

Willow Creek salmonid use and habitat suitability

Salmonid Habitat Restoration Priorities Meeting

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June 1, 2022



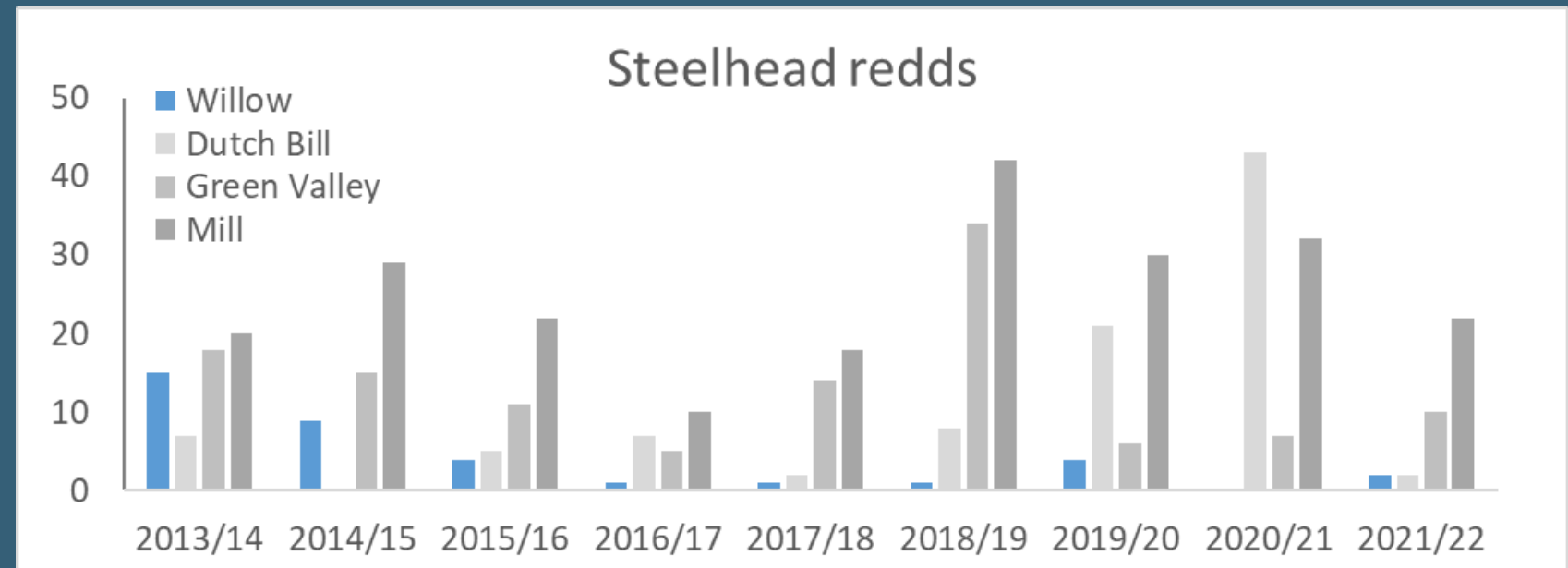
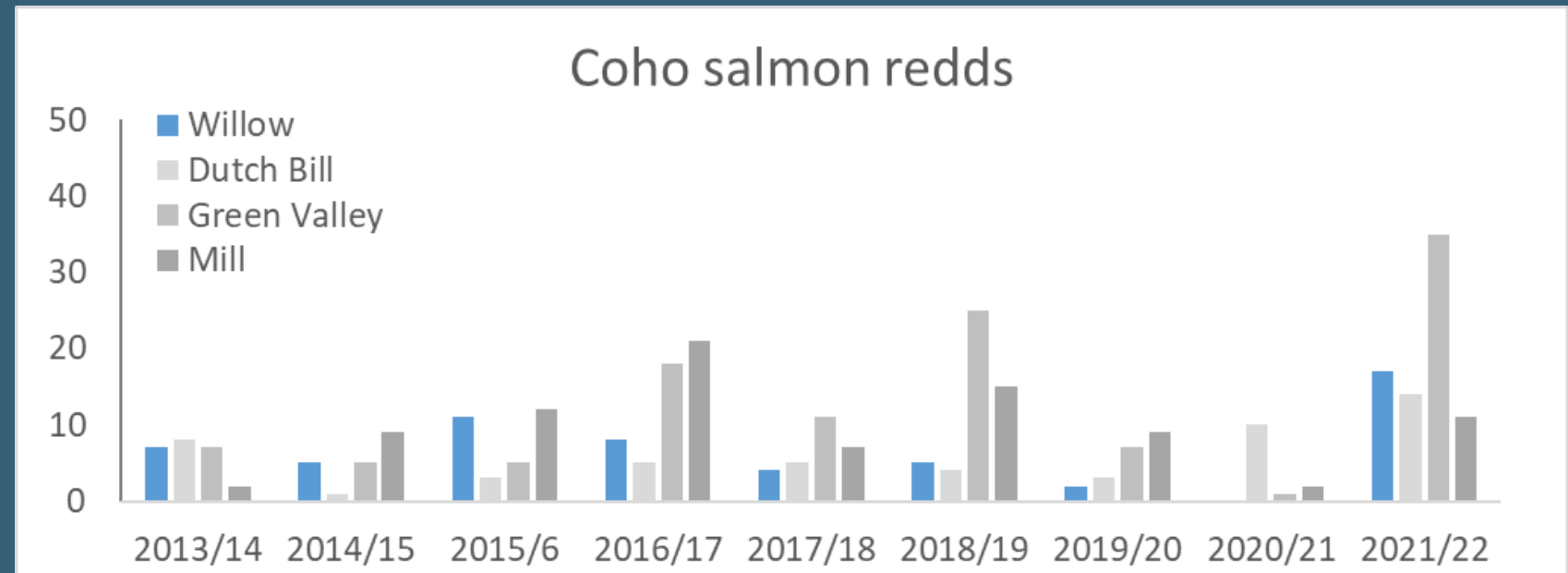
Introduction



- CA Sea Grant and Sonoma Water data and outcomes from salmonid life-cycle monitoring and summer habitat assessments over past $\pm$ decade
- In most cases, data collection not designed to specifically assess SHaRP attributes, but we can draw conclusions or make assumptions about some attributes from data and observations

Willow Creek salmonid redd observations

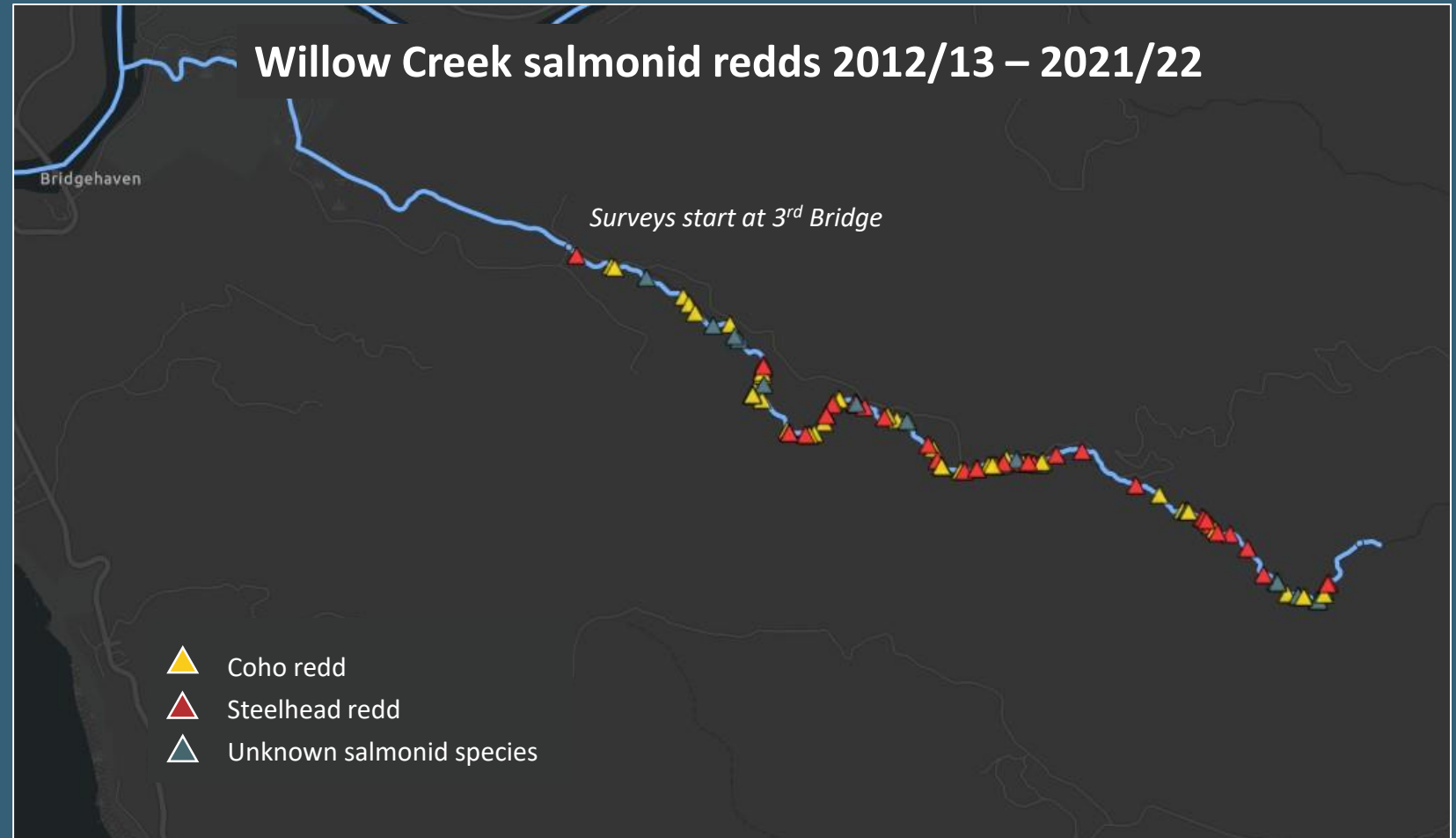
- Fish return to Willow to spawn in most years
- Of all redd observations in 4 LCM/ SHaRP streams over past 9 years, 19% of coho and 8% of steelhead were in Willow
- No redds observed in drought winter of 2020/21



Coho and steelhead redds observed during Coastal Monitoring Program spawner surveys.

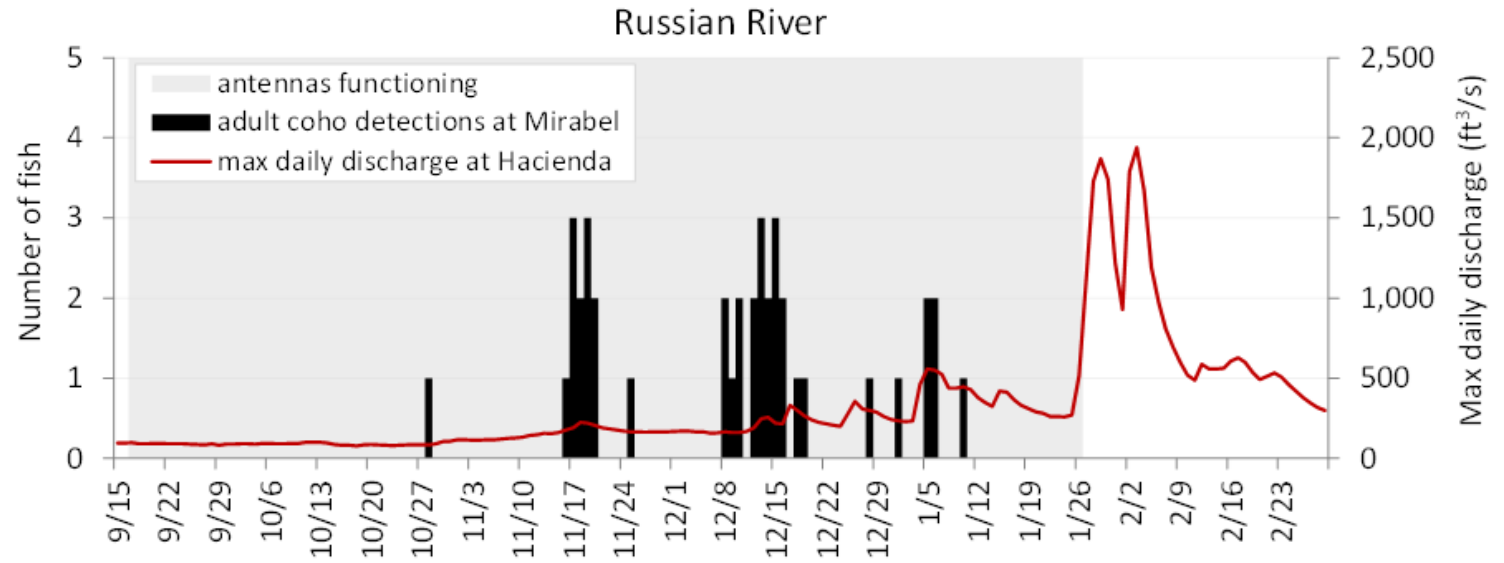
Spawning distribution

- Surveys start at 3rd bridge – very limited spawning habitat downstream
- Coho and steelhead spawning distributed fairly evenly throughout upper reaches
- No clear change in pattern across years, when fish can access upper spawning reaches

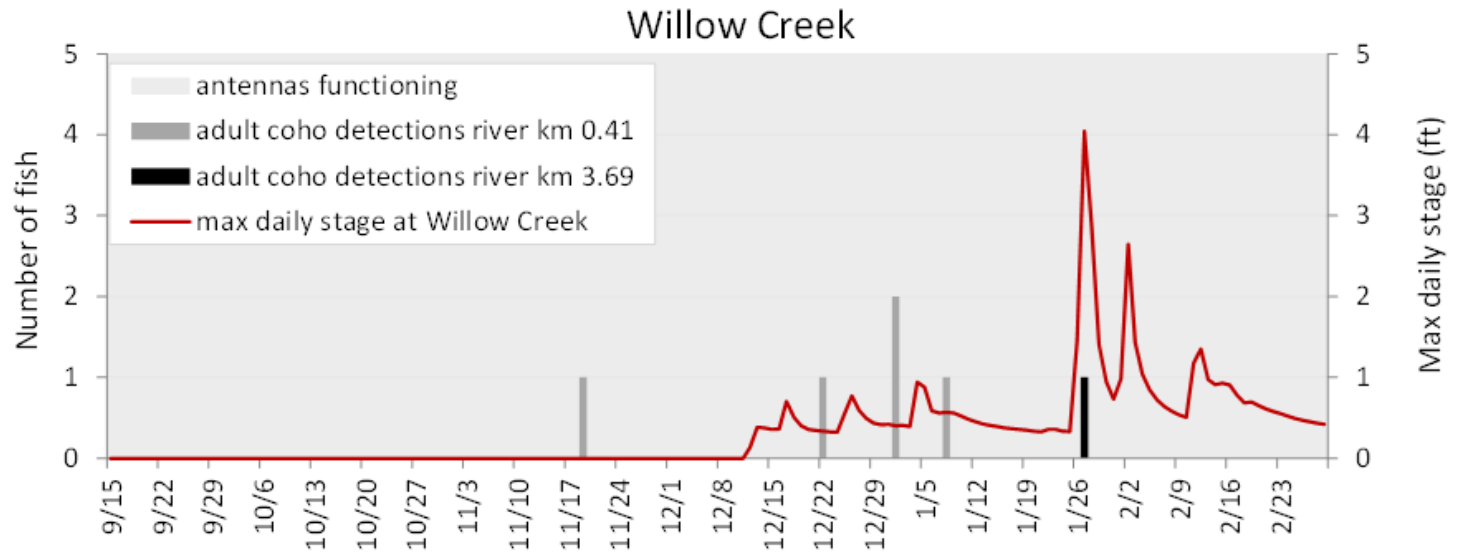


Impacts of water quantity on spawning

- Adults cannot access Willow Creek spawning habitat until significant rain event occurs
- Winter 2020/21, adults entered river in fall, a few entered lower Willow November, but not upper spawning reaches until large rain event last week of January (1 tagged fish)
- No redds observed, no yoy following summer
- Redd stranding: In winter of 2021/22, 12 of 17 redds observed (71%) became dry or partially dry during spawner season

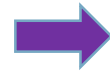


Detections of PIT-tagged coho salmon adults passing upstream of the Mirabel Russian River antenna array, September 15, 2020 - March 1, 2021. Discharge data from USGS.



Detections of PIT-tagged coho salmon adults entering Willow Creek between September 15, 2020 and March 1, 2021. Stage data from CSG.

Spawning adults and redd success



Attribute: Water Quantity

- **Key points:*
 - *Salmonids using entire stream above 3rd Bridge for spawning*
 - *Adult passage appears limited during low flows in braided sections of stream between 2nd and 3rd Bridge*
 - *Passage requires significant rain event*
 - *During winter drought conditions in 2020/21, no spawning observed – could become more common with increased dry conditions*
 - *In dry or flashy water years, redd sites can dry prior to fry emergence*
 - *Changing climate patterns, including later rainy season onset, increase in winter and spring drought conditions, and flashier storm events appear to be reducing spawning window and success*



Coho salmon in Willow Creek

Young-of-the-year distribution, wet year: 2019

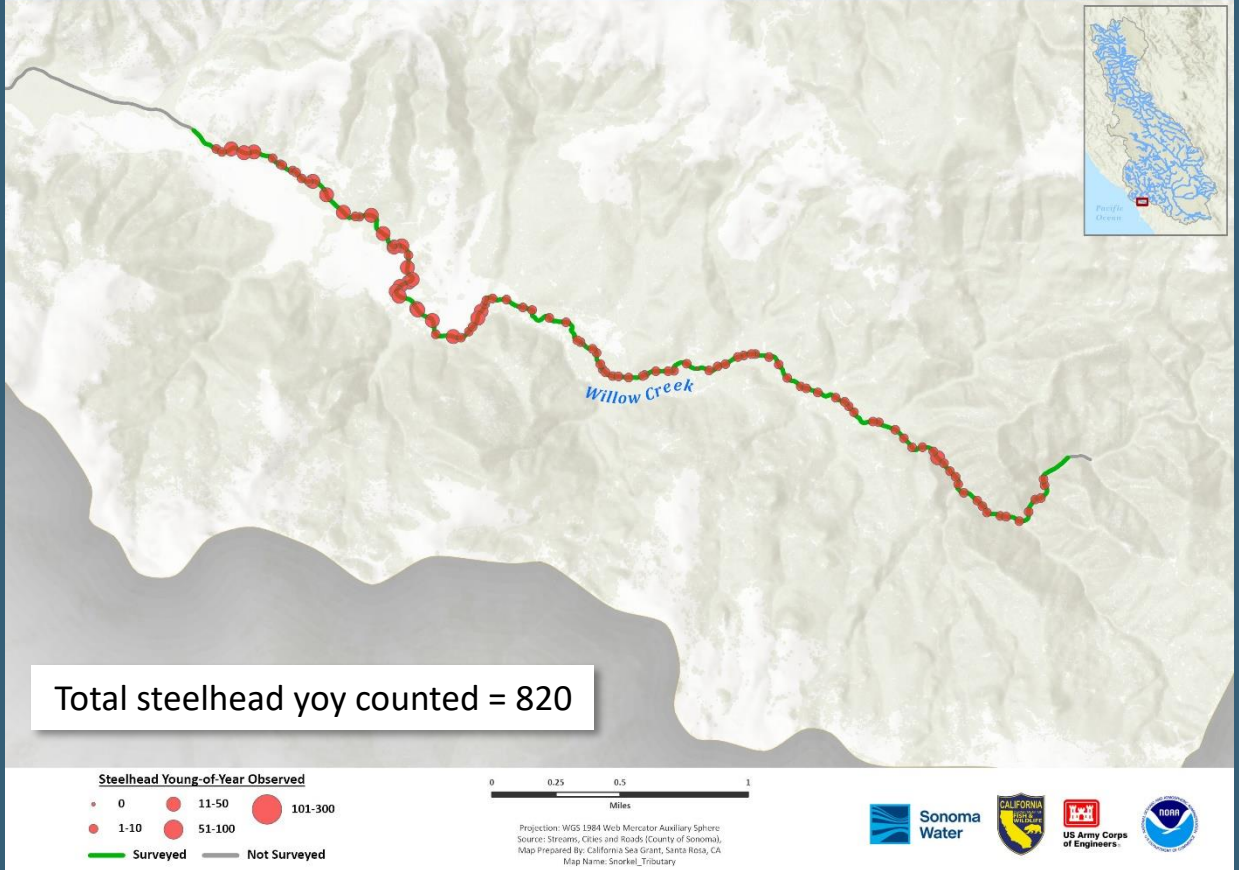
2019 Willow Creek: Juvenile Coho Salmon Distribution

Russian River Salmon and Steelhead Monitoring Program



2019 Willow Creek: Juvenile Steelhead Distribution

Russian River Salmon and Steelhead Monitoring Program

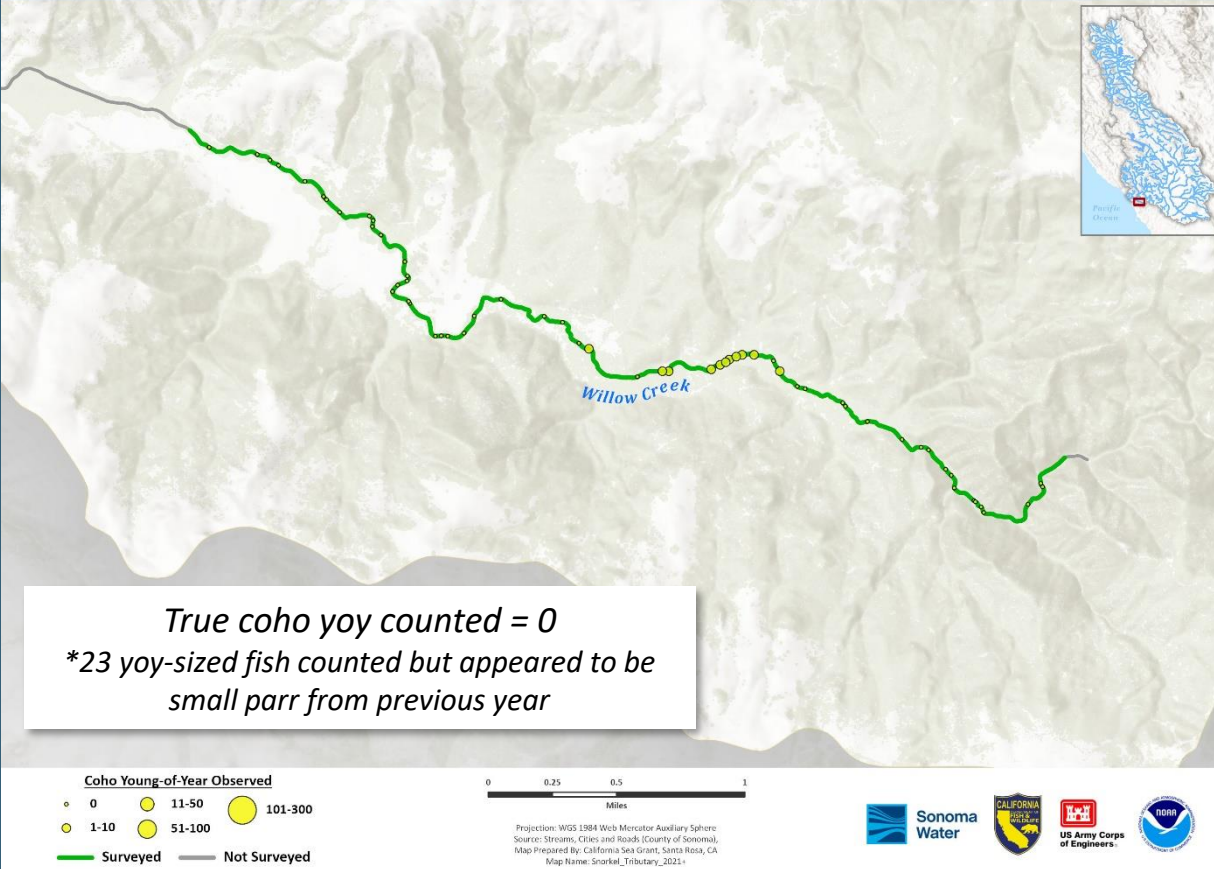


- Fish observed during summer 2019 Coastal Monitoring Program snorkel surveys (every 2nd pool)
- Yoy distributed throughout stream when winter/spring flows sufficient to allow access to all of stream, follows previous winter's redd distribution

Young-of-the-year distribution, winter drought year: 2021

2021 Willow Creek: Juvenile Coho Salmon Distribution

Russian River Salmon and Steelhead Monitoring Program



2021 Willow Creek: Juvenile Steelhead Distribution

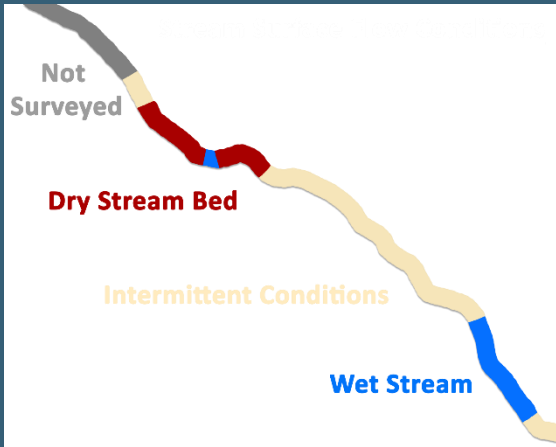
Russian River Salmon and Steelhead Monitoring Program



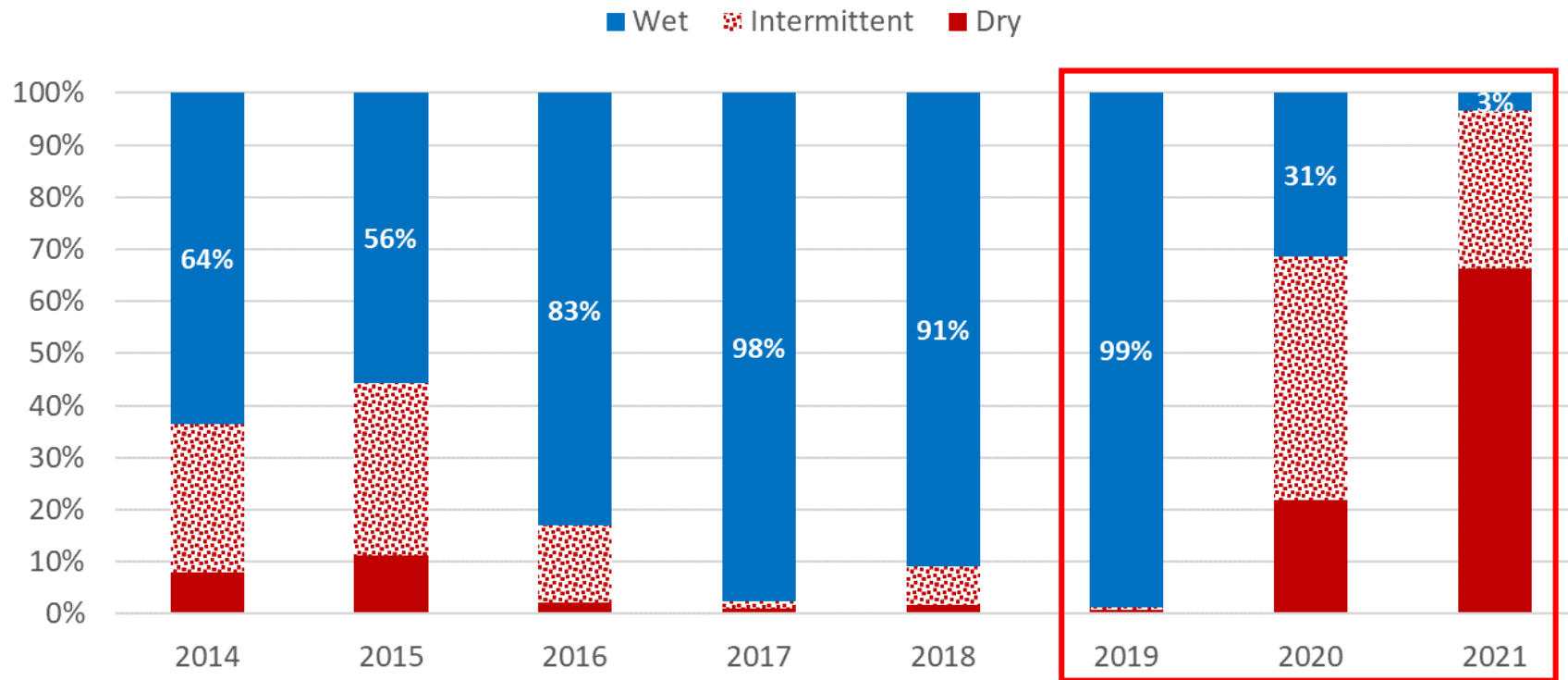
- No salmonid yoy observed
- **Key point: Rearing occurred throughout all of stream above 3rd Bridge except in year following winter drought of 2020/21*

Late-summer wetted habitat

➡ Attribute: Water Quantity



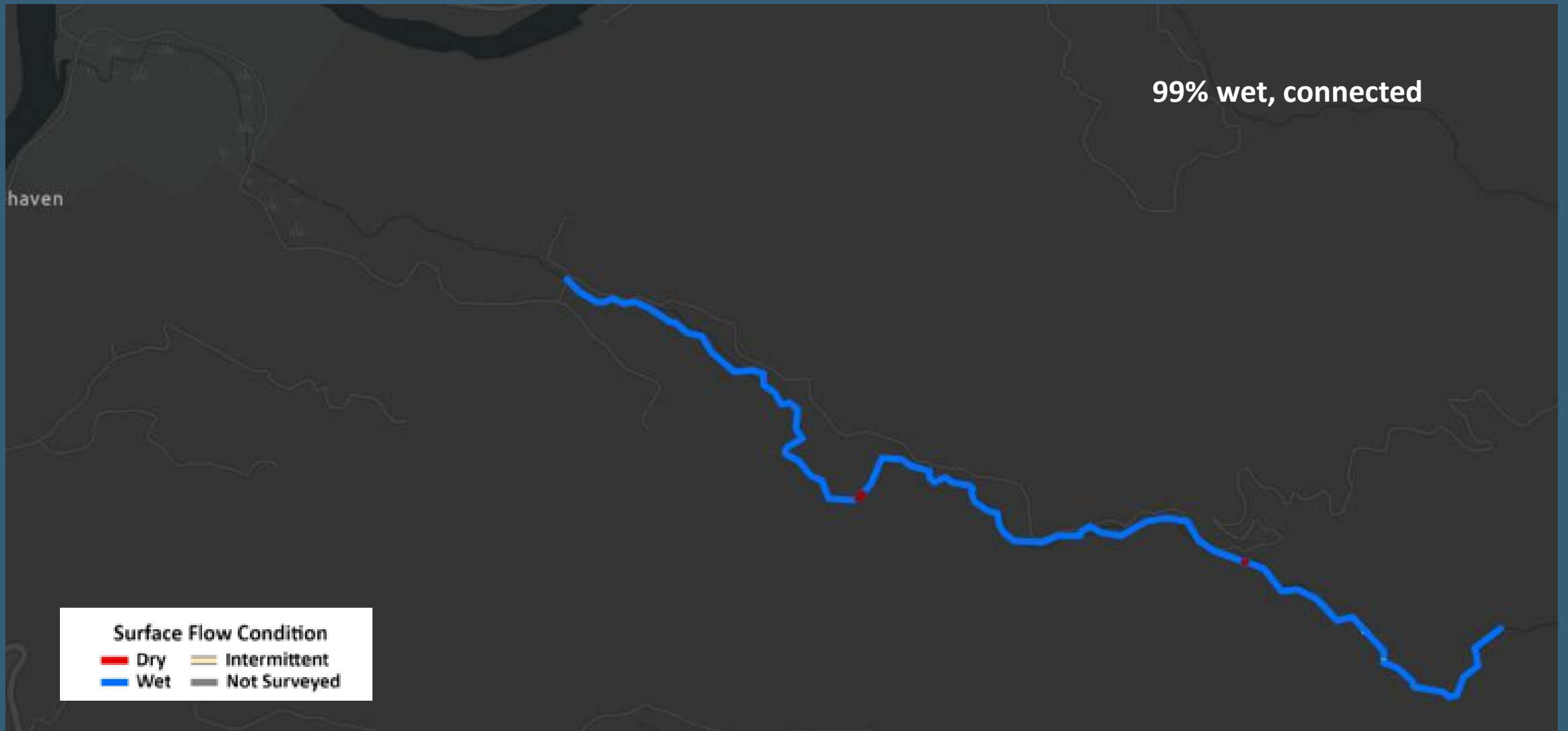
Willow Creek baseflow channel conditions



Total proportion of Dutch Bill Creek stream channel that is wet, dry, or intermittent at driest time of year. Flow release implemented in summers of 2015, 2016, 2018-2021. Length of channel sampled varied between years.

- On average over past 8 years, 66% of Willow Creek above 3rd Bridge stayed wet and connected through the dry season
- Sharp reductions in recent drought years - only 14% remained wet when averaged over past 2 years

Baseflow wetted habitat - 2019



Baseflow wetted habitat - 2020



Baseflow wetted habitat - 2021

➡ Attribute: Water Quantity, possibly Sediment Conditions

- **Key points:*
 - *Willow Creek is flow-impaired for rearing fish*
 - *Experienced rapid decreases in available summer wetted habitat in recent drought years, if pattern continues will not be able to support rearing juveniles*
 - *Possibly influenced by sediment delivery, bedload redistribution in addition to reduced flow*

3% wet, connected

Surface Flow Condition

Dry	Intermittent
Wet	Not Surveyed

Summer dissolved oxygen

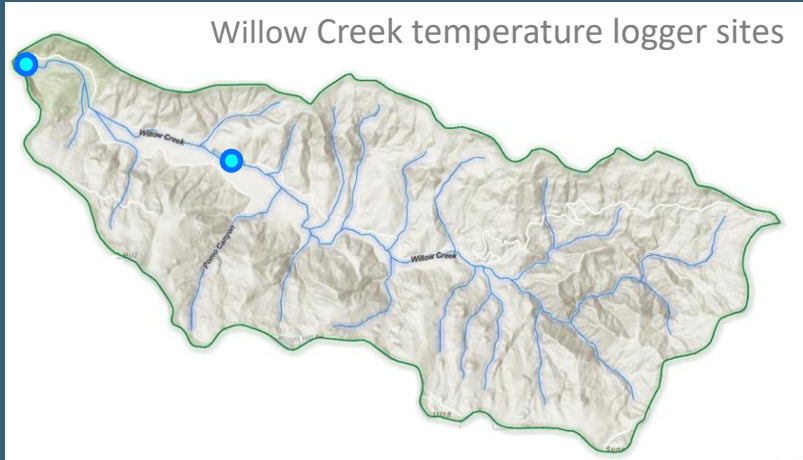
- Spot measurements of dissolved oxygen taken during late-summer wetted habitat surveys 2017-2021

Year	Minimum DO (mg/L)	Stream average DO (mg/L)	Maximum DO (mg/L)
2017	4.22	6.50	9.43
2018	1.82	6.01	9.68
2020	0.08	2.45	6.91
2021	1.09	2.86	7.25

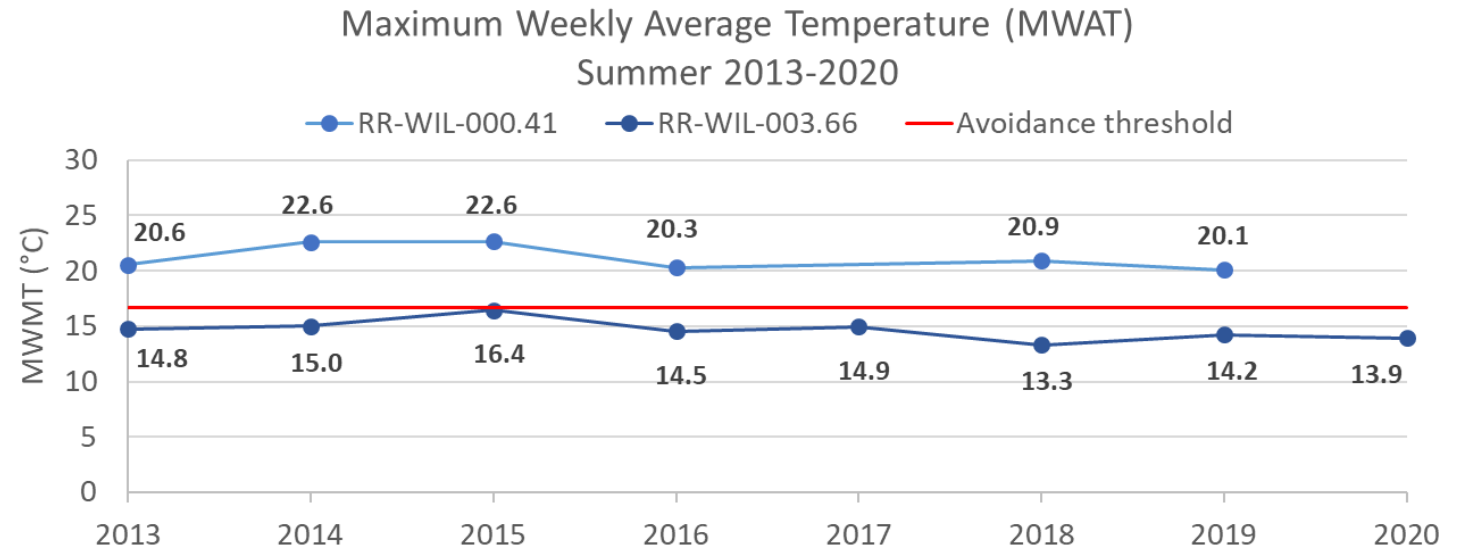
- Wet year (2017- only lower sample reach) – 64% of pools met objective, 100% above mortality threshold
- Dry year (2020) – 2% of pools met objective, 35% above mortality threshold
- DO generally lowest in lowest section of sample reach



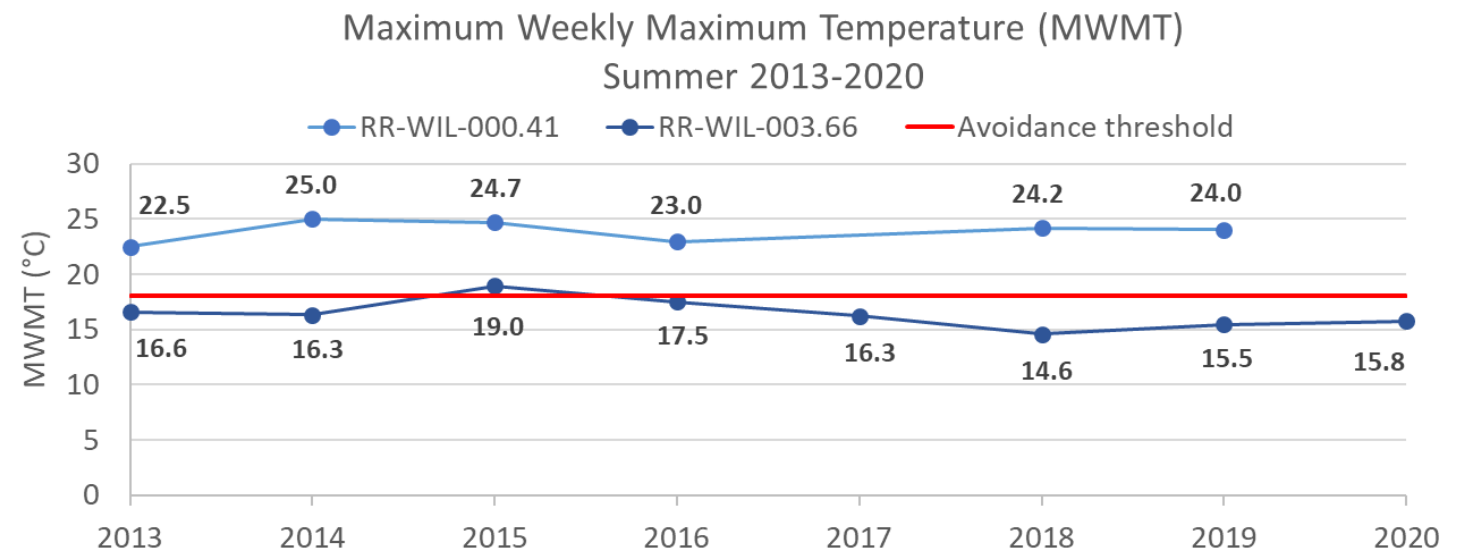
Summer water temperature



- Temperatures in lower gauge pool exceeded salmonid avoidance thresholds all summers
- Max temperatures in lower gauge pool above 20°C salmonid impairment level – likely influenced by tidal estuary
- Summer temperatures in upper gauge pool generally suitable for salmonids



Mean weekly average water temperature at lower and upper Willow gauging sites from June 15 -October 16, compared to 16.7°C MWAT avoidance threshold (Welsh et al. 2001)



Mean weekly maximum water temperature at lower and upper Willow gauging sites from June 15-October 16 compared to 18°C MWMT avoidance threshold (Welsh et al. 2001)

Summer water quality



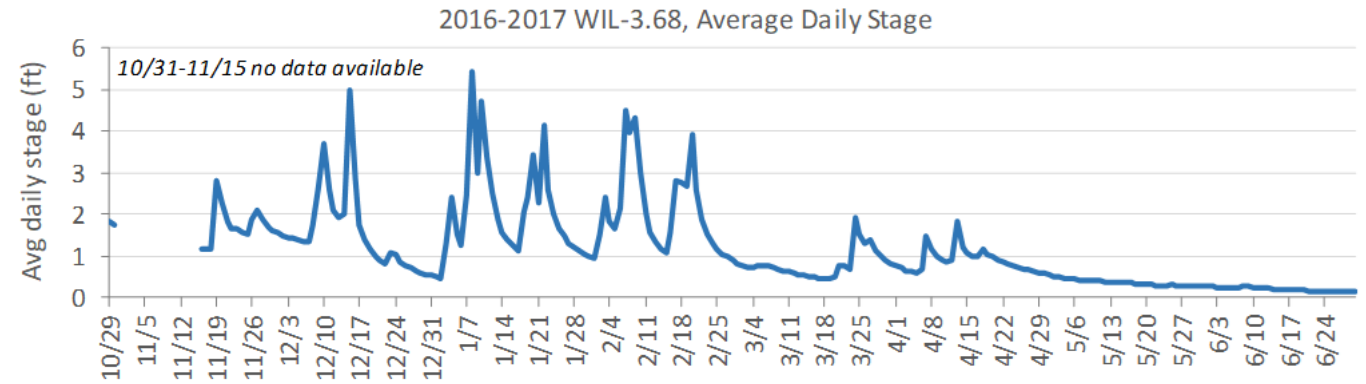
Attribute: Water Quality

- **Key points:*
 - *Summer DO concentrations in Willow Creek appear driven by flow. In general:*
 - *DO not suitable in dry summers with low connectivity*
 - *DO suitable in summers with higher flow and connectivity*
 - *DO higher in upper reach*
 - *Temperatures in upper Willow Creek monitoring pool suitable for salmonids*
 - *Temperatures in monitoring pool at mouth exceeded impairment thresholds*
- 
- Mouth of Willow Creek
- *Fish can tolerate lower DO and higher temperatures as trade-off for greater feeding opportunities*
 - *Lower Willow Creek may be providing valuable growth opportunities, in which case passage between lower and upper reaches with better water quality is critical*

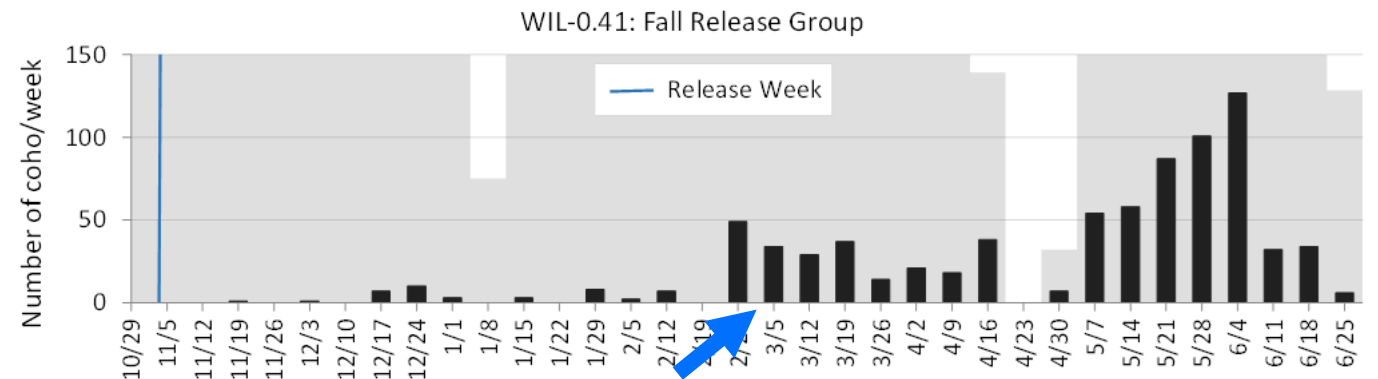
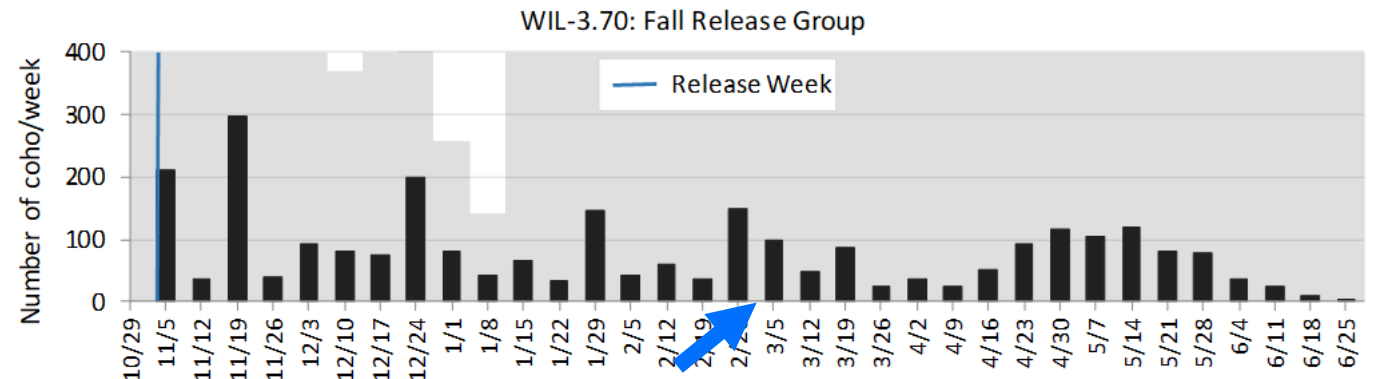
Overwinter rearing – emigration

- Willow Creek has lowest early (pre-March 1) emigration from stream, along with Green Valley Creek
- Fish leave upper reaches over fall/winter at relatively high rate, move into lower reach between 3rd Bridge and mouth to overwinter
- Winter 2016/17: Estimated 30% of fish passed the trap site (WIL-3.70) before March 1, but only 2% left the stream (WIL-0.41) before March 1

**Sample population = hatchery coho stocked previous fall.*



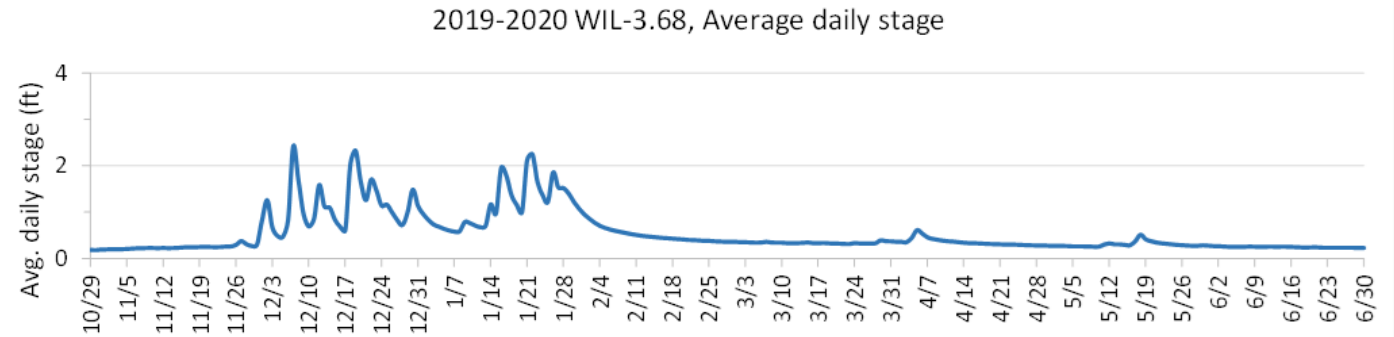
Average daily stage height at Willow Creek smolt trap site, October 29, 2016 - June 30, 2017.



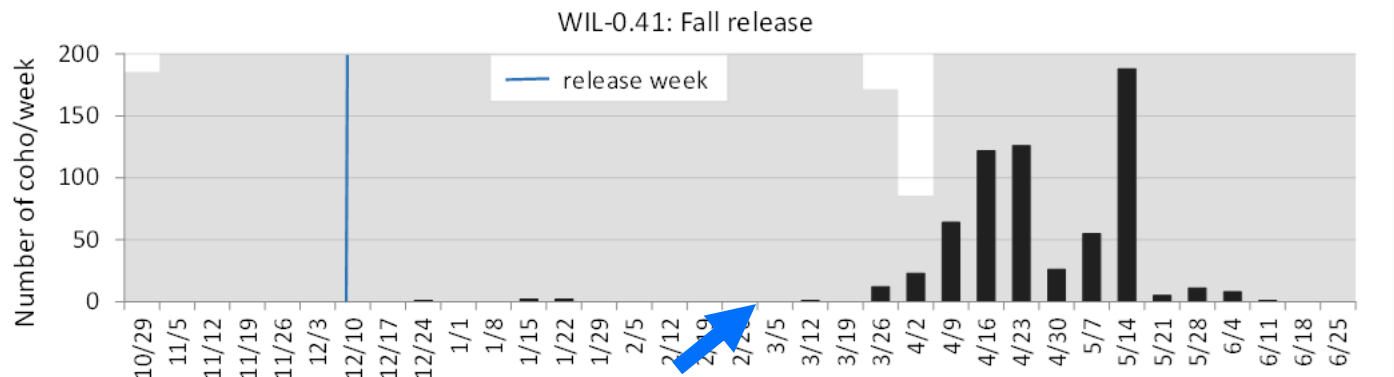
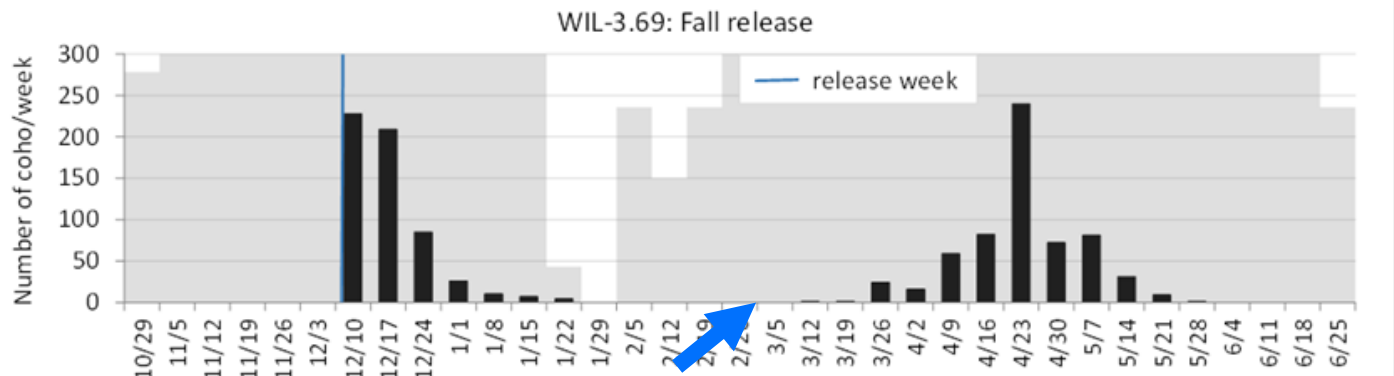
Number of fall-release coho salmon moving past Willow Creek smolt trap site (3.70) and antenna near mouth (0.41) each week between October 29, 2016 - June 30, 2017. Shaded background = % of week antennas and/or traps operating.

Overwinter rearing – emigration

- Drier-than-average, moderate winter - 2019/20 = same story
- Estimated 29% of fish passed the trap site (rkm 3.70) before March 1, but 0% left the stream before March 1

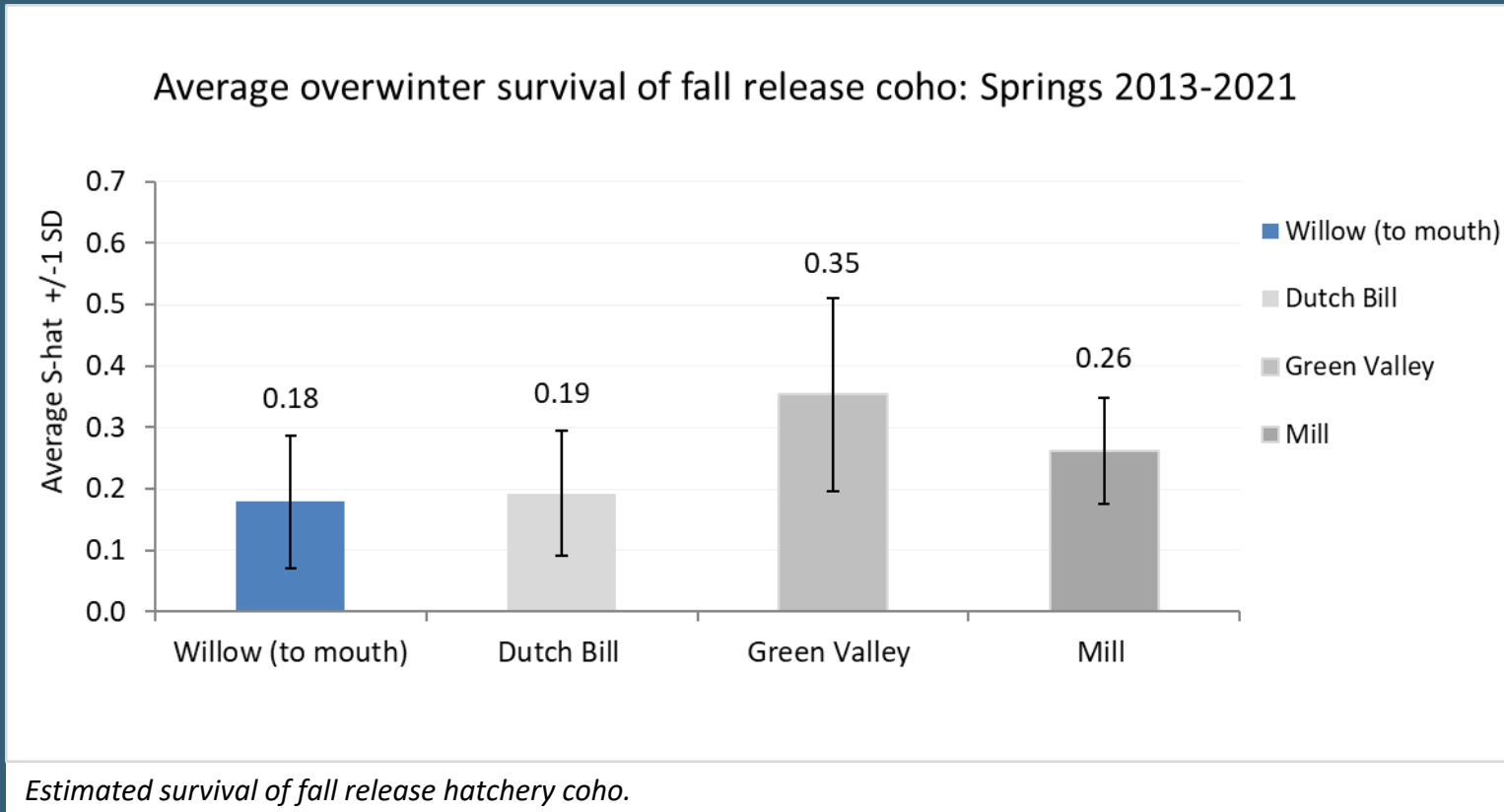


Average daily stage height at Willow Creek smolt trap site, October 29, 2019 - June 30, 2020.



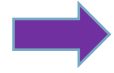
Number of fall-release coho salmon moving past Willow Creek smolt trap site (3.70) and antenna near mouth (0.41) each week between October 29, 2019 - June 30, 2020. Shaded background = % of week antennas and/or traps operating.

Overwinter rearing - survival



- On average over past 9 years, Willow Creek had lowest overwinter survival off all LCM/SHaRP streams
- Low-flow, downstream passage barriers in braided sections of channel between 2nd and 3rd Bridge likely contribute to lower survival

Overwinter rearing

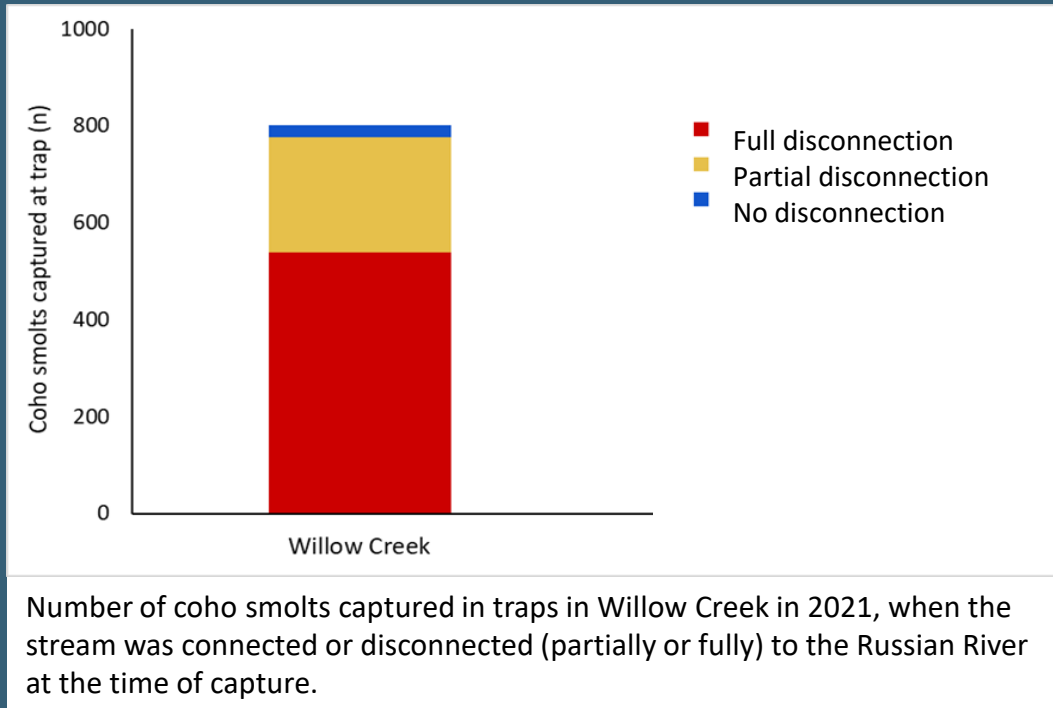


Attributes: Water Quantity

- **Key points:*
 - *Relatively high proportion of juvenile fish leave upper Willow Creek early to overwinter in complex, productive habitat downstream*
 - *Low flow passage barriers in braided sections of stream between 2nd and 3rd Bridge appear to be contributing to low overwinter survival to mouth of stream*
 - *Downstream passage issues likely reducing smolt production*



Smolt emigration



- 2021: Willow Creek partially disconnected from the river in early April, fully disconnected in late April
- 97% of smolts were captured at the trap after the stream was partially or fully disconnected
- Without relocation efforts, very few smolts would have had access to emigrate

Smolt outmigration

➡ Attribute: Water Quantity



- **Key points:*
 - *Braided sections of channel between 2nd Bridge and 3rd Bridge inhibit smolt passage at low flows*
 - *Insufficient spring flows led to early disconnection in April 2021 – would have prevented nearly entire cohort of smolts from completing their life cycle without intervention*
 - *This earliest noted disconnection was due to extreme drought, but may also have been influenced by changes in bedload distribution*

Willow Creek non-native species

➡ Attribute: Invasive and Non-native Species

Non-native aquatic species captured in Willow Creek smolt trap, all years											
Species	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Bluegill	NA	0	0	0	0	0	0	0	0	1	0
Bullfrog	NA	0	1	0	0	0	0	0	0	1	0
Fathead minnow	NA	0	0	0	0	0	0	0	0	0	0
Green sunfish	NA	0	0	0	0	0	1	0	0	0	0
<i>Other non-native species observed during snorkel surveys or trapping, but not listed in table include signal crayfish</i>											

**Key point: Non-native species observed in incredibly low numbers in Willow Creek and do not appear to impact salmonids*

Willow Creek – Key observations

- Complex habitat in lower Willow offers valuable winter rearing opportunities for fish but braided, shallow sections of channel between 2nd and 3rd Bridge present major passage issues for emigrating smolts, and likely adults, at low flows
- Low water quantity has negative impacts on Willow Creek salmonids at all life stages
 - Summer flow impairment in recent years renders the stream unsuitable to support rearing fish
 - Relatively drastic increases in dry channel in Willow Creek in recent drought years, as compared to other Russian River streams – possibly influenced by bed mobility
 - Adult salmonids not able to successfully spawn in 2020/21, likely due to winter drought conditions
 - Early spring disconnection in 2021 cut off vast majority of annual smolt run from river



Iconic photo of wild coho in Willow Creek, 2013: Derek Acomb, CDFW

Willow Creek – key observations

- Upper Willow Creek generally maintains suitable temperatures for rearing salmonids, while the lowest section near the mouth exceeds impairment thresholds
 - Lower section believed to provide valuable growth opportunities, play important role in productivity, but has not been empirically documented
 - Passage between reaches with cooler temps and warmer reaches with higher prey availability is necessary
 - Limited dissolved oxygen data suggest summer DO concentrations are driven by streamflow, further warranting flow improvements
- Invasive species do not appear to have a measurable impact on salmonids in Willow Creek



Iconic photo of wild coho in Willow Creek, 2013: Derek Acomb, CDFW