Mill Creek salmonid use

…and what it tells us about habitat suitability

Salmonid Habitat Restoration Priorities Meeting

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Introduction

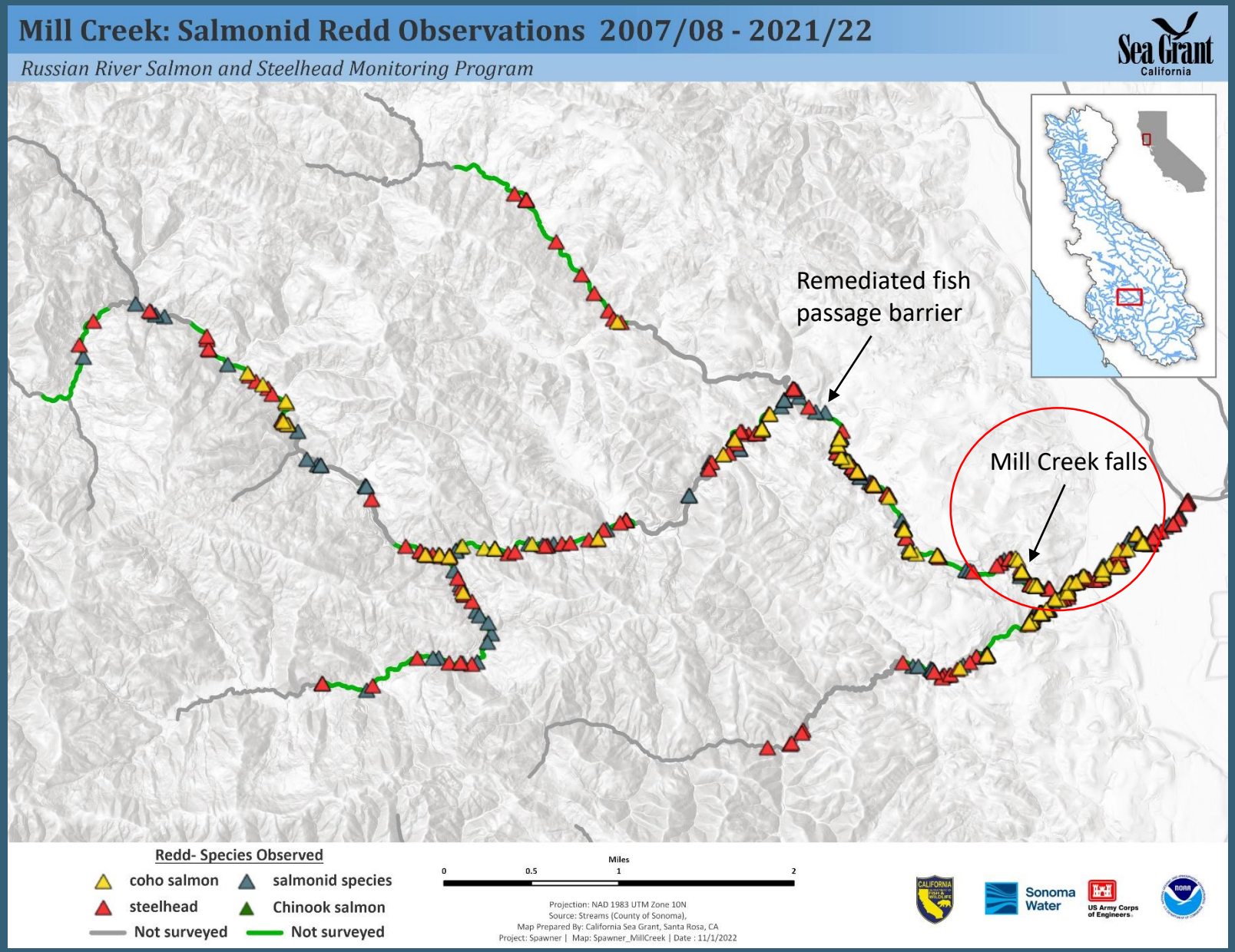
Presentation:

1. Overview – salmon use of watershed and limiting factors by life stage
2. Summary – highlight key points by SHaRP attribute

- Data from CA Sea Grant and Sonoma Water's salmonid life-cycle monitoring and specialized research
- Monitoring not designed to specifically assess SHaRP attributes

ADULT SPAWNING & REDD SUCCESS

Adult returns/redd distribution



- Spawning throughout stream
- Often higher density of coho redds below falls
- Few coho redds observed in upper Felta and Palmer creeks
- Minimal spawning activity in Wallace Creek

Woody debris blocking passage point at Mill Creek falls

2022 Before

2022 After

Photos and passage clearance: Derek Acomb, CDFW

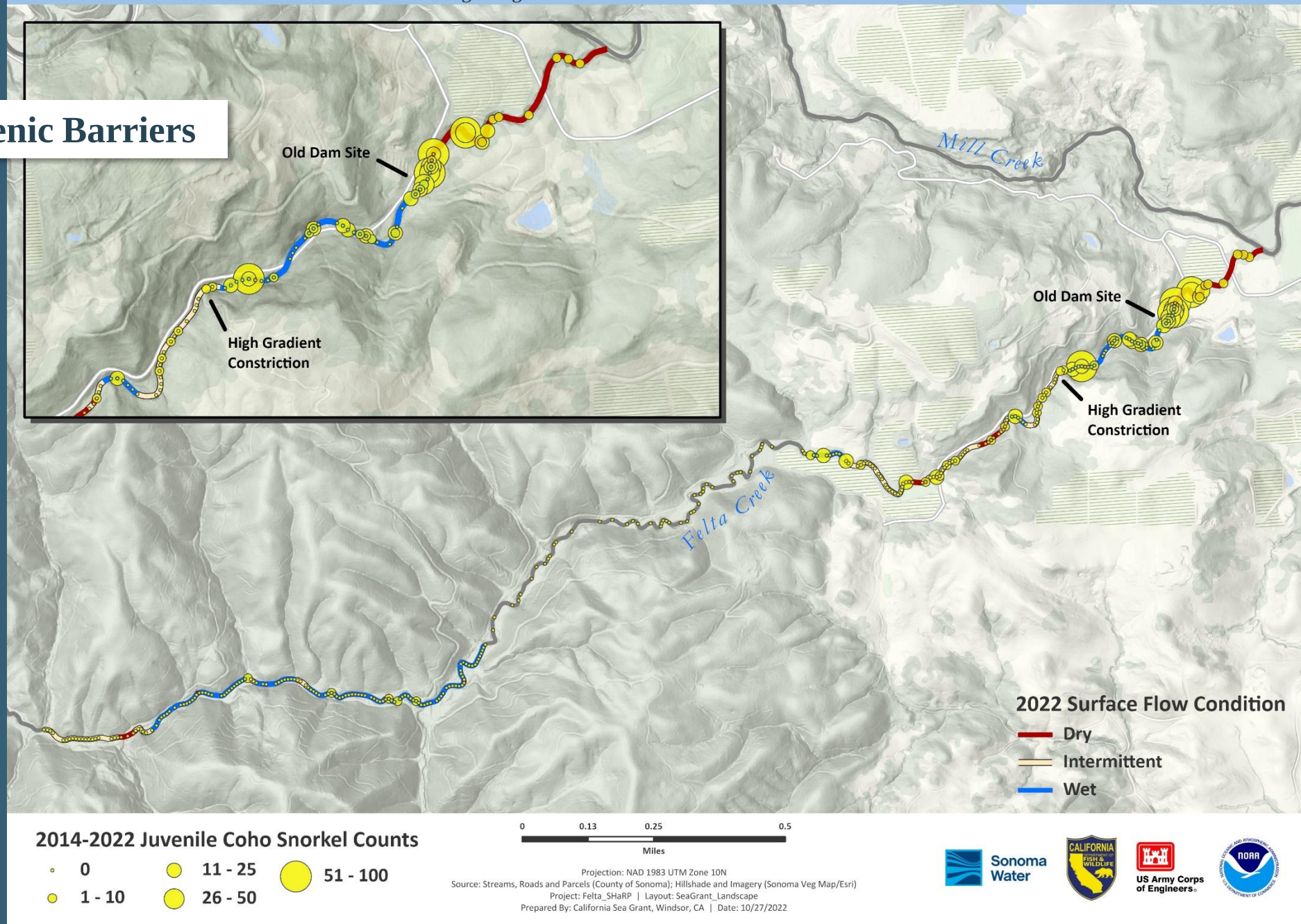
Attribute: Anthropogenic Barriers

- Logs create fish habitat, cut firewood rounds left in the stream cause problems

Felta Creek adult passage

Attribute: Anthropogenic Barriers

- Passage into upper Felta Creek limited at old dam sill and high-gradient constriction point
- Remediating dam and maintaining debris at constriction point could improve access to wetter reaches upstream
- Passage projects should be paired with efforts to increase summer streamflow in upper reach



Impacts of low flow on spawning

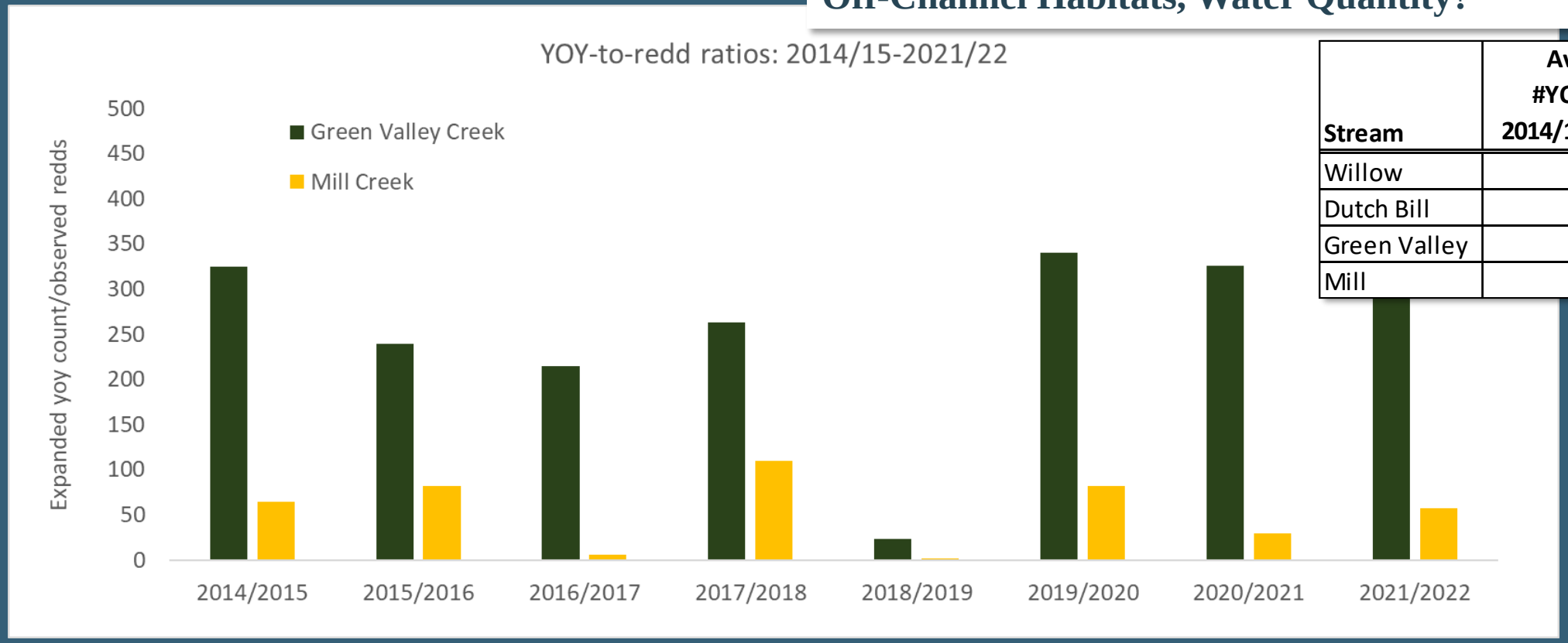
Attribute: Water Quantity

- Stream disconnection during coho and steelhead spawning window:
  - Mill Creek closures – 56% of 9 years
  - Felta Creek closures – 89% of 9 years
- Winter drought 2020/21: high % basinwide redds seen in Mill Creek, all adults returned to Mill from other streams
  - Drawn into system by Dry Creek flow?
  - Suggests high importance during dry winters, warrants continued evaluation
- Redds can become stranded prior to fry emergence in dry springs
  - 55% of Felta redds dry/partially dry during 2021/22 spawner surveys

Mill Creek at the Felta Creek confluence, January 23, 2014

Spawning success

Attributes: Instream Structural Complexity, Off-Channel Habitats, Water Quantity?



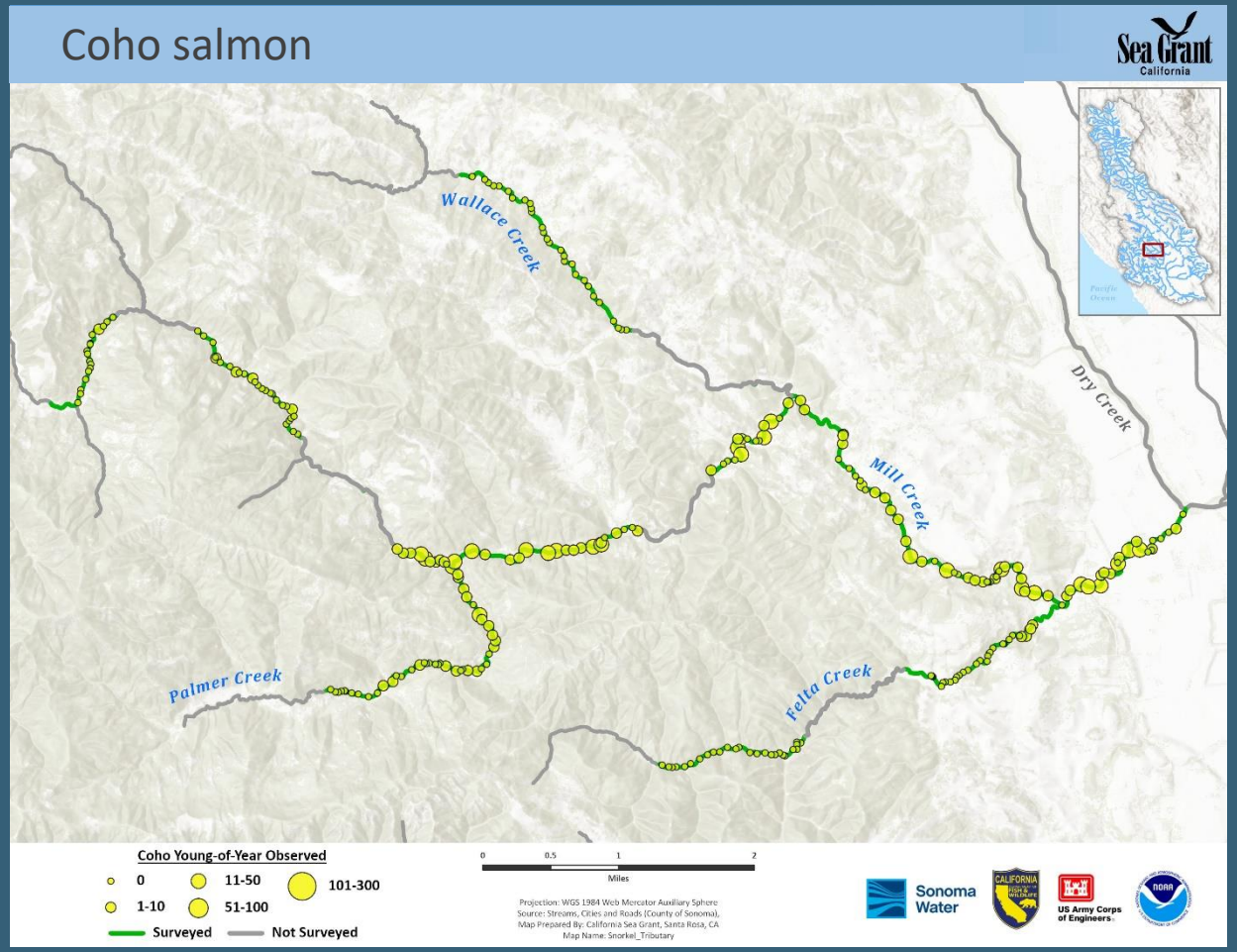
Stream	Average #YOY/redd 2014/15-2021/22
Willow	184
Dutch Bill	304
Green Valley	272
Mill	54

- Mill Creek significantly lower yoy-to-redd ratio than other studied streams
  - **Causes of very limited natural production should be investigated**
- Flashiness due to alteration of natural drainage patterns, incision, disconnection from floodplain, changing climate may play role
- Adding structures to reduce redd scour and yoy displacement could improve natural production
- Sediment inputs should be evaluated – anecdotal evidence of high inputs from Wallace Creek

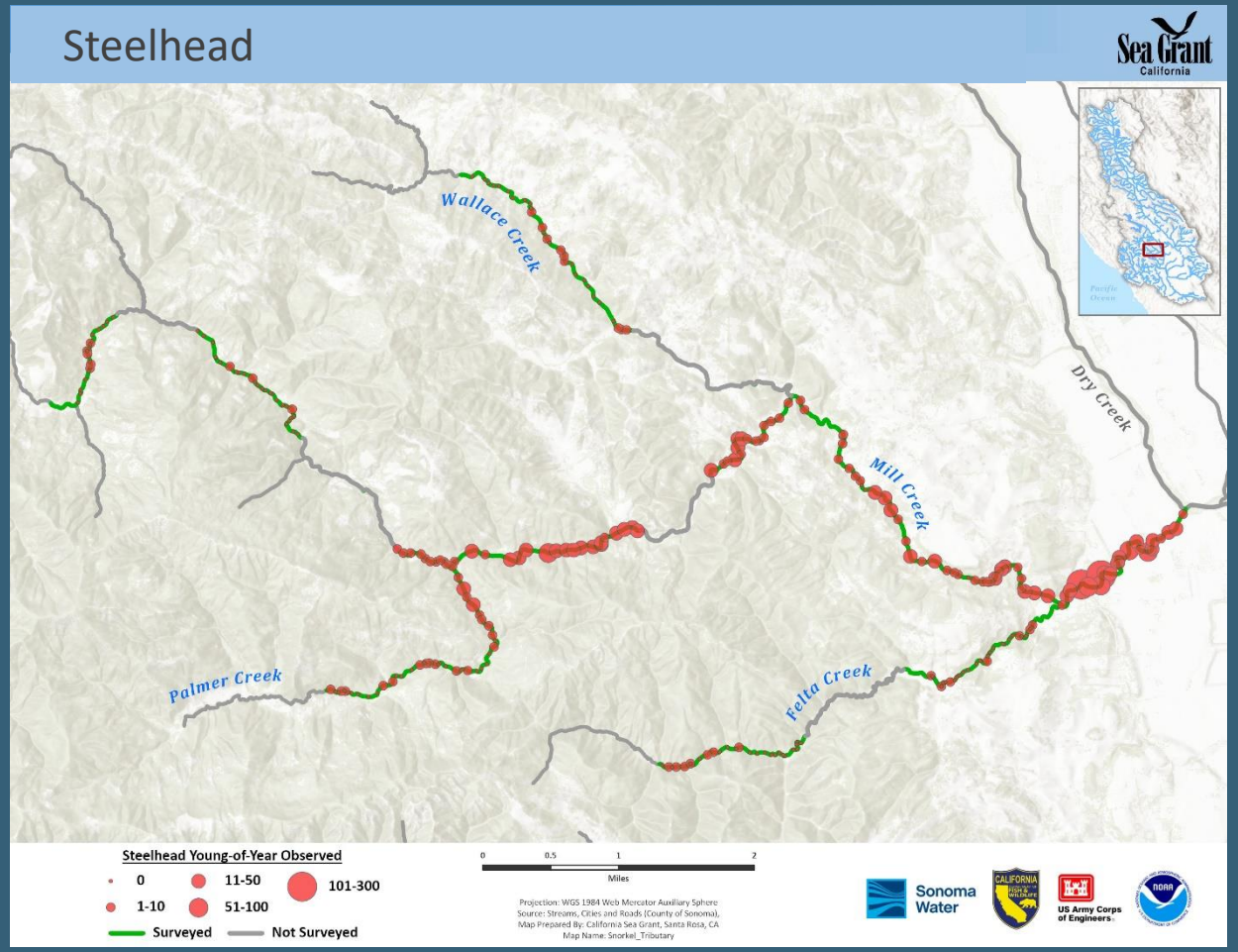
YOUNG-OF-THE-YEAR (YOY) & SUMMER REARING

Young-of-the-year distribution: 2020 example

Coho salmon



Steelhead

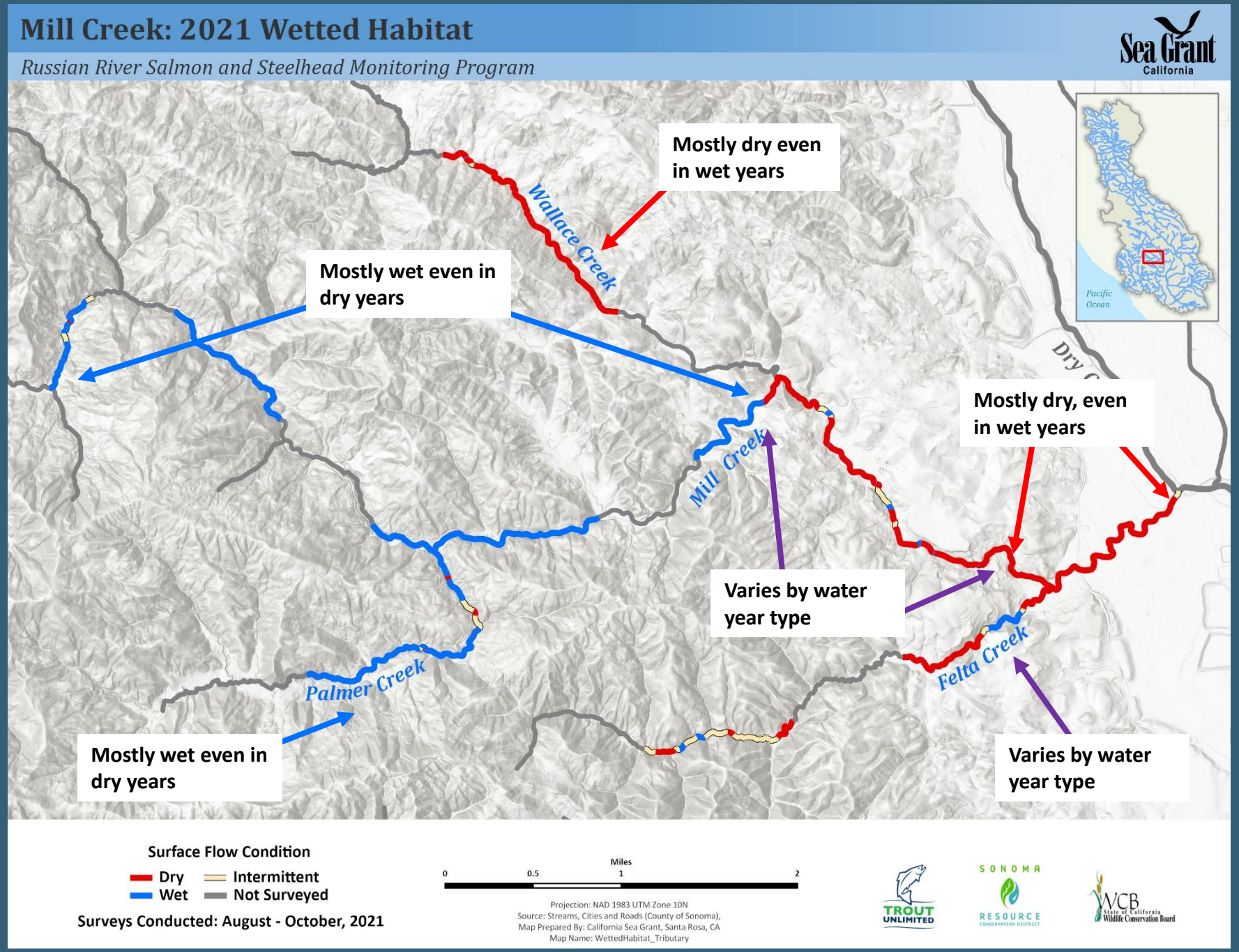


- Coho and steelhead yoy generally distributed throughout stream
- Common to see high densities in reach below falls
- Minimal use of Wallace Creek

Late-summer wetted habitat distribution

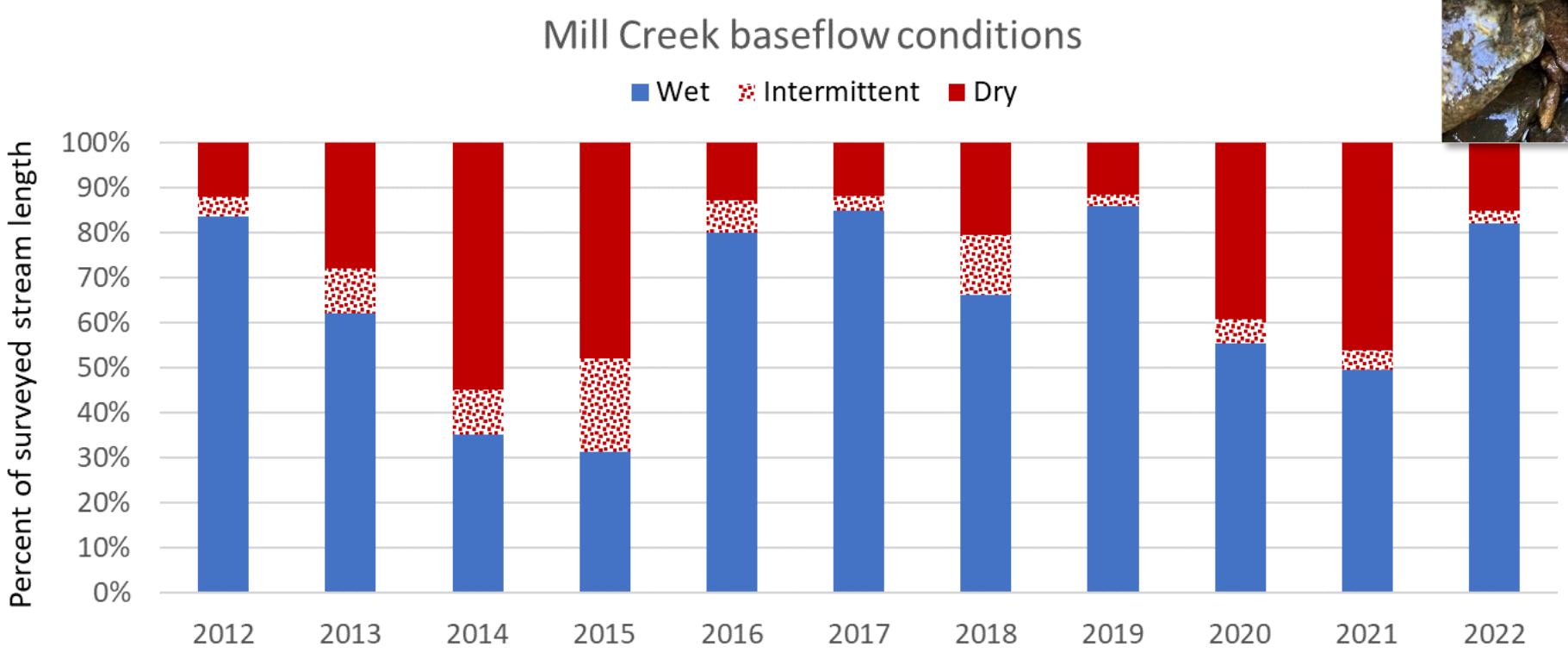
- Mill below falls extensive drying all years
- Falls to above Wallace marginal
- Mill above Wallace perennial flow
- Felta marginal
- Wallace always dries
- Palmer mostly perennial

**Grey lines = not surveyed*



Late-summer wetted habitat

Attribute: Water Quantity

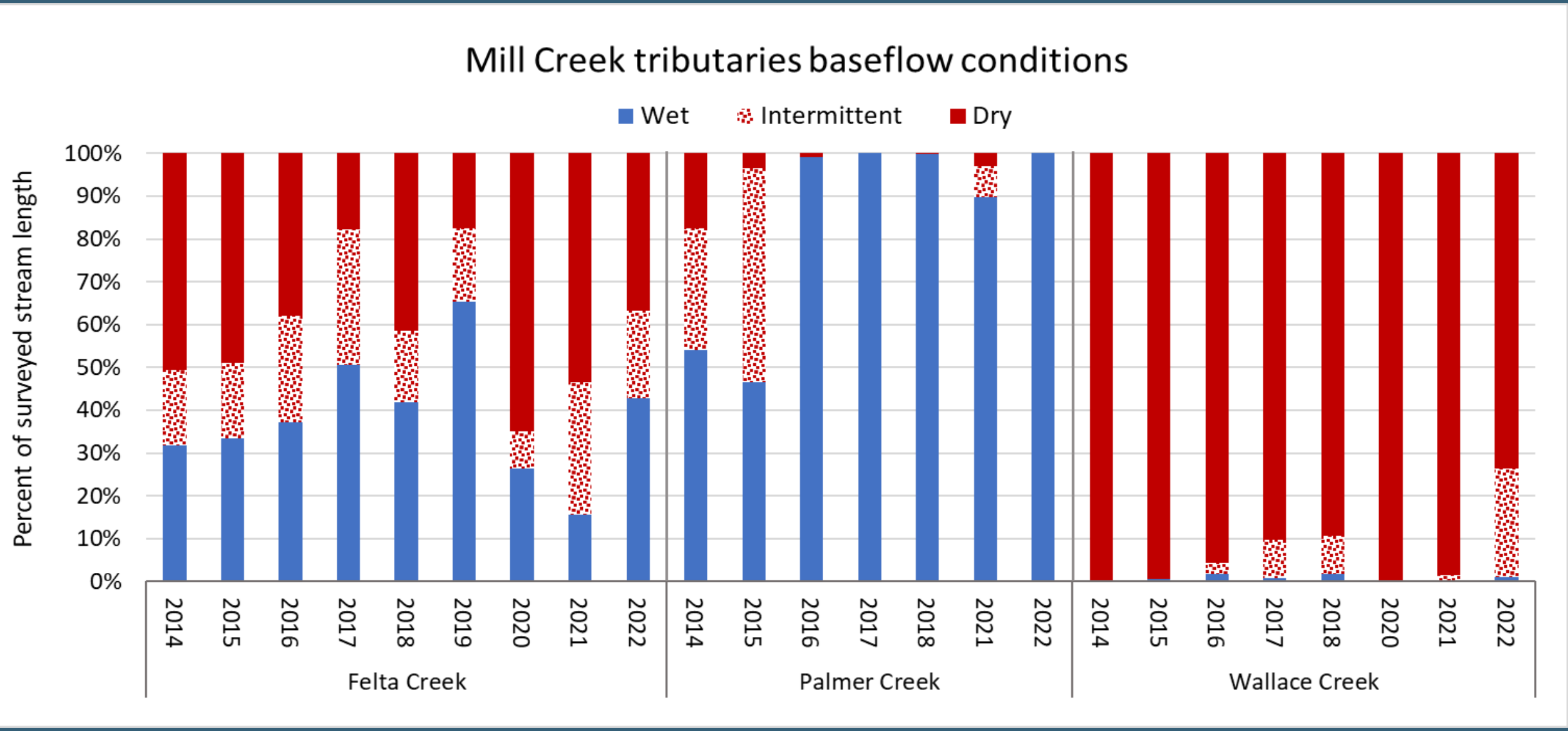


Cumulative proportion of surveyed channel that was wet, dry, or intermittent at the driest time of year. Length of channel sampled varied between years.

How does drying impact fish?

- *10 year average: 53% of salmon and steelhead yoy in habitat that stayed wet & connected (range 20-76%)*
- ***2015 (driest): 20% of fish in wet, connected pools***

- ***11-yr average: 27% of surveyed channel dry, 8% intermittent, 65% wet & connected***
- ***2015 (driest): 55% dry, 31% wet & connected***



Late-summer conditions, on average since 2014:

- ***Felta: 38% wet and connected (range 16-65%)***
- ***Palmer: 84% wet and connected (range 46-100%)***
- ***Wallace: 1% wet and connected (range 0-2%)***

- Wallace Creek
  - Virtually no summer rearing habitat
  - Not contributing summer flow to Mill Creek

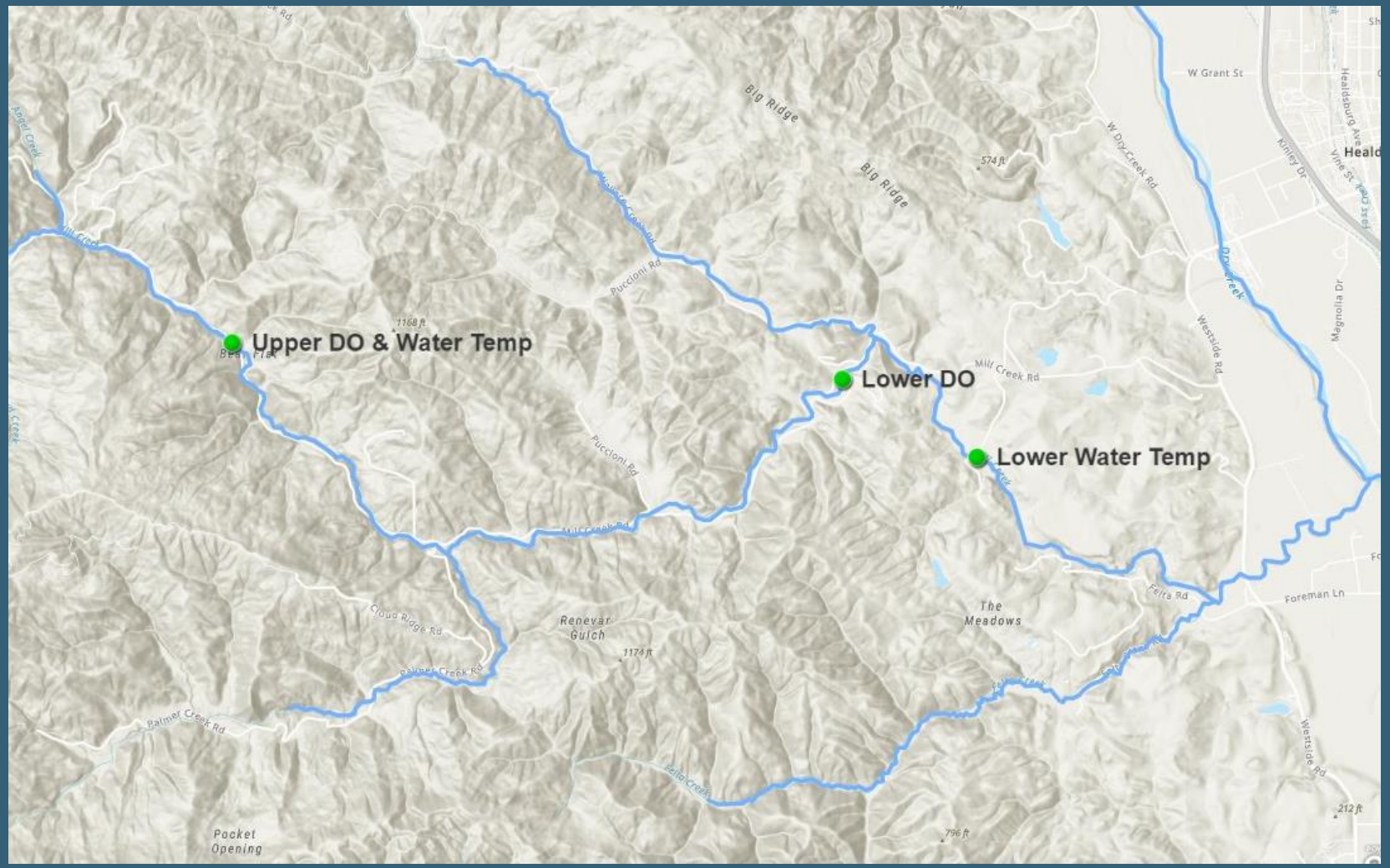
- Felta Creek
  - Middle and upper stretch provides summer rearing habitat, best in wet years
  - Not contributing summer flow to Mill Creek
  - Flow enhancement could improve rearing

- Palmer Creek
  - Provides summer habitat refugia even in dry years
  - Contributes summer flow to Mill Creek
  - Summer streamflow should be preserved

Mill Creek characteristics mouth to falls

- Deeply incised, influenced by Warm Springs Dam
- Trout Unlimited data shows groundwater up to ~15’ below summer surface water elevation
- CRWI evaluation shows alluvium >200’ deep near mouth
- Likely not possible to restore summer streamflow, but important for smolt outmigration

Summer water quality sampling

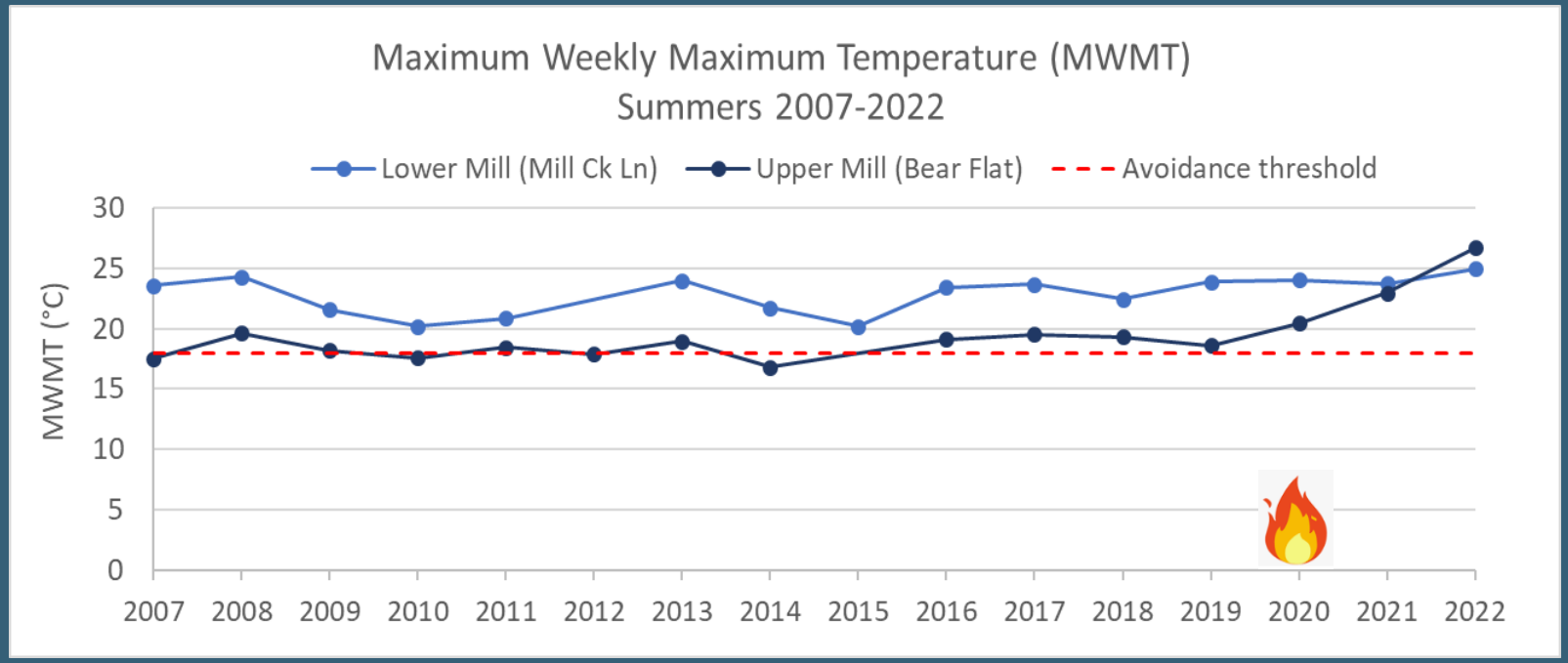


- 2007-2022 continuous summer water temperature gages, Mill Creek Lane (lower) & Bear Flat (upper)
- 2017-2019 continuous summer dissolved oxygen gages, above Wallace (lower) & Bear Flat (upper)

Summer water temperature

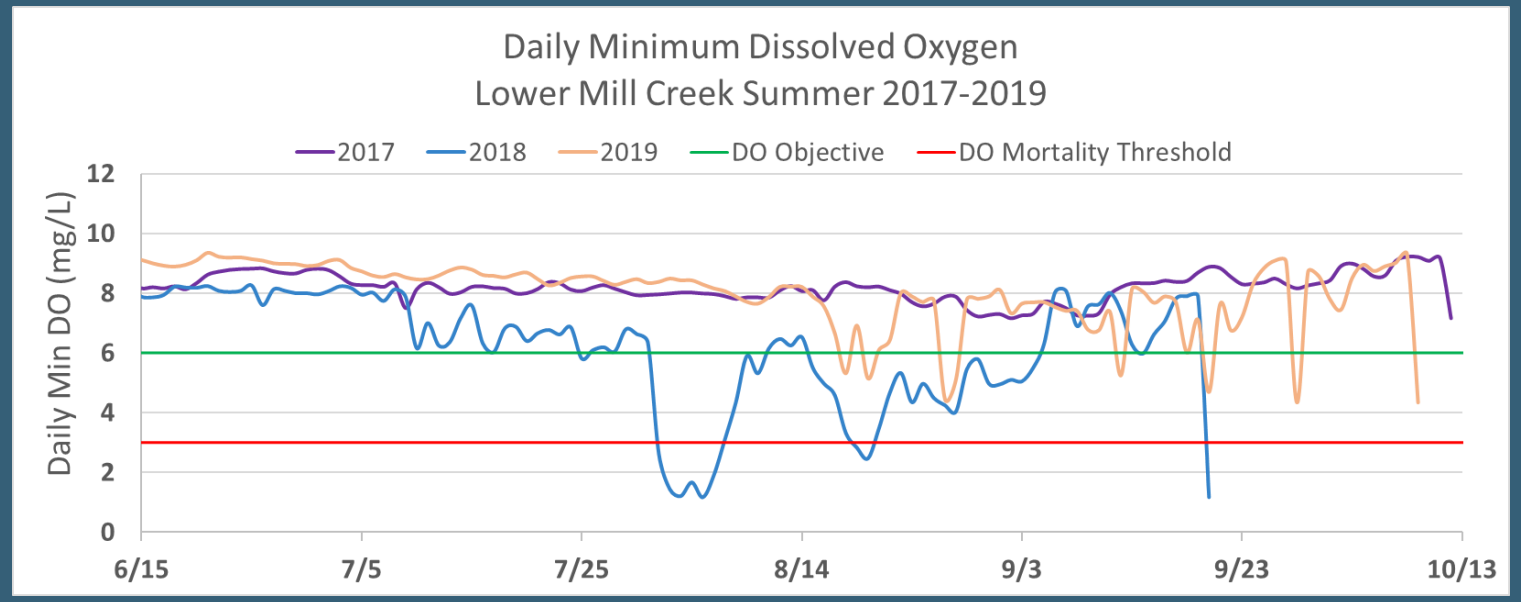
- Lower Mill gage site (light blue)
  - Maximum temperatures exceed salmonid tolerance levels every summer
- Upper gage site (dark blue)
  - Generally suitable temperatures pre-fire
  - Post-fire temperatures highest in long-term record
  - 2022 surpassed lower “control” pool temps

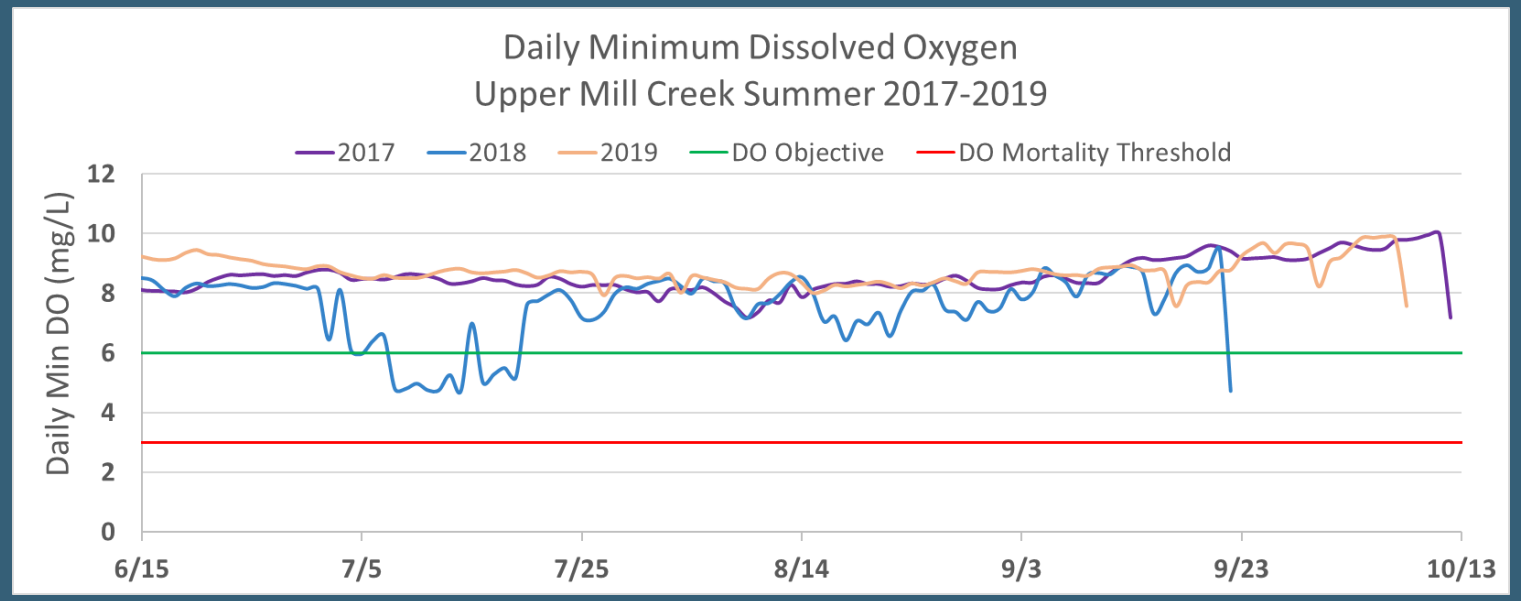
Attribute: Water Quality & Riparian Condition



Mean weekly maximum water temperatures at gaging sites 6/15 -10/16, compared to 18°C MWMT avoidance thresholds from Mattole River watershed (Welsh et al. 2001)

Summer dissolved oxygen





15-minute DO readings in Mill Creek gaging pools compared to minimum daily regional objective (NCRWQCB 2015) and lab mortality threshold (USEPA 1986)

Wet years (2017 & 2019) shown in purple and beige, below average water year (2018) shown in blue

- Lower Mill gage site
  - DO generally well-suited for rearing salmonids in wet years, dropped to dangerously low levels periodically in 2018
  - Need more dry-year data

- Upper Mill gage site
  - DO consistently well-suited for rearing salmonids 2017-19
  - Not sampled since fire

Attribute: Water Quality

Mill Creek non-native species

Attribute: Invasive Species

Non-native aquatic species captured in Mill Creek smolt trap											
Species	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**10-yr total**
Bluegill	3	29	4	56	71	72	17	2	0	4	**258**
Bullfrog	65	41	11	12	74	73	11	0	1	0	**288**
Crayfish sp	5	0	0	1	3	17	8	0	0	3	**37**
Fathead minnow	4	0	14	103	68	128	22	1	19	9	**368**
Green sunfish	3	5	6	22	16	12	42	5	0	48	**159**
Largemouth bass	0	0	0	1	2	1	2	0	0	0	**6**

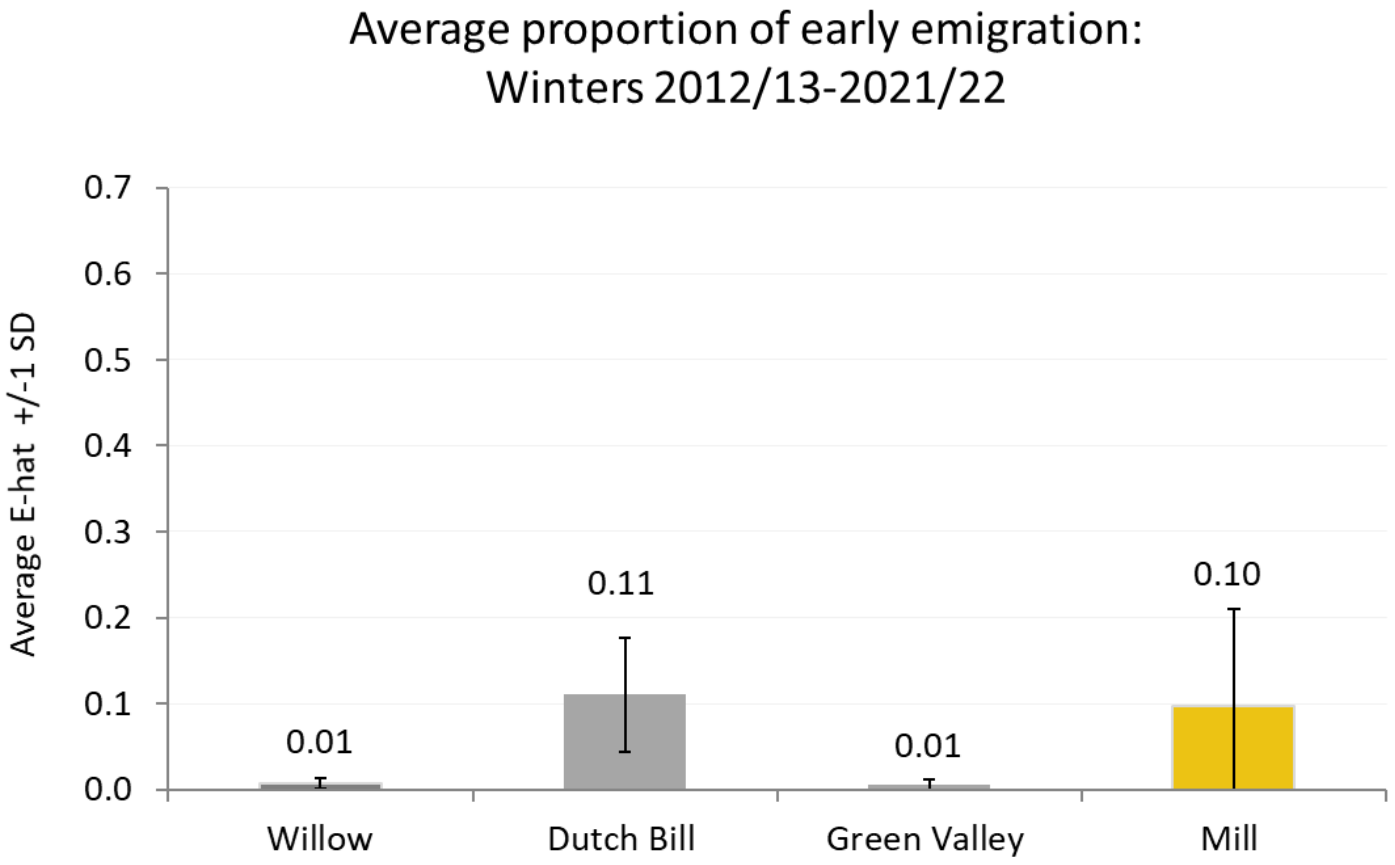
**Presence of crayfish species also documented on 53 occasions during snorkel surveys*

- Non-native aquatic species observed in low numbers
  - Do not appear to have measurable impact on salmonids in Mill Creek and tributaries
- If future water temperature increases under climate change conditions, could possibly favor warmer water species
  - Continued long-term fish monitoring would detect problems

OVERWINTER REARING & OUTMIGRATING SMOLTS

Overwinter rearing

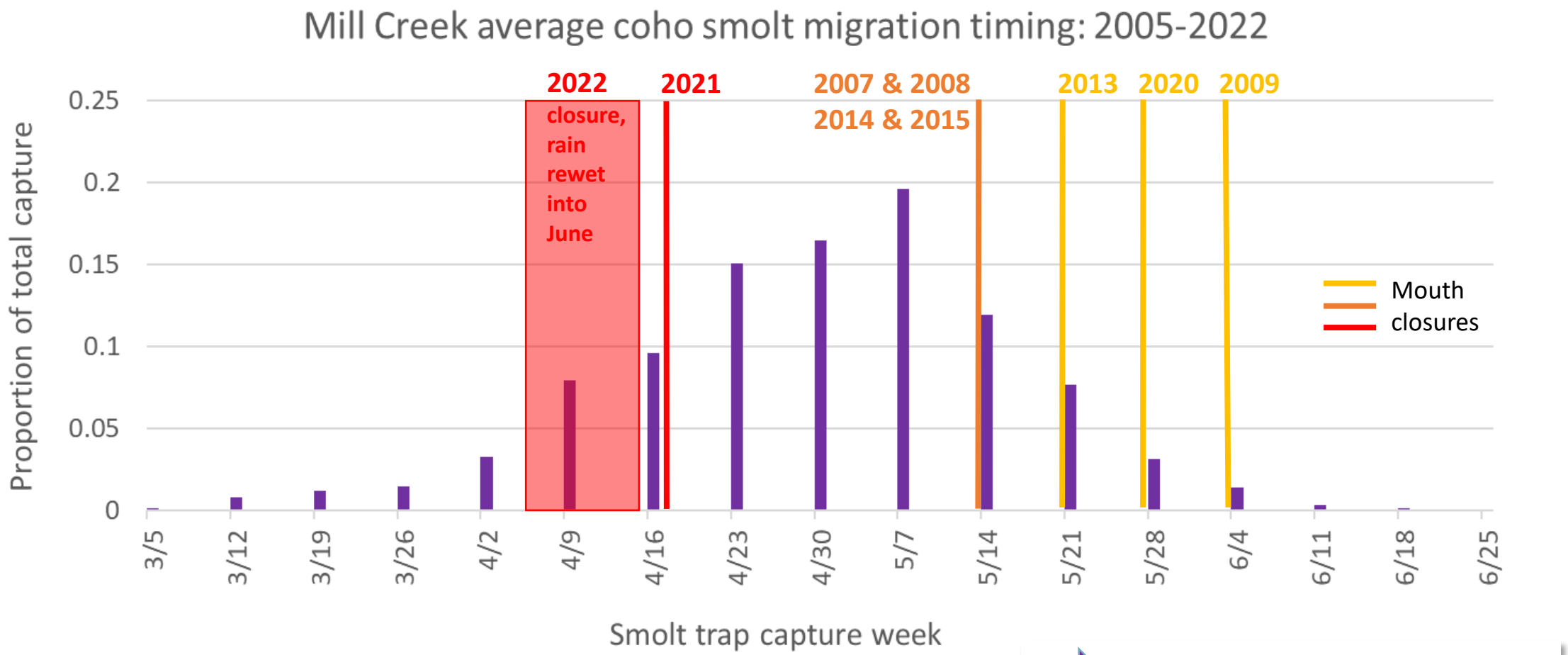
Potential attributes: Instream structural complexity, Off-channel habitats, Water Quantity



Estimated average emigration of fall release hatchery coho out of streams prior to March 1

- Mill Creek high % of smolts emigrate early (pre-spring)
- Generally lower early emigration in winters without large storm events suggests movement not volitional
- Likely influenced by lack of high-flow refugia (complex structure, off-channel habitat) and possibly flow flashiness

Effects of low flow on smolt emigration



Average proportional weekly smolt trap captures, all years

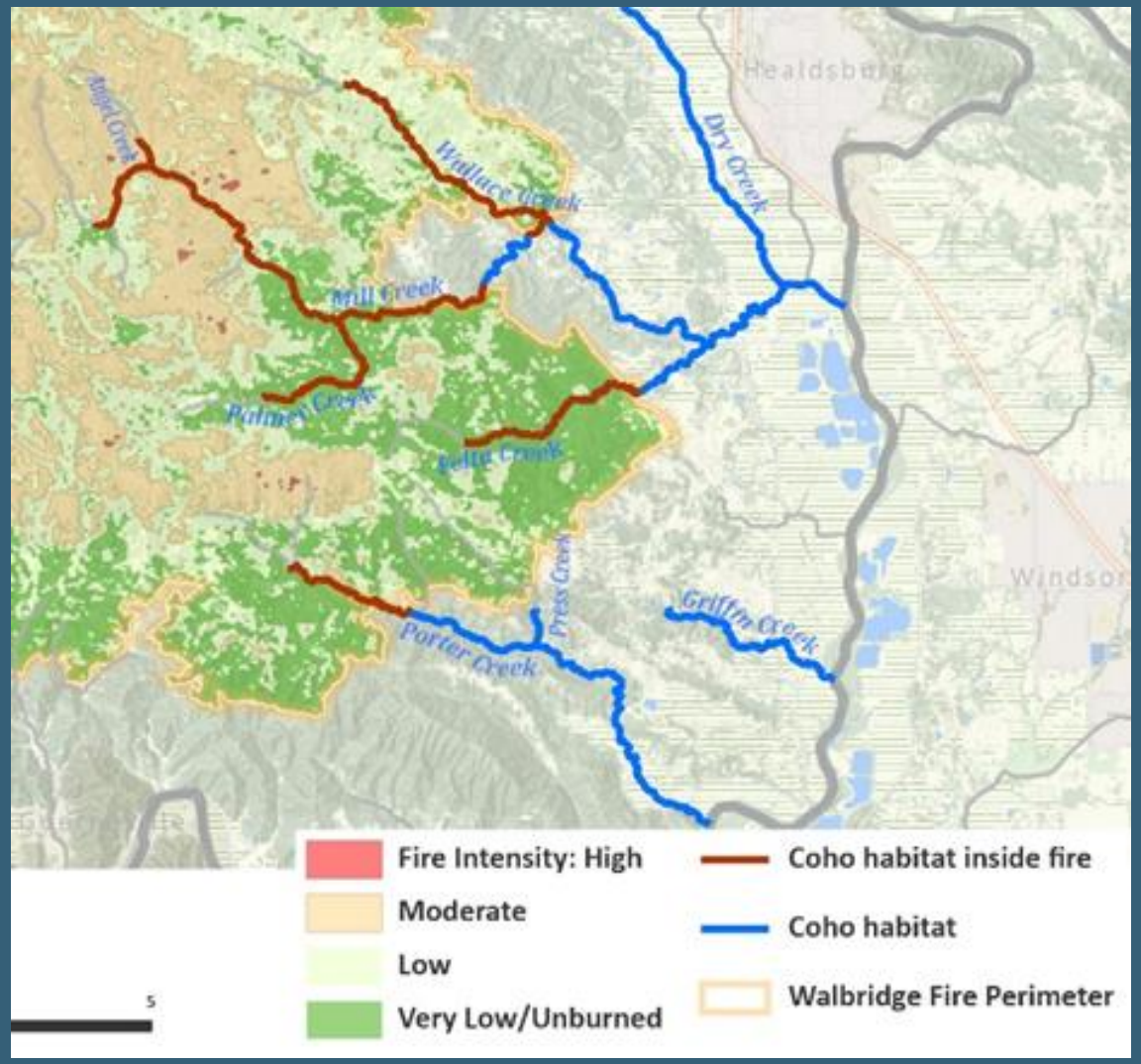
- Mouth closures during spring smolt outmigration window: Mill Creek 56% of last 16 years, Felta Creek 86% of last 7 years (no data prior)

Effects of low flow on smolt emigration

Attribute: Water Quantity

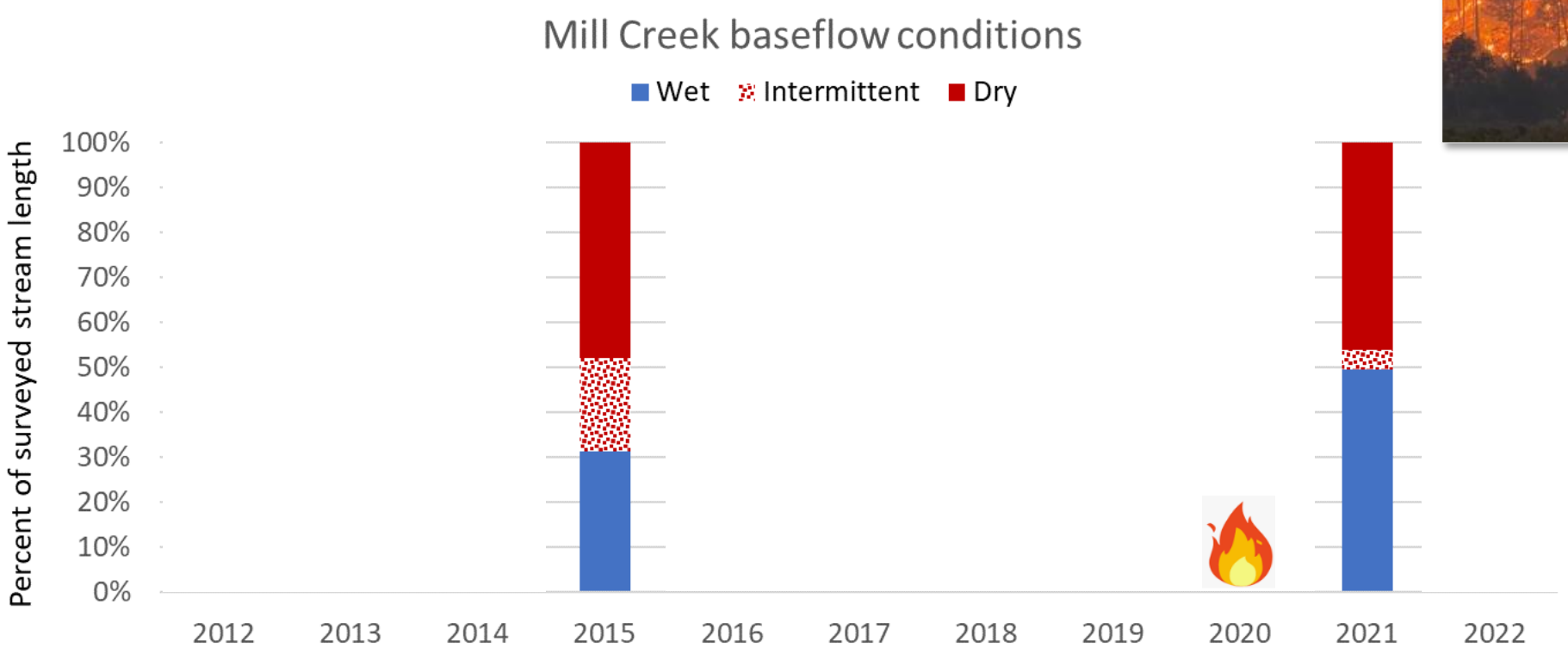
- Mill Creek 2021:
  - Disconnected prior to peak spring outmigration
  - 94% of smolts entered trap/attempted to emigrate after mouth closure
- UCB/CSG study – decreased streamflow on Mill Creek and other study streams contracted emigration window up to 3 weeks
- CRWI report: *"Flow enhancement efforts intended to sustain or extend the spring flow recession to ensure passable conditions for outmigrating smolts…is one of the most important restoration goals for the watershed"*

WALBRIDGE FIRE & SALVAGE LOGGING IMPACTS



Late-summer wetted habitat – fire effects

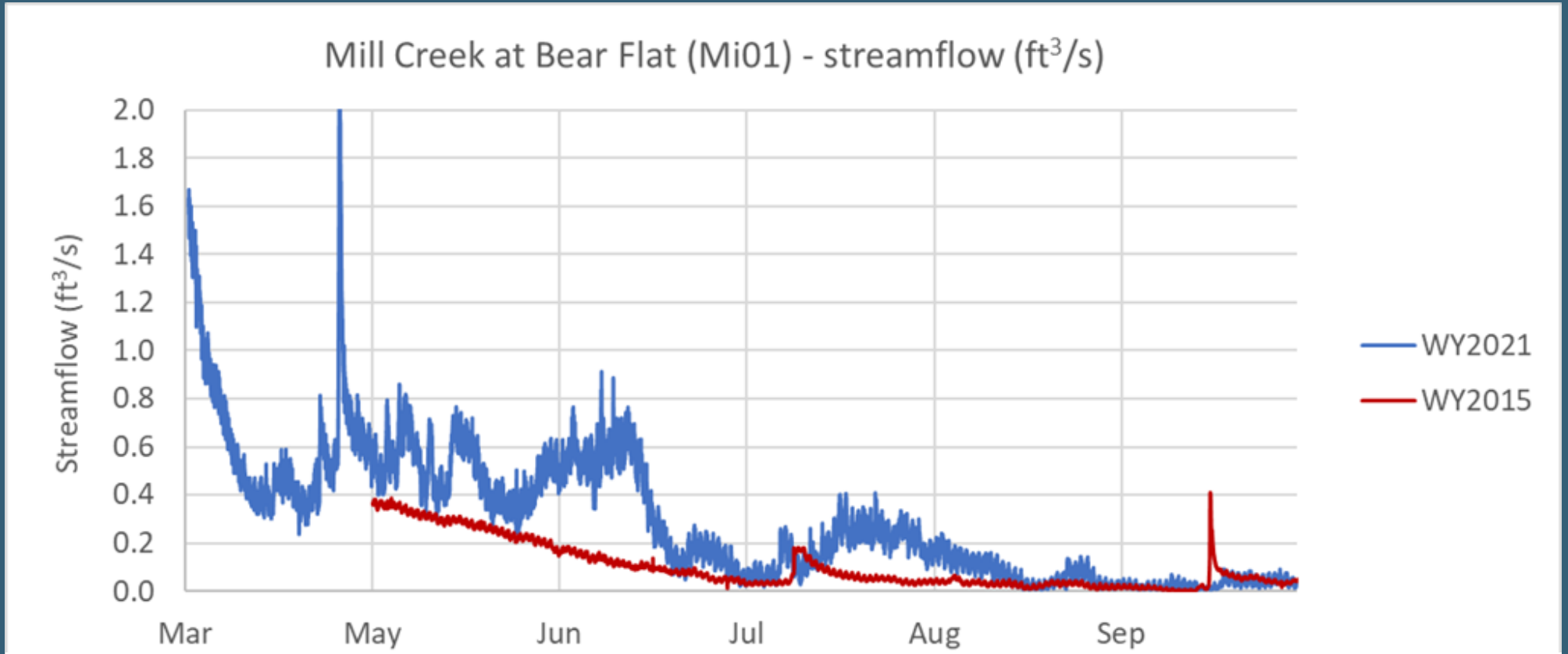
Attribute: Water Quantity



Cumulative proportion of surveyed channel that was wet, dry, or intermittent at the driest time of year. Length of channel sampled varied between years.

- *Compared two driest recent drought years*
- *2021 drier than 2015, less late-summer wetted habitat basinwide, but Mill Creek had 18% more wetted habitat*

Streamflow changes post-fire



Streamflow in peak drought years before (2015) and after (2021) the 2020 Walbridge Fire. Data, graph: Trout Unlimited

- Increase in streamflow post-fire due to reduced evapotranspiration from extensive vegetation loss
- Studies in other watersheds show baseflows peaked 2 years post-fire (Saxe et al. 2018) and 5 years post-harvest (Coble et al. 2020) then decreased over time with forest regrowth
- Proactive, broad-scale forest management important for maintaining sufficient streamflow in Mill system

Observed fire and salvage logging impacts

Attributes: Riparian Condition, Sediment Conditions, Water Quality, Water Quantity, Instream Structural Complexity, Anthropogenic Barriers

- Short-term increases in streamflow, long-term decreases predicted
- Broad-scale erosion, hillslope destabilization/landslides, sedimentation of pools and spawning gravels
- Loss of structural complexity due to burning of instream wood and excessive sedimentation
- Loss of riparian vegetation - increasing summer water temperatures, possible impacts to trophic system
- Invasive plant colonization
- Cut wood rounds in stream clogging passage points

Upper Mill Creek, September 2020

Upper Mill Creek, September 2021

Attribute: Anthropogenic Barriers

- Small wood debris causing fish passage problems
  - Whole logs in stream channel and on banks should be left to move naturally, not cut into rounds
- Ongoing maintenance/debris clearing is necessary at Mill Creek falls and high-gradient constriction point in lower Felta Creek
- Consider remediation of Felta Creek historic dam structure limiting access to perennial flow reaches, pair with streamflow enhancement in upper reach

Cut wood blocking passage at Mill falls

Fish rescue below Felta dam site

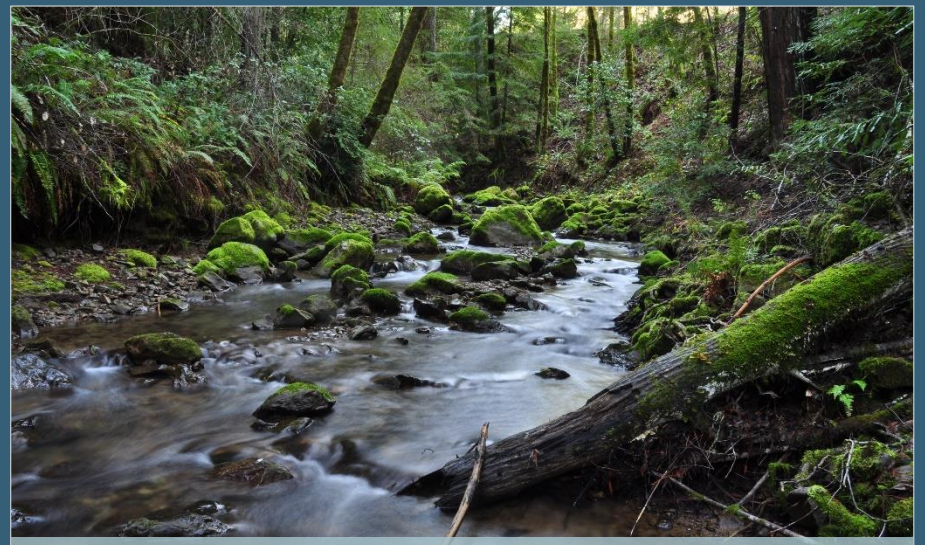
Attributes: Instream Structural Complexity & Off-Channel Habitats

- Increasing instream structural complexity (e.g., channel spanning structures and large wood) and floodplain connectivity would likely help:
  - Reduce high early emigration of juvenile salmon
  - Increase natural production (redd-to-yoy success)

- Increased floodplain connectivity should yield additional benefits like increased groundwater recharge and primary productivity

- Large wood recruited from fire and logging activities should be left in channel to increase structural complexity

Mill Creek above confluence with Palmer



Mill Creek below Angel Creek

Attributes: Riparian Condition & Sediment Conditions

- Lack of riparian vegetation and increase in active hillslope erosion, sediment inputs due to intensive burn in upper watershed warrant:
  - Riparian revegetation
  - Exotic vegetation management
  - Upslope erosion control work
- Long-term monitoring and adaptive management
- Role of sediment in redd-to-yoy success should be investigated
- Anecdotal evidence that Wallace Creek may contribute substantial amount of fine sediment into Mill Creek warrants investigation

Mill Creek above Bear Flat, September 2021

Upper Mill Creek, September 2021

Attributes: Water Quality

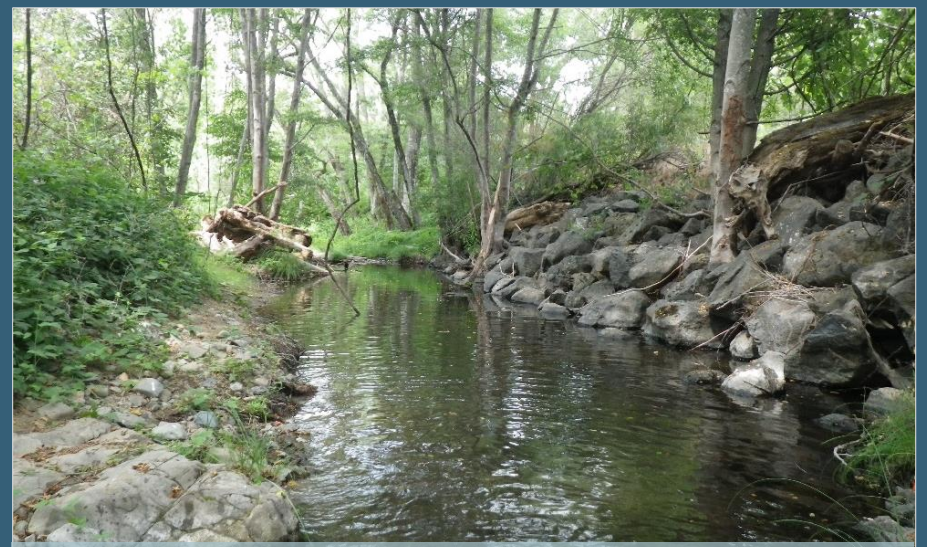
- Water temperatures in upper Mill Creek not suitable for salmonids post-fire
- Temperatures in lower reaches generally too warm for salmonids
- Dissolved oxygen (DO) at lower Mill Creek gaging site too low in drier years
- Upper Mill Creek DO post-fire unknown
- Additional riparian vegetation and summer stream flow would likely improve water quality over time
- Inputs from hillslope erosion may influence water quality and should be evaluated, managed
- Ongoing water quality monitoring needed

Water quality monitoring site, Mill Creek above Wallace

Lower Mill Creek, September 2021

Attribute: Water Quantity (low flow)

- Insufficient streamflow is a limiting factor for:
  - Returning adults and spawning success in dry years
  - Outmigrating smolts in majority of years
  - Rearing young-of-the-year every year
- Watershed-scale flow enhancement needed!
  - CRWI model has/can test proposed scenarios
- Lowest reach of Mill Creek from mouth to falls – improve stream connectivity through spring smolt outmigration
- Upper watershed – forest management to remediate predicted decreases in flow post-fire
- Palmer Creek – preserve summer flow refugia



Mill Creek above Wallace, July 2015

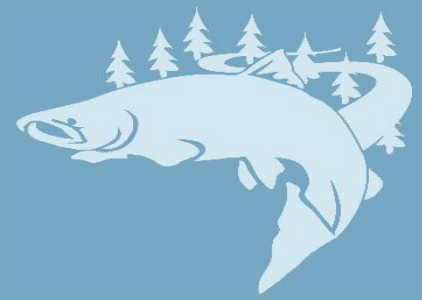
Mill Creek above Wallace, September 2015

Attribute: Water Quantity (high flow)

- Flashiness due to alteration of natural drainage patterns may play a role in redd-to-yoy success and early juvenile emigration
- Fire impacts may increase runoff
- Could grow worse under future climate change predictions of fewer, larger winter storms
- Restoring more natural drainage patterns and increasing infiltration could reduce flashiness and help to recharge groundwater

Mill Creek falls at high flows

Mill Creek Watershed additional observations



- Changing climate patterns are reducing salmonid spawning and smolt outmigration windows and influencing spawning distribution patterns

- Fire aftermath and changing climate patterns present opportunities
  - Long-term monitoring important to document changes and guide adaptive management

- None of our assessments or recommendations have considered traditional ecological knowledge from the Pomo and other tribes that have lived in this watershed for thousands of years. Perspectives of local indigenous people should be incorporated into future assessments and watershed restoration planning


Questions?