DRY-SEASON FLOW MONITORING IN REDWOOD CREEK AND IMPLICATIONS FOR IMPROVING AQUATIC HABITAT THROUGH FLOW ENHANCEMENT

Jay Stallman, Stillwater Sciences

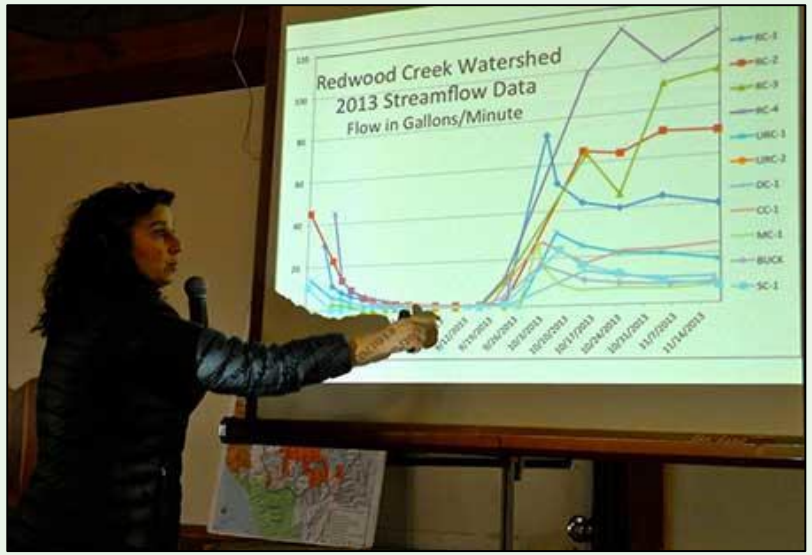
Pond Planning and Groundwater Recharge Workshop and Field Tour

Saturday, August 17, 2019 • Beginnings Octagon, Briceland

WCB State of California Wildlife Conservation Board

Sanctuary Forest

REDWOOD CREEK MONITORING & OUTREACH
2013-2019



Salmonid Restoration Federation:

- Low Flow Monitoring
- Community Outreach
- Water Conservation Workshops
- Water Rights Clinics
- Education Campaign

Bill Eastwood and Randy Klein:

- Monitoring Plan
- Quality Assurance Plan
- Low Flow Monitoring
- Hydrology Report

Stillwater Sciences:

- Feasibility Study
- Target Flow
- Planning & Design
- Technical Assistance

SEASONAL DRYING AND FLOW IMPAIRMENT

- In California's Mediterranean climate, portions of channel network are seasonal
- Seasonal drying that disconnects channel network can prohibit distribution of aquatic organisms: stranding, predation, and mortality
- Season drying can be limiting factor within a fish population
- Organisms often rely on persistent wetted reaches during dry periods
- Timing and duration of seasonal drying and channel disconnection highly variable
- Factors controlling seasonal drying are natural (climate, geology, geomorphology, vegetation) and anthropogenic (land use change, deforestation, consumptive water use)

REDWOOD CREEK FLOW MONITORING PROJECT

Objectives

1. Quantify streamflow from late Spring through Fall
2. Identify locations where flows may be impaired
3. Prioritize reaches for actions that augment low flow

Methods

- Stage measurements: manual and continuous
- Discharge measurements: current meter, Parshall flume, bucket & stop watch
- Temperature measurements

Locations

- 15 total monitoring sites
- 10 sites currently operating
- 3 to 7 sites with continuous stage recorders (varies by year)

Period

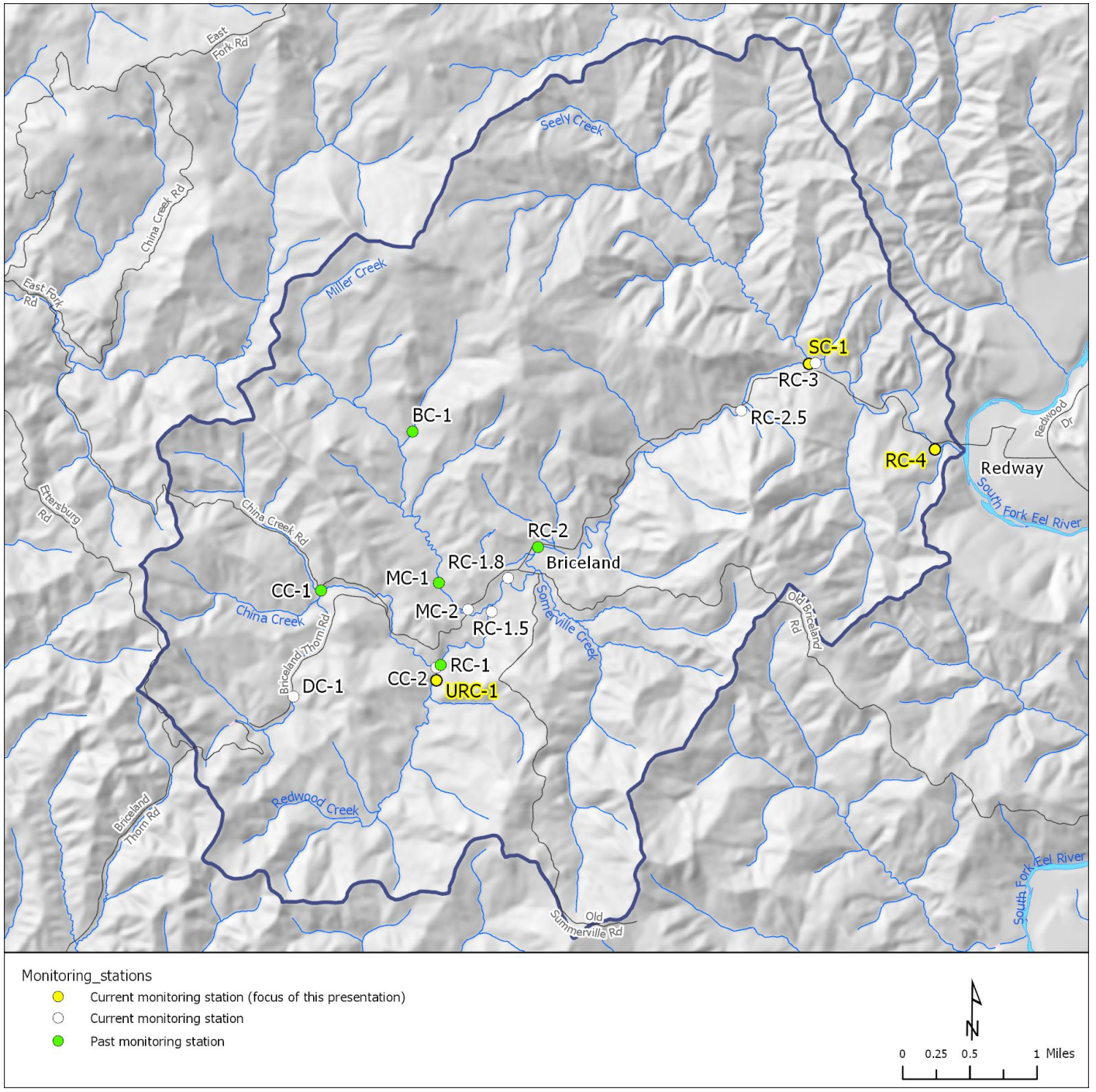
- June –November
- 2013-2019

Analyses

- Redwoods Creek low flow record and trends
- Correlations to long-term flow and precipitation records in nearby areas
- Estimation and forecasting

FLOW MONITORING SITES

Description	Name	River Mile Upstream from Mouth	Drainage Area (mi^2)	Period of Operation	Status
Buck Creek	BC-1	5.3	0.8	2013-2016	Discontinued
Dinner Creek	DC-1	6.3	1.0	2013-2019	Current
Upper China Creek	CC-1	6.3	2.2	2013	Discontinued
Upper Redwood Creek	URC-1	6.3	2.7	2013-2019	Current
Upper Miller Creek	MC-1	5.3	3.4	2013-2016	Discontinued
Lower Miller Creek	MC-2	5.3	3.6	2015-2019	Current
Lower China Creek	CC-2	6.3	3.9	2014-2019	Current
Seely Creek	SC-1	2.1	5.8	2013-2019	Current
Mainstem Redwood Creek	RC-1	6.2	6.7	2013-2017	Discontinued
Mainstem Redwood Creek	RC-1.5	5.3	6.9	2018/2019	Current
Mainstem Redwood Creek	RC-1.8	5.0	10.7	2018/2019	Current
Mainstem Redwood Creek	RC-2	4.5	14.0	2013-2017	Discontinued
Mainstem Redwood Creek	RC-2.5	2.7	17.1	2015-2019	Current
Mainstem Redwood Creek	RC-3	2.0	23.5	2013-2019	Current
Mainstem Redwood Creek	RC-4	0.4	25.8	2013-2019	Current



Seely Creek (SC-1)

June 3, 2019

August 4, 2015

Upper Redwood Creek (URC-1)

June 3, 2019

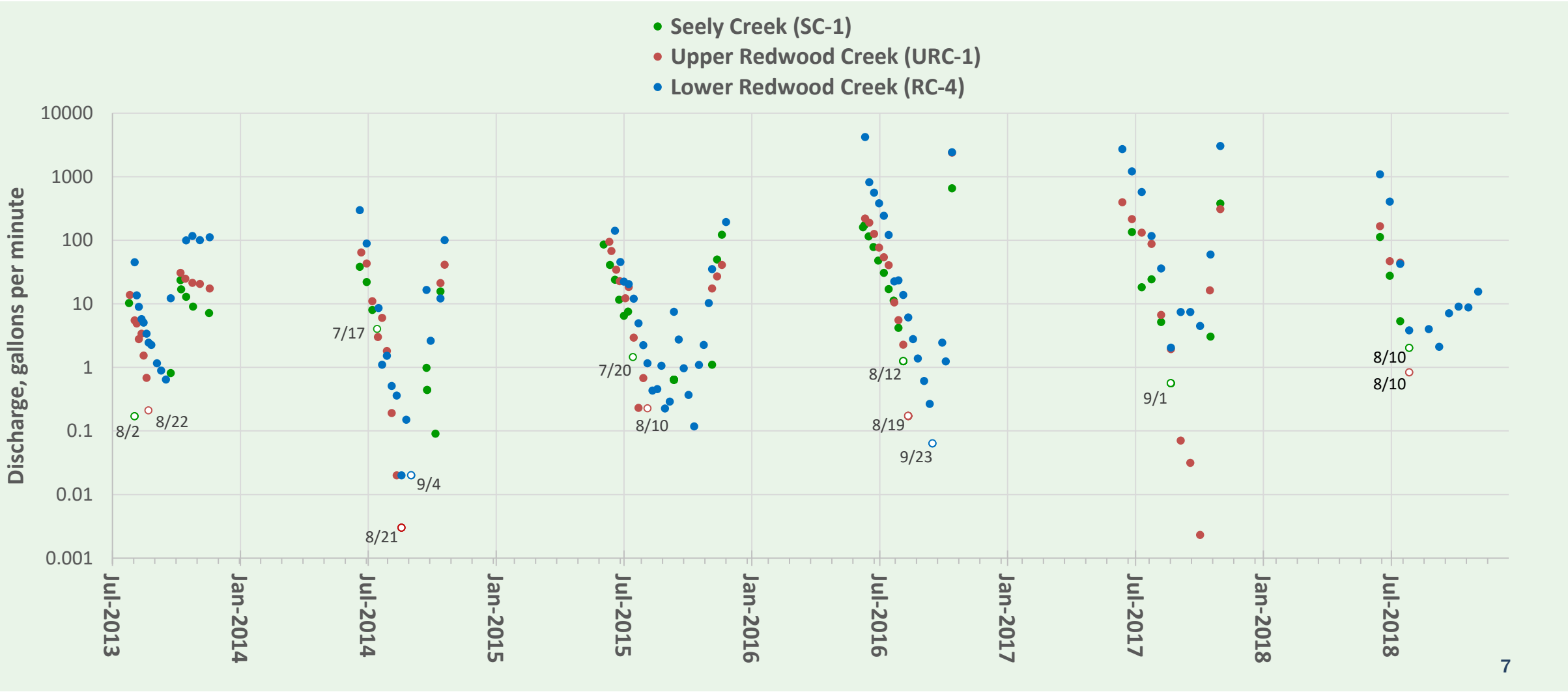
August 4, 2015

Lower Redwood Creek (RC-4)

June 3, 2019

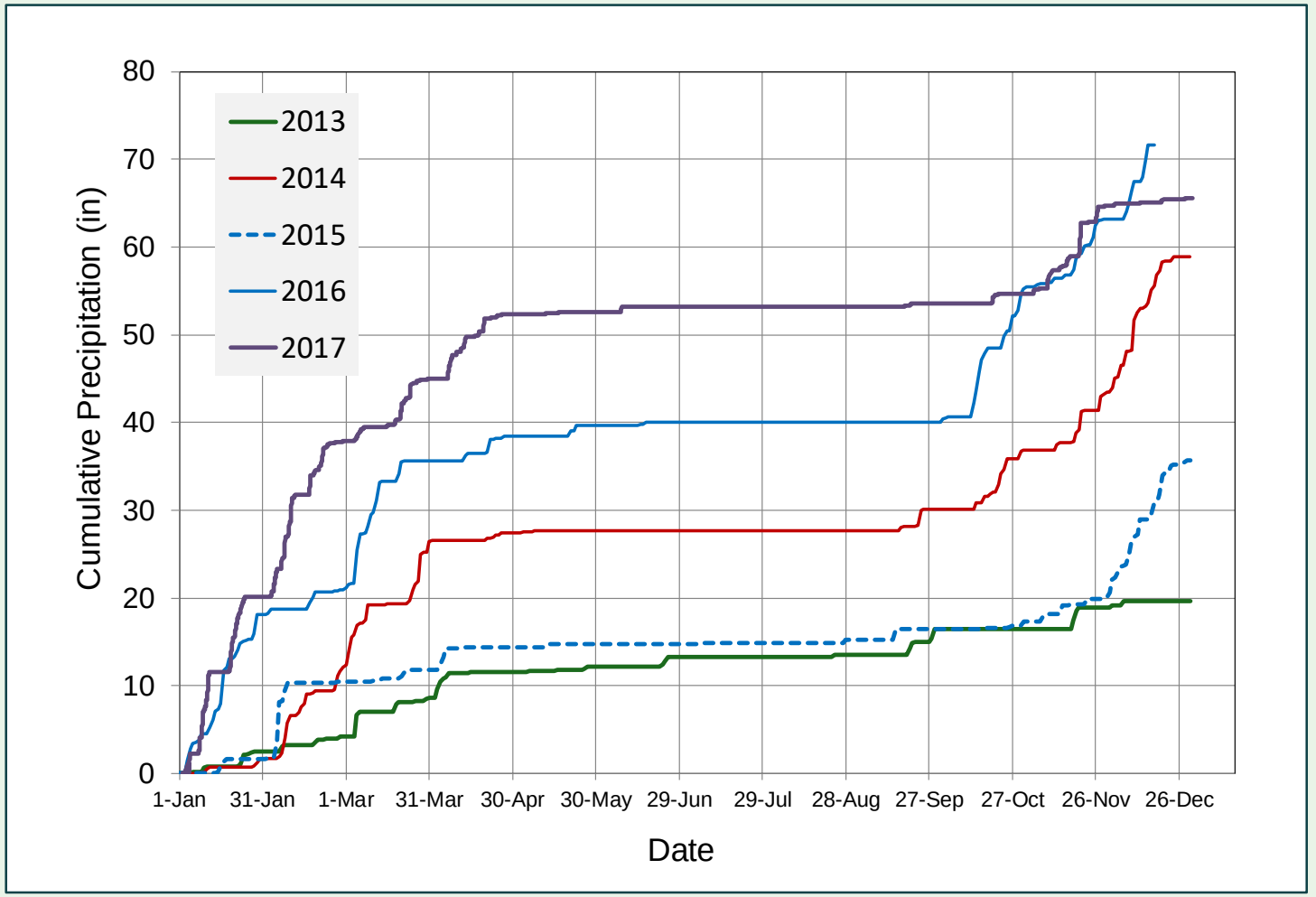
August 4, 2015

LOW FLOW DISCHARGE MEASUREMENTS, 2013–2018



LOW FLOW DISCHARGE MEASUREMENTS, 2013–2018

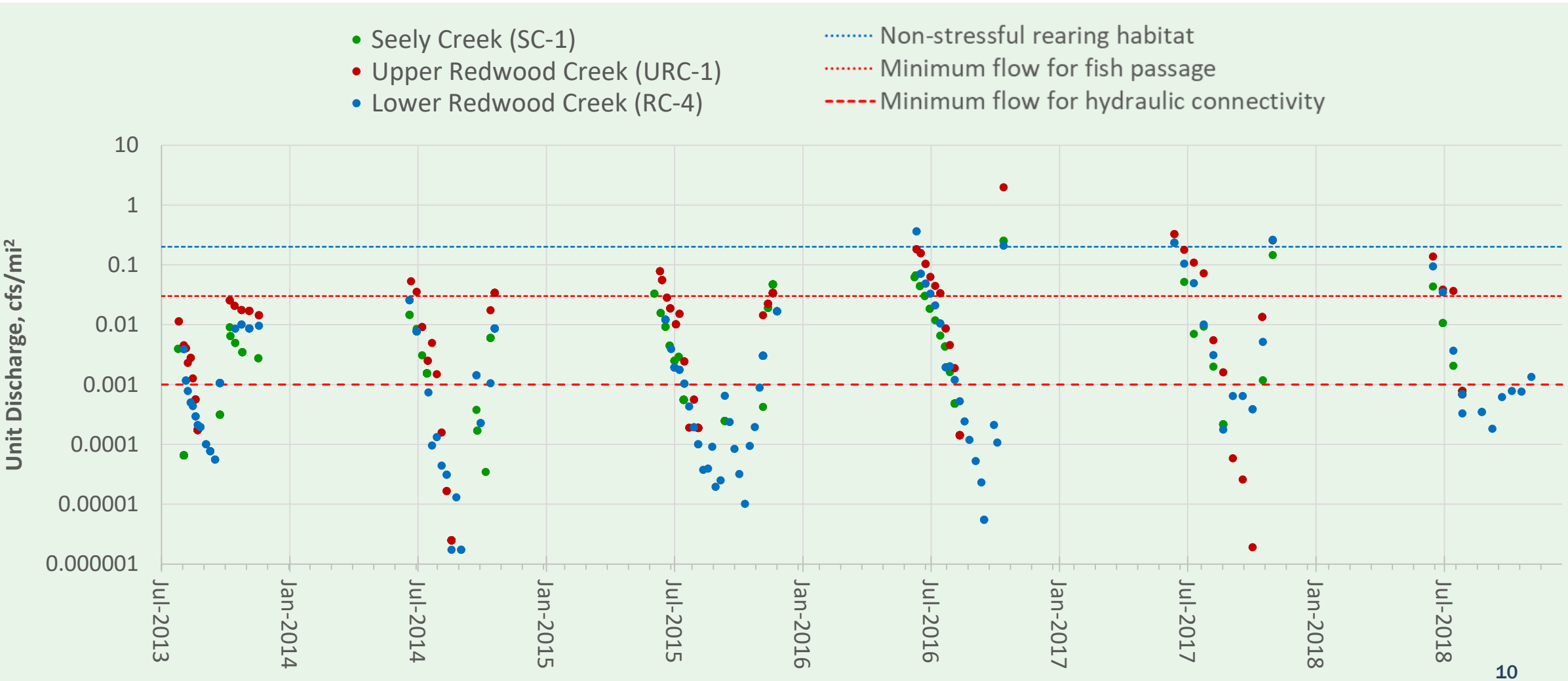
Site	Year	Date of last measured flow before going dry
SC-1	2013	8/2
	2014	7/17
	2015	7/20
	2016	8/12
	2017	9/1
	2018	8/10
URC-1	2013	8/22
	2014	8/21
	2015	8/10
	2016	8/19
	2017	flow year round
	2018	8/10
RC-4	2013	flow year round
	2014	9/4
	2015	flow year round
	2016	9/23
	2017	flow year round
	2018	flow year round



PRELIMINARY LOW FLOW THRESHOLDS

Site	DA, mi²	Low Flow Threshold			
		Fish Passage		Hydraulic Connectivity	
		cfs	gpm	cfs	gpm
SC-1	5.8	0.17	78	0.006	2.6
URC-1	2.7	0.08	36	0.003	1.2
RC-4	25.8	0.77	347	0.026	12

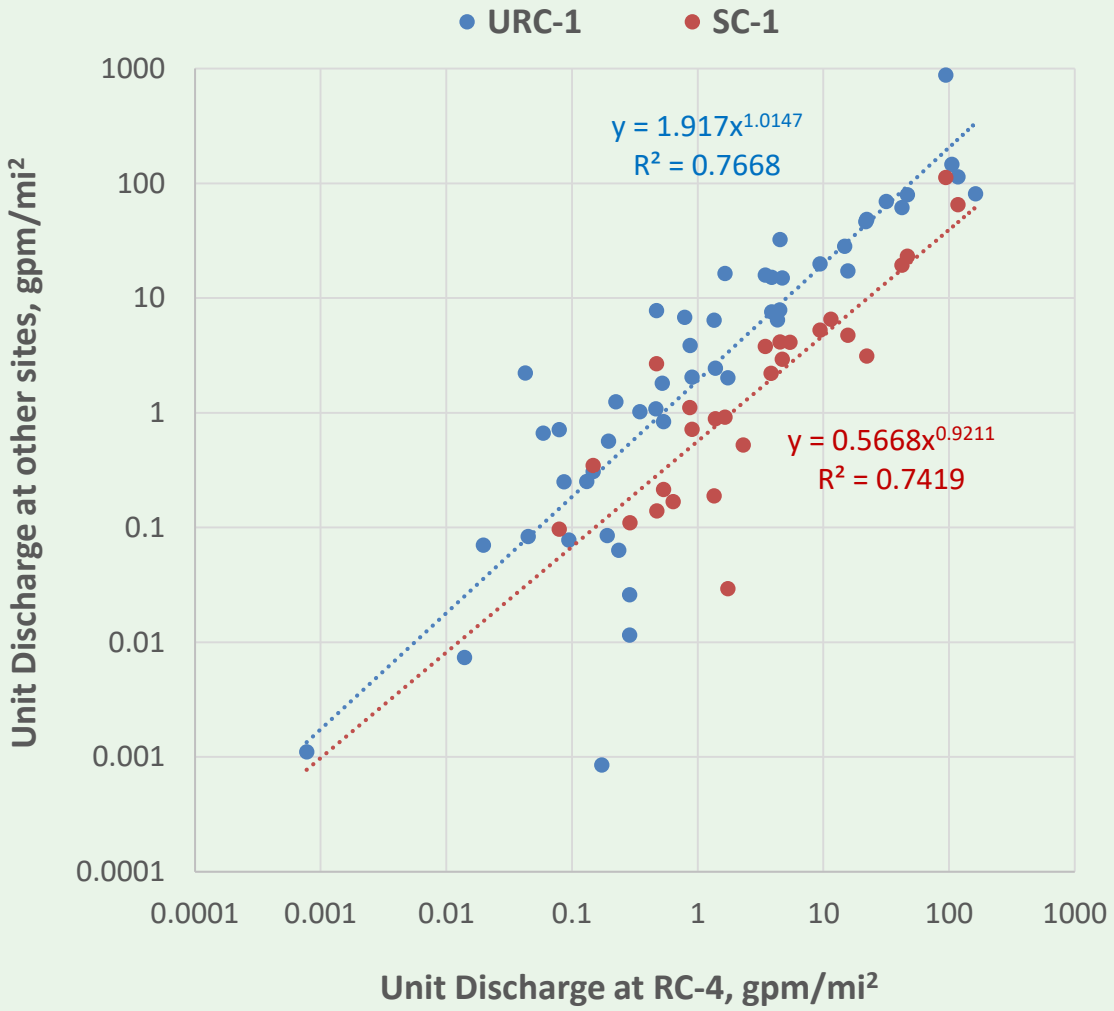
LOW FLOW THRESHOLDS AT MONITORING SITES



LOW FLOW THRESHOLDS AT MONITORING SITES

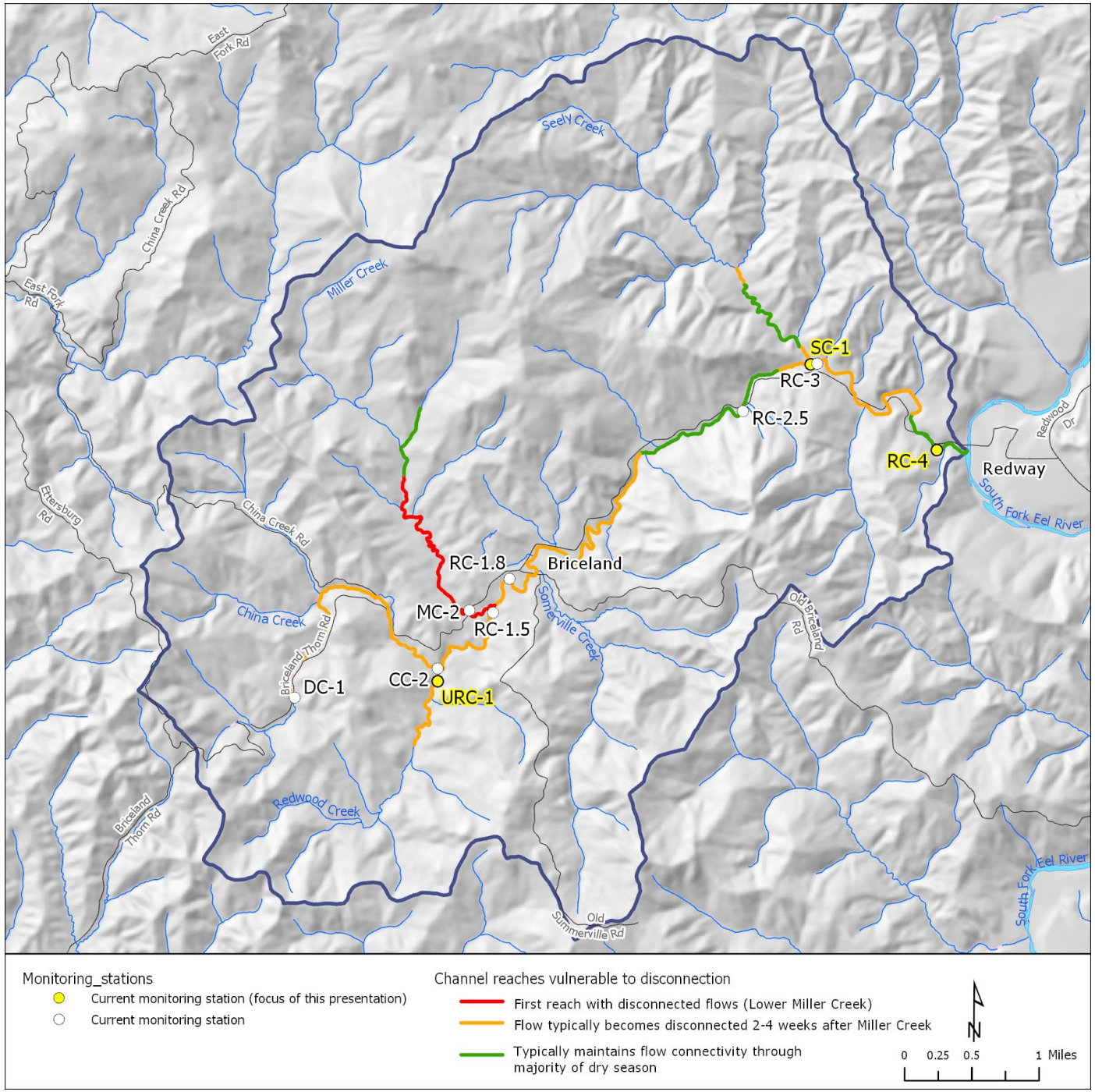
Site	Year	Date Monitoring Began	Date of last measurement when low flow threshold was met		
			Non-Stressful Rearing	Fish Passage	Hydraulic Connectivity
			0.20 cfs/mi^2	0.03 cfs/mi^2	0.001 cfs/mi^2
SC-1	2013	7/25	--	--	7/25
	2014	6/22	--	--	7/17
	2015	6/8	--	6/8	7/20
	2016	6/15	--	6/30	8/5
	2017	7/7	--	7/7	8/18
	2018	6/29	--	6/29	8/10
URC-1	2013	7/26	--	--	8/19
	2014	6/24	--	7/2	7/31
	2015	6/16	--	6/26	7/21
	2016	6/18	--	7/22	8/12
	2017	6/23	7/7	8/4	9/1
	2018	6/29	--	7/28	8/10
RC-4	2013	8/2	--	--	8/8
	2014	6/22	--	6/22	7/19
	2015	6/24	--	6/24	7/21
	2016	6/18	6/18	7/8	8/19
	2017	6/23	6/23	7/21	9/29
	2018	6/29	--	7/13	7/28

EXTRAPOLATING THRESHOLDS FROM A COMPLIANCE POINT



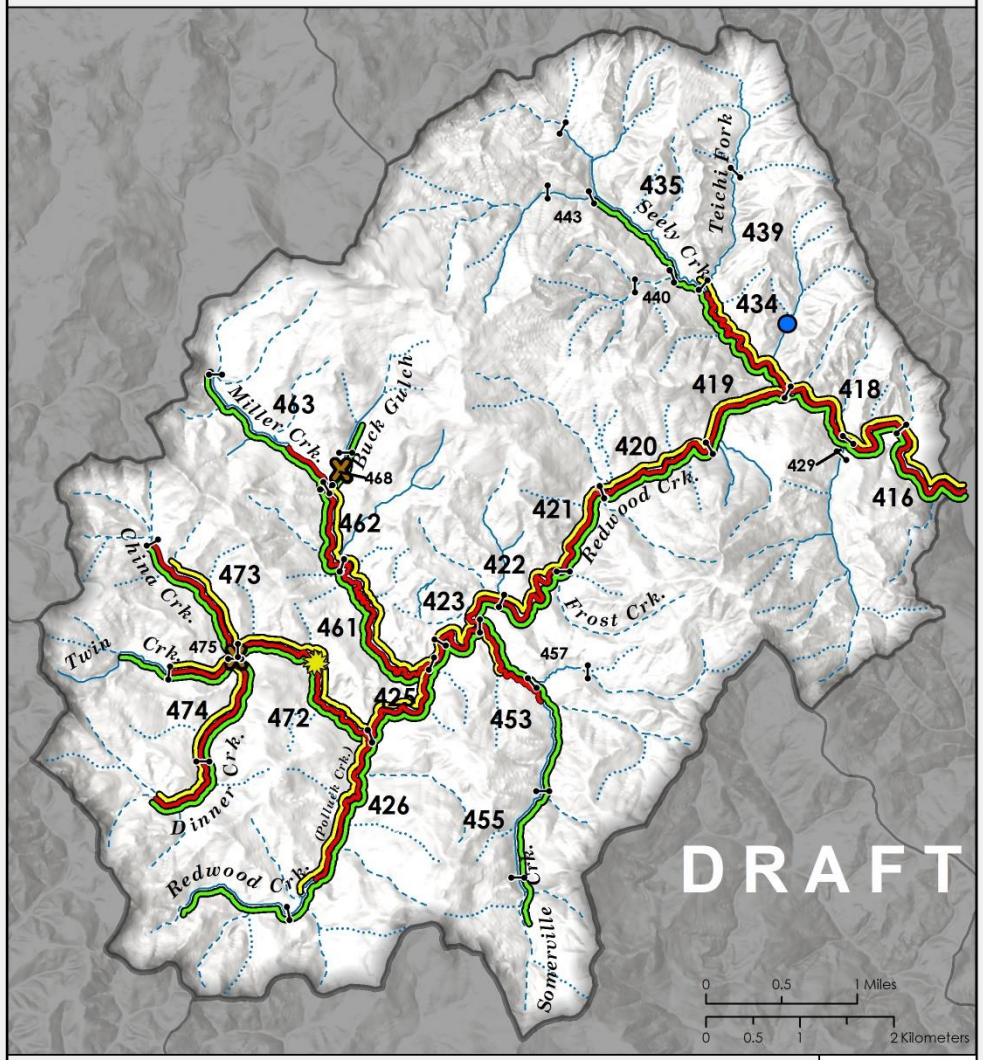
CHANNEL NETWORK DISCONNECTION

- Lower Miller Creek is the most flow-impaired reach
- Many stream reaches disconnect for several months each dry season
- Several stream reaches maintain connectivity through most of the dry season
- Understanding of flow connectivity within the channel network will be refined based on field investigations and terrain analyses



Salmon Habitat Restoration Priority (SHaRP) Watersheds

Distribution — **Redwood Creek**



Survey Reach Nodes

Watercourses
- Perennial
- Intermittent
- Ephemeral

Distribution
- Coho
- Chinook
- Steelhead (winter)

Natural Barriers
- Falls
- Other Debris Accumulation
- Road Crossing

Priority Watersheds

Prepared by: CPeters, CDFW **Date:** 20190805 **File:** D:\GIS\projects\SHaRP_maps\redwood\SHaRP_redwood_maps.mxd **Data Sources:** Distribution: CDFW (Coho, 2016; Steelhead, 2012), NOAA Fisheries (Chinook, 2005), updated 2019; Barriers: CDFW (PAD, 2019); Reaches: CDFW Coastal Monitoring Program (2016); Watercourse and watershed: NHD, USGS; Terrain: ESRI terrain multi-directional hillshade map service.

Salmon Habitat Restoration Priority (SHaRP) Watersheds

Redd Density: Total (Coho Survey, 2010-2018) — **Redwood Creek**

Survey Reach Nodes

Watercourses
- Perennial
- Intermittent
- Ephemeral

Total Redd Mean Density*
Redds/km (mean)
- 0
- 0.1 - 5
- 5 - 9
- 9 - 15
- 15 - 22
- 22 - 38

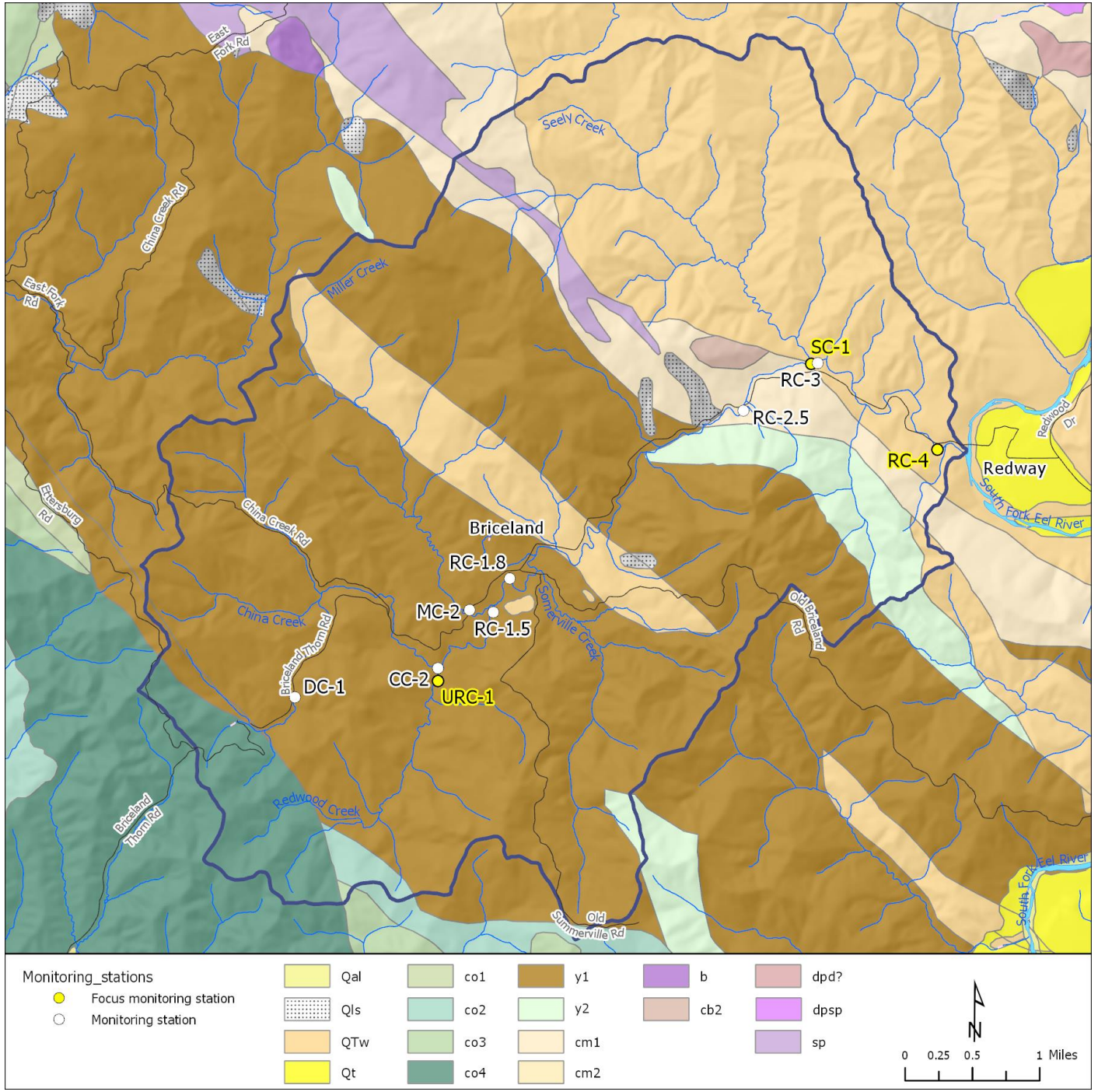
Priority Watersheds

* Density is calculated as the mean for all years a reach was surveyed. Symbology range represents data for all seven priority watersheds.

Prepared by: CPeters, CDFW **Date:** 20190805 **File:** D:\GIS\projects\SHaRP_maps\redwood\SHaRP_redwood_maps.mxd **Data Sources:** Redds: 2010 - 2018 spawner surveys by CDFW (2019); Reaches: CDFW Coastal Monitoring Program (2016); Watercourse and watershed: NHD, USGS; Terrain: ESRI terrain multi-directional hillshade map service.

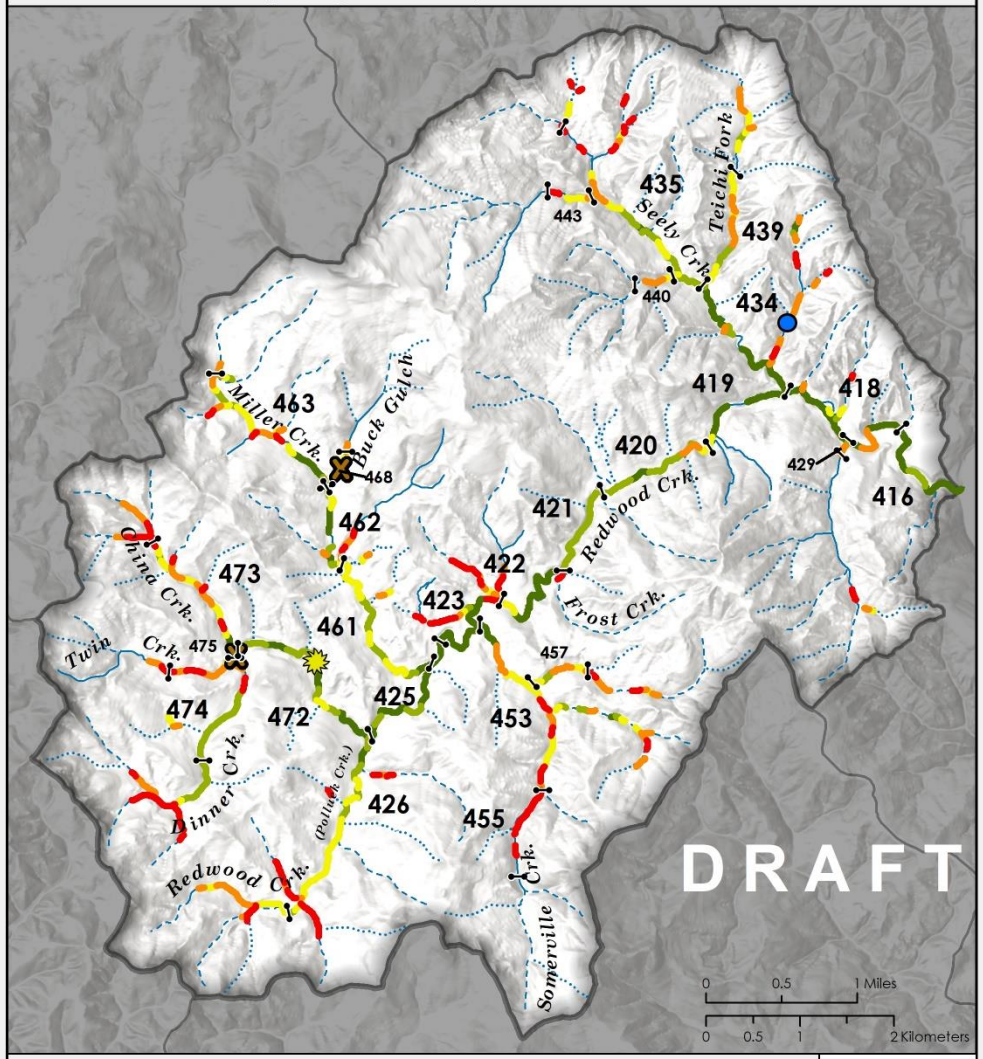
GEOLOGIC AND GEOMORPHIC CONTROLS

- **Diverse geology**
- **Flow connectivity related to geomorphic conditions (e.g., channel gradient and valley width):**
  - Narrow confined valleys = greater connectivity
  - Broader alluvial valleys = first to become disconnected
- **Flow connectivity also influenced by other site-specific conditions:**
  - Bedrock lithology, stratigraphy, weathering, and fracture patterns, faulting
  - Soil type and depth
  - Vegetation



Salmon Habitat Restoration Priority (SHaRP) Watersheds

Mean Gradient Percent (Passage Evaluation) — **Redwood Creek**



Survey Reach Nodes

Watercourses
- Perennial
- Intermittent
- Ephemeral

Mean Gradient Percent*
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5

Natural Barriers
- Falls
- Other Debris Accumulation
- Road Crossing

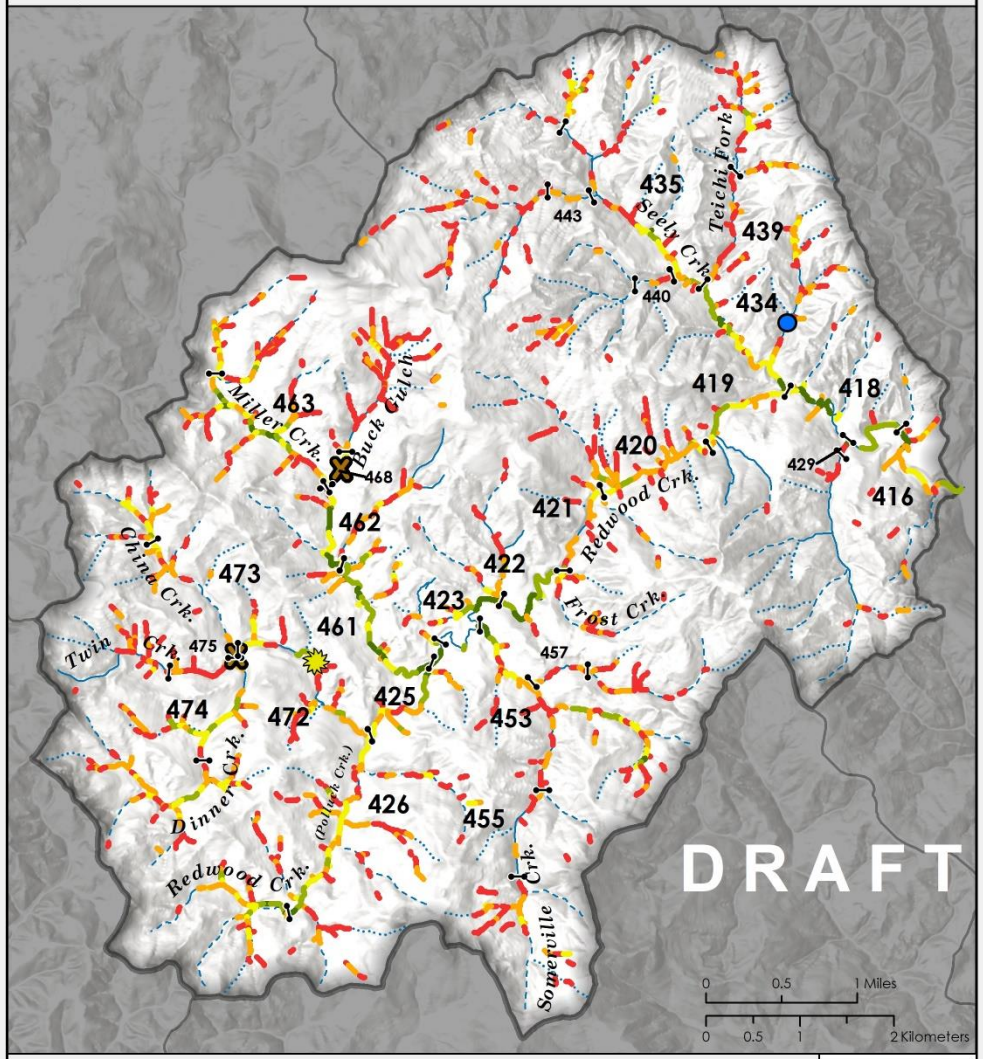
Priority Watersheds

* Symbology range is restricted to 0-5%.

Prepared by: CPeters, CDFW **Date:** 20190805 **File:** D:\GIS\projects\SHaRP_maps\redwood\SHaRP_redwood_maps.mxd **Data Sources:** Gradient: NOAA Fisheries (2011, review pending); Barriers: CDFW (PAD, 2019); Reaches: CDFW Coastal Monitoring Program (2016); Watercourse and watershed: NHD, USGS; Terrain: ESRI terrain multi-directional hillshade map service.

Salmon Habitat Restoration Priority (SHaRP) Watersheds

Valley Width — **Redwood Creek**



Survey Reach Nodes

Watercourses
- Perennial
- Intermittent
- Ephemeral

Valley Width (m)*
- 24 - 27
- 28 - 33
- 34 - 41
- 42 - 54
- 55 - 75

Natural Barriers
- Falls
- Other Debris Accumulation
- Road Crossing

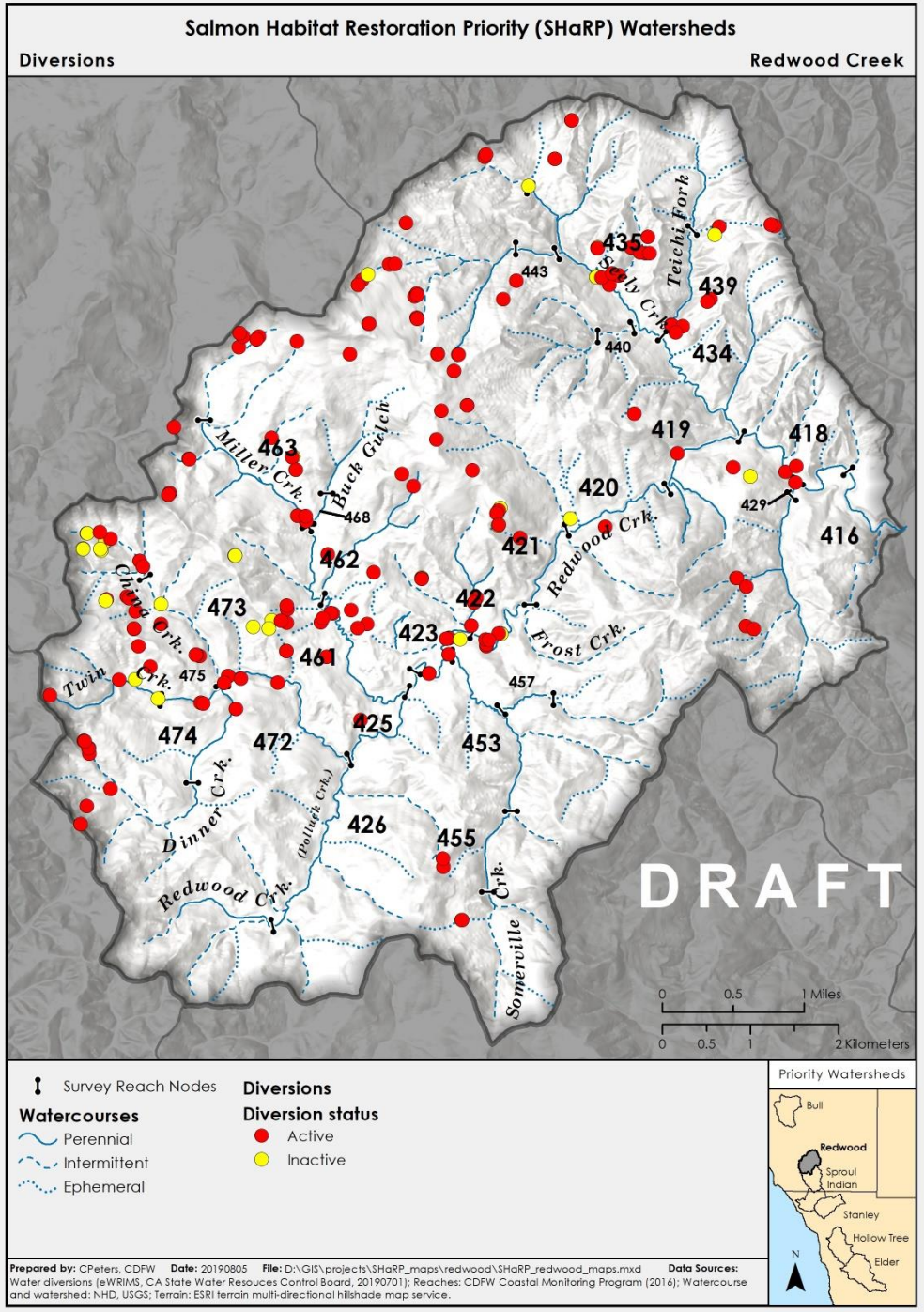
Priority Watersheds

* Symbology range represents data for all seven priority watersheds and is restricted to 24-75 meters.

Prepared by: CPeters, CDFW **Date:** 20190805 **File:** D:\GIS\projects\SHaRP_maps\redwood\SHaRP_redwood_maps.mxd **Data Sources:** Gradient: NOAA Fisheries (2011, review pending); Barriers: CDFW (PAD, 2018); Reaches: CDFW Coastal Monitoring Program (2016); Watercourse and watershed: NHD, USGS; Terrain: ESRI terrain multi-directional hillshade map service.

CONSUMPTIVE WATER USE

- Approximately 400 parcels
- Significant consumptive use
- Northern sub-watersheds have most consumptive use (Seely, Miller, and China)
- Southeastern tributaries under timber/ranch ownership have significantly less consumptive use (Upper Redwood and Somerville)
- Consumptive use estimated to be 1,000 gal/day per parcel; total of 150,000 gal of use during five-month dry season
- Many landowners implementing storage and forbearance



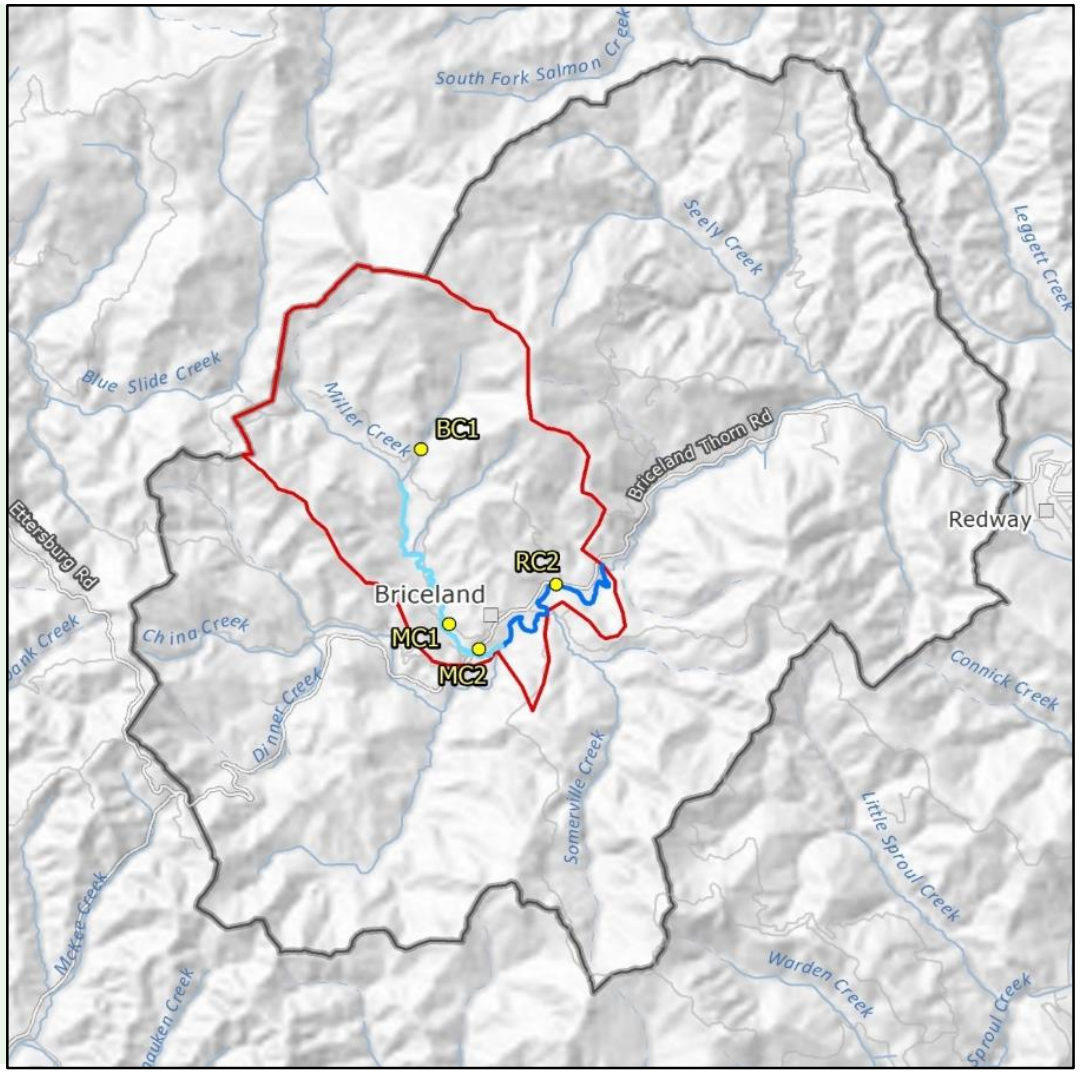
REDWOOD CREEK FLOW ENHANCEMENT FEASIBILITY STUDY

- Analyzed flow monitoring results
- Identified preliminary flow thresholds
- Estimated consumptive water use
- Identified and prioritize potential flow enhancement pilot projects within focus study area

Redwood Creek near Briceland (just upstream of RC-2)

July 27, 2018

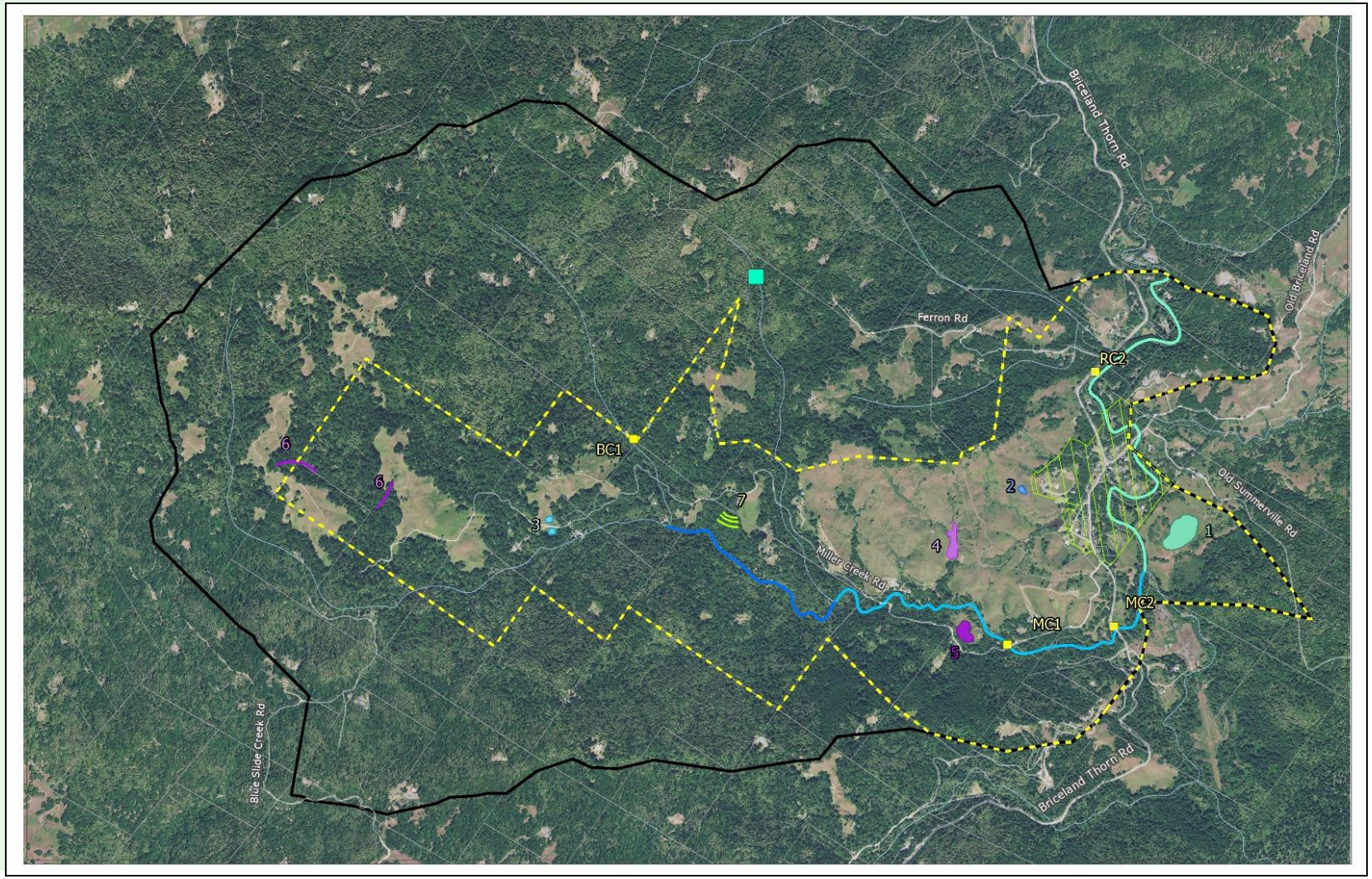
August 24, 2018



REDWOOD CREEK FLOW ENHANCEMENT FEASIBILITY STUDY

Primary findings & recommendations

- Lower Miller Creek is the most flow-impaired tributary
- Marshall Ranch flow enhancement highest priority site
- Assessment of flow enhancement opportunities throughout watershed should be conducted prior to advancing any other pilot projects



REDWOOD CREEK FLOW ENHANCEMENT PLANNING PROJECT

- Planning project funded by WCB
- 2018-2020 low flow monitoring
- 2019 community outreach
- 2019 compile geospatial data
- 2019/2020 – Hydrogeomorphic assessment
  - Field investigation of stream channels, floodplains, and low terraces
  - Delineate channel connectivity during low flow conditions (e.g., wet and dry channel reaches)
  - Document site conditions conducive to flow enhancement projects
- 2019/2020 – Water availability analyses

REDWOOD CREEK FLOW ENHANCEMENT PLANNING PROJECT

- 2019/2020 – Flow Enhancement Project Development
  - Based on field assessment and geospatial analyses, divide the watershed into sub-areas
  - Define restoration approaches applicable to each area
  - Analyze how each restoration approach will address project goals
  - Prioritize each action with input from TAC
    - Degree of certainty and timescale of expected benefit
    - Degree to which restoration approach addresses mechanisms of impairment
    - Project feasibility (cost, impacts, and risks)
  - Develop watershed-wide implementation plan

THANKS TO PARTNERS AND FUNDERS

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North Coast Regional Water Quality Control Board

Humboldt Area Foundation

Wildlife Conservation Board

Humboldt Fish and Game Commission