A Preliminary Assessment of Residual Hatchery Steelhead in the Hood River, OR

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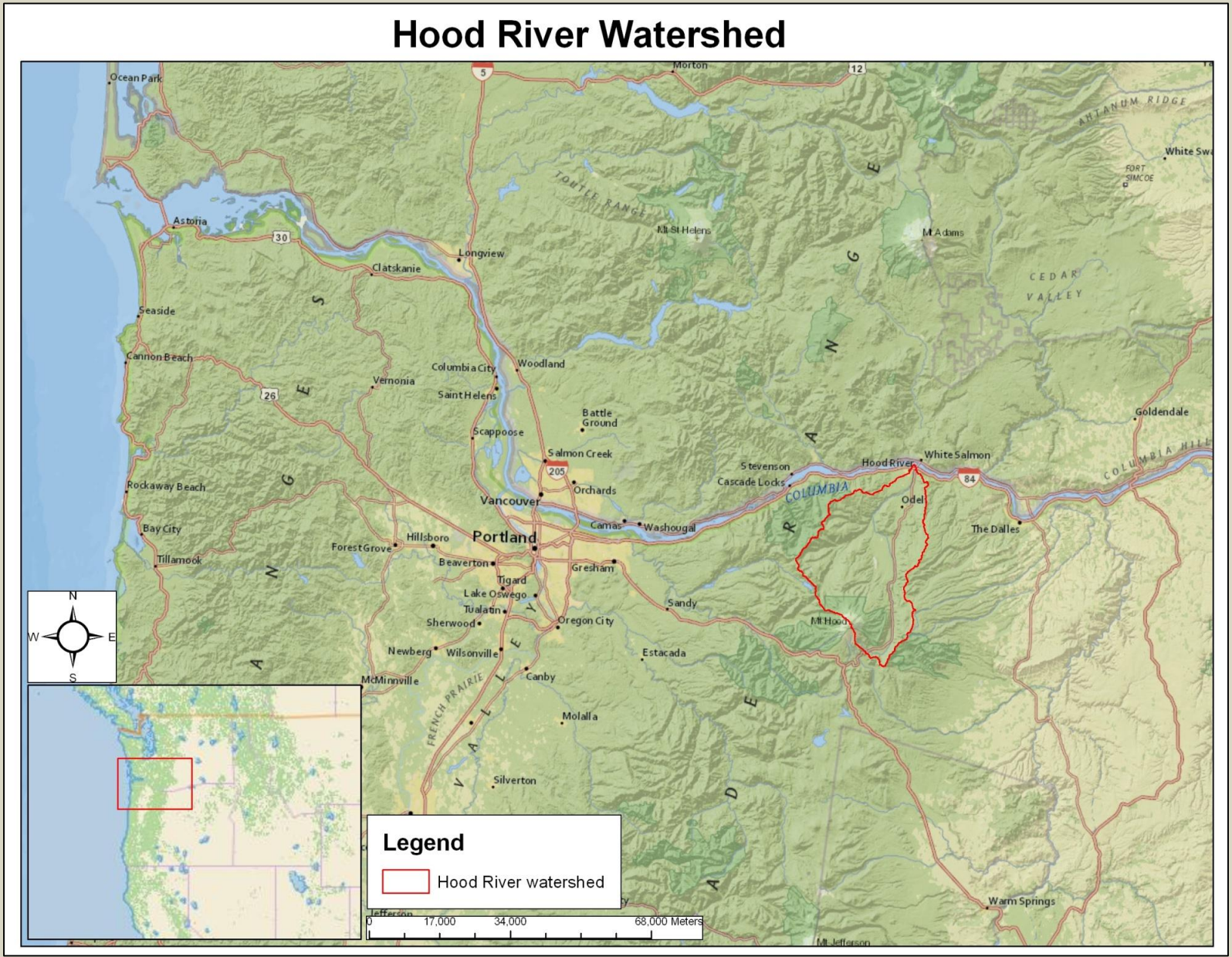
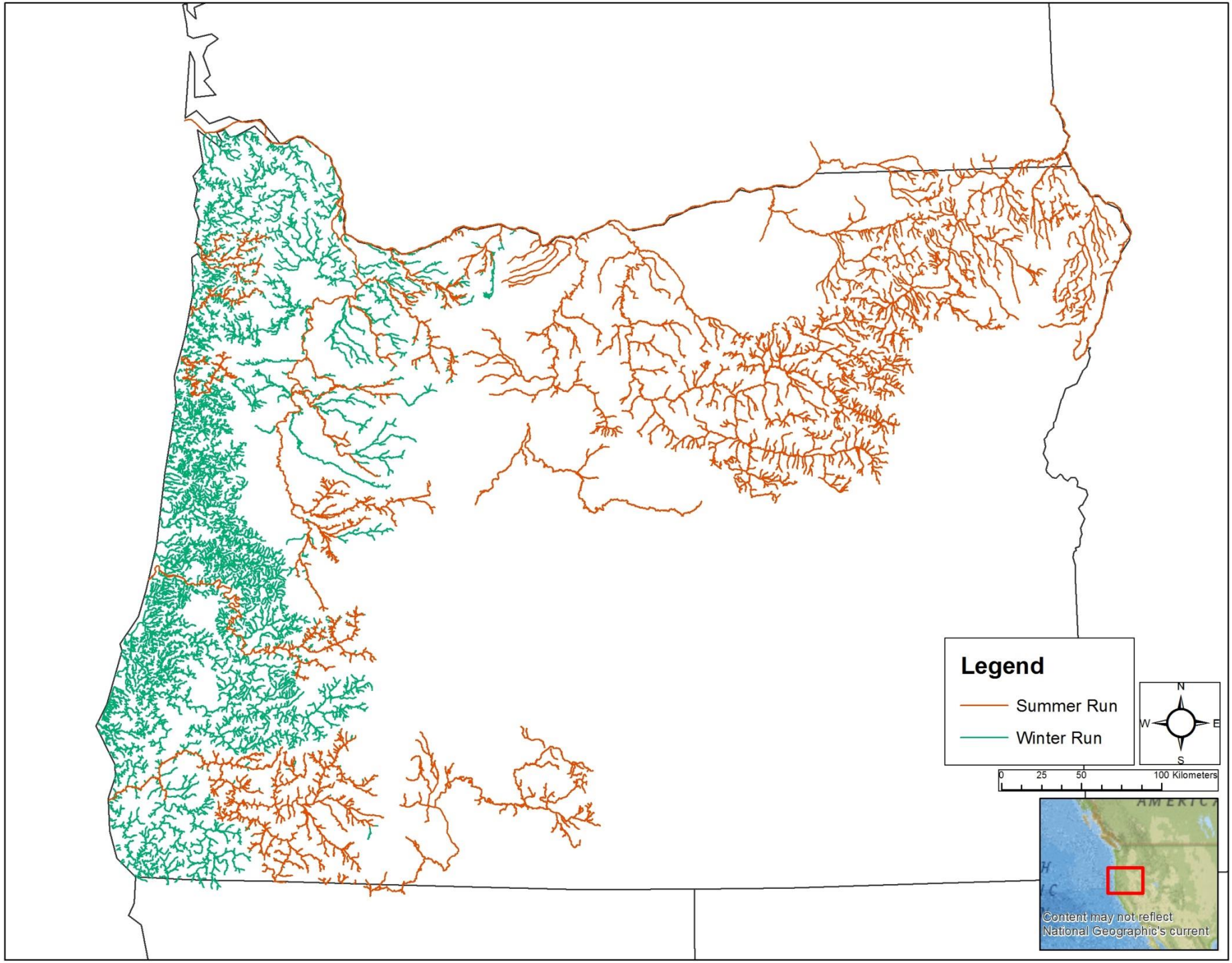
www.historichoodriver.com

OREGON
Fish & Wildlife

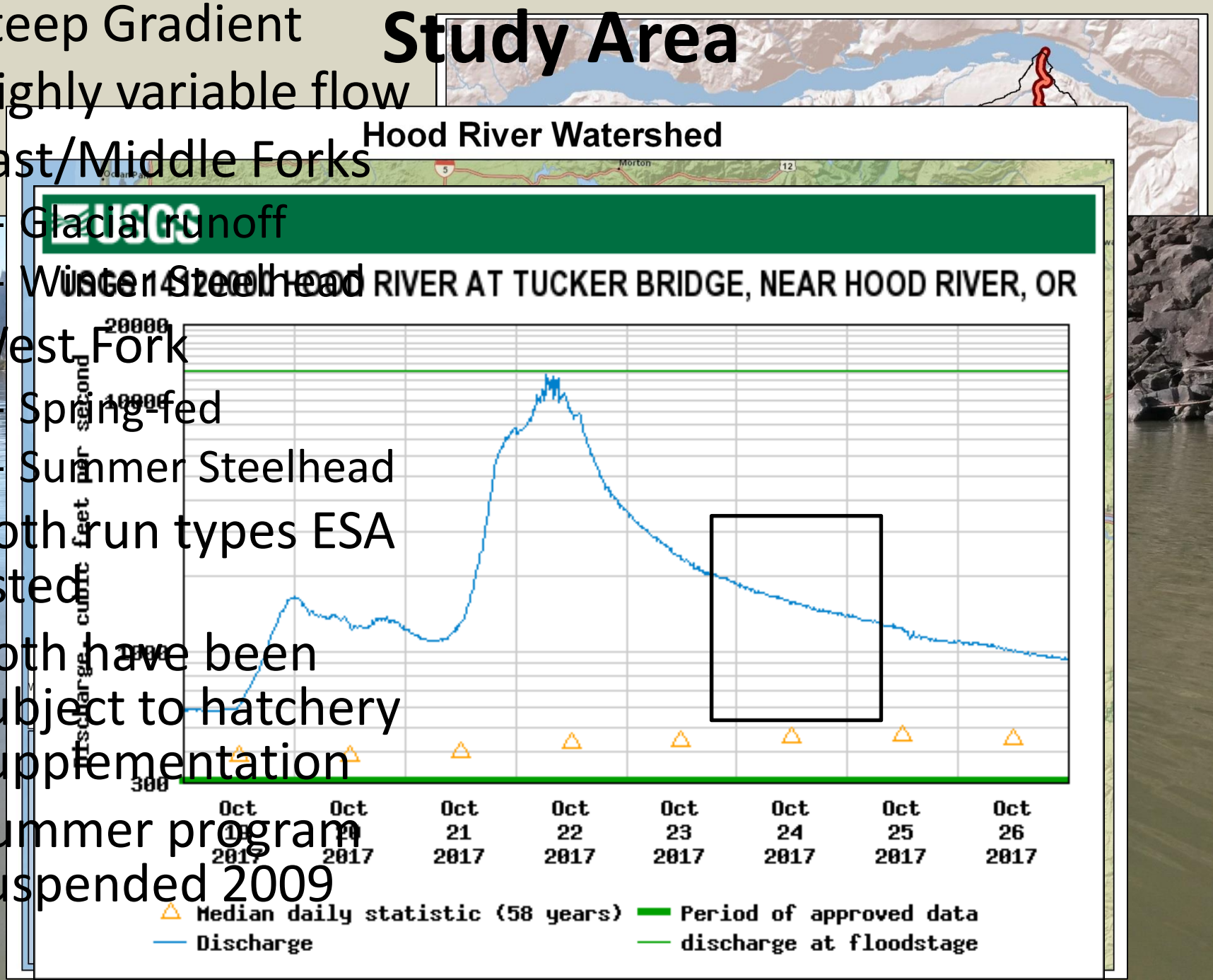
Study Area


Hood River Watershed
Ocean Park
Astoria
Morton
Longview
Clatskanie
Seaside
Cannon Beach
Columbia City
Woodland
Vernonia
Saint Helens
Battle Ground
Scappoose
Salmon Creek
Rockaway Beach
Vancouver
Orchards
Bay City
Camas
Washougal
Portland
Hillsboro
Forest Grove
Tillamook
Beaverton
Gresham
Tigard
Lake Oswego
Tualatin
Sherwood
Oregon City
Sandy
Newberg
Wilsonville
Estacada
McMinnville
Canby
Molalla
Silverton
Jefferson
Mt Jefferson
Warm Springs
Mt Hood
Odell
The Dalles
Stevenson
Cascade Locks
Hood River
White Salmon
Goldendale
Mt St Helens
Mt Adams
White Swan
FORT SIMCOE
CEDAR VALLEY
COLUMBIA HILLS
COLUMBIA
TOUTLE RANGE
ANTANUM RIDGE
COAST RANGES
CASCADE RANGE
WILLAMETTE VALLEY
FRENCH PRAIRIE
DEER
N
S
E
W
Legend
Hood River watershed
0
17,000
34,000
68,000 Meters


Legend
Summer Run
Winter Run
N
W
E
S
0 25 50 100 Kilometers
Content may not reflect
National Geographic's current

Study Area

- Steep Gradient
- Highly variable flow
- East/Middle Forks
  - Glacial runoff
  - Winter Steelhead
- West Fork
  - Spring-fed
  - Summer Steelhead
- Both run types ESA listed
- Both have been subject to hatchery supplementation
- Summer program suspended 2009



Hood River Winter Steelhead Hatchery Program

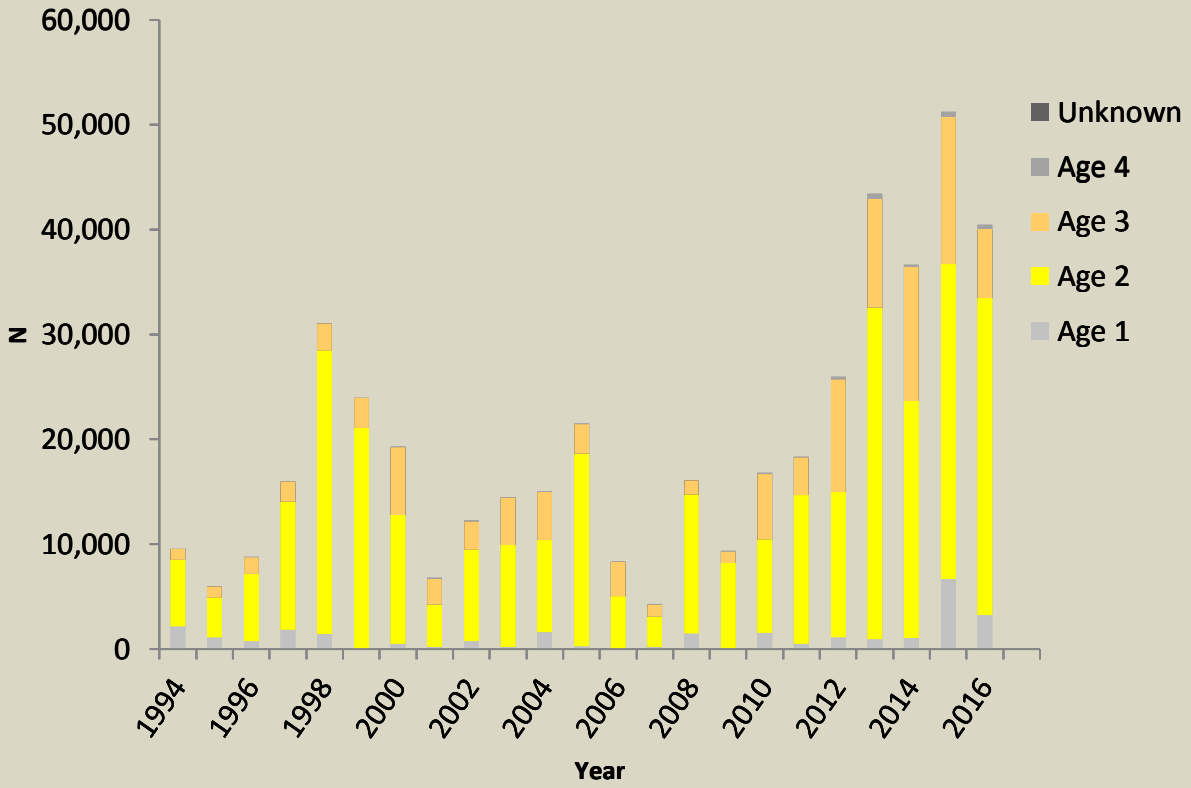
- Currently classified as an integrated program
- Mean release total (1988 – 2017) = 47,644
- Released as Age 1 Smolts
- “Volitional” release

Hatchery Smolt Life History Pathways

- Delayed migrant
  - May emigrate after additional 1-2 years in freshwater
- Smolt
  - True age 1 outmigrant
- Resident
  - Exclusive freshwater life history
  - Potentially precocial

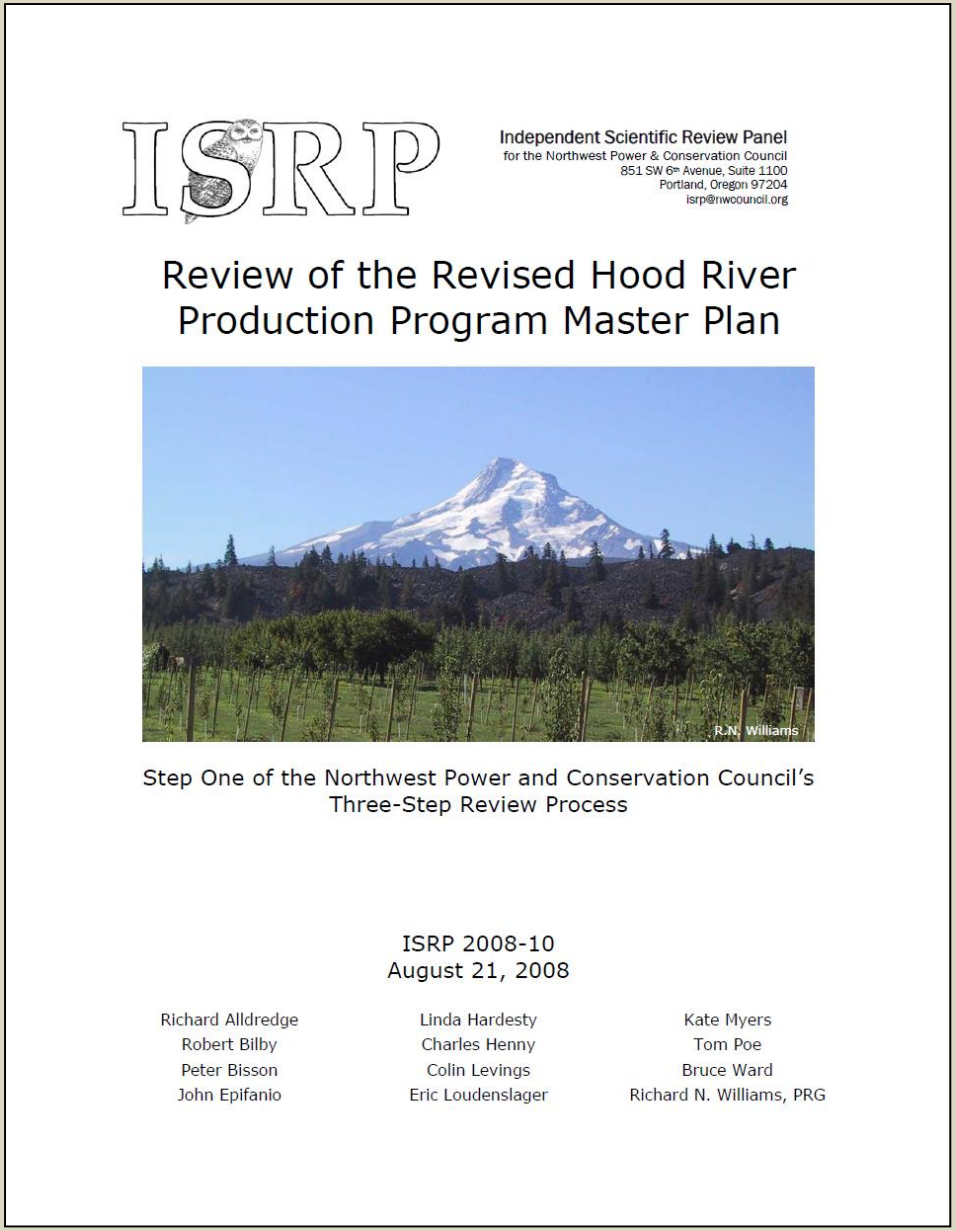
Hood River Wild Steelhead Life History

- Age 1 release strategy may not be ideal for conservation of wild populations where typical smolt age is 2-3 (Tatara et al. 2017)
- Mean age at migration (1994 – 2013), Hood River winter/summer steelhead smolts
  - Age 1: 6.3%
  - Age 2: 70.5%
  - Age 3: 22.7%
  - Age 4: 0.5%
- ≈90% migrate as age 2 or 3 (Peven et al. 1994)



Study Impetus

- ISRP Review of the Revised Hood River Production Program Master Plan (August 2008)
  - "The effect of residualized steelhead…was insufficiently addressed"
  - "…assess the extent to which residualism of hatchery steelhead is resulting in the displacement of wild fish from Hood River habitat"
- Master Plan Revision (NWPCC process)



ISRP

Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Portland, Oregon 97204
isrp@nwcouncil.org

Review of the Revised Hood River Production Program Master Plan

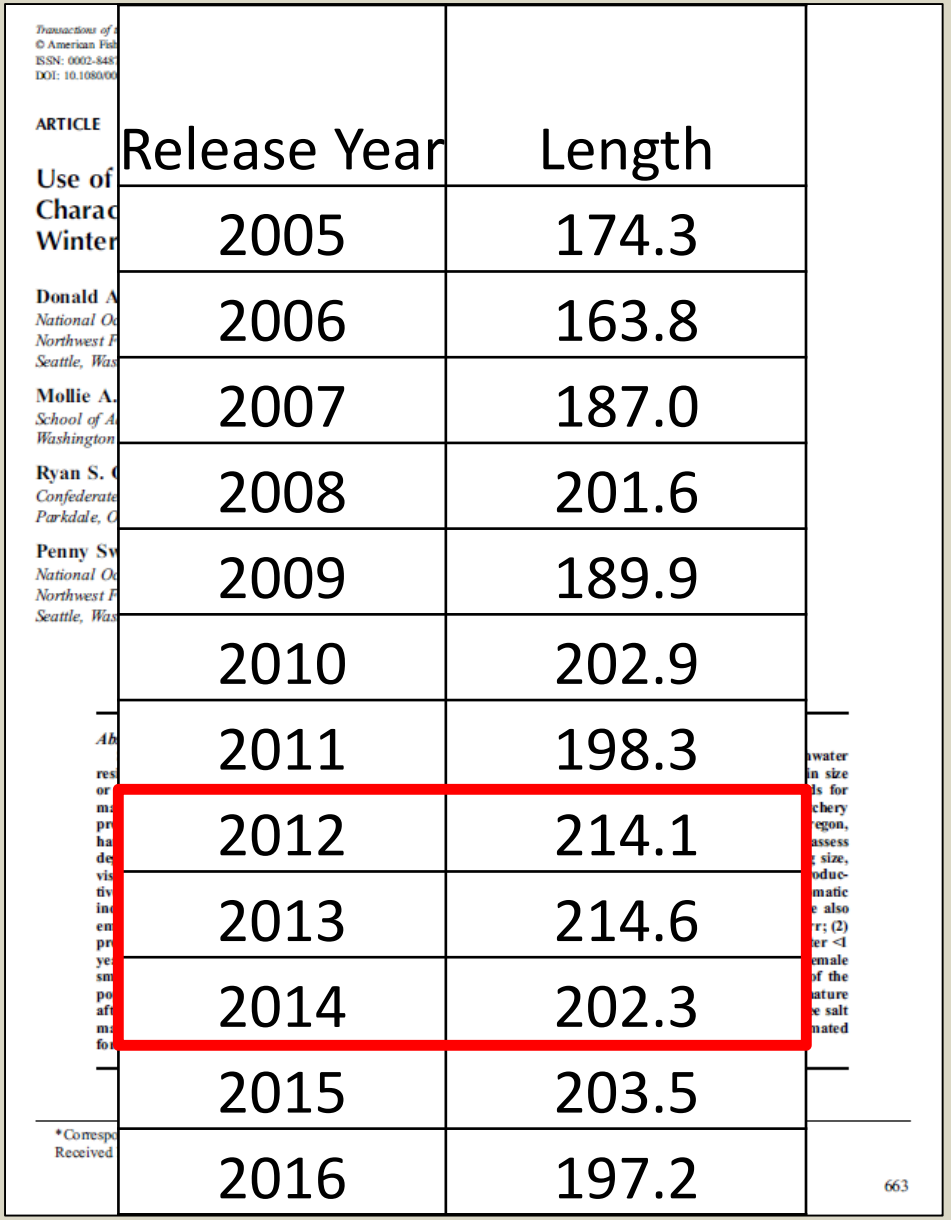
Step One of the Northwest Power and Conservation Council's Three-Step Review Process

ISRP 2008-10
August 21, 2008

Richard Alldredge
Robert Bilby
Peter Bisson
John Epifanio
Linda Hardesty
Charles Henny
Colin Levings
Eric Loudenslager
Kate Myers
Tom Poe
Bruce Ward
Richard N. Williams, PRG

NOAA Physiology Study

- Co-managing agency CTWS contracted w/NOAA (Larsen et al. 2017)
- Evaluated 300 hatchery steelhead from each brood year 2011 – 2013
- Estimated ≈ 96 – 97% of annual release group was destined for smoltification
  - Out of 50K released, "approximately 1,500-2,000 of them may residualize in the basin."
  - Non-smolts = 0.1%
    - "Only one male steelhead was categorized as an immature parr over all years combined." (n=900)



Release Year	Length
2005	174.3
2006	163.8
2007	187.0
2008	201.6
2009	189.9
2010	202.9
2011	198.3
2012	214.1
2013	214.6
2014	202.3
2015	203.5
2016	197.2

Applied Context

- Assess findings when data is available
  - Evaluate knowns within status-trend monitoring framework
- Bonneville Power Administration funding declining
  - Particularly Monitoring and Evaluation programs
  - Ability to answer complex questions potentially diminishing

Objectives

1. Estimate the proportion of release group that residualizes and survives to outmigrate as an age 2 smolt

Hatchery Smolt Life History Pathways

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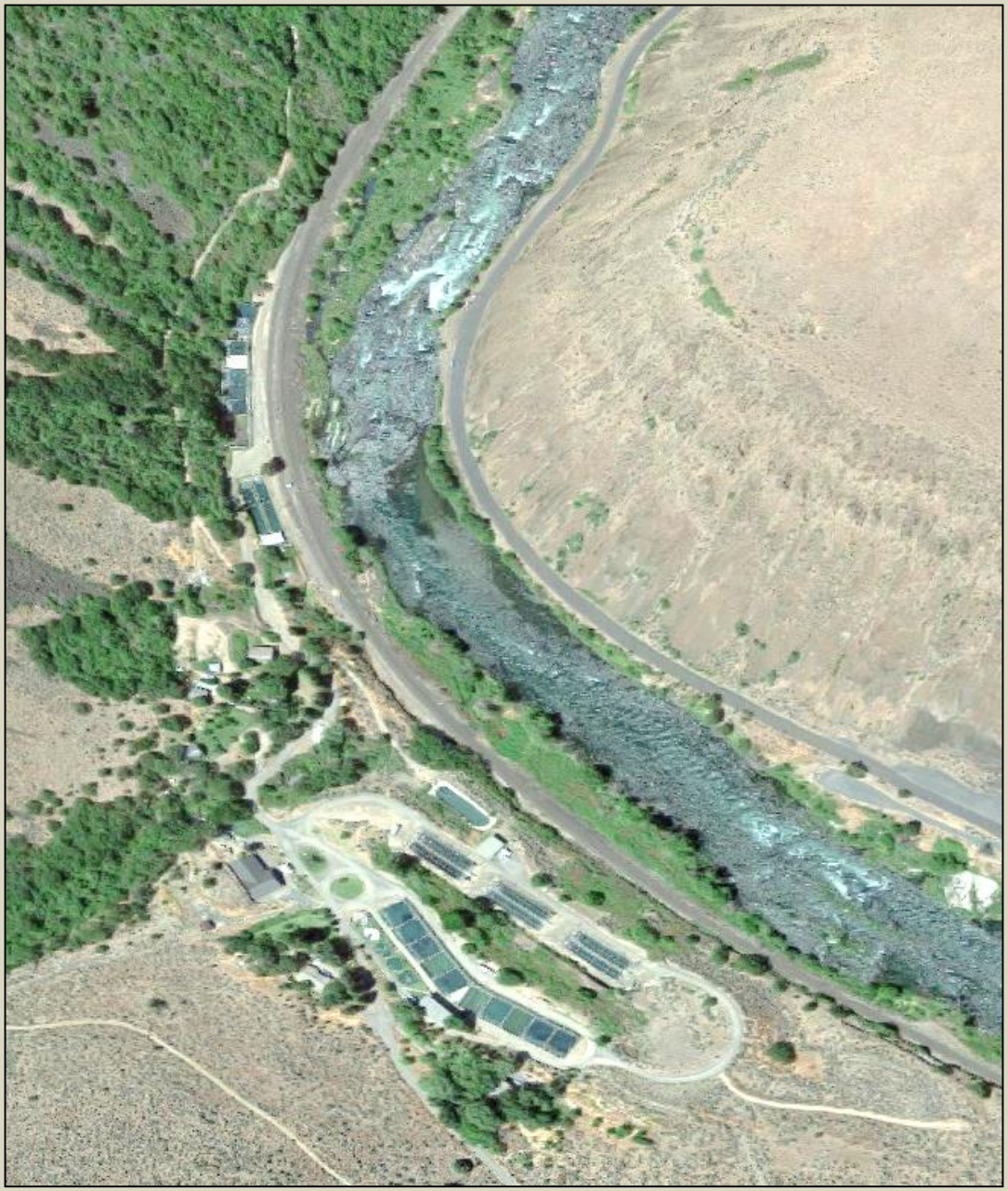
Objectives

1. Estimate the proportion of release group that residualizes and survives to outmigrate as an age 2 smolt
2. Address the role of size within the context of residualism
3. Assess the effects of hatchery residuals on wild fish

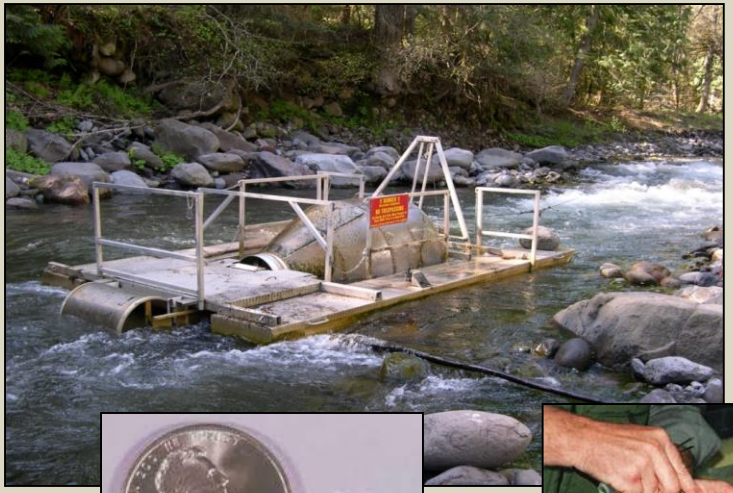
Methods—Oak Springs Subsampling

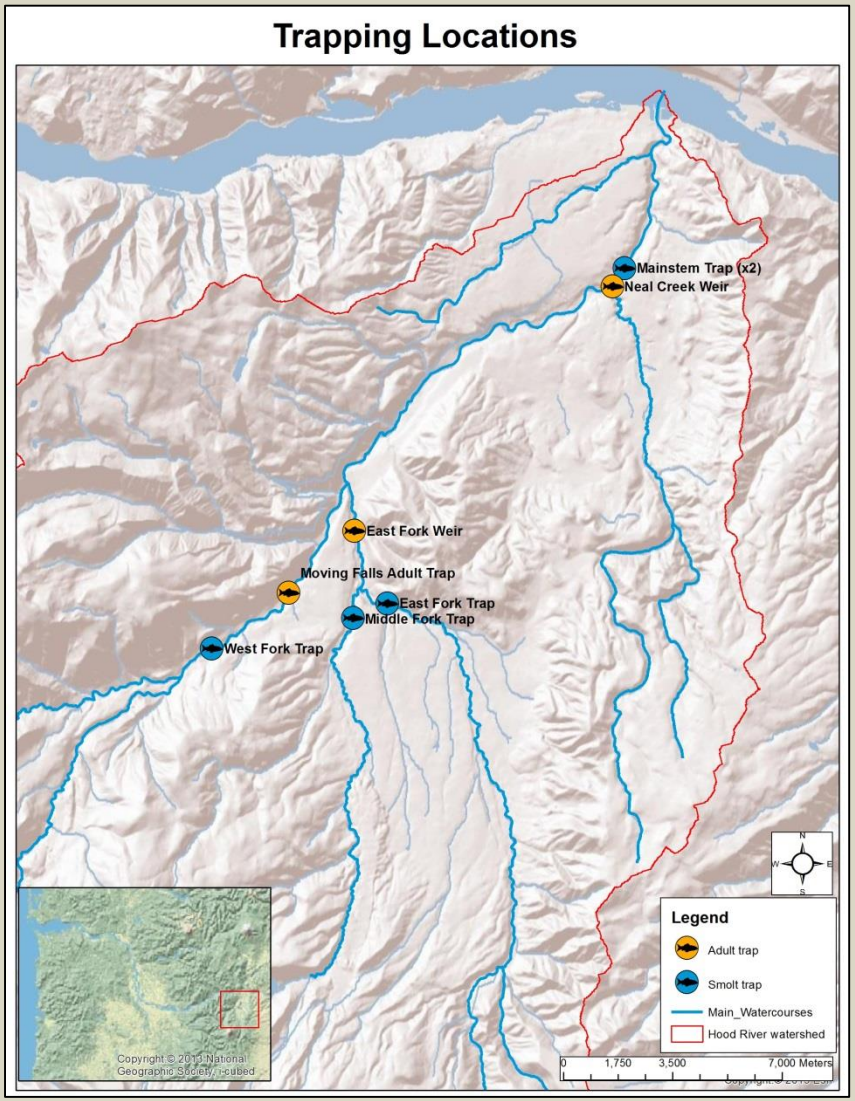
- 400 – 800 individuals sampled for:
  - Length
  - Weight
  - Fin clip accuracy
  - Fin clip quality
- Performed 1 – 2 weeks prior to release



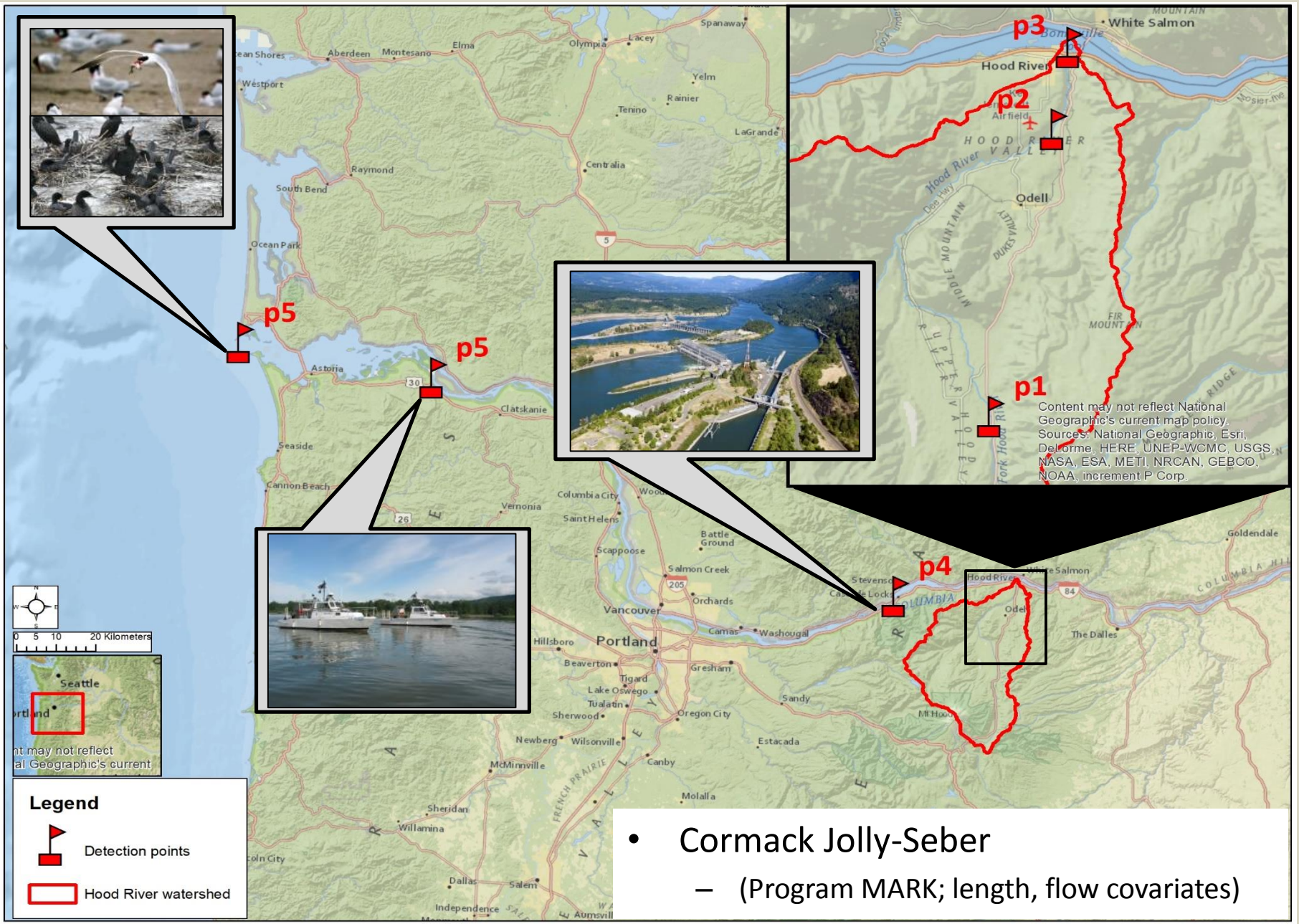
Methods: PIT tagging

- Hatchery winter steelhead
  - Approximately 50,000 total release
    - CTWSRO ≈ 10%
    - ODFW ≈ 1% – 5%





Smolt Survival Estimation



- Cormack Jolly-Seber
  - (Program MARK; length, flow covariates)

Quantifying Residuals

- Estimated total number of residuals calculated by:

$$N_y = \frac{\sum_{y_i}^{n} (d_{ky+1}) \times \left[\frac{1}{(p_{ky+1})} \right]}{M_y}$$

where:

N_y = Total residuals originating from release year *y*

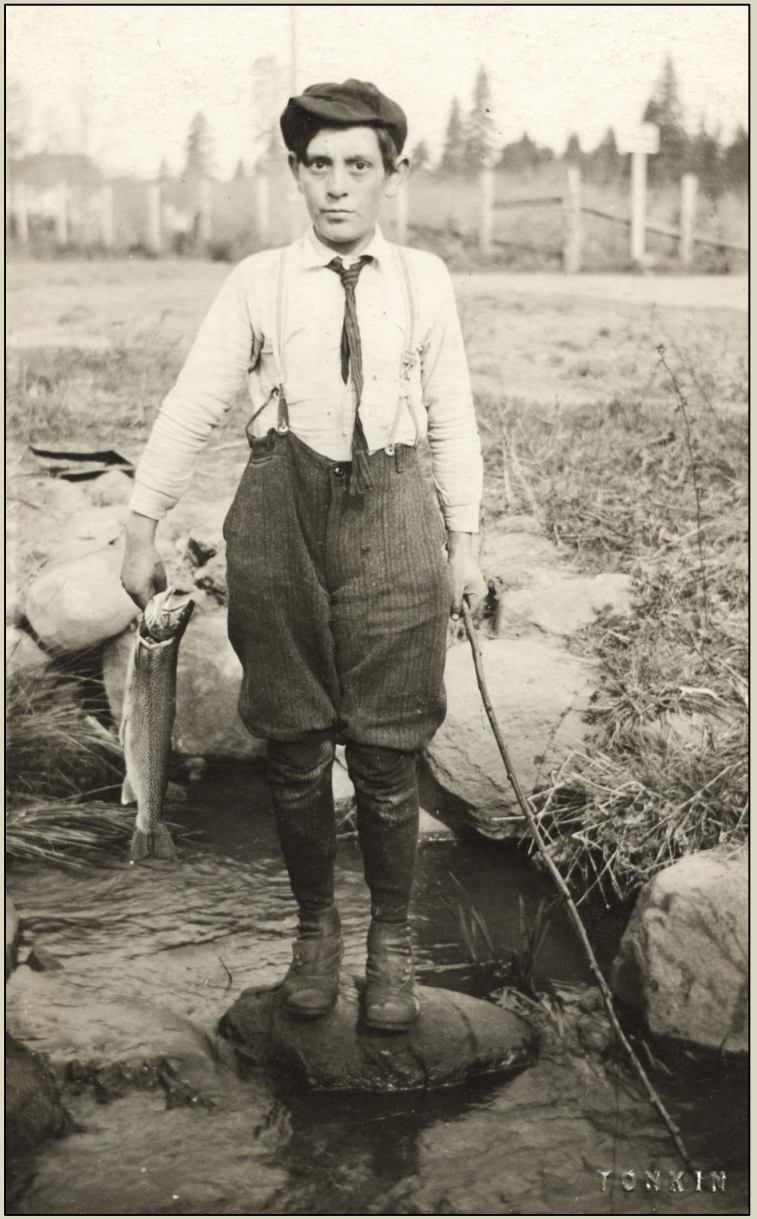
d_{ky} = Recaptures/interrogations of hatchery winter steelhead during release year *y*

p_{ky} = probability of detection at site k during release year *y*

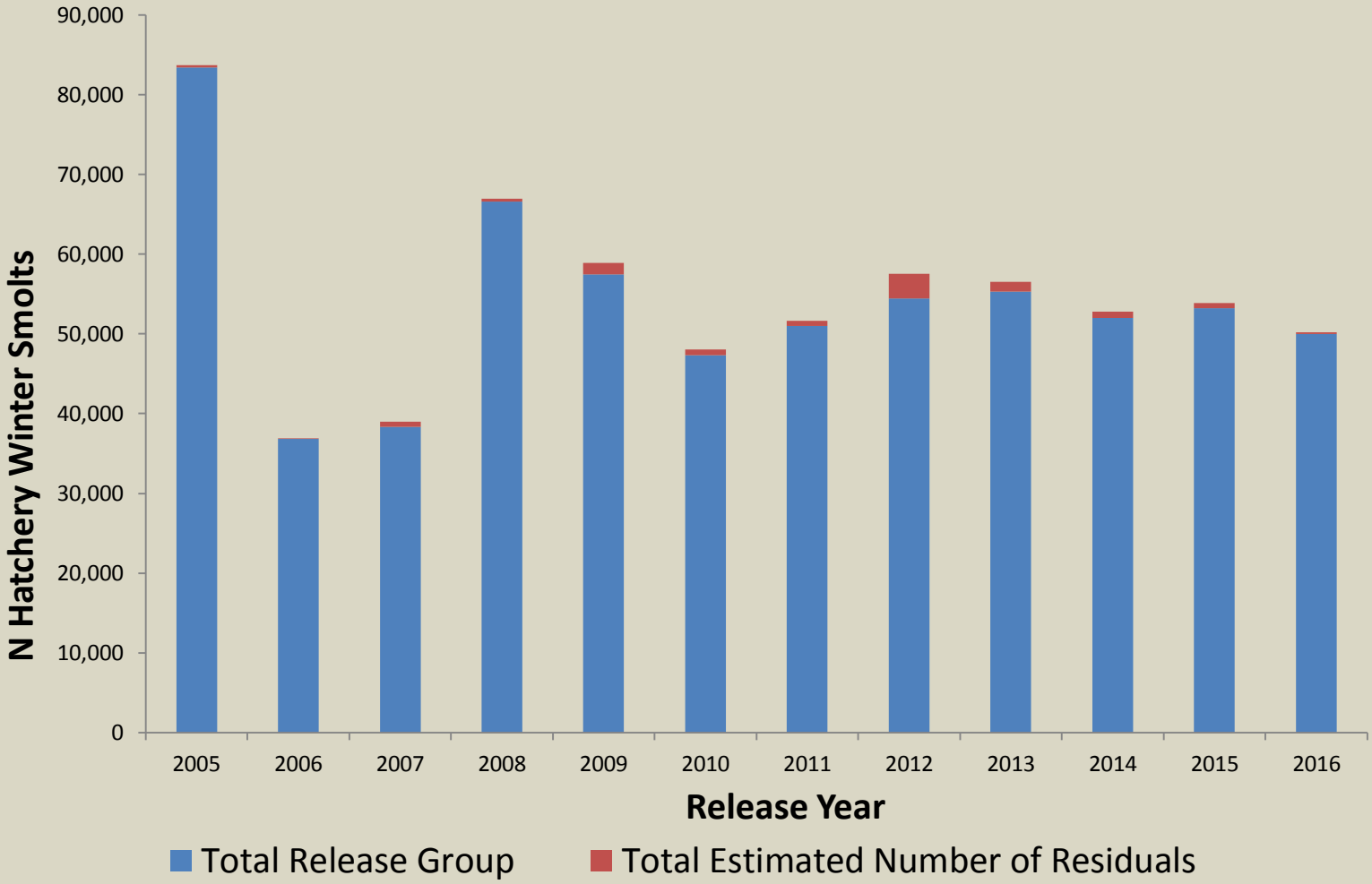
M_y = Proportion of hatchery release group year *y* that was PIT tagged

Methods—Smolt Production MR Model

- Response variable
  - Abundance of wild age 2 smolts
- Predictor variables
  - Average flow rate during Sept 1 – Oct 15 the year prior to smolt migration
  - Average flow rate during April – May of brood year
  - Average fork length of age 2 smolts
  - Smolt abundance of elder age class
  - Total adult spawners during Brood Year
  - Proportion of wild vs. hatchery spawners
  - Dec – April flow variance
  - % Residuals

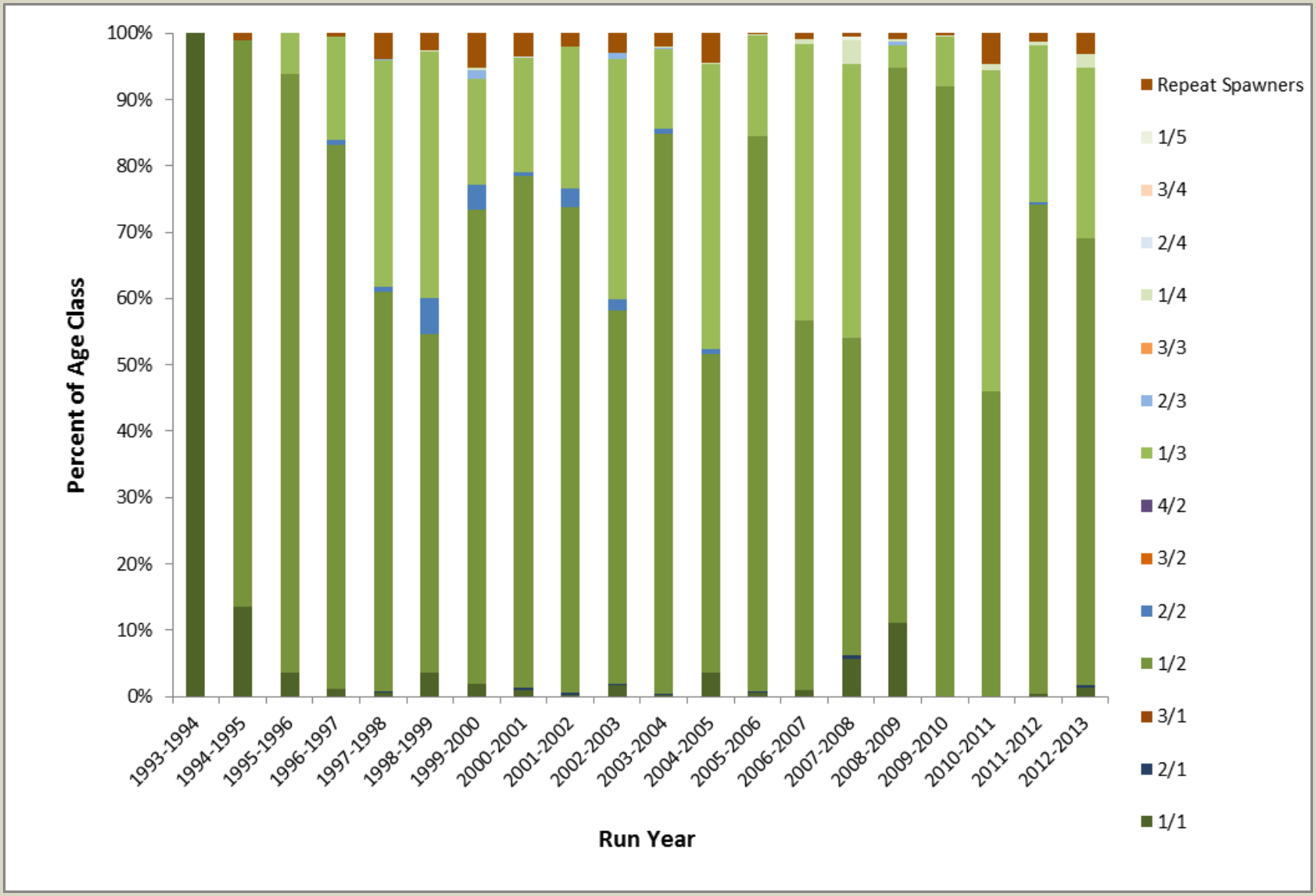


Results



Mean = 1.57% [0.22% - 5.61%]

FW-2 Reproductive Contribution



Results—Model Selection

R software (AICmodavg)

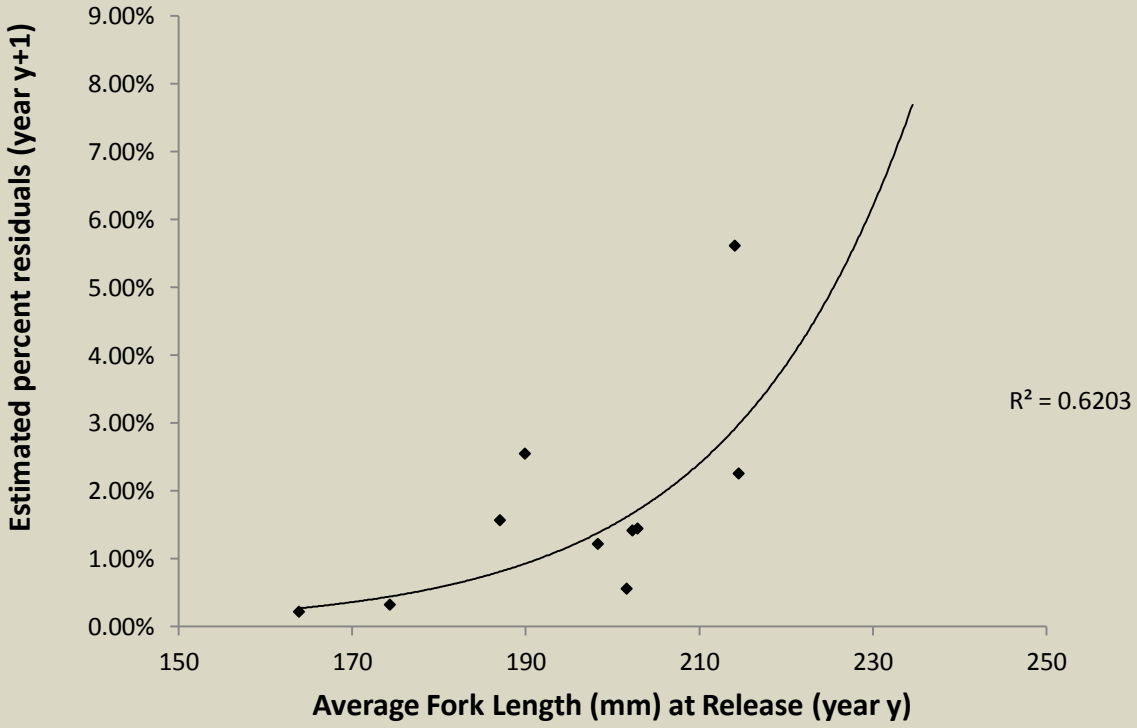
Modnames	K	AICc	Delta_AICc	ModelLik	AICcWt	LL	Cum.Wt
RES	3	164.528	0	1.00E+00	9.07E-01	-76.26402	0.9068704
RES+PP	4	170.9752	6.447176	3.98E-02	3.61E-02	-74.82094	0.9429747
MTLF+RES	4	171.718	7.189983	2.75E-02	2.49E-02	-75.19234	0.9678782
intercept only	2	173.4687	8.940636	1.14E-02	1.04E-02	-83.53433	0.9782561
AVGQBY+RES	4	173.5492	9.021168	1.10E-02	9.97E-03	-76.10793	0.9882245
PP	3	174.1981	9.670027	7.95E-03	7.21E-03	-81.09903	0.995431
AVGQBY	3	176.0126	11.484585	3.21E-03	2.91E-03	-82.00631	0.9983397
MTLF	3	177.4915	12.963473	1.53E-03	1.39E-03	-82.74575	0.9997283
MTLF+PP	4	182.3592	17.83116	1.34E-04	1.22E-04	-80.51293	0.99985
AVGQBY+PP	4	183.2205	18.692494	8.73E-05	7.92E-05	-80.9436	0.9999292
MTLF+AVGQBY	4	184.8096	20.281595	3.94E-05	3.58E-05	-81.73815	0.999965
AVGQBY+RES+PP	5	185.0423	20.514301	3.51E-05	3.18E-05	-72.52117	0.9999968
MTLF+RES+PP	5	189.638	25.109943	3.53E-06	3.20E-06	-74.81899	1
min	6	240.7415	76.213428	2.82E-17	2.56E-17	-72.37073	1

Results—Model Selection

```
Call:
lm(formula = ATWOS ~ RES, data = mydata2)

Residuals:
   Min     1Q Median     3Q    Max
 -7266  -1340   1190   1918   3774

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)     4434       1952   2.272  0.06353 .
RES           460336      82757   5.563  0.00143 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3858 on 6 degrees of freedom
Multiple R-squared:  0.8376, Adjusted R-squared:  0.8105
F-statistic: 30.94 on 1 and 6 DF,  p-value: 0.001429
```

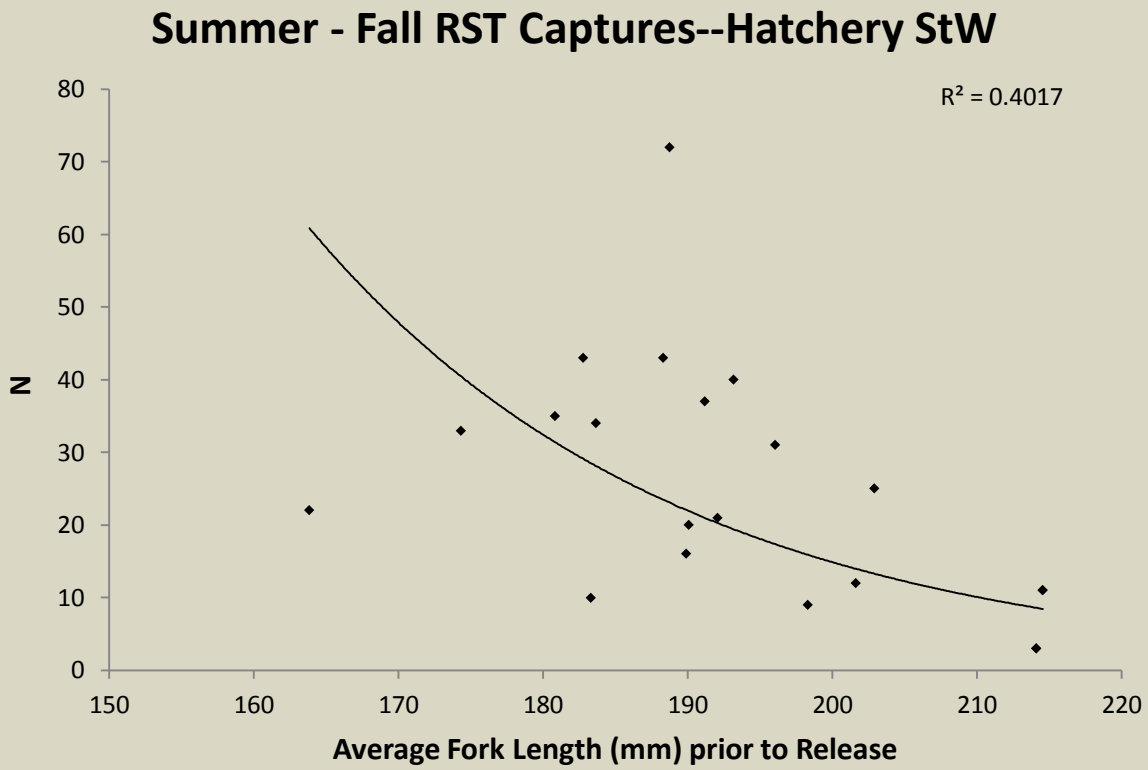
Results—Fork Length of Residuals

- Estimated percent of FW2 hatchery outmigrants increases as average length at release increases?
- Generally larger fish are more likely to survive to the following year and be detected
- Good environmental conditions likely benefit both wild and hatchery fish

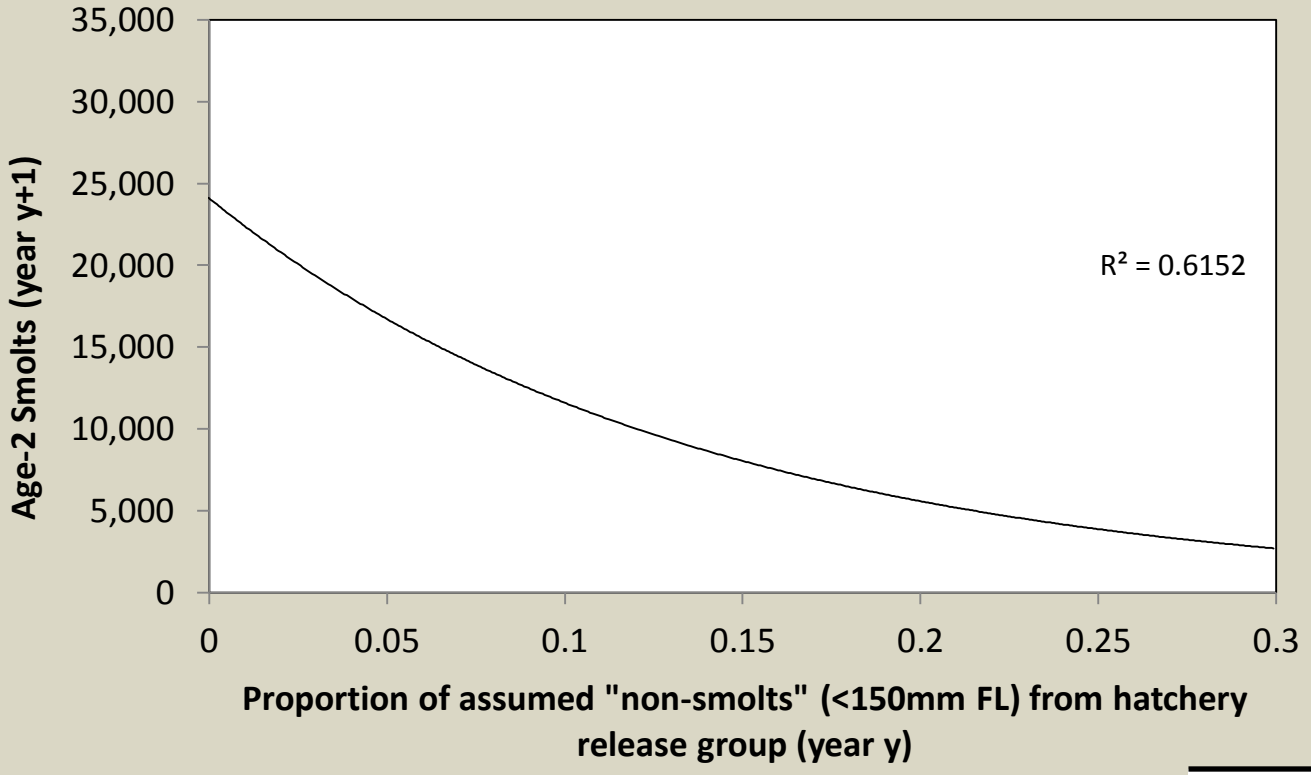


Results—Fork Length of Potential Residuals

- Summer/Fall trapping
- Size ↑'s, frequency ↓'s



Impacts on Wild Steelhead

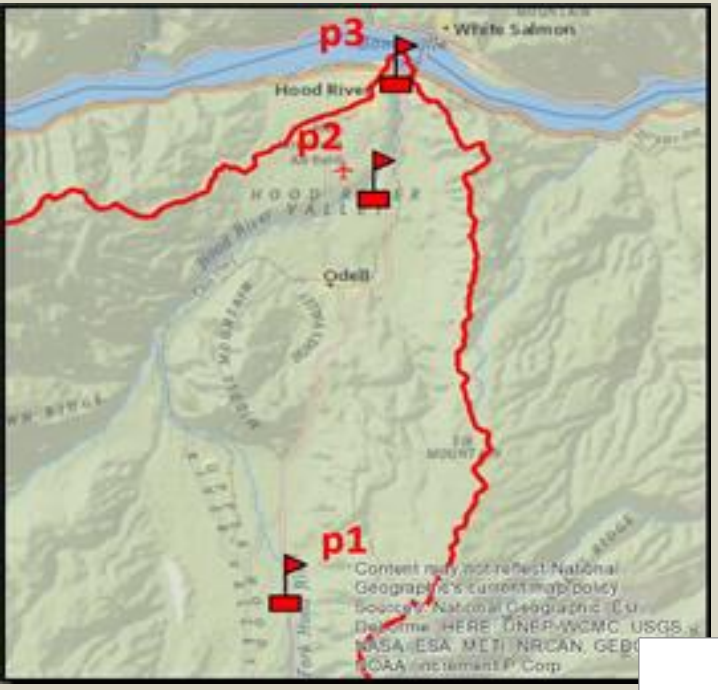


- McMichael et al. (1999) observed displacement in 79% of hatchery vs. wild contests—"Hatchery steelhead behaviorally dominated wild *O. mykiss* in most situations."
- ISRP (2008) noted "yearling 'residuals' may compete with and displace wild underyearling parr, but die over summer (likely due to physiological reasons)"

MONTH	CF
July	1.04
August	0.91
September	0.91
October	0.86
March	0.86

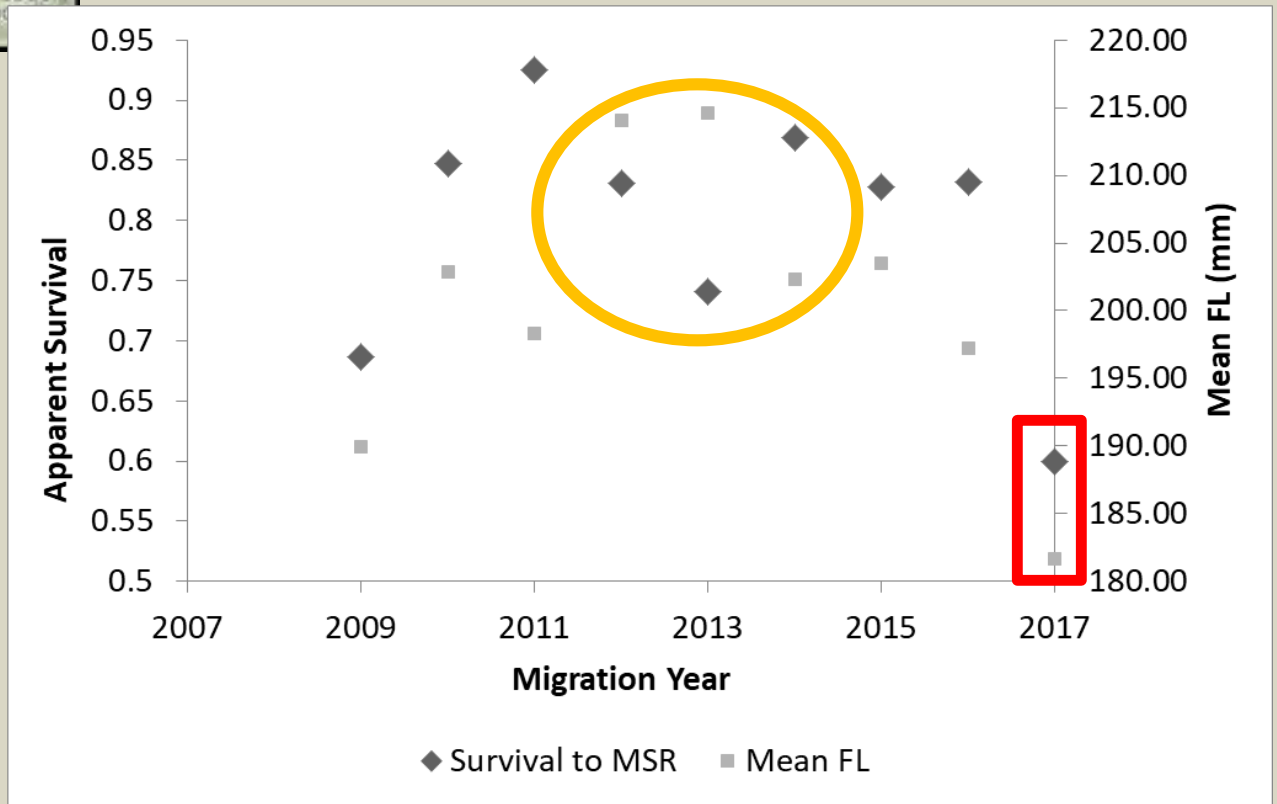
Effects of Residuals

- Residuals may consume native salmonid fry
- Competition for prey resources
- Displacement from rearing habitat
  - Dispersal up to 21 km upstream from release site (Jonasson et al. 1995)
  - Kennedy (ORAFS 2016) noted 32% of hatchery release occupied area between release area and screw trap in Abernathy Creek (≈4km)
- Negative interactions with wild fish (McMichael et al. 1999; Kennedy ORAFS 2016)



Apparent Survival, Length

- ϕ_1: surrogate to estimate potential for non-migratory behavior?



Conclusions

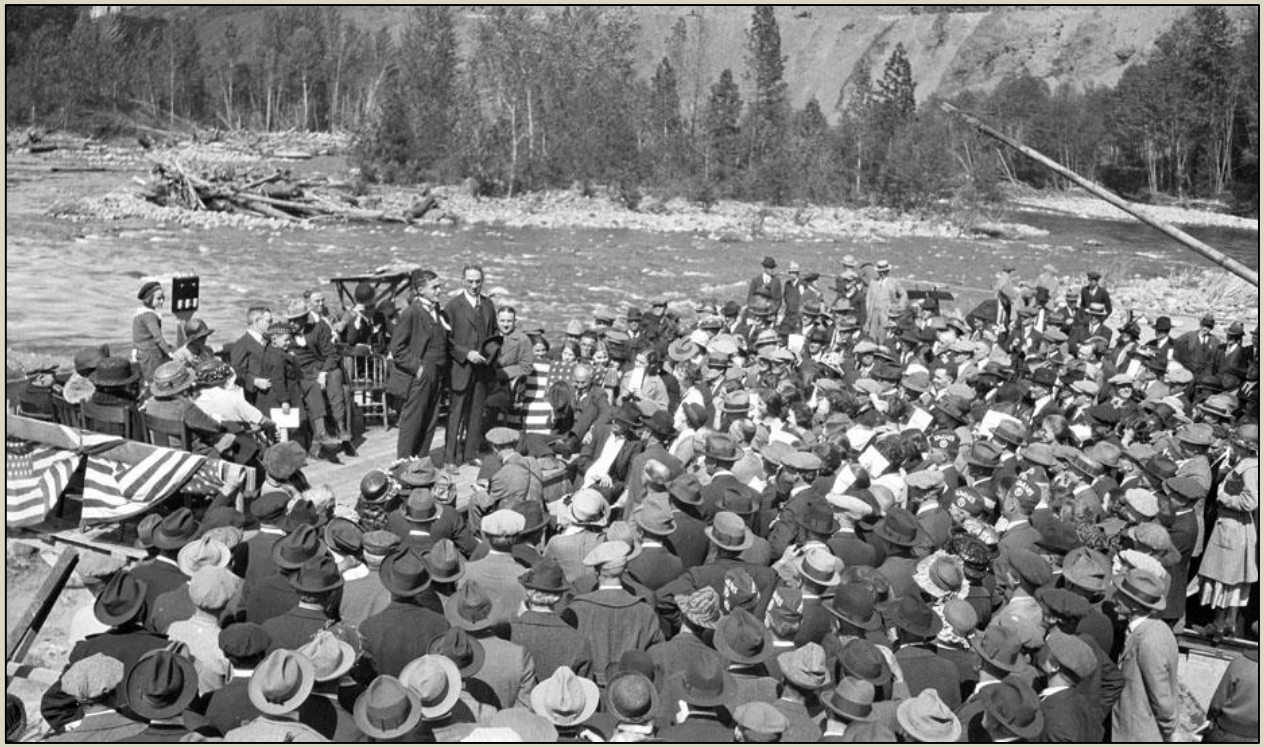
- Overall rate of residualism for FW2 appears relatively low (<2% of annual release group)
  - Estimate is crude at best
- A higher proportion of non-smolts appears to have a detrimental effect on wild parr
  - 2018 outmigration pending
- Non-migrant component not captured very well in Larsen et al. study
  - Sample size?
  - Sample method?
  - Real-time stress response not captured?
    - Non-migrants not always defined by FL<150mm

Management Implications

- Size grading and removal of non-smolt hatchery steelhead recommended
  - SAR rates for undersized fish poor (Snow et al. 2013)
    - Implement a true volitional release strategy and remove non-migrants
  - Christie (OSU Blouin Lab) estimated 1% of gene flow from residual hatchery fish, but 20% from resident *O.mykiss*
  - Non-smolts can be transferred to impoundment
- Acclimate and release lower in the river
  - Current release: rm 21.2
  - Experimental release: rm 4.6
  - Dispersal up to 21 km upstream from release site (Jonasson et al. 1995)
- Rear hatchery smolts to age 2 (Tatara et al.)

Acknowledgements

- Bonneville Power Administration
- ODFW Mid-Columbia District and Hood River Program staff
- Joshua McCormick, ODFW
- CTWSRO
- USGS
- ODFW Restoration and Enhancement Program
- PTAGIS (Pacific States Marine Fisheries Commission)
- NOAA Fisheries



BONNEVILLE POWER ADMINISTRATION

OREGON Fish & Wildlife

Confederated Tribes of the Warm Springs Indian Reservation of Oregon

USGS science for a changing world

PTAGIS

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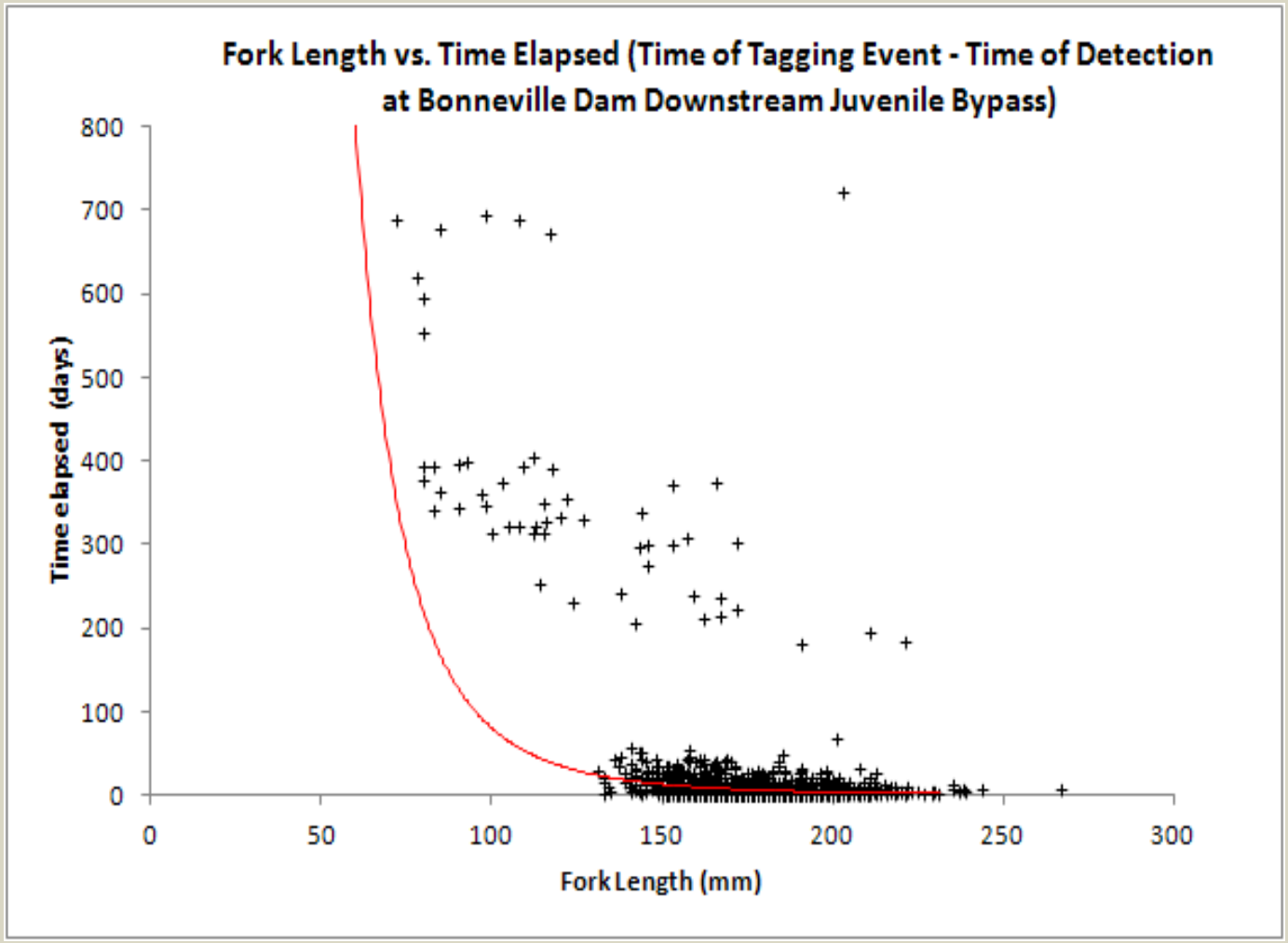
QUESTIONS


Fork Length vs. Time Elapsed (Time of Tagging Event - Time of Detection at Bonneville Dam Downstream Juvenile Bypass)
Time elapsed (days)
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
Fork Length (mm)