

Population Productivity of Spring Chinook Salmon Reintroduced above Foster Dam on the South Santiam River

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South Santiam Spring Chinook Salmon

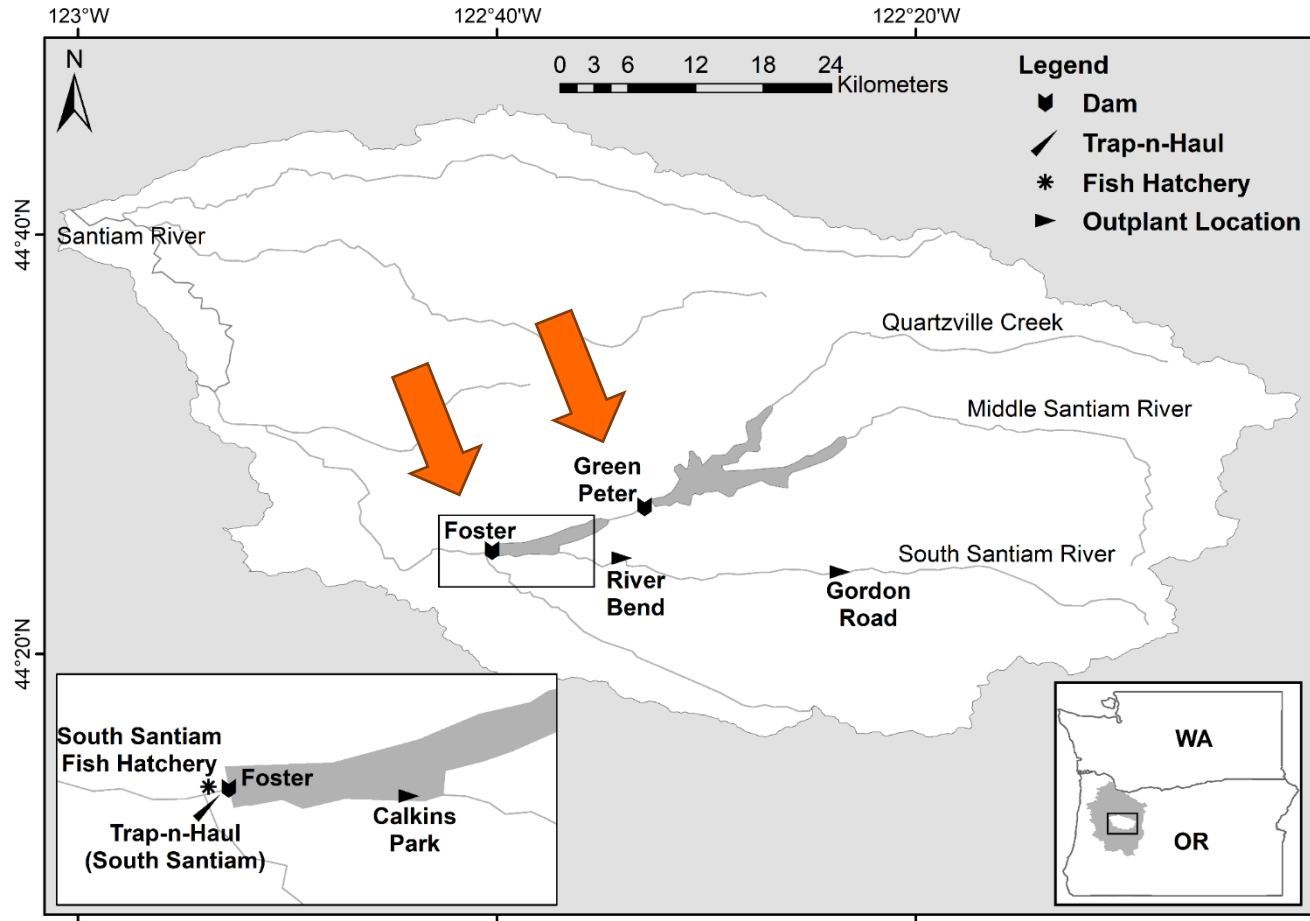
- Upper Willamette River ESU

Threatened

- Barriers to dispersal

Foster Dam

Green Peter Dam



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Foster Dam

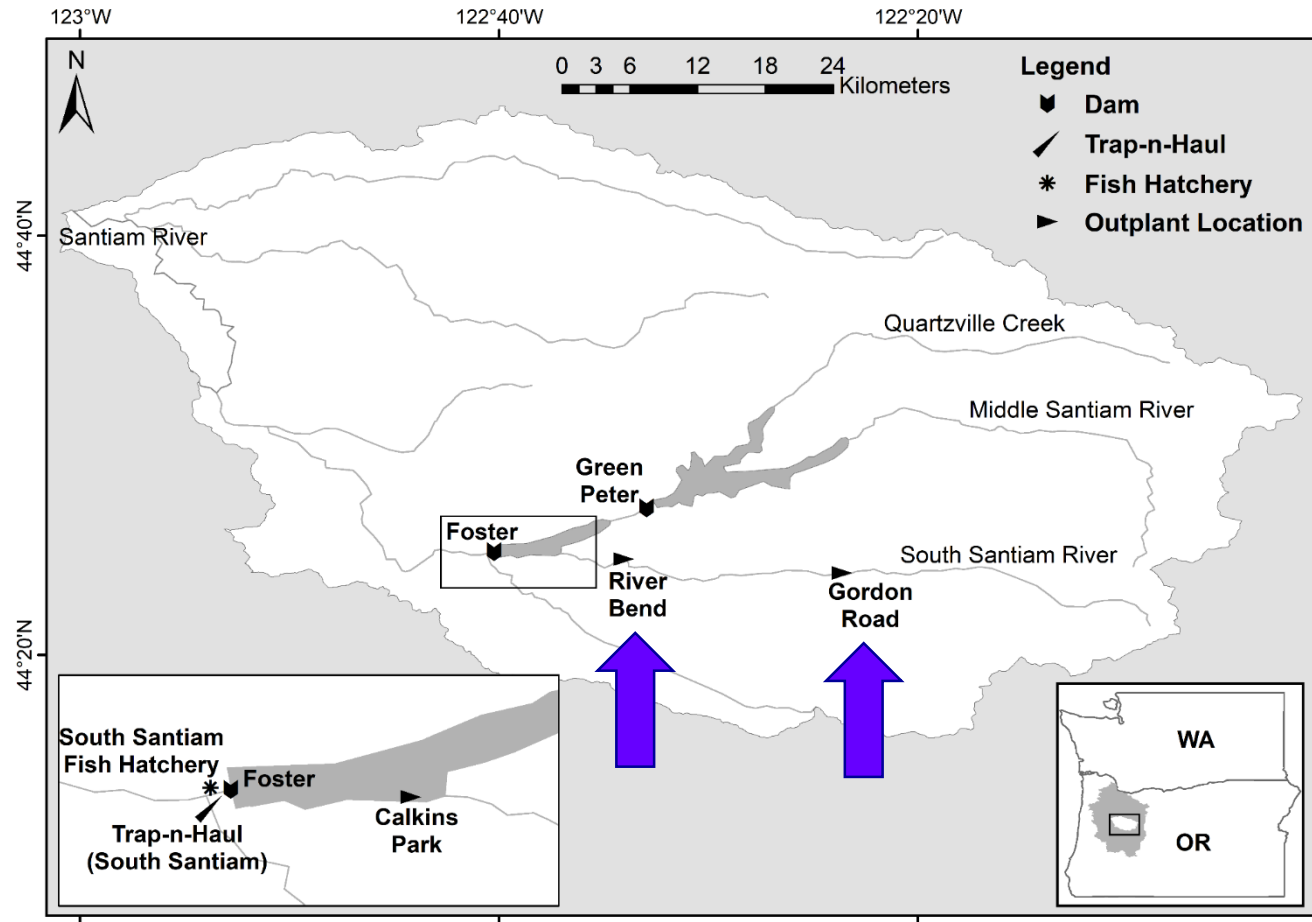
Green Peter Dam

- Outplanting began in 1996

Hatchery-origin (HOR)

- Since 2009, release only

Natural-origin (NOR)



South Santiam Genetic Pedigree

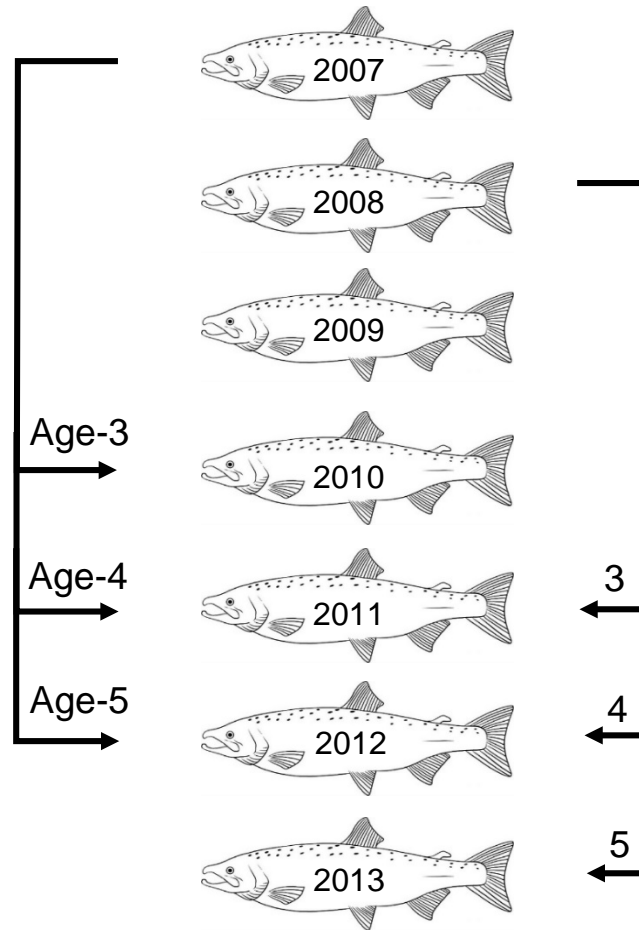
Starting in 2007,
a fin clip for
genetic analysis



South Santiam Genetic Pedigree

O'Malley et al. (2014)

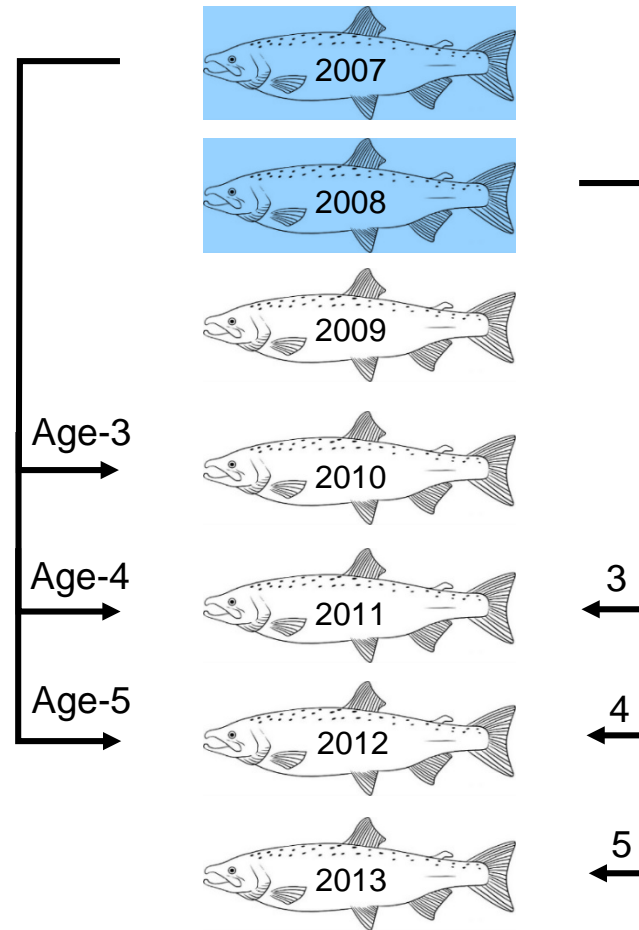
Identify parent-offspring relationships



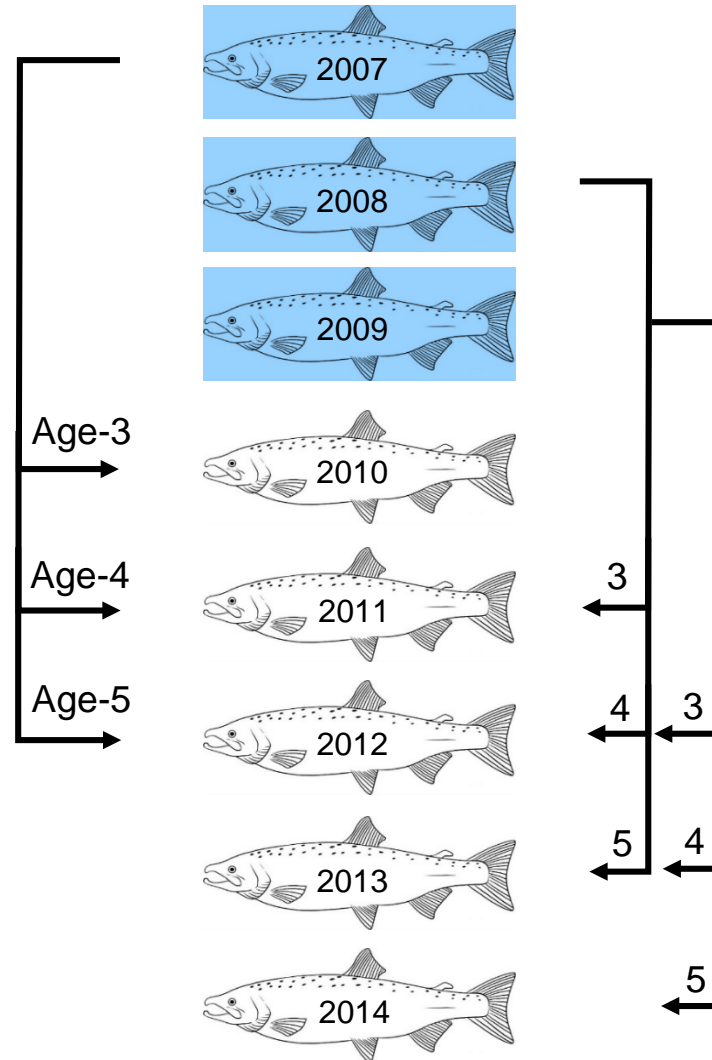
South Santiam Genetic Pedigree

O'Malley et al. (2014)

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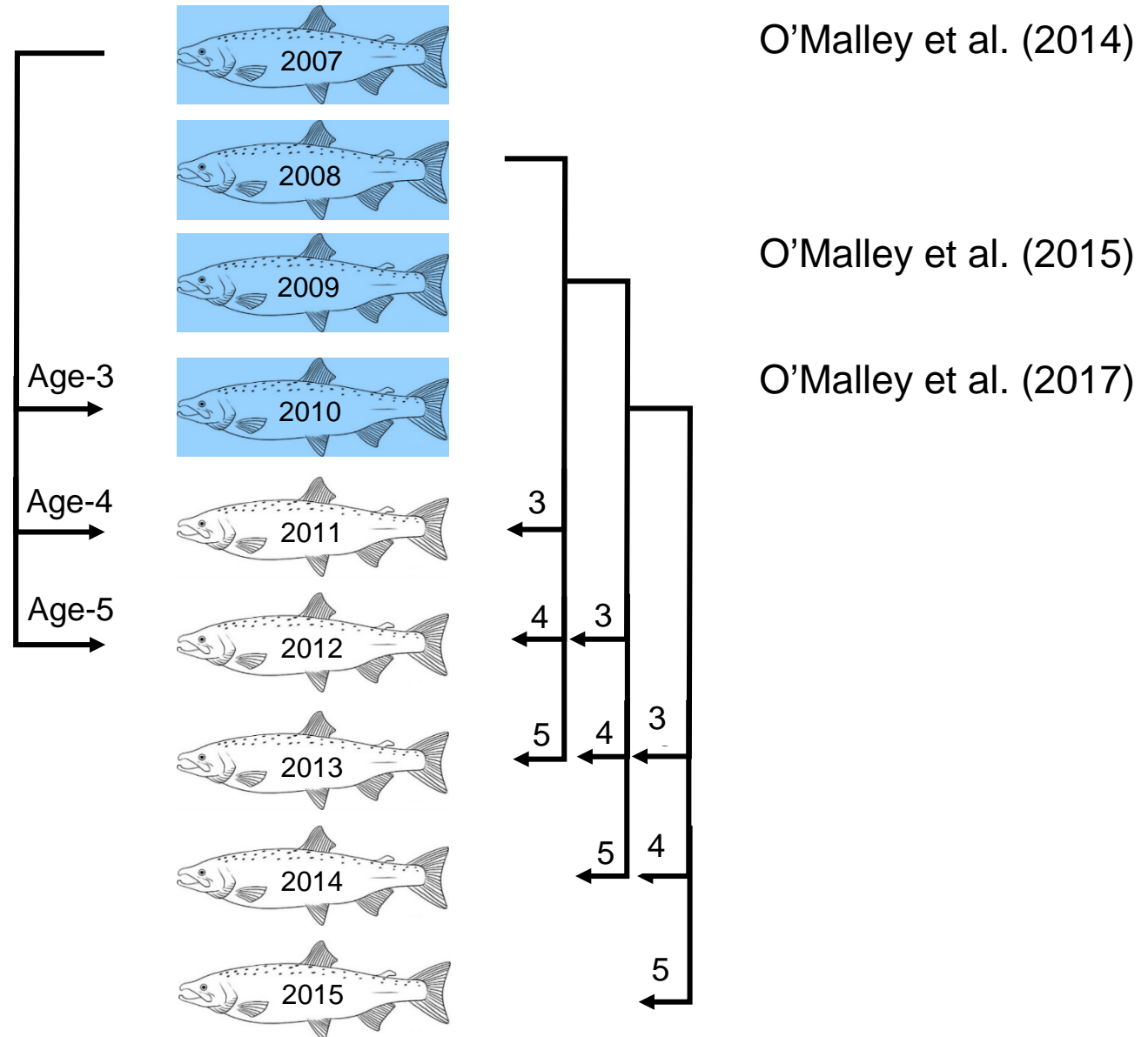
South Santiam Genetic Pedigree



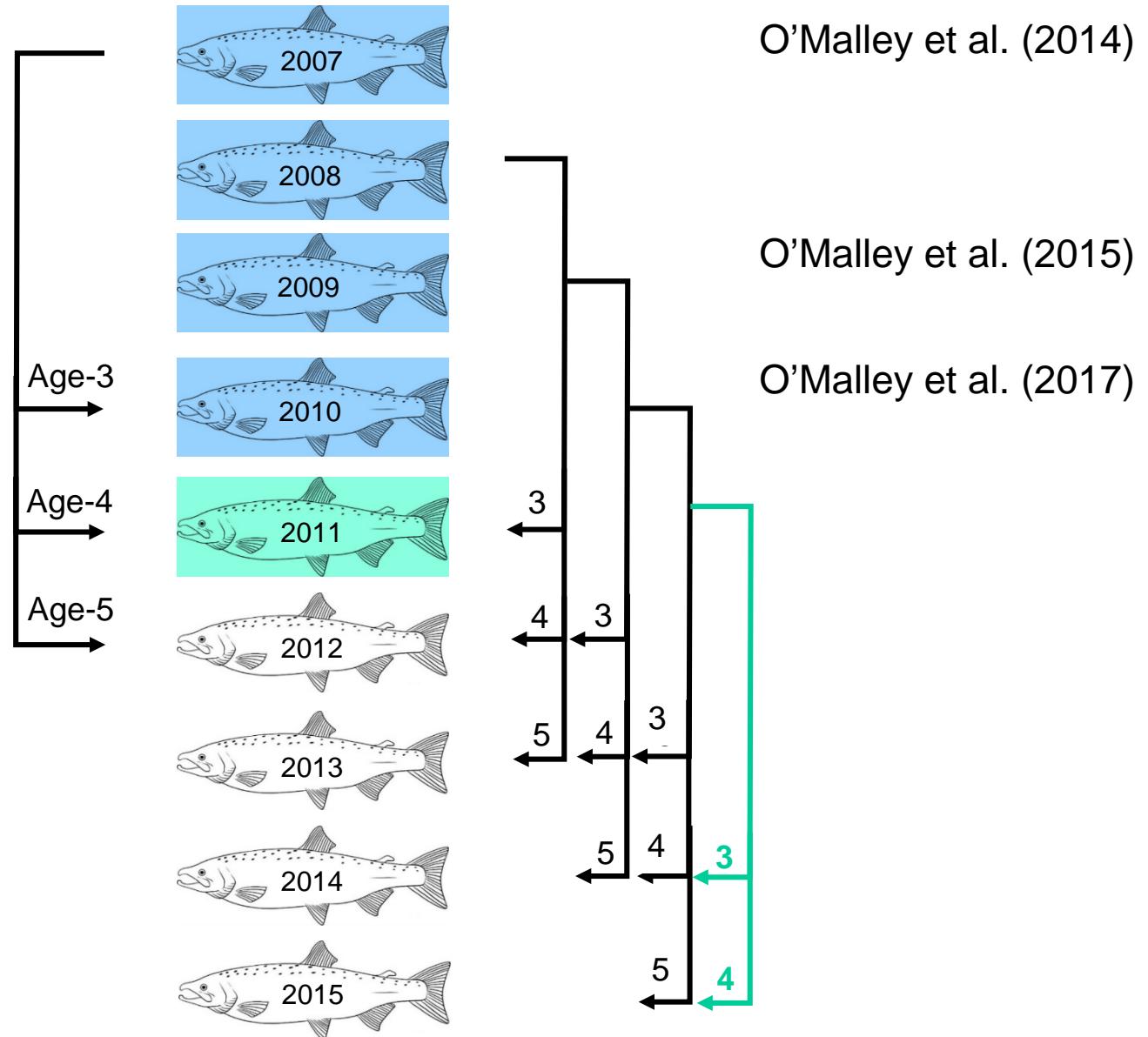
O'Malley et al. (2014)

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South Santiam Genetic Pedigree



South Santiam Genetic Pedigree



Objectives

- Assign the 2015 returning adult offspring (live/carcass) to putative parents
 - reintroduced above Foster Dam in 2010 and 2011
 - or sampled as carcasses below Foster Dam in 2011
- Estimate female cohort replacement rate (CRR) for salmon reintroduced in 2010
- Estimate the fitness of salmon reintroduced above Foster Dam in
 - 2010 (total lifetime fitness: age-3, age-4, and age-5 progeny)
 - 2011 (preliminary fitness: age-3 and age-4 progeny only)
- Estimate the fitness of salmon below Foster Dam (carcass samples) in
 - 2011 (preliminary fitness: age-3 and age-4 progeny only)

Spring Chinook Genetic Pedigree Samples

Above Foster Dam



	Year	N
Parent	2010	700
Parent	2011	1202
Offspring	2013	940
Offspring	2014	411
Offspring	2015	598

Below Foster Dam



	Year	N
Parent	2010	NA
Parent	2011	66
Offspring	2013	80
Offspring	2014	87
Offspring	2015	79

Spring Chinook Genetic Pedigree Samples

Above Foster Dam

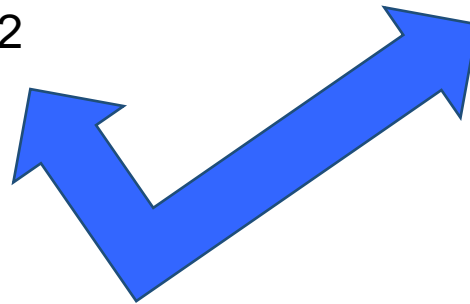


Below Foster Dam



	Year	N
Parent	2010	700
Parent	2011	1202
Offspring	2015	598

	Year	N
Parent	2010	NA
Parent	2011	66
Offspring	2015	79



Spring Chinook Genetic Pedigree Samples

Above Foster Dam

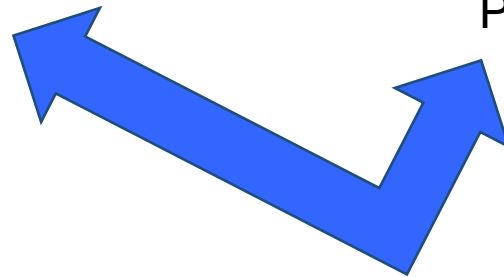


Below Foster Dam



	Year	N
Parent	2010	700
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Offspring	2015	598

	Year	N
Parent	2010	NA
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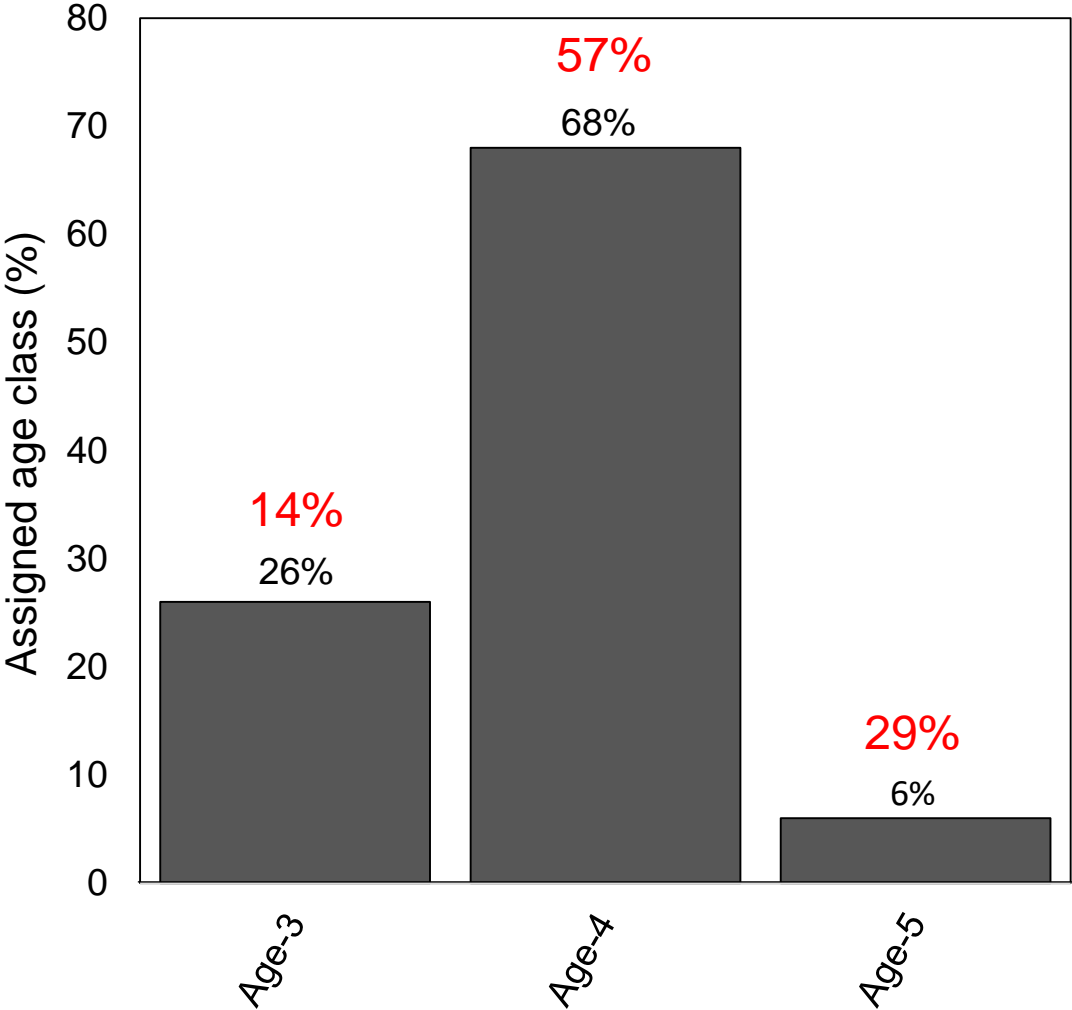
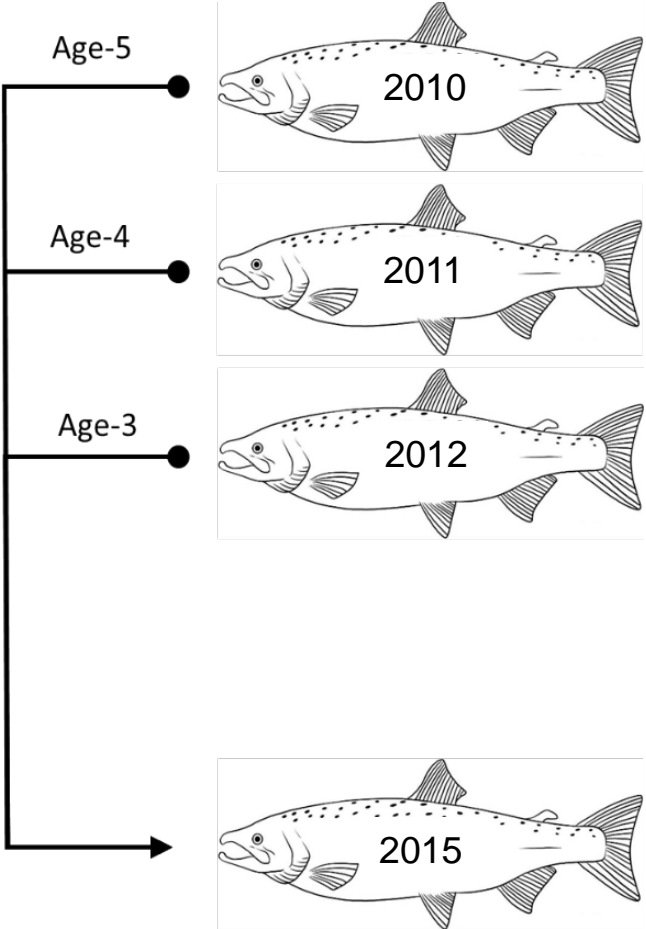


Results: Assignment Rates

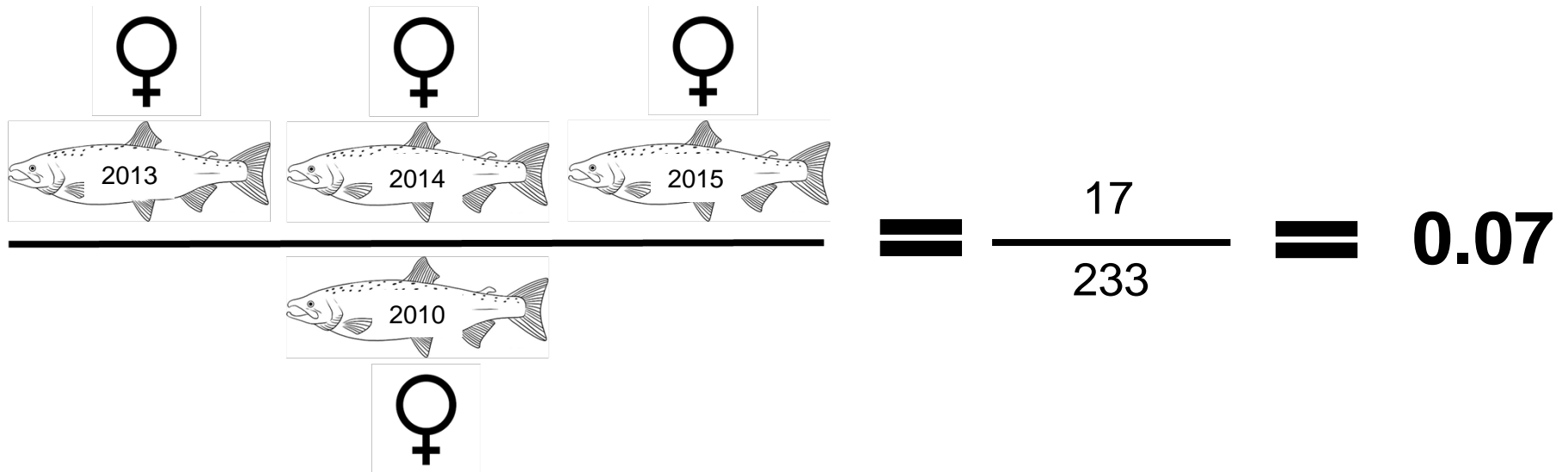
- 20% (138/677) of the 2015 adult returns assigned to parents
 - 89% (123/138) to salmon reintroduced above Foster in 2010 and 2011
 - 11% (15/138) to carcasses sampled below Foster in 2011



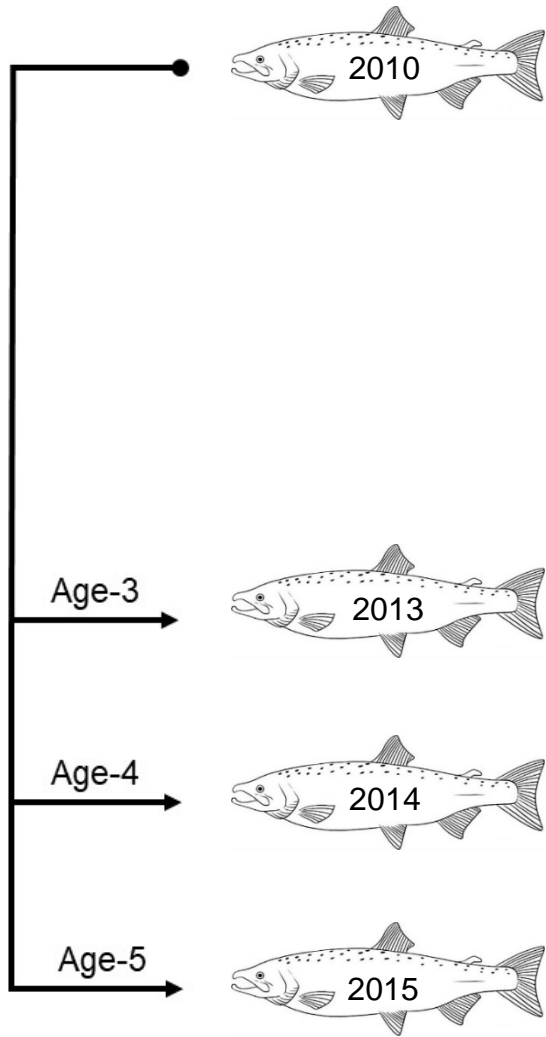
Results: Age Structure of the 2015 Returns



Results: Female Replacement Rate for the 2010 Cohort



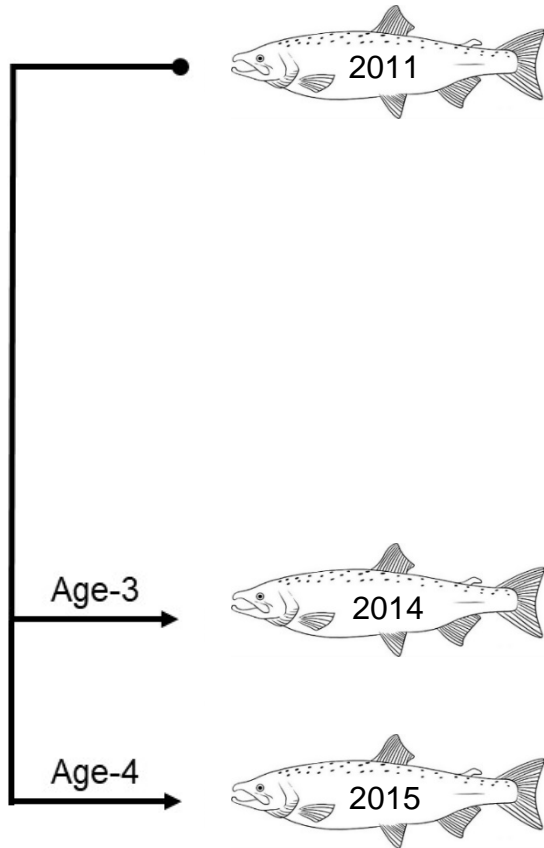
Results: Total Lifetime Fitness of Salmon Reintroduced in 2010



- Only 9% (63/700) produced at least one adult return to the South Santiam River during 2013-2015

Year	Sex	N	Mean	SD	Range
2010	M	467	0.10	0.43	0 - 3
	F	233	0.19	0.63	0 - 5

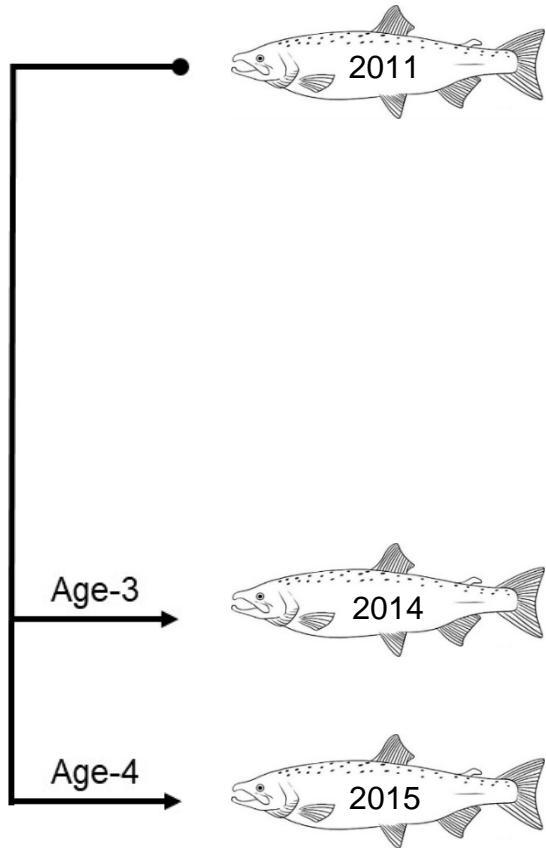
Results: Preliminary Fitness of Salmon Reintroduced in 2011



- Only 7% (90/1202) produced at least one adult return to the South Santiam River during 2013-2015

Year	Sex	N	Mean	SD	Range
2011	M	676	0.13	0.66	0 - 9
	F	526	0.16	0.81	0 - 11

Results: Preliminary Fitness of Salmon Below Foster Dam in 2011



- 17% (11/66) produced at least one adult return to the South Santiam River in 2014 and 2015

Year	Sex	N	Mean	SD	Range
2011	M	27	0.29	0.60	0 - 2
	F	39	0.20	0.69	0 - 4

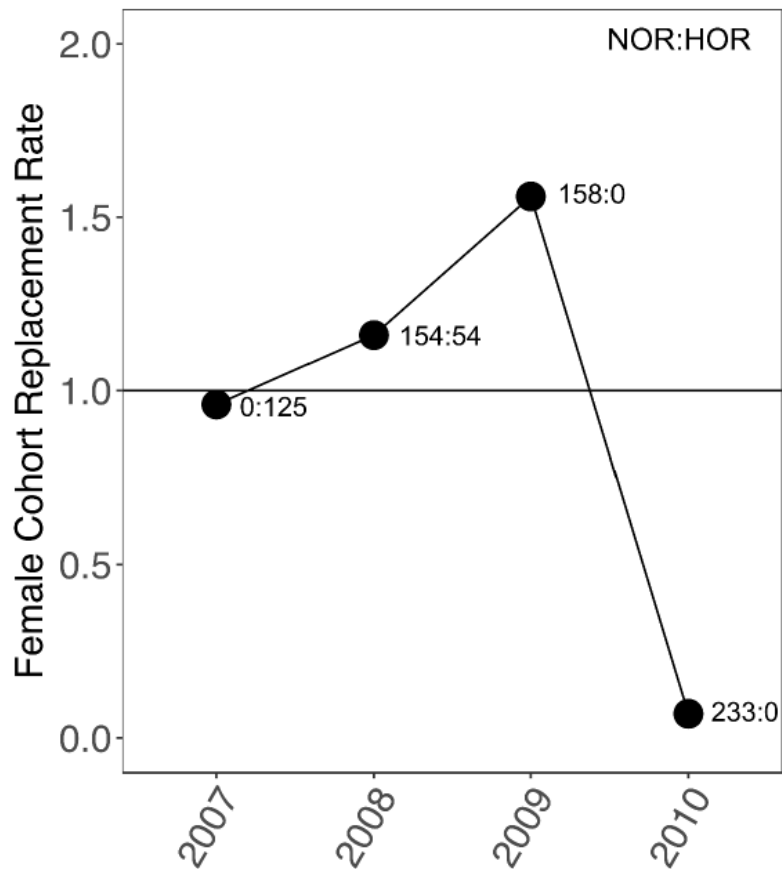


Summary and Discussion

- In 2015, 20% (138/677) of the adult salmon assigned as offspring compared to 44% (171/390) of the adult returns that assigned in 2014
 - Unassigned salmon could be offspring of salmon that spawned below Foster Dam in 2010 and 2011
- In 2015, only 6% of the returns were age-5 (i.e. offspring of 2010 parents) opposed to the expected 29% within the sub-basin
 - Provides support of an above-dam 2010 brood failure due to a high water event

Summary and Discussion

- The 2010 female cohort replacement rate was 0.07



Summary and Discussion

- TLF estimates for salmon reintroduced in 2010 were low with only 9% of reintroduced salmon producing ≥ 1 adult return to the South Santiam River in 2013-2015
 - In contrast, 48% of reintroduced salmon in 2009 produced ≥ 1 adult return
 - Decreased trap efficiency in 2014 and 2015 may have resulted in a lower sampling rate of adult offspring from previously reintroduced salmon

Future Research

- Disentangle environment (e.g. flood events) from origin (NOR vs. HOR) effects on the productivity of salmon reintroduced above Foster Dam
 - Only 4 data points:

Year	Releases (NOR/HOR)	Genotyped	M:F	Female CRR
2007	18/385	252	1:1	0.96
2008	163/527	659	2:1	1.16
2009	434/0	412	1.6:1	1.55
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2011	1202/0	1202	1.2:1	?

- Preliminary fitness estimates for salmon reintroduced in 2011 are low

Future Research

- In 2011, only 7% (90/1202) of reintroduced salmon produced age-3 or age-4 adult offspring
 - In comparison, 8% (58/700) of reintroduced salmon in 2010 produced age-3 or age-4 adult offspring
 - Possible reduced trap efficiency in 2014 and 2015 contributed to downwardly biased fitness estimates
- Additional years of pedigree analysis are needed to test this hypothesis and determine if trap modifications or operations at Foster Dam have resulted in increased sampling of adult offspring

Acknowledgements



**US Army Corps
of Engineers®**

- Rich Piaskowski, USACE
- Cameron Sharpe, ODFW
- ODFW field staff



Ecosystem Indicators	Year																			
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PDO (Sum Dec-March)	17	6	3	12	7	19	11	15	13	9	5	1	14	4	2	8	10	20	18	16
PDO (Sum May-Sept)	10	4	6	5	11	16	15	17	12	13	2	9	7	3	1	8	18	20	19	14
ONI (Average Jan-June)	19	1	1	6	13	15	14	16	8	11	3	10	17	4	5	7	9	18	20	12
46050 SST (°C; May-Sept)	16	9	3	4	1	8	20	15	5	17	2	10	7	11	12	13	14	19	18	6
Upper 20 m T (°C; Nov-Mar)	19	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2	20	18	17
Upper 20 m T (°C; May-Sept)	16	12	14	4	1	3	20	18	7	8	2	5	13	10	6	17	19	9	15	11
Deep temperature (°C; May-Sept)	20	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	19	18	13	17
Deep salinity (May-Sept)	19	3	9	4	5	16	17	10	7	1	2	14	18	13	12	11	20	15	8	6
Copepod richness anom. (no. species; May-Sept)	18	2	1	7	6	13	12	17	15	10	8	9	16	4	5	3	11	19	20	14
N. copepod biomass anom. (mg C m ⁻³ ; May-Sept)	18	13	9	10	3	15	12	19	14	11	6	8	7	1	2	4	5	16	20	17
S. copepod biomass anom. (mg C m ⁻³ ; May-Sept)	20	2	5	4	3	13	14	19	12	10	1	7	15	9	8	6	11	17	18	16
Biological transition (day of year)	17	8	5	7	9	14	13	18	12	2	1	3	15	6	10	4	11	20	20	16
Ichthyoplankton biomass (log (mg C 1000 m ⁻³); Jan-Mar)	20	11	3	7	9	18	17	13	16	15	2	12	4	14	10	8	19	5	6	1
Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	9	13	1	6	4	10	18	16	3	12	2	14	15	11	5	7	8	17	20	19
Chinook salmon juvenile catches (no. km ⁻¹ ; June)	18	4	5	15	8	12	16	19	11	9	1	6	7	14	3	2	10	13	17	20
Coho salmon juvenile catches (no. km ⁻¹ ; June)	18	7	12	5	6	2	15	19	16	4	3	9	10	14	17	1	11	8	13	20
Mean of ranks	17.1	7.0	5.8	6.9	5.8	12.4	15.1	16.2	10.9	8.9	2.7	8.3	12.2	8.2	6.5	7.6	12.3	15.9	16.4	13.9
Rank of the mean rank	20	6	2	5	2	14	16	18	11	10	1	9	12	8	4	7	13	17	19	15

Ecosystem Indicators not included in the mean of ranks or statistical analyses

Physical Spring Trans. UI based (day of year)	3	7	19	16	4	12	14	20	12	1	6	2	8	11	17	9	18	10	5	15
Physical Spring Trans. Hydrographic (day of year)	19	3	13	8	5	12	14	20	6	9	1	9	17	3	11	2	15	7	16	18
Upwelling Anomaly (April-May)	9	3	16	5	8	13	12	20	9	4	6	7	14	16	14	11	18	1	2	19
Length of Upwelling Season UI based (days)	6	2	18	11	1	13	9	20	5	3	8	3	15	17	15	14	19	10	7	12
SST NH-5 (°C; May-Sept)	9	6	5	4	1	3	20	16	10	18	2	19	11	7	14	13	15	12	17	8
Copepod Community Index (MDS axis 1 scores)	19	3	5	7	1	13	14	17	15	10	2	6	12	9	8	4	11	18	20	16
Coho Juv Catches (no. fish km ⁻¹ ; Sept)	11	2	1	4	3	6	12	14	8	9	7	15	13	5	10	NA	NA	NA	NA	NA

WFSR	Project	Dates	Reports
2014	South Santiam Genetic Pedigree	2007-2012	
2015	South Santiam Genetic Pedigree	2007-2013	O'Malley et al. (2014)
2016	South Santiam Genetic Pedigree	2007-2014	O'Malley et al. (2015)
	North Santiam Genetic Pedigree	2007-2014	O'Malley et al. (2015)
2017	North Santiam Genetic Pedigree	2007-2015	O'Malley et al. (2017)
2018	South Santiam Genetic Pedigree	2007-2015	O'Malley et al. (2017)
	Fall Creek Genetic Pedigree	2011-2015	O'Malley et al. (2017)

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