# Spawning success of spring Chinook salmon in Fall Creek, the North Fork Middle Fork Willamette and South Santiam, 2008-2015

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# *Alternate Title*

# 2015: The year of the swimming dead

**Warm Water Expected To Keep Killing Willamette River Salmon**
*The Oregonian*, June 18

**Warm Waters Cause Central Oregon Salmon Die-Off** *OPB*, July 15


thefisheriesblog.com

**Warm Water Hitting Returning Sockeye Hard: NOAA Says Maybe 80 Percent Mortality For Upper Columbia** *Associated Press*, July 31, 2015

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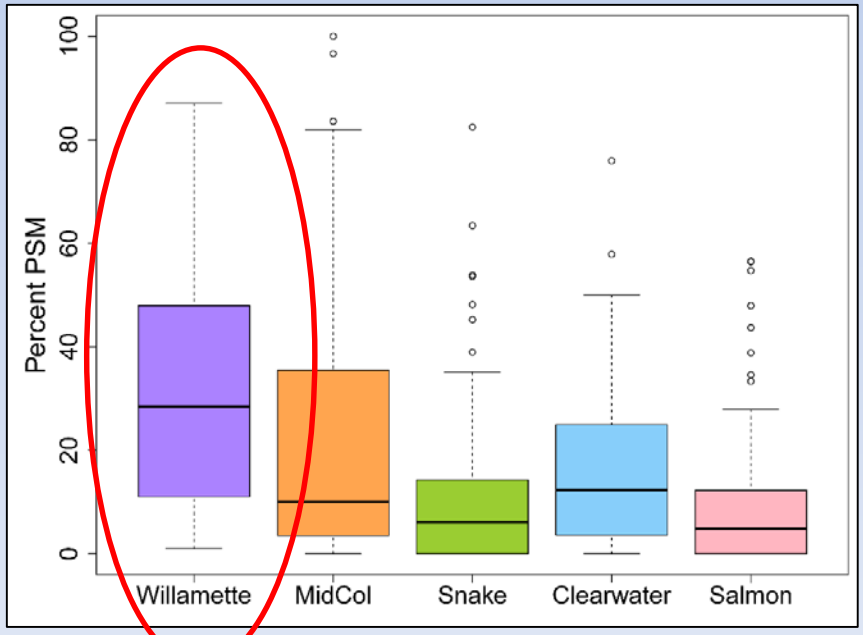
# Background: Adult outplant program

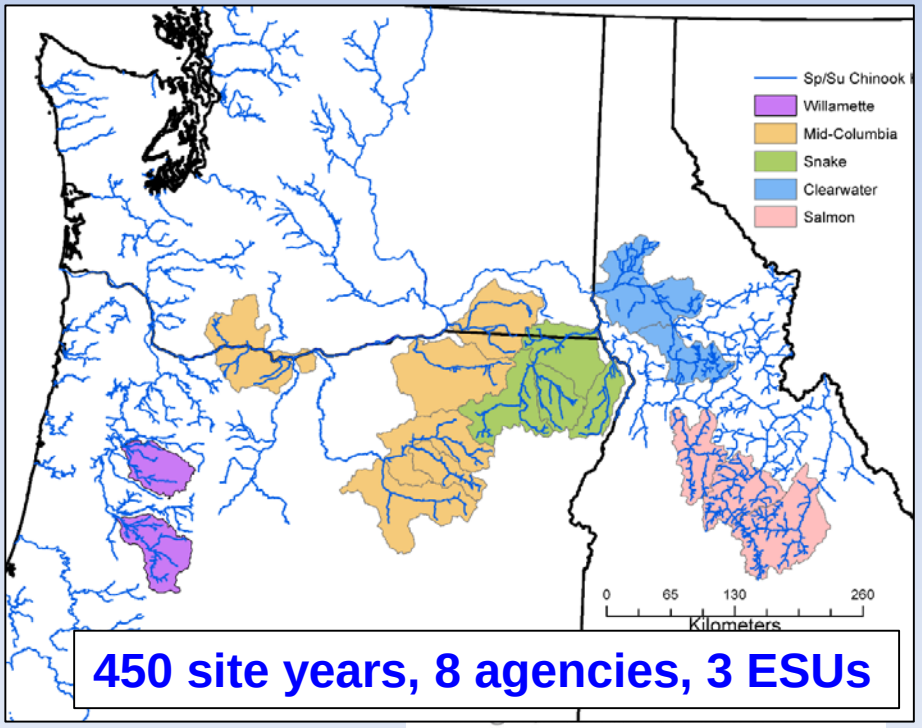
- Collect returning adult Spring Chinook at traps and hatcheries in WIL tributaries
- Outplant ‘surplus’ fish above (and below) dams
- ‘Trap and Haul’ by truck to historic habitat

# Background: Prespawn mortality

- Adult Chinook PSM is a regional issue
  - Temperature-mediated mortality
  - Disease, density-dependent effects
- WIL spring Chinook have relatively high PSM




Bowerman, Caudill, & Keefer *in prep*




**450 site years, 8 agencies, 3 ESUs**

# 2008-2015 WIL tributary objectives

- Monitor prespawn mortality
  - Radiotelemetry, PIT tags
  - Spawning ground surveys

- Assess covariates
  - Fish traits: size, sex, condition, migration timing, energetics
  - Temperature exposure
  - Toxin loads
  - *Disease, pathogens, etc (Schreck, Kent et al.)*

**No disease objectives in 2015, Summary reports available**

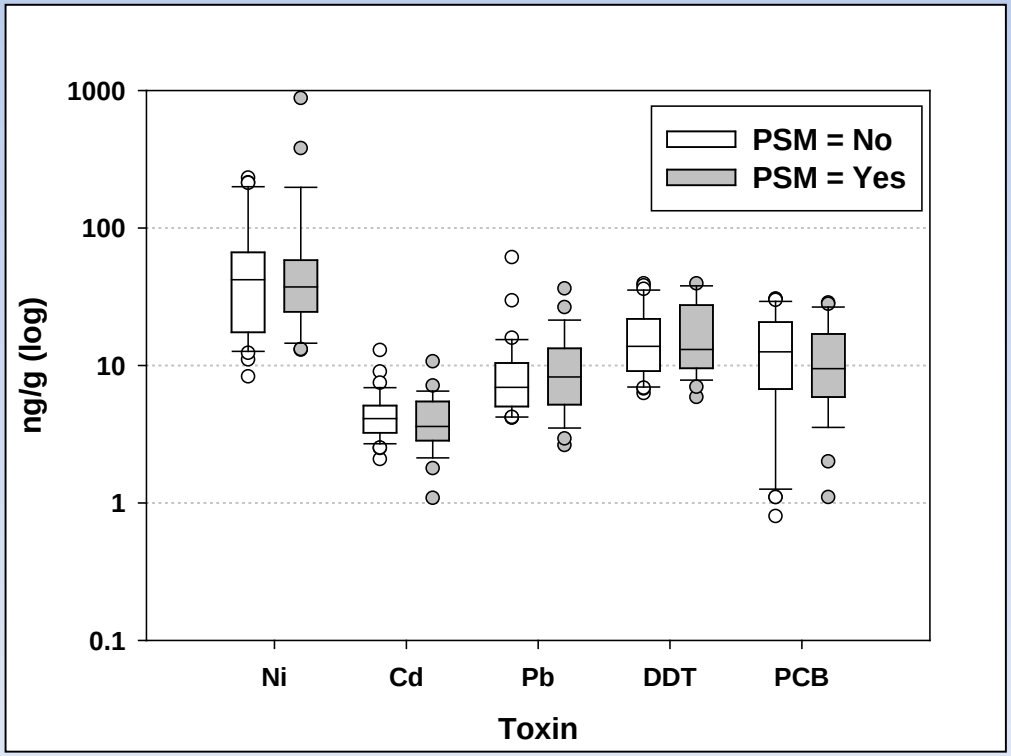
# 2015-specific objectives

- Fall Creek, NF Middle Fork, S Santiam, N Santiam
  - PSM estimates
  - Inter-annual PSM patterns
  - Temperature monitoring
- Foster Reservoir releases
  - Thermal refuge?
- *Toxins analysis*
- *Minto radio-tagging*
  - *Fallback behavior*
  - *Movement to Big Cliff*

# Toxins summary: 2013-2014

- Assessed Ni, Cd, Pb, DDT, PCB

| PSM | S Santiam | Fall Creek | NF Middle Fork | Total |
|---|---|---|---|---|
| No | 13 | 1 | 23 | **37** |
| Yes | 7 | 5 | 14 | **26** |




**Statistical tests by tributary, by year, by toxin:**

***No smoking gun for PSM***

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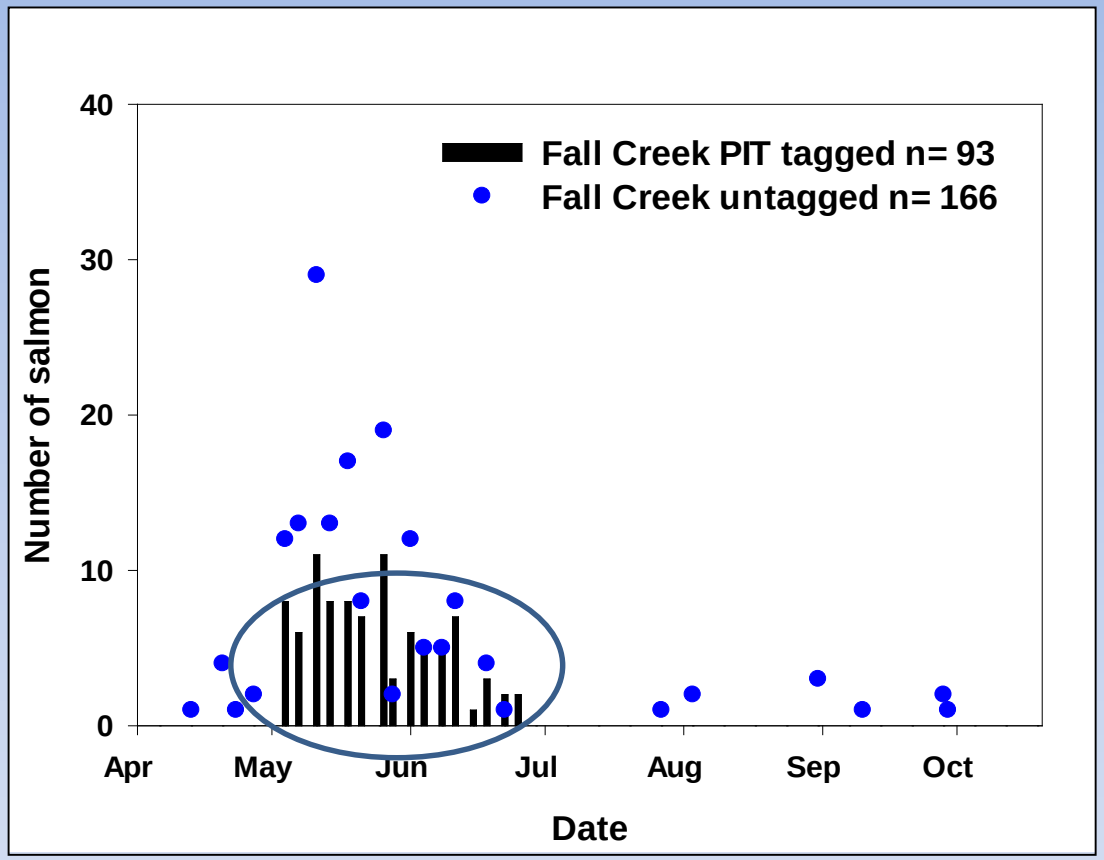
# Minto project: *terminated*

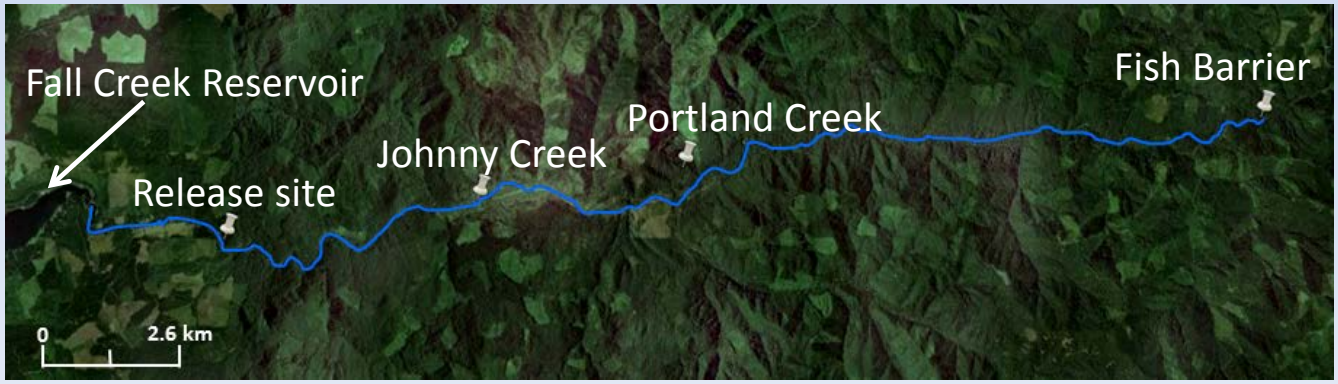
- Early July: 10 salmon radio-tagged, released
- 22 July: 5 salmon radio-tagged, held at Minto
  - By 30 July, all 5 were dead or moribund
  - Stopped collection and tagging
- 4 morts sent to OSU Pathology Lab
  - Kidneys liquified, muscle falling off ribs, BKD, Furunculosis

# Spawning ground surveys

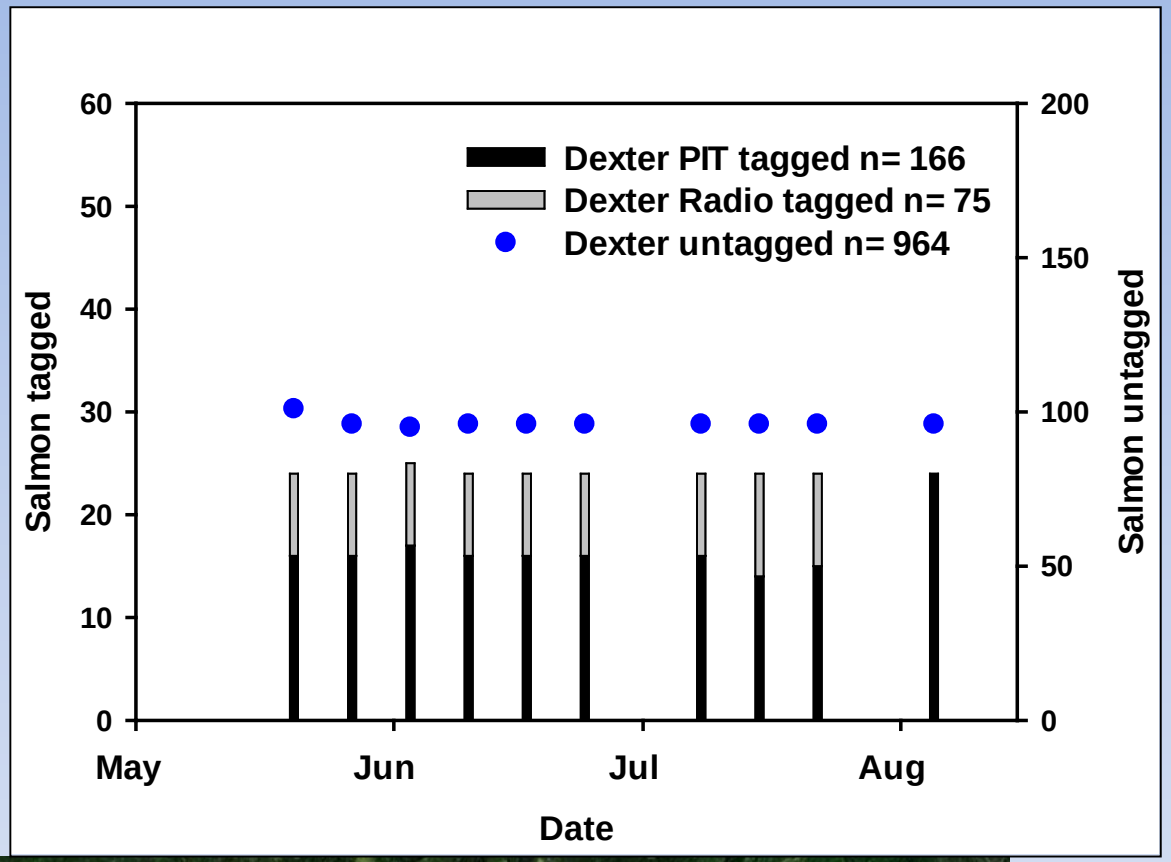
- June to October walking carcass surveys
  - Joint effort by UI and ODFW
  - UI: 10-22 surveys per river
- Carcasses scanned for PIT and radio tags
- Spawning success assessed
  - Focus on females

# 2015 Fall Creek PIT tagging



# 2015 Dexter radio & PIT tagging





Release site: NF Middle Fork

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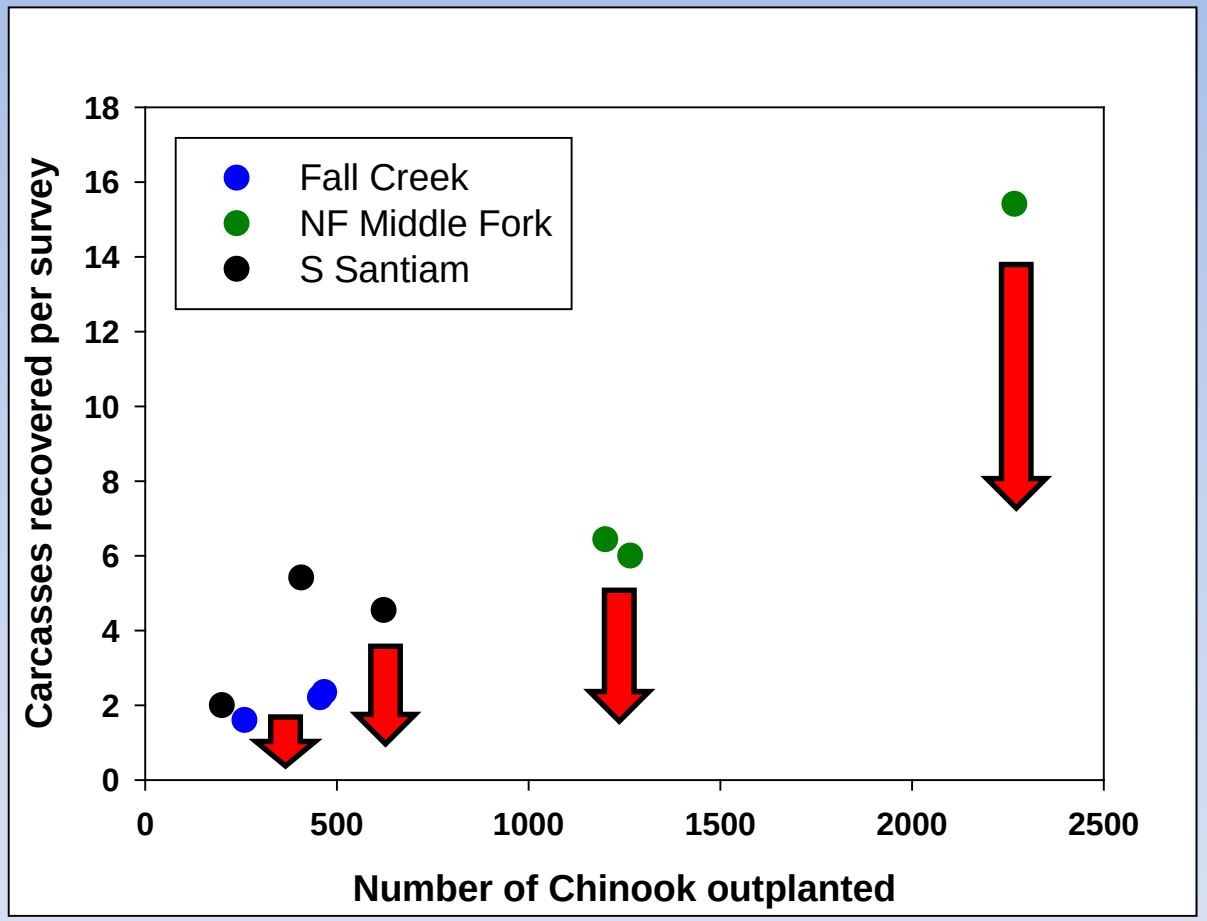
# CPUE: carcass recovery (2013-2015)




**All carcasses examined**

**~50%**

**Female egg retention assessed**

**~25%**

**Female subsample in acceptable condition used in PSM estimates**

**1: Carcass recovery proportional to outplant abundance**

**2: Samples for PSM estimates often small**

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# 2015 PIT and radio recovery rates

| Location | # Released | | # Recovered on SG | | % Recovered on SG | |
|---|---|---|---|---|---|---|
| | PIT | Radio | PIT | Radio | PIT | Radio |
| Fall Creek | 93 | | 5 | | 5.4% | |
| NFMF | 166 | 75 | 22 | 10 | 13.3% | 13.3% |
| SF Santiam | | | | | | |
| SF (Foster Res) | | | | | | |

- Includes males and females

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# 2015 Female prespawn mortality (PSM)

| Location | Suitable Females recovered | | PSM | | % PSM | | |
|---|---|---|---|---|---|---|---|
| | PIT | Radio | PIT | Radio | PIT | Radio | Total |
| Fall Creek | No suitable recoveries despite multiple surveys | | | | | | |
| NFMF | 4 | 3 | 3 | 1 | 75% | 33% | 57% |
| SF Santiam | | | | | | | |
| SF (Foster Res) | | | | | | | |

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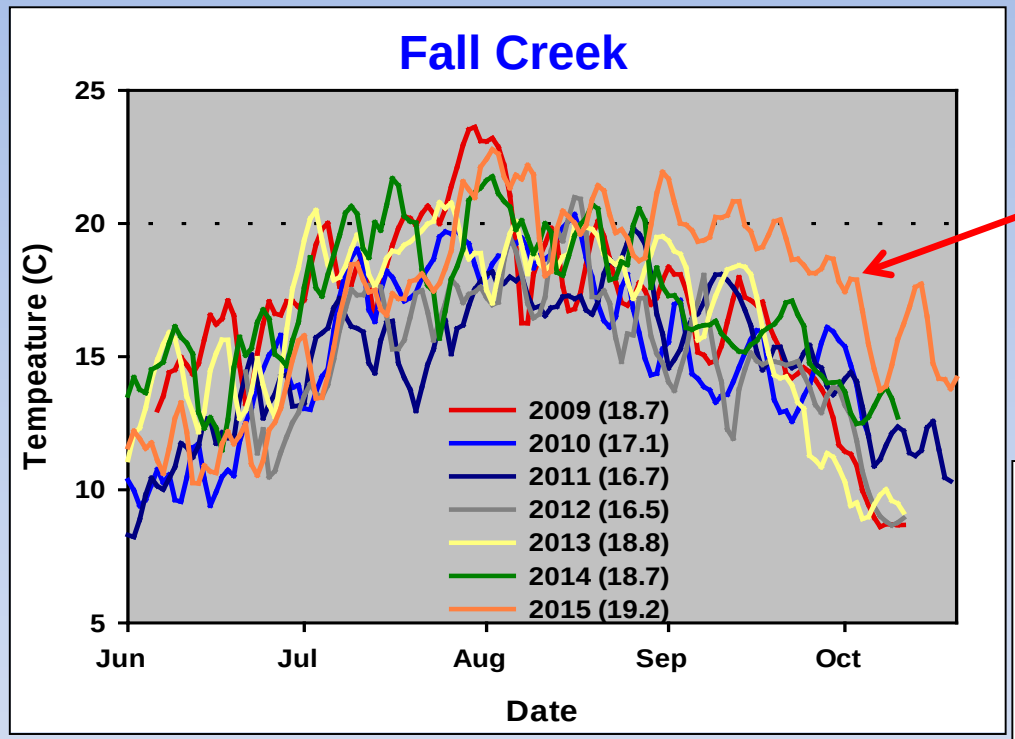
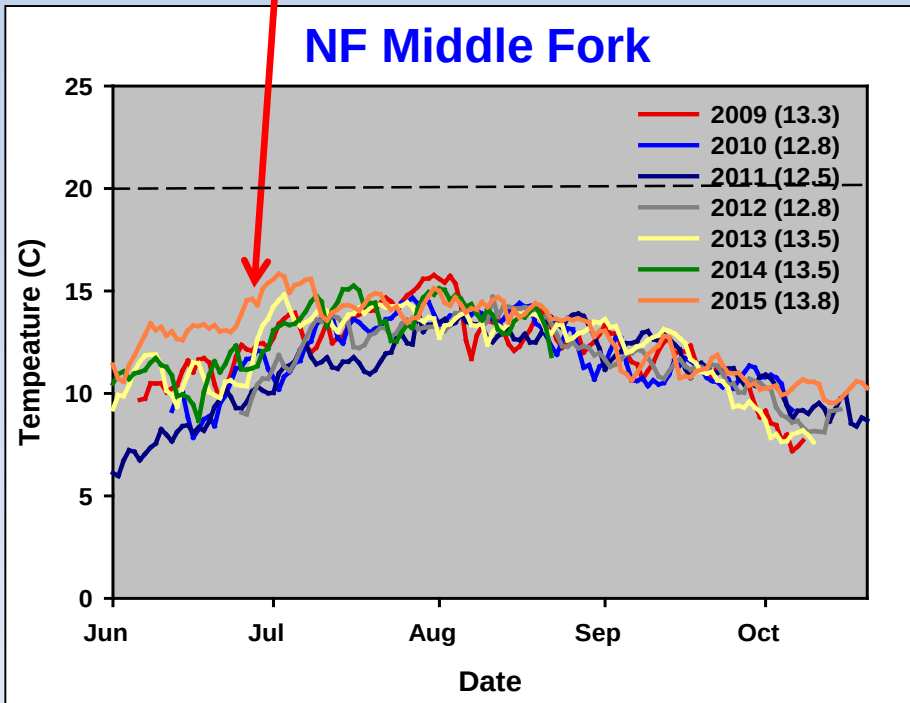
# Release site temperatures

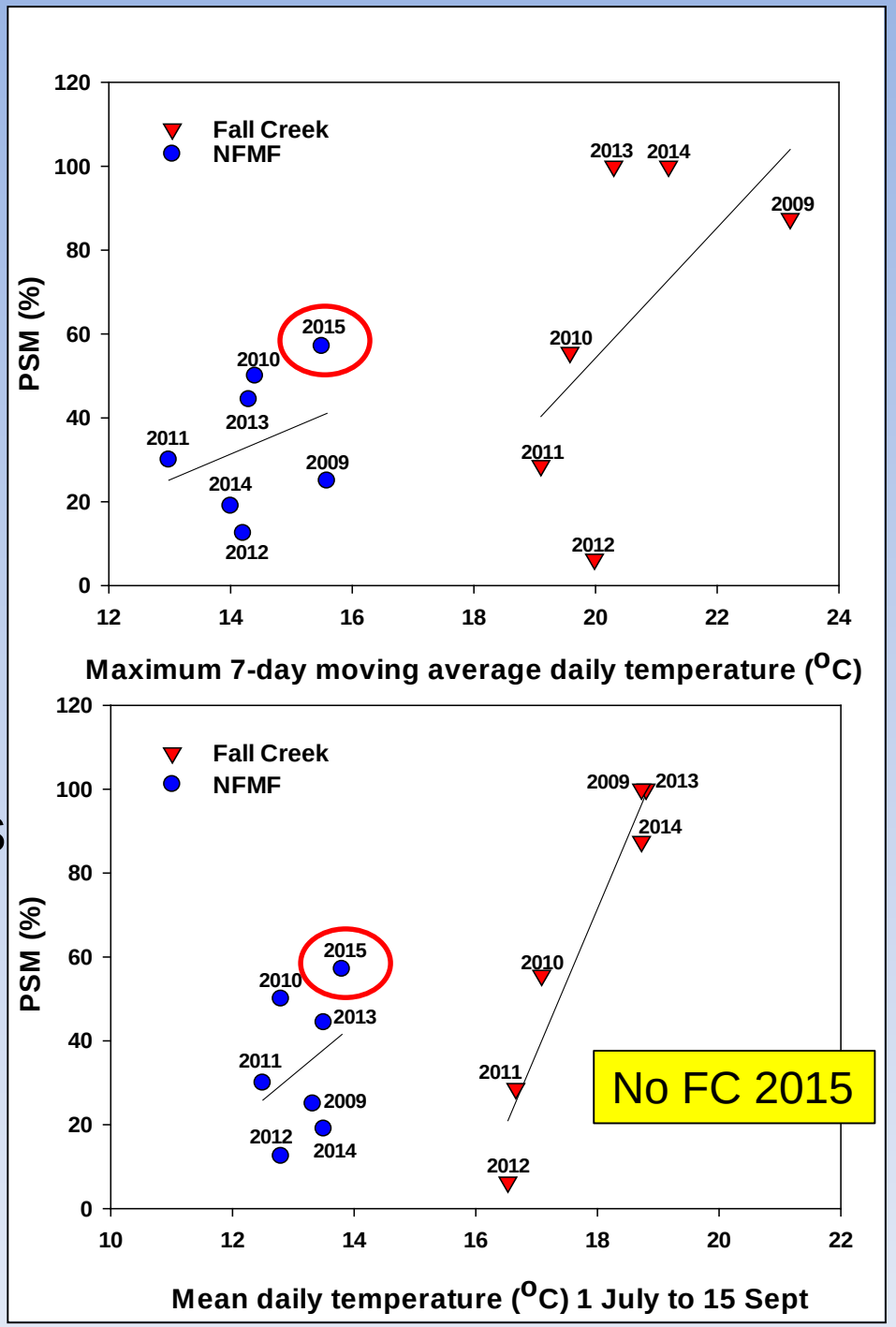



2015 had the highest mean temperatures (1 Jul – 15 Sept)



# Multi-year analyses

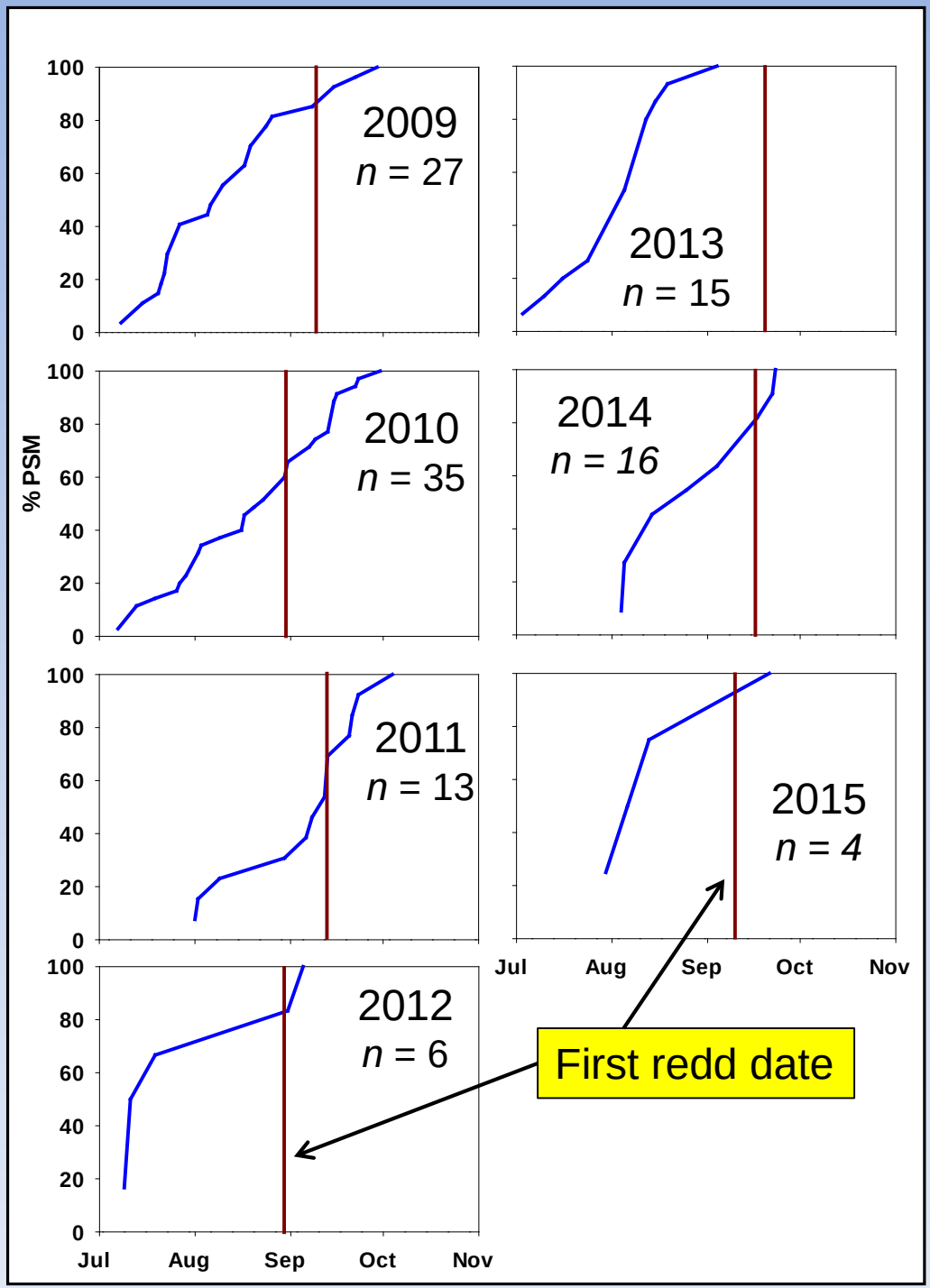
- NFMF vs Fall Creek
  - Stream temperature appears to be a primary driver
- Fall Creek models
  - PSM ▲ for late migrants
  - PSM ▲ with fish size
- NFMF models
  - Few statistically significant covariates



# Fall Creek cumulative PSM%

- **ALL tagged and untagged female carcasses**

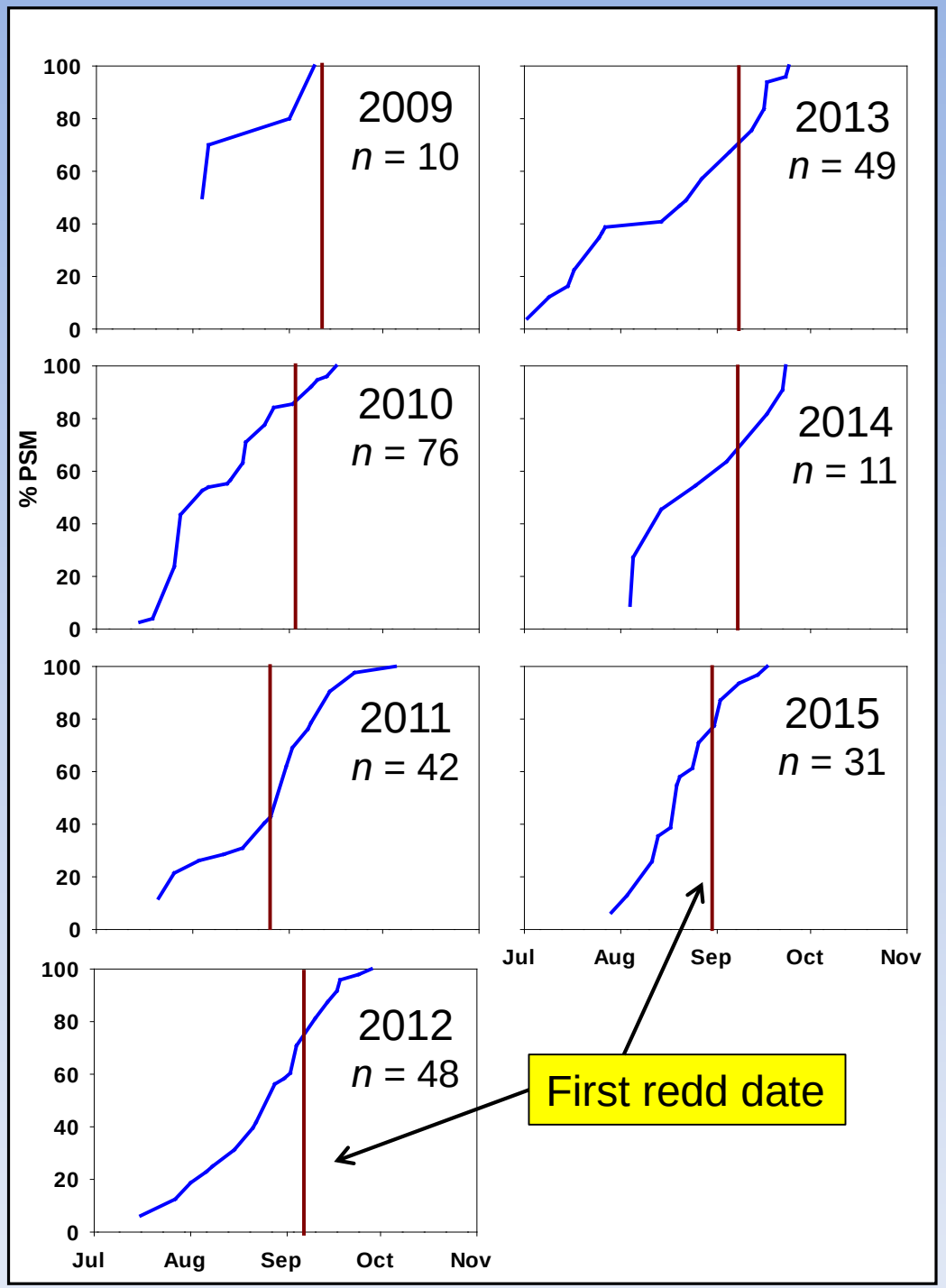
- **Majority of PSM was prior to redd building in all years**



# NF Middle Fork cumulative PSM%

**Same pattern: most die before spawning onset**

**Very important that surveys begin during the holding period**



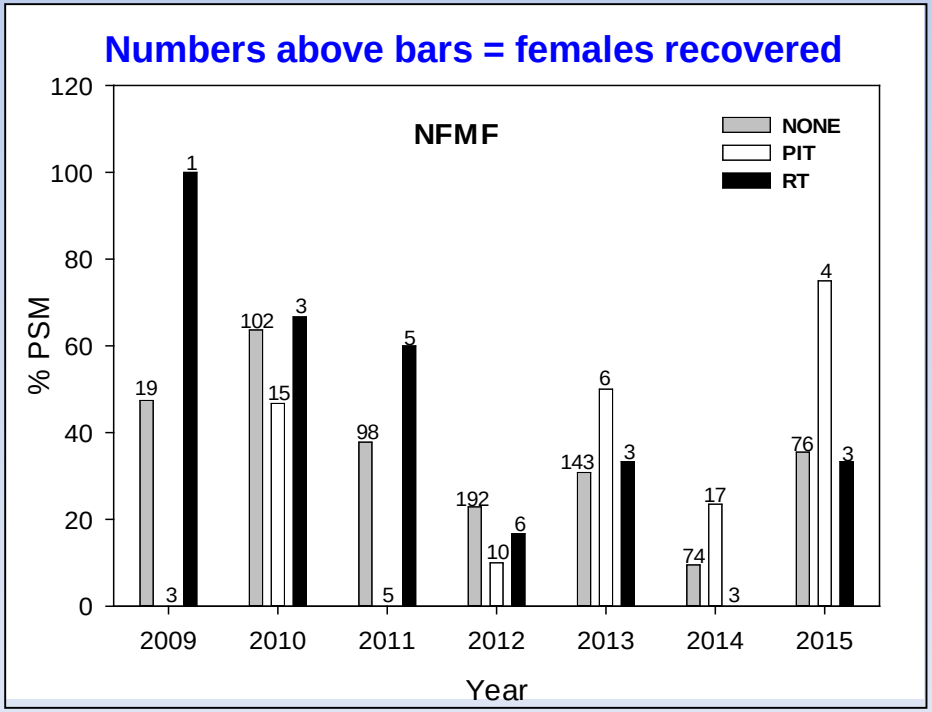
# PSM × tag type: NF Middle Fork

- Females only (2009-2015)
  - Untagged (*n* = 19-192 / year)
  - PIT-tagged (*n* = 3-17 / year)
  - Radio-tagged (*n* = 1-6 / year)

None: 33.1%

PIT: 30.0%

RT: 37.5%




| | Chi-sq | df | *P* |
|---|---|---|---|
| Tagtype | 0.6 | 2 | 0.729 |
| Year | 69.7 | 6 | <0.001 |

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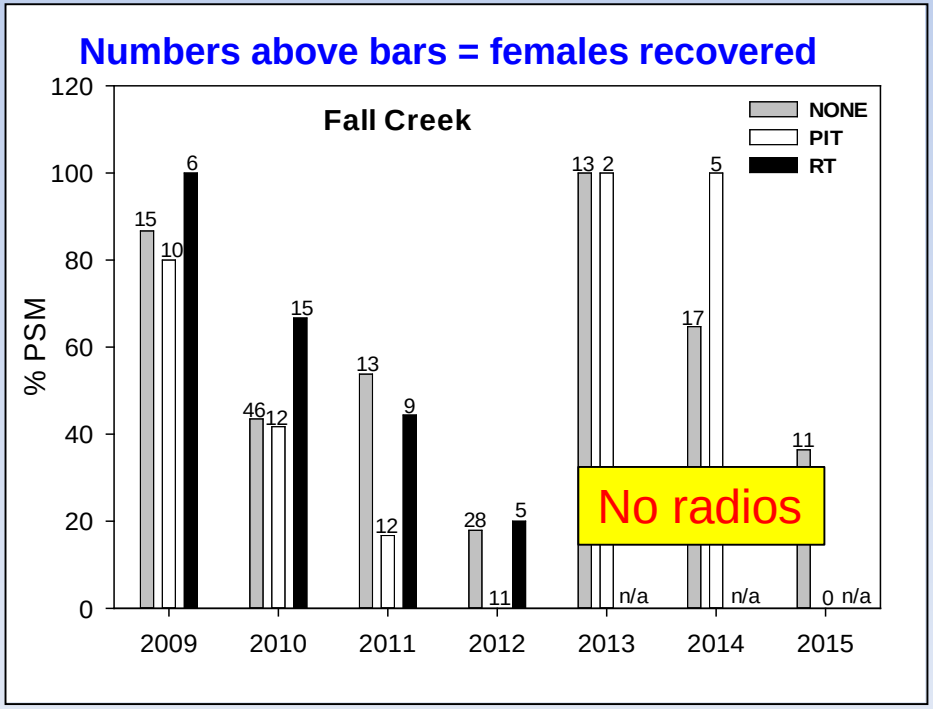
# PSM × tag type: Fall Creek

- Females only (2009-2012)
  - Untagged (*n* = 15-46 / year)
  - PIT-tagged (*n* = 10-12 / year)
  - Radio-tagged (*n* = 5-15 / year)

None: 44.1%

PIT: 33.3%

RT: 60.0%




| | Chi-sq | df | *P* |
|---|---|---|---|
| Tagtype | 6.4 | 2 | 0.040 |
| Year | 30.7 | 3 | <0.001 |

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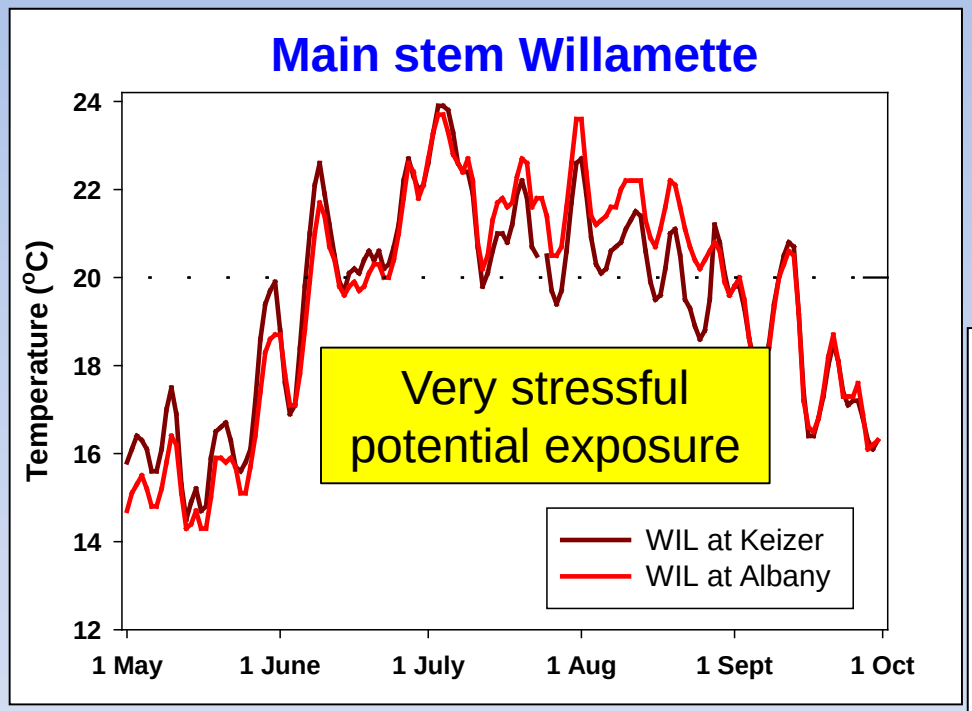
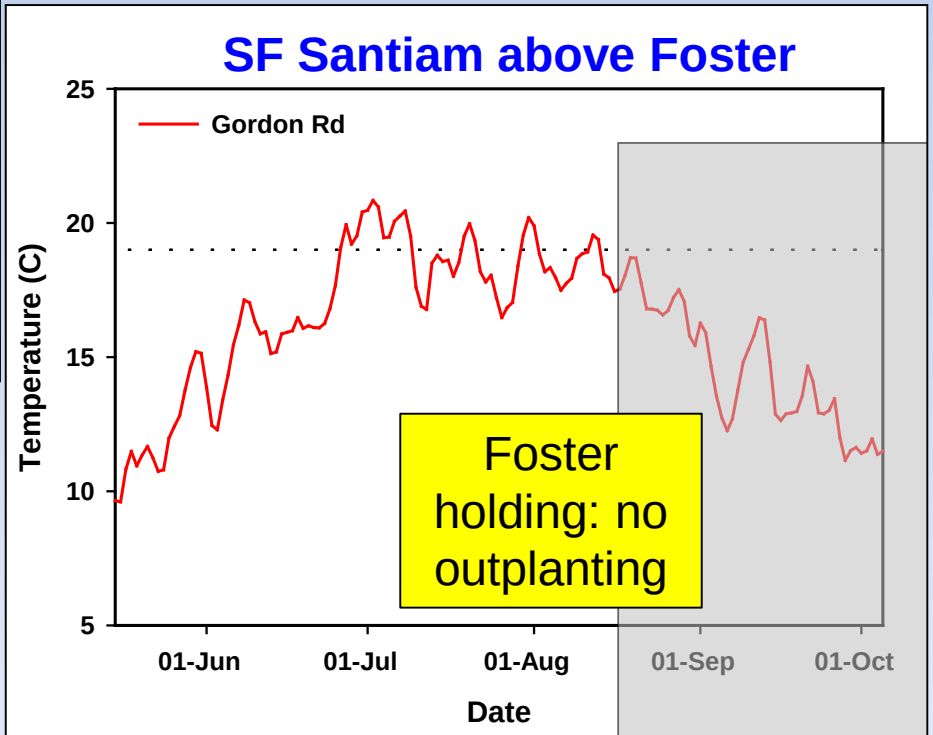
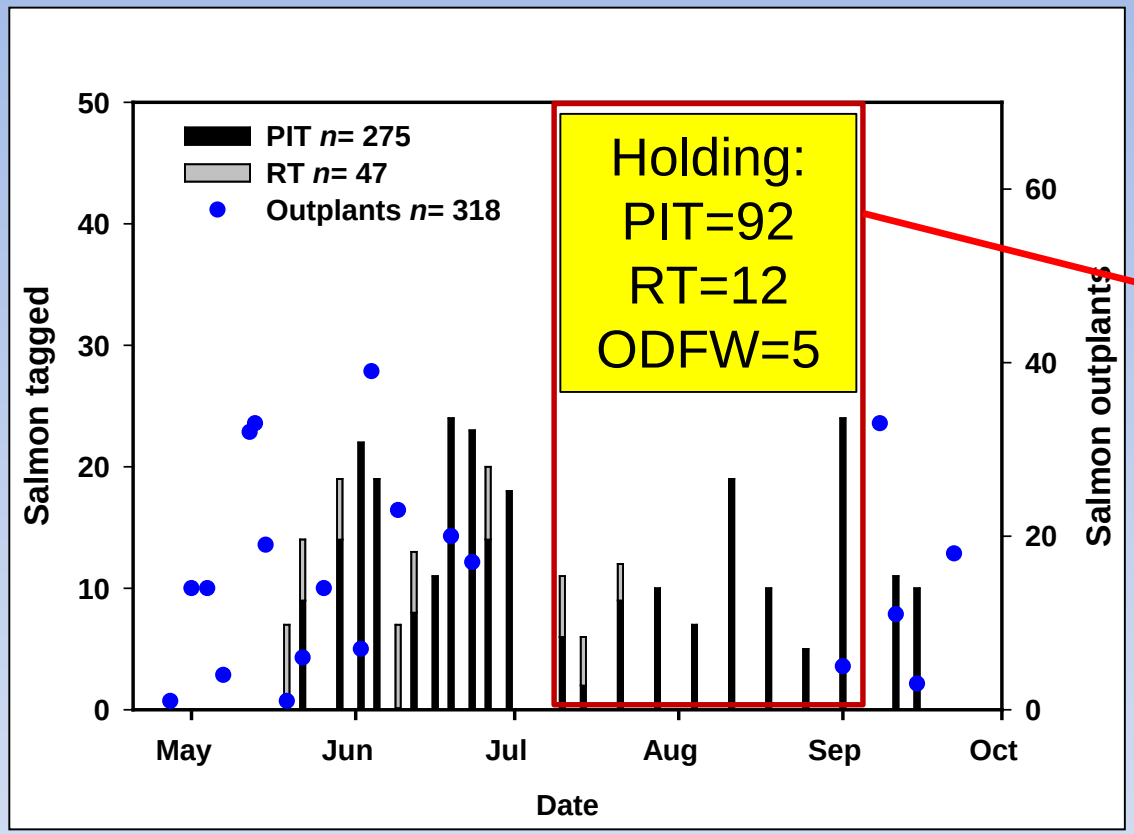
# South Fork Santiam: 2015

- High water temperature confounded study



# South Fork Santiam releases




1) High-risk fish

2) Methods very different from previous years

# SF Santiam: the 2015 narrative

- Ponding decision: 2 July (Gordon Road: 19 °C)
- 104 fish ponded (92 PIT, 12 RT), 11 July to 7 Sept
- 18 mortalities: 9% of PIT, 83% of RT, 17% of total

Radio-tagging hastened demise

- Broodstock mortalities 107 of 1,293 (8%)
  - Additional visual culls
  - Another 19% culled after ELISA for BKD

Very high mortality
Typical: ~2%

- 14 Foster mort samples sent to OSU
  - Positive for *C. shasta*, *Aeromonas* and *Psuedomonas*
  - *Columnaris* suspected but inconclusive due to frozen tissue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# 2015 PIT and Radio recovery rate

| Location | # Released | | # Recovered on SG | | % Recovered on SG | |
|---|---|---|---|---|---|---|
| | PIT | Radio | PIT | Radio | PIT | Radio |
| Fall Creek | 93 | 0 | 5 | — | 5.4% | — |
| NFMF | 166 | 75 | 22 | 10 | 13.3% | 13.3% |
| **SF Santiam** | **267** | **23** | **69** | **3** | **25.8%** | **13.0%** |
| **SF (Foster Res)** | **—** | **14** | **—** | **0** | **—** | **0%** |

- Includes males and females

- **Relatively high recovery rate**

3 temperature pods recovered sans carcass

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# 2015 Female Prespawn Mortality

| Location | Suitable females recovered | | PSM | | % PSM | | |
|---|---|---|---|---|---|---|---|
| | PIT | Radio | PIT | Radio | PIT | Radio | Total |
| Fall Creek | No suitable recoveries | | | | | | |
| NFMF | 4 | 3 | 3 | 1 | 75% | 33% | 57% |
| SF Santiam | 24 | 1 | 9 | 0 | 38% | 0% | 36% |
| SF (Foster Res) | No suitable recoveries | | | | | | |

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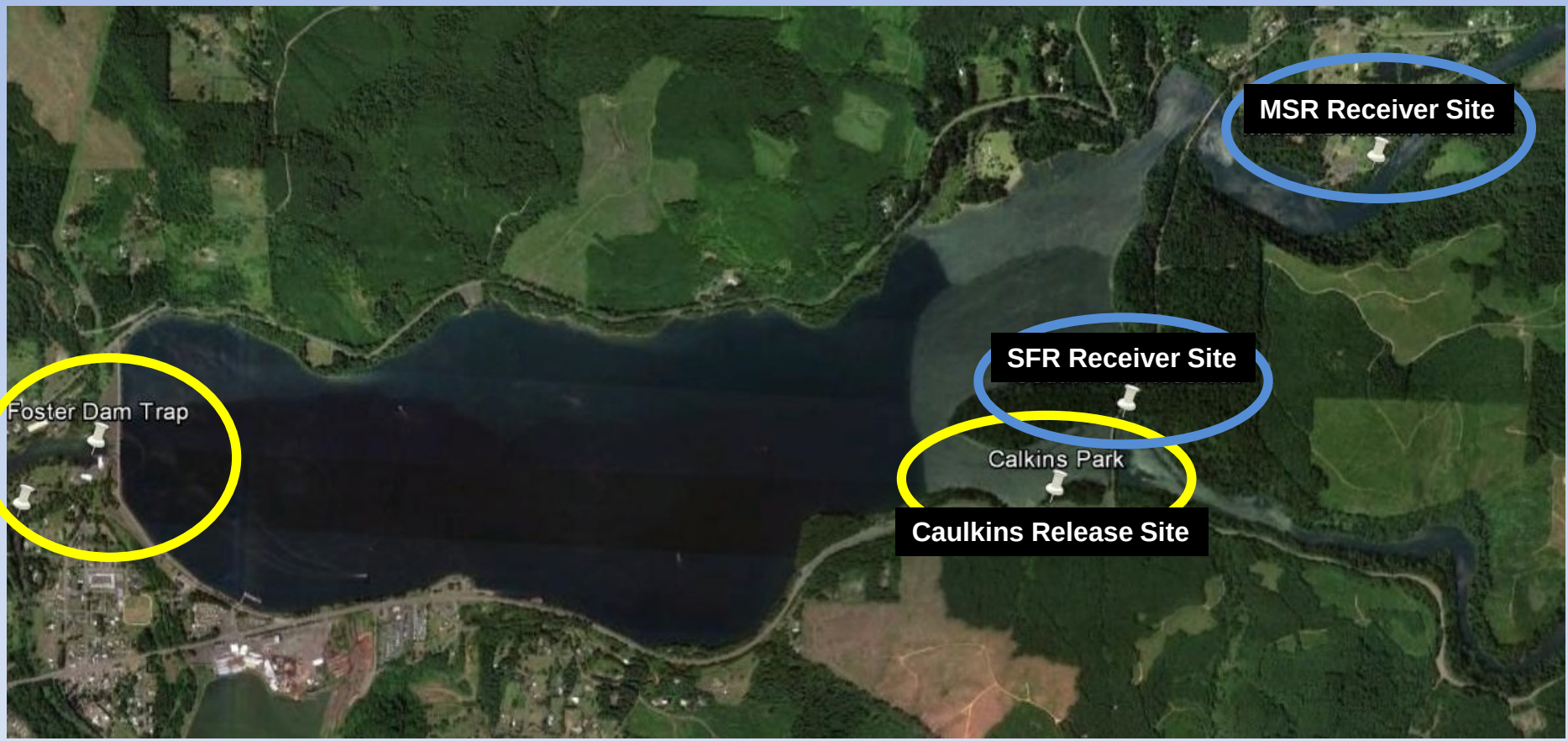
# Foster Reservoir release study

- Do salmon use hypolimnetic refuge prior to tributary entry?

# Receiver sites near Foster

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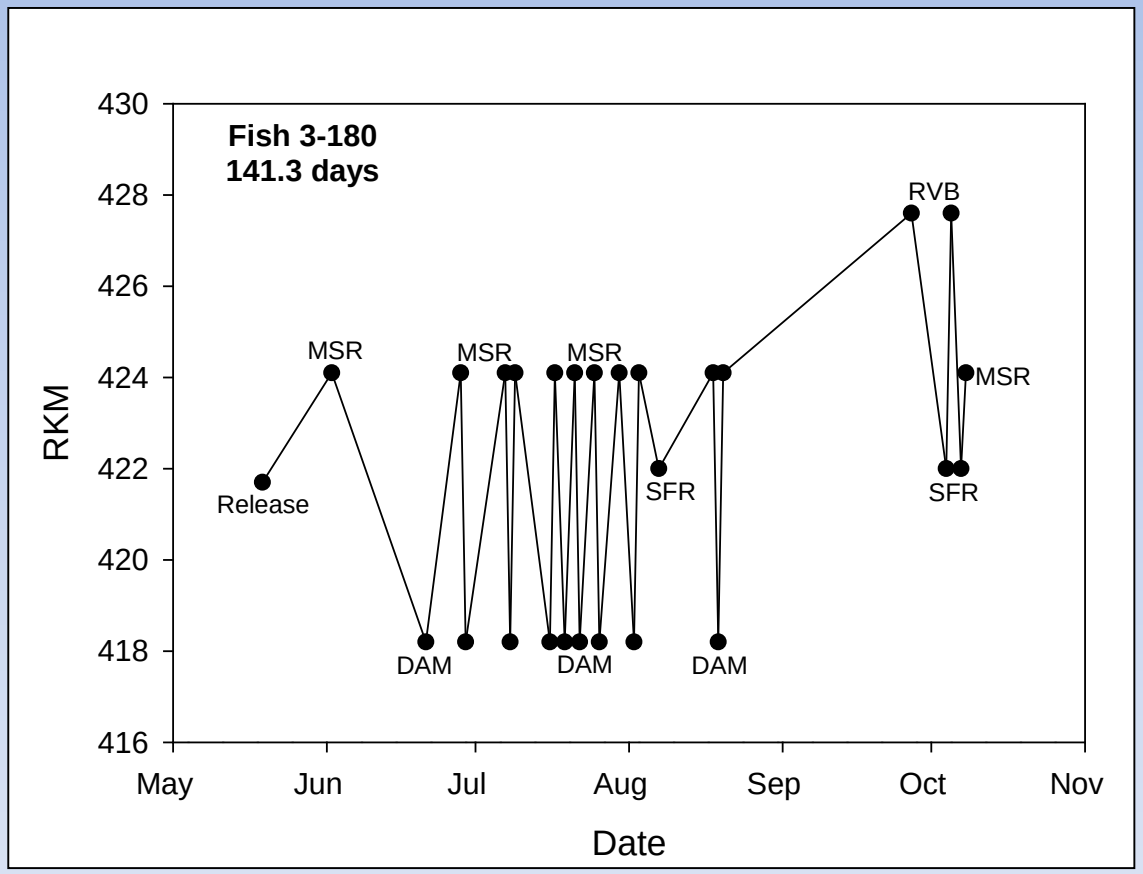
# Salmon behavior in reservoir




**2014: 23% (10/44) fell back**

- **~1-32 d in reservoir before fallback**

**2015: 14% (2/14) fell back**

- **13-16 d in reservoir before fallback**

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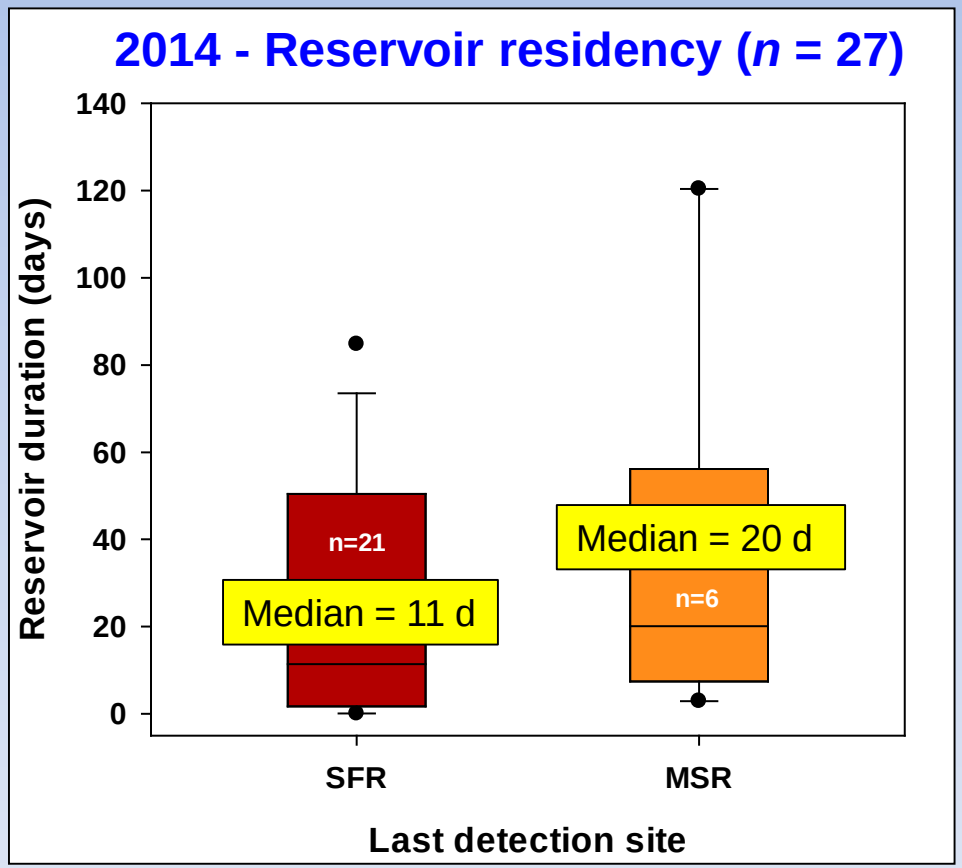
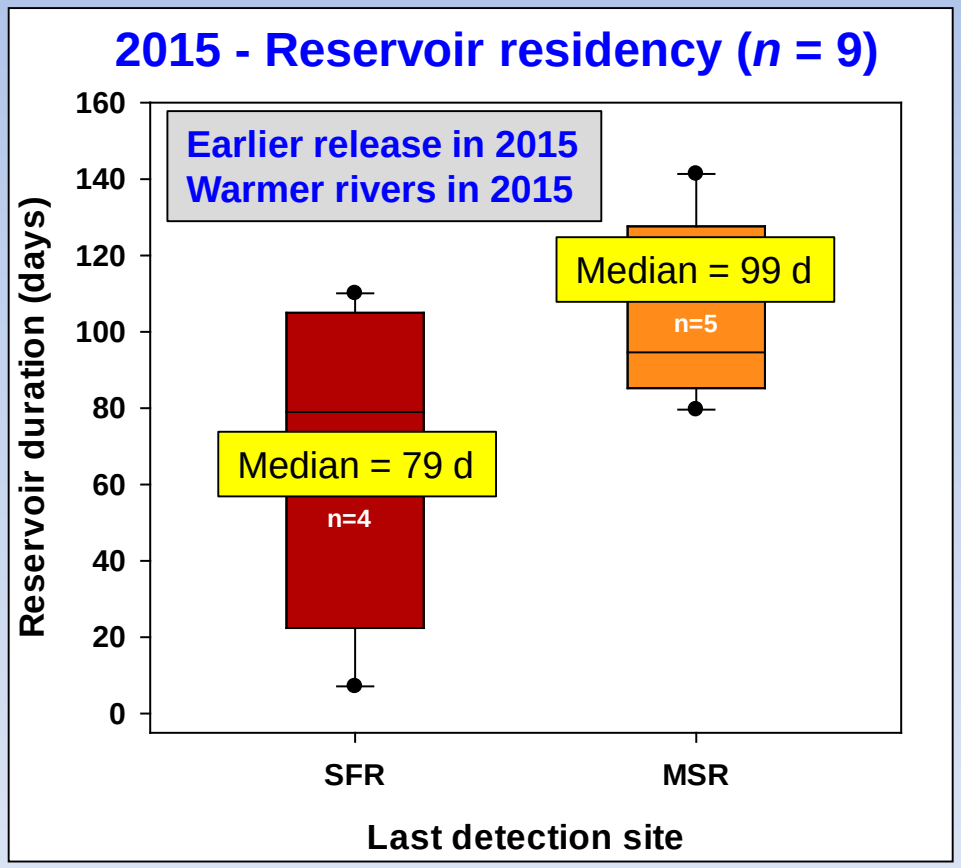
# Salmon behavior in reservoir

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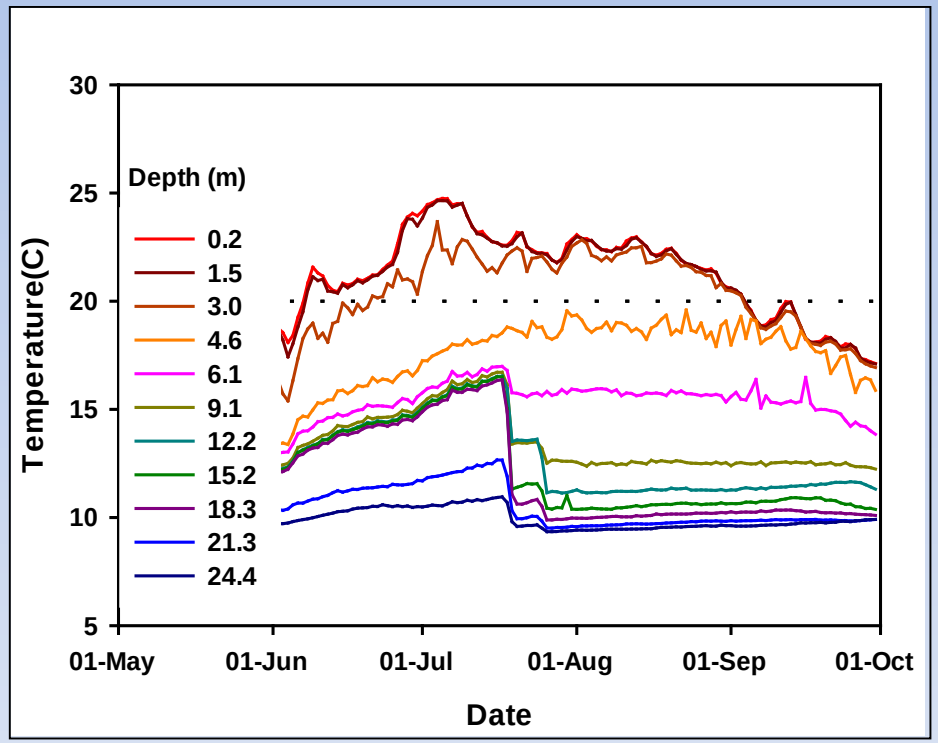
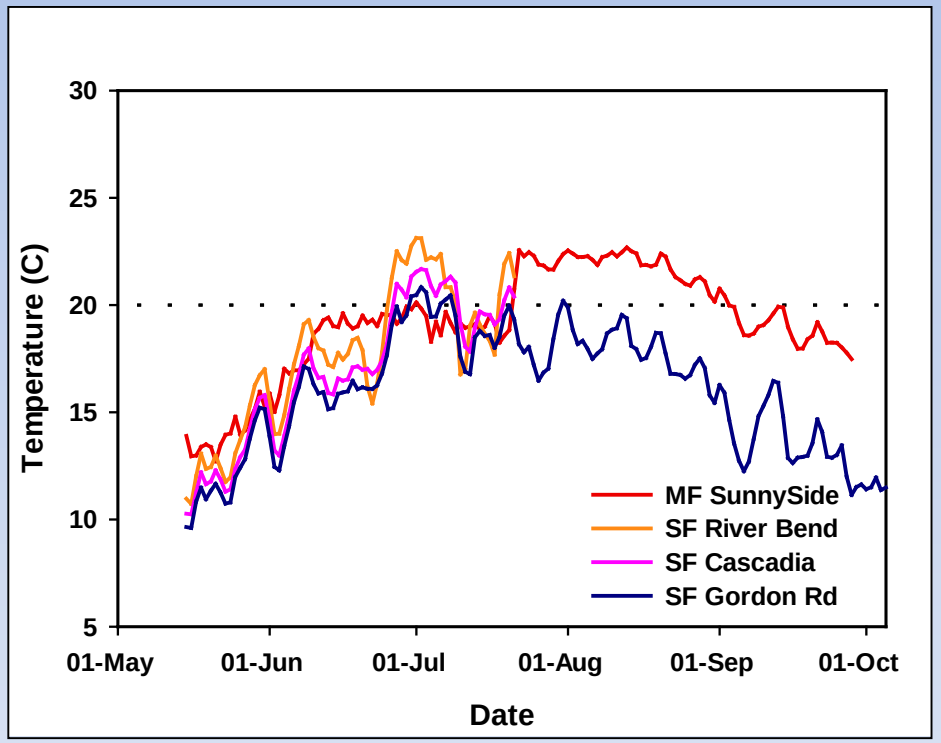
# Reservoir & river temperatures

**Foster Reservoir (USACE FOS_S1 Temperature String)**




**South Fork and Middle Santiam River sites upstream from reservoir**

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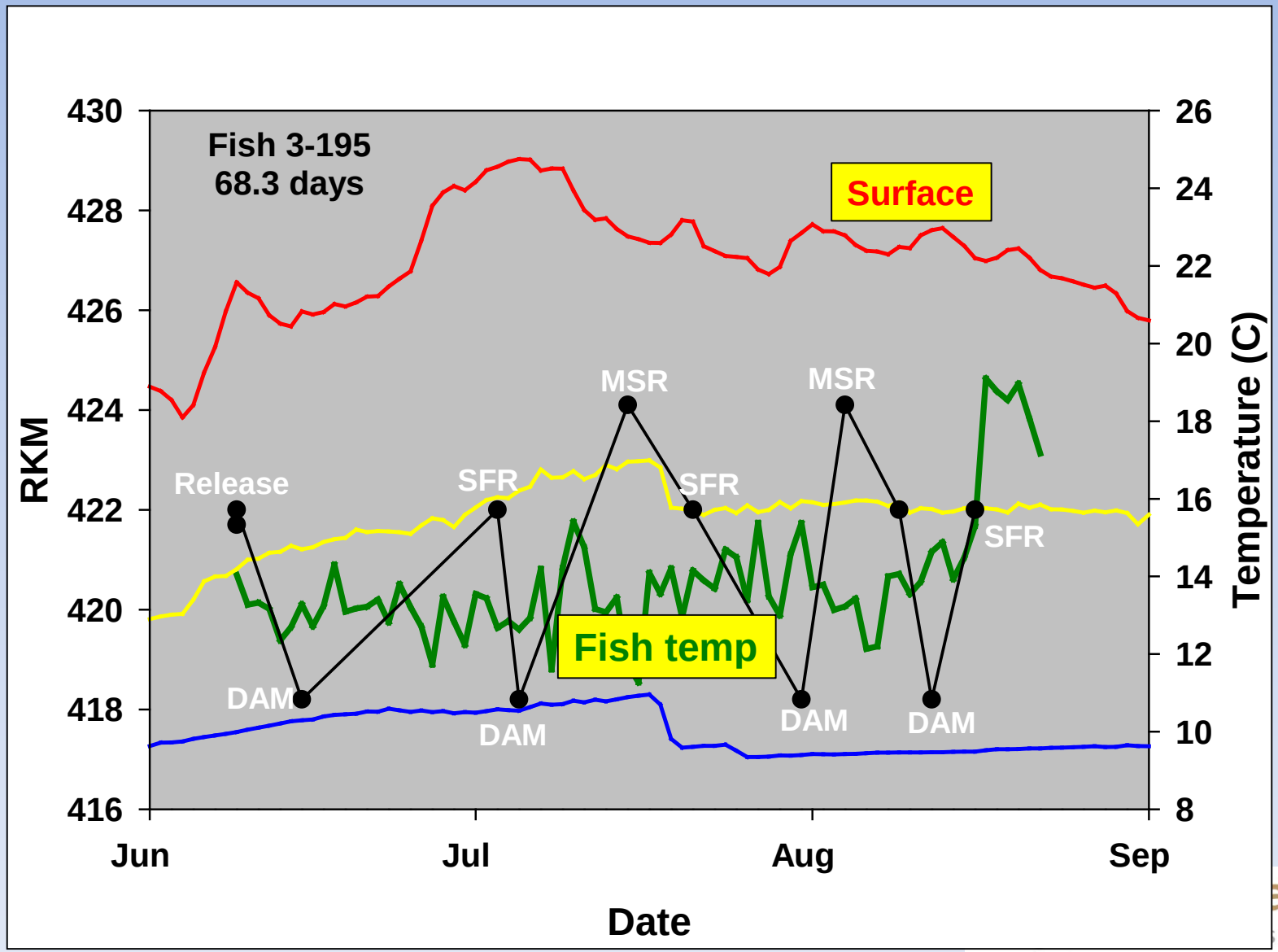
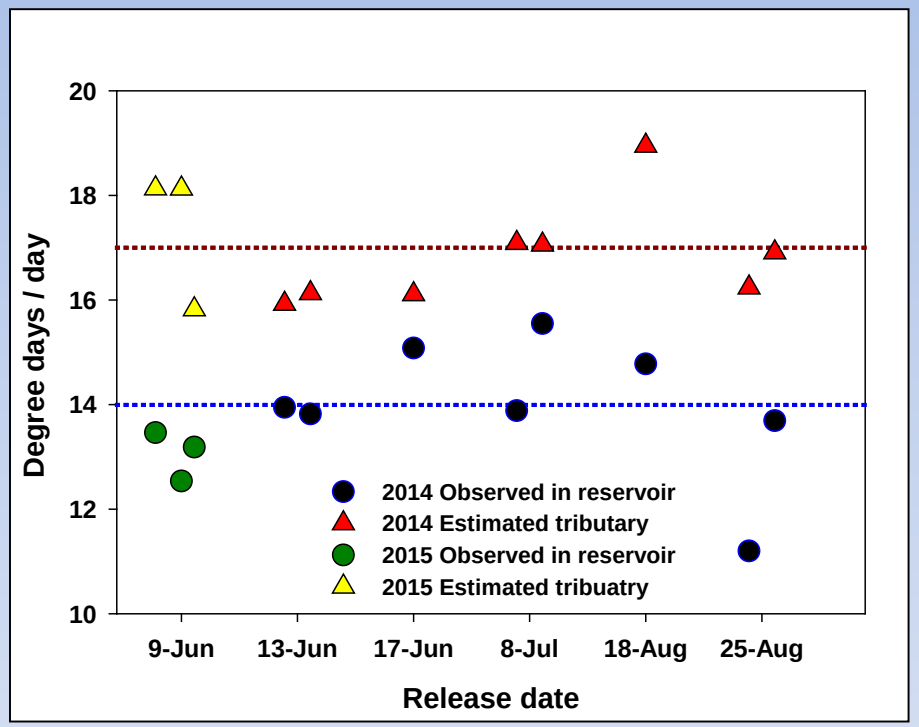
# Thermal history in reservoir

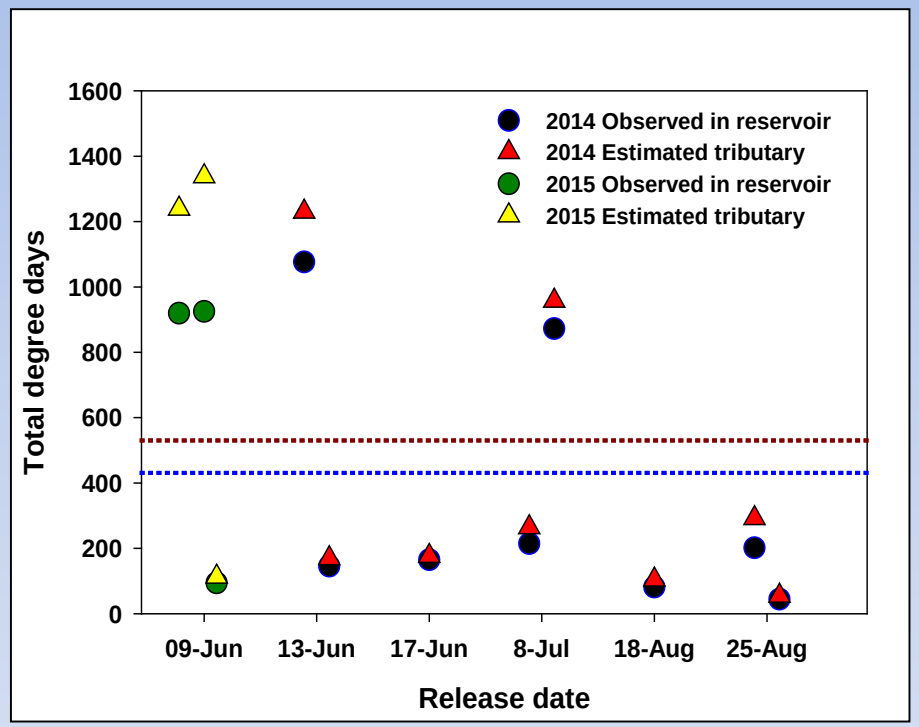


# Thermal benefit of reservoir release

**Mean benefit = 3.3 degree days/d**




**Mean benefit = 99 Total degree days / fish**




- **Data from 11 fish with recovered thermal loggers**

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# Summary

- Prespawn mortality
  - Toxins: No smoking gun
  - NFMF: 57% mortality = highest across study years
  - S Santiam: ~36% = high, but confounded
  - Fall Creek: hot, no suitable carcasses collected
- Foster Reservoir releases
  - Extended holding (up to 3+ months)
  - Thermal benefit compared to river
- Minto: project stopped


***Adult salmon study truism:***
***'The most important data are often the most difficult to collect'***

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# Acknowledgements


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OSU

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