and Natural-Origin Chinook

2003 / 2007	Expected	Observed
H X H	45.9%	19.9%
H X N & N X H	43.7%	52.5%
N X N	10.4%	27.6%

Contingency table X<sup>2</sup> test p-value = 0.000

2004 / 2008	Expected	Observed
H X H	9.3%	2.6%
H X N & N X H	42.3%	16.0%
N X N	48.4%	81.4%

# Conclusions

- The number of observed natural-origin Chinook is higher than expected while the number of observed hatchery-origin Chinook is lower than expected in the 2003 / 2007 collections
- More hatchery-origin females assigned as a parent than hatchery-origin Males in the 2003 / 2007 collections
- Results from the 2004 / 2008 collections incomplete without the analysis of the remaining hatchery-origin parents (# of N X N likely inflated)
- Number of natural-origin adults returning in 2004 was 10X greater than 2003



## Future Work

- Statistical analyses using COLONY to error check the number of natural origin parents from the 2003 and 2004 collection years
- Completion of the 2004 adults and 2008 offspring
- Analysis of the third generation - 2011 returning 4 yr olds
- Estimation of impacts (potential bias) from fisheries harvest

## Acknowledgements

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