Evaluating Salmon Habitat & Watershed Conditions to Inform Salmonid Recovery Actions Workshop

A Workshop at the 35th Annual Salmonid Restoration Conference held in Davis, CA from March 29 – April 1, 2017.

Session Overview

- Session Coordinators:
  - Thomas H. Leroy and Danny Hagans, Pacific Watershed Associates

This workshop provided restorationists and land managers with information on tools and techniques to evaluate and improve watershed conditions for salmonids and other native fishes at a watershed scale. After presentations, we concluded with a panel discussion to more fully explore the habitat monitoring techniques covered during the workshop and to consider how to best integrate them into your watershed planning efforts. Attendees took home from this workshop a baseline understanding of several scientifically sound techniques for evaluating watershed conditions, their limitations, and how to strategically employ them in their local watersheds to inform and prioritize salmon recovery.

Presentations

(1) State of the Salmonids—Fish in Hot Water
Patrick Samuel, California Trout

(2) Is Habitat Restoration Targeting Relevant Ecological Needs for Endangered Species?: Using Pacific Salmon as a Case Study
Katie Barnas, NOAA Fisheries

(3) Managing Landscape Cumulative Effects Using Innovative Planning Technology and Process
Barry Wilson, CE Analytic Ltd.

(4) Assessing Salmonid Habitat Conditions and Management Actions in the Garcia Watershed Using the U.S. EPA's Environmental Monitoring and Assessment Program (EMAP-West) and the California Surface Water Ambient Monitoring Program (SWAMP)
Jonathan Warmerdam, North Coast Regional Water Quality Control Board, and Jennifer Carah, The Nature Conservancy

(5) What Does Habitat Monitoring Data Mean to Salmonids? Creating Status, Trend, and Recovery Information from Field Data
Sean P. Gallagher, California Department of Fish and Wildlife

(6) Building on CMP Monitoring Efforts to Document Insufficient Stream Flow as a Bottleneck to Salmonid Survival in Tributaries of the Russian River, CA
Sarah Nossaman, University of California Sea Grant

Presentations

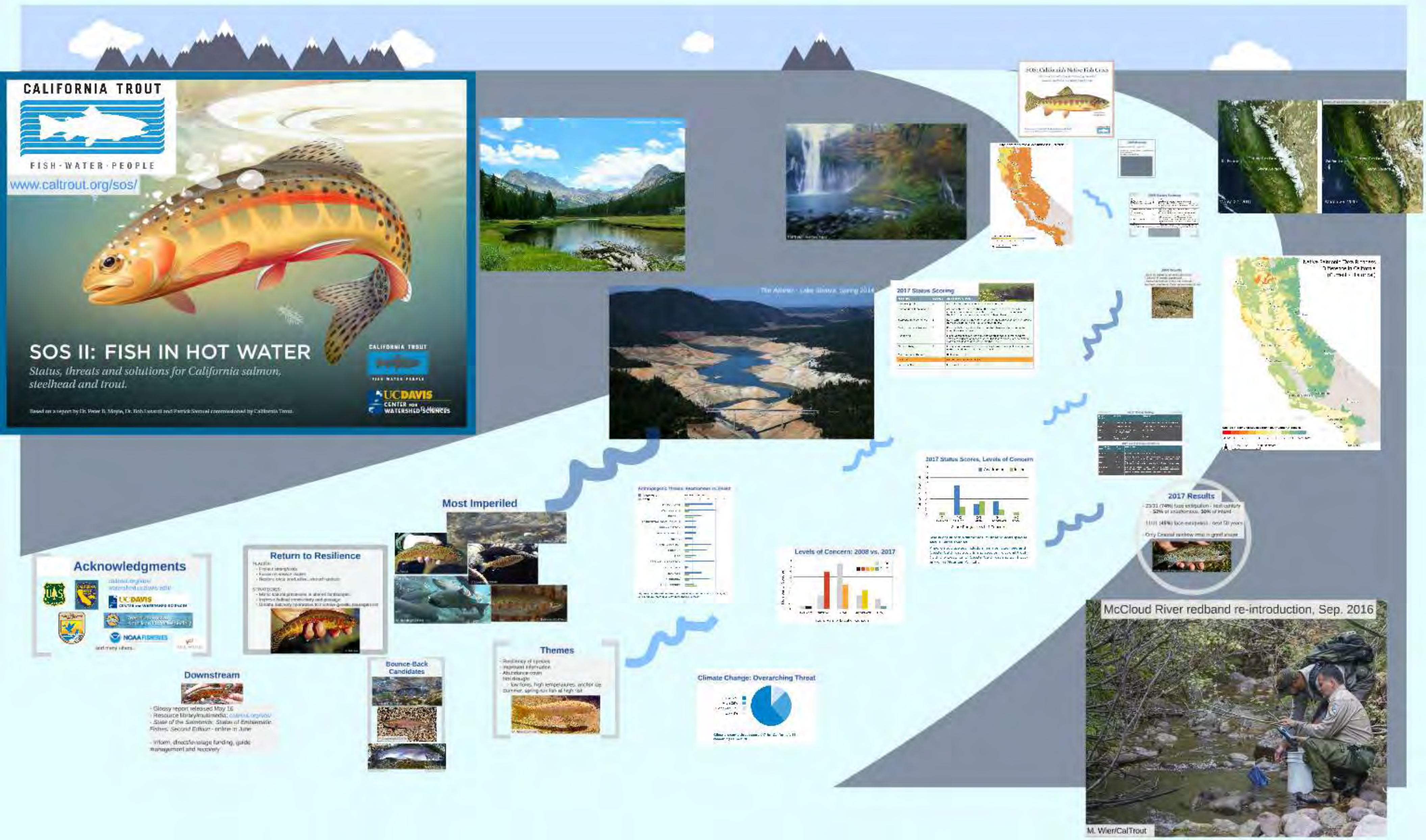
(7) Developing and Deploying a Network of Water Quantity/ Quality Sensors to Monitor and Protect Streams for Salmonids
Brad Job, Pacific Watershed Associates

(8) Factors Influencing Chinook Egg Survival in the Regulated Cle Elum River, WA
Mark D. Bowen, Environmental Science Associates

(9) Evaluating Sediment Effects and Utilizing Sediment Budget Elements to Prioritize Watershed Scale Salmonid Habitat Recovery to Reduce Cumulative Impacts
Danny Hagans, Pacific Watershed Associates

(10) Valley Bottom Geomorphology, Inundation, and Connectivity: Identifying and Prioritizing Floodplain and Off-Channel Habitat Restoration Opportunities
Jay Stallman, Stillwater Sciences

(11) Evaluating Stream Channel Corridors for Habitat Improvement Projects
Thomas H. Leroy, Pacific Watershed Associates



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SOS II: FISH IN HOT WATER
Status, threats and solutions for California salmon, steelhead and trout.
UCDAVIS
CENTER for WATERSHED SCIENCES
2017 Status Scoring
2017 Status Scores, Levels of Concern
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Levels of Concern: 2008 vs. 2017
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Climate Change: Overarching Threat
Downstream
Bounce-Back Candidates
McCloud River redband re-introduction, Sep. 2016
M. Wier/CalTrout

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SOS II: FISH IN HOT WATER

Status, threats and solutions for California salmon, steelhead and trout.

Based on a report by Dr. Peter B. Moyle, Dr. Rob Lusardi and Patrick Samuel commissioned by California Trout.

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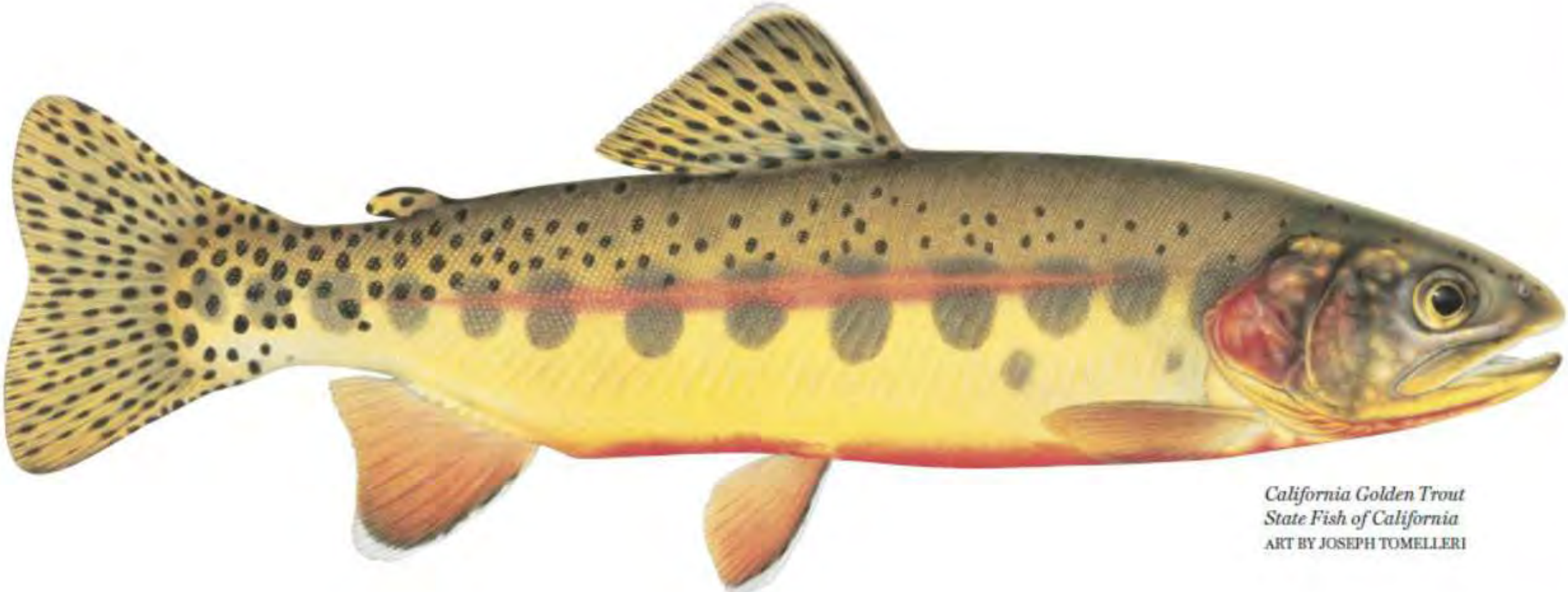
R. Waters

SOS: California's Native Fish Crisis

Status of and solutions for restoring our vital salmon, steelhead and trout populations

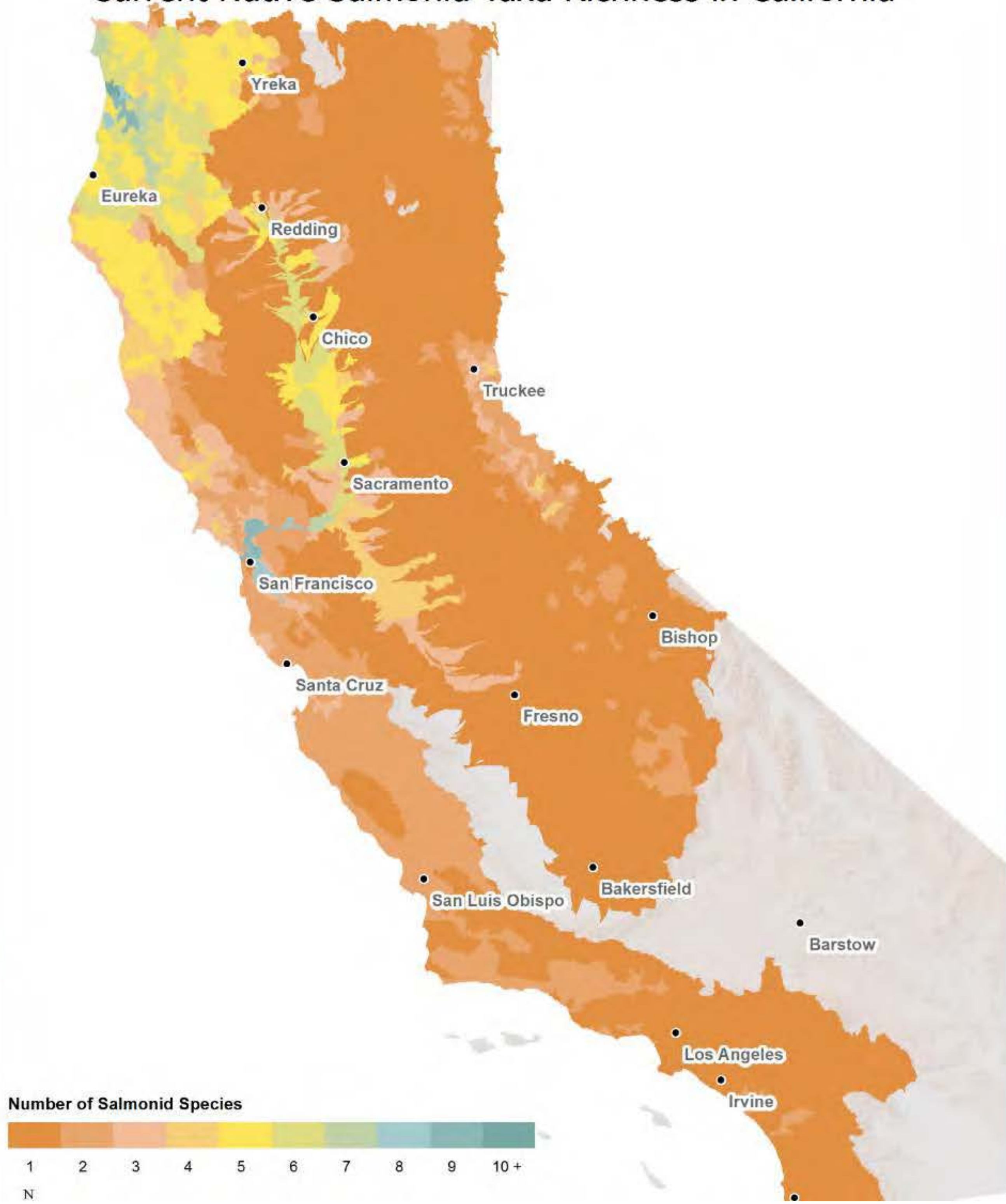


California Golden Trout
State Fish of California
ART BY JOSEPH TOMELLERI

Based on a report by Dr. Peter B. Moyle, Dr. Joshua A. Israel, and Sabra E. Purdy, commissioned by California Trout

CALIFORNIA TROUT
KEEPER OF THE STREAMS

Current Native Salmonid Taxa Richness in California



2008 Methods

Assessed California's 32 salmonids:*

- literature review: peer-reviewed, gray literature
- expert interviews
- biologists' expert judgment

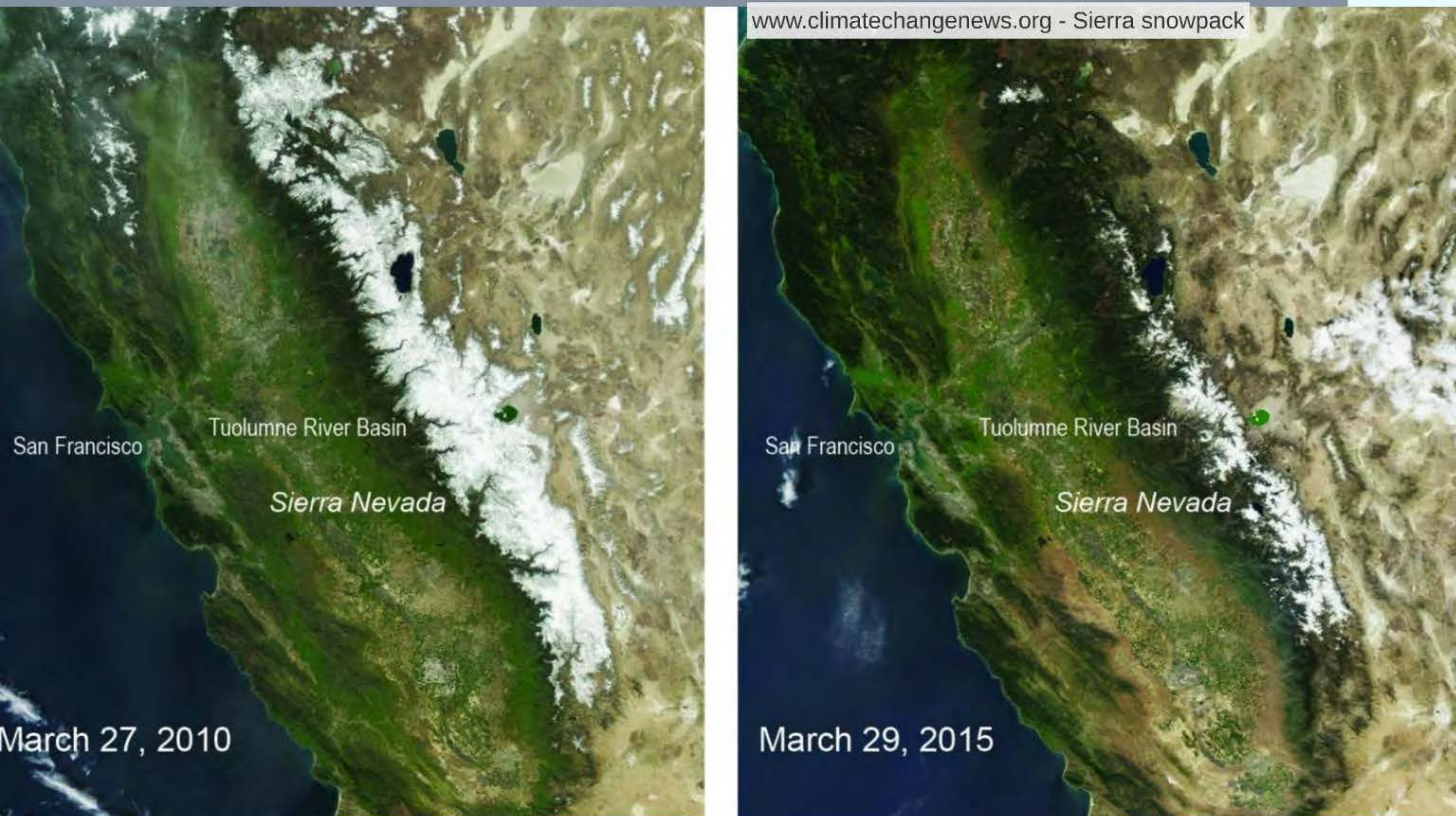
2008 Status Scoring

Metric	Score	Justification
1B Area occupied (1-5)	5	Found in most watersheds from Eel River north.
2 Effective population size (1-5)	3	This would be a '5' if we assumed all populations are genetically interconnected. Most appear to be small and isolated.
3 Intervention dependence (1-5)	3	Persistence requires improved management of heavily logged watersheds.
4 Tolerance (1-5)	3	Moderately tolerant of conditions in California streams
5 Genetic risk (1-5)	4	Little information on genetics available; hybridization with steelhead may be a problem in some streams.
6 Climate change (1-5)	2	Because most populations are in small streams, there is considerable range-wide vulnerability to climate change.
Average	3.3	20/6
Certainty (1-4)	2	Information is scattered and not systematically compiled.

Table 4. Metrics for determining the status of coastal cutthroat trout; 1 is poor and 5 is excellent.

2008 Results

- 20 of 31 (**65%**) faced extirpation from California **if trends continued**...
- Sacramento River winter-run Chinook, Southern steelhead, Coho salmon most at risk


San Francisco
Tuolumne River Basin
Sierra Nevada
March 27, 2010
www.climatechangenews.org - Sierra snowpack
San Francisco
Tuolumne River Basin
Sierra Nevada
March 29, 2015

The Atlantic - Lake Shasta, Spring 2014

McCloud River redband re-introduction, Sep. 2016

M. Wier/CalTrout

2017 Status Scoring

METRIC	SCORE	JUSTIFICATION
Area occupied	3	CC Chinook salmon occupy 5 major watersheds.
Estimated adult abundance	3	All populations have less than 1,000 spawners in most years, but there is some mixing among populations; there have been recent increases in the Eel River population, but reliable data are lacking.
Intervention dependence	3	Long-term declines indicate intervention needed, especially in improved flows and habitat in the Russian and Eel rivers.
Environmental tolerance	3	Fall-run life history allows for moderate tolerance of environmental conditions encountered.
Genetic risk	2	Major watersheds may have distinct populations, all threatened by small size and similar genetic issues. The loss of spring-run life history was a major loss of diversity within the ESU.
Climate change	2	Likely to accelerate declines, especially in reservoir-dominated systems with reduced flows and altered channels.
Anthropogenic threats	1	8 Medium threats.
Average	2.9	LEVEL OF CONCERN: HIGH
Certainty (1-4)	3	Fairly well studied.

2017 Threat Rating

THREAT RATING	CRITERIA	TIMELINE
CRITICAL	Could push species to extinction.	3 species generations or 10 years, whichever is less.
HIGH	Could push species to extinction.	10 species generations or 11-50 years, whichever is less.
MEDIUM	Unlikely to drive a species to extinction by itself but contributes to increased extinction risk.	Next 100 years.
LOW	May reduce populations but extinction unlikely as a result.	Next 100 years.

2017 Level of Concern Criteria

STATUS/LEVEL OF CONCERN	STATUS SCORE	DEFINITION
EXTINCT	0.0	Extirpated from inland waters of California.
CRITICAL	1.0-1.9	High risk of extinction in the wild; abundance critically low or declining; current threats projected to push species to extinction in the wild in 10-15 generations.
HIGH	2.0-2.9	High risk of becoming a critical concern species; range and abundance significantly reduced; trajectory to extinction in 15-20 generations if no actions taken.
MODERATE	3.0-3.9	Declining, fragmented and/or small populations possibly subject to rapid status change; management actions needed to prevent increased conservation concern.
LOW	4.0-5.0	Populations are not in significant decline; abundant and widespread.

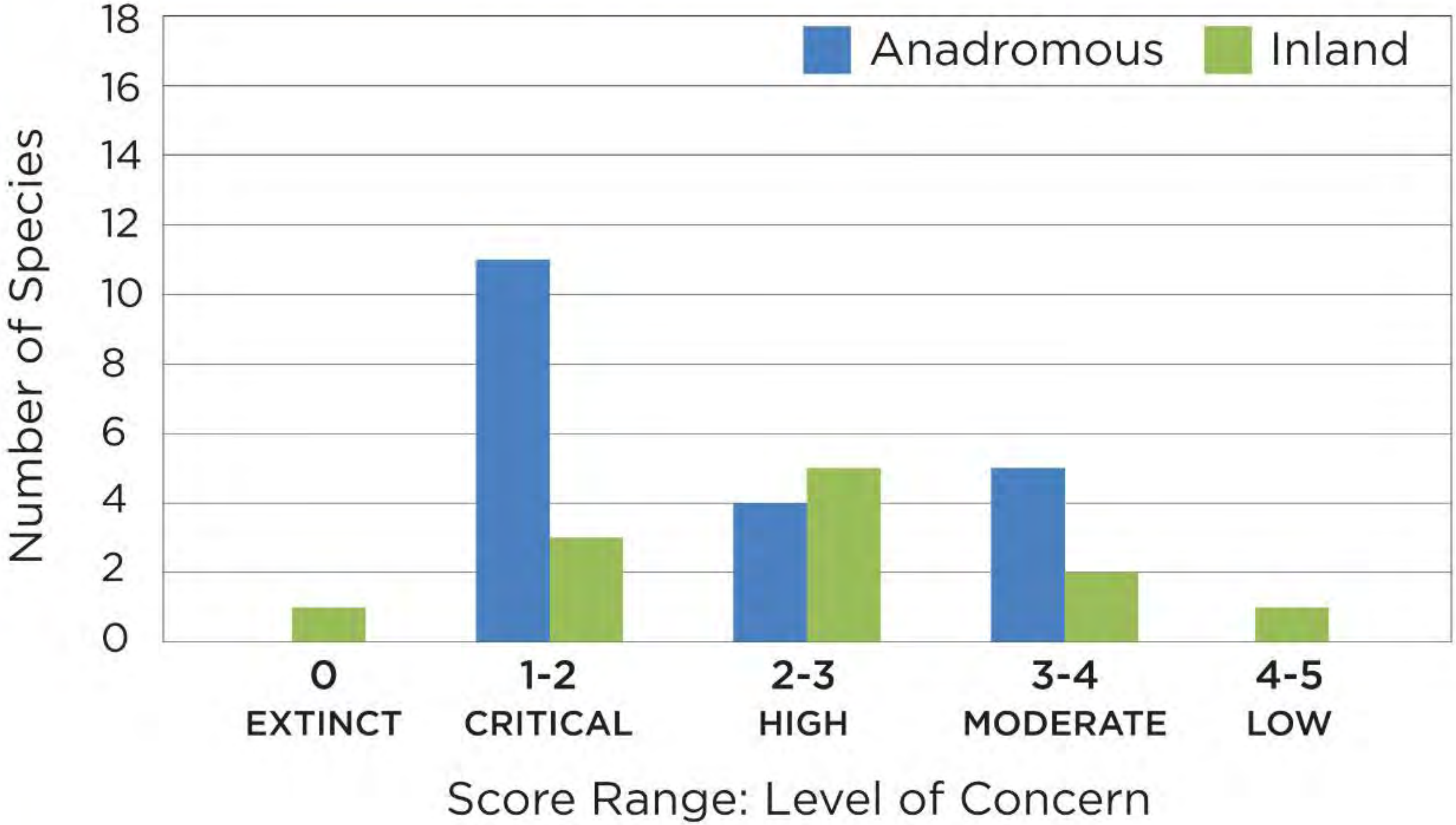
2017 Results

- 23/31 (**74%**) face extirpation - next century
    - **52%** of anadromous, **30%** of inland

- 11/31 (**45%**) face extirpation - next 50 years

- Only Coastal rainbow trout in good shape

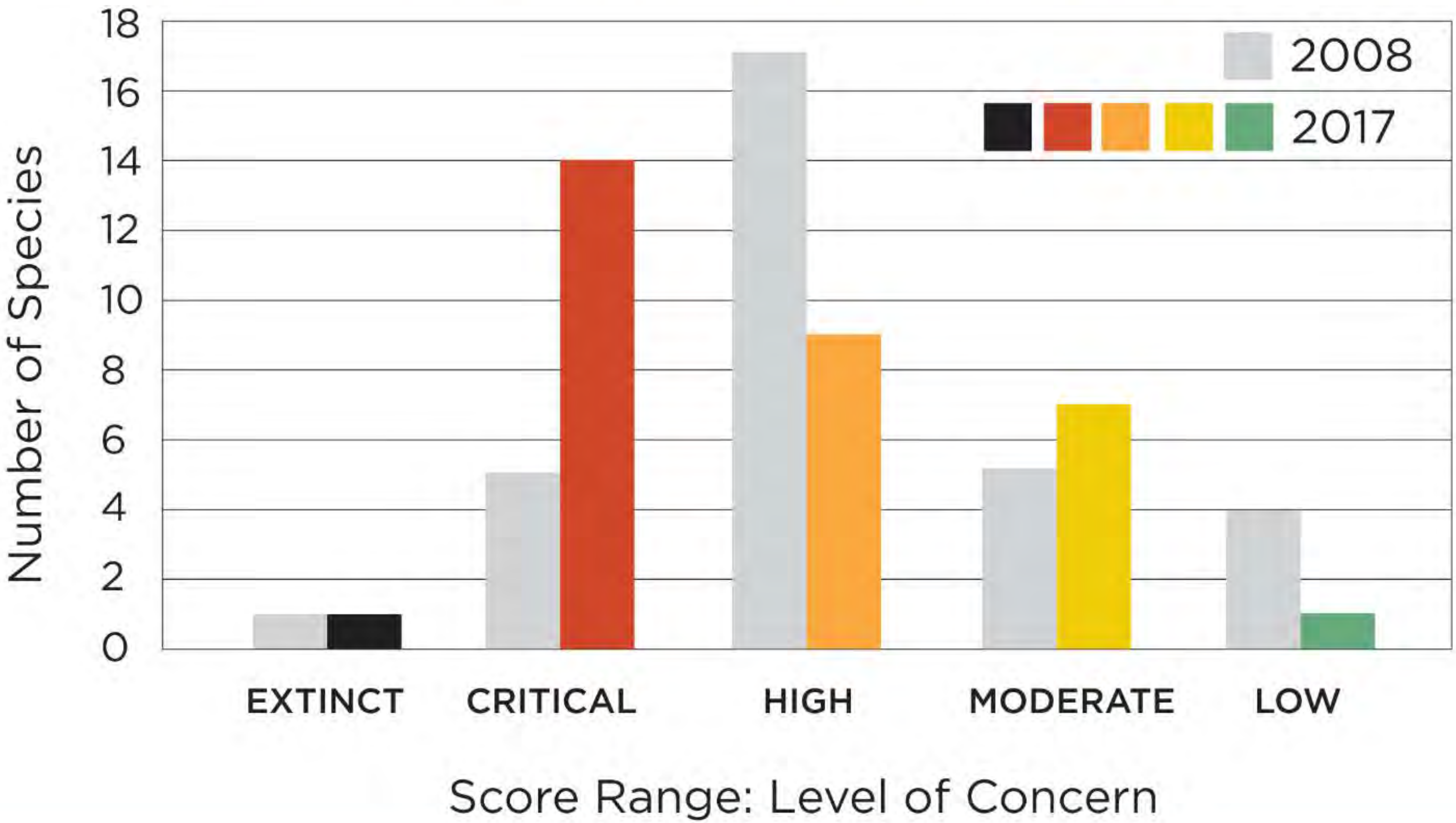
2017 Status Scores, Levels of Concern



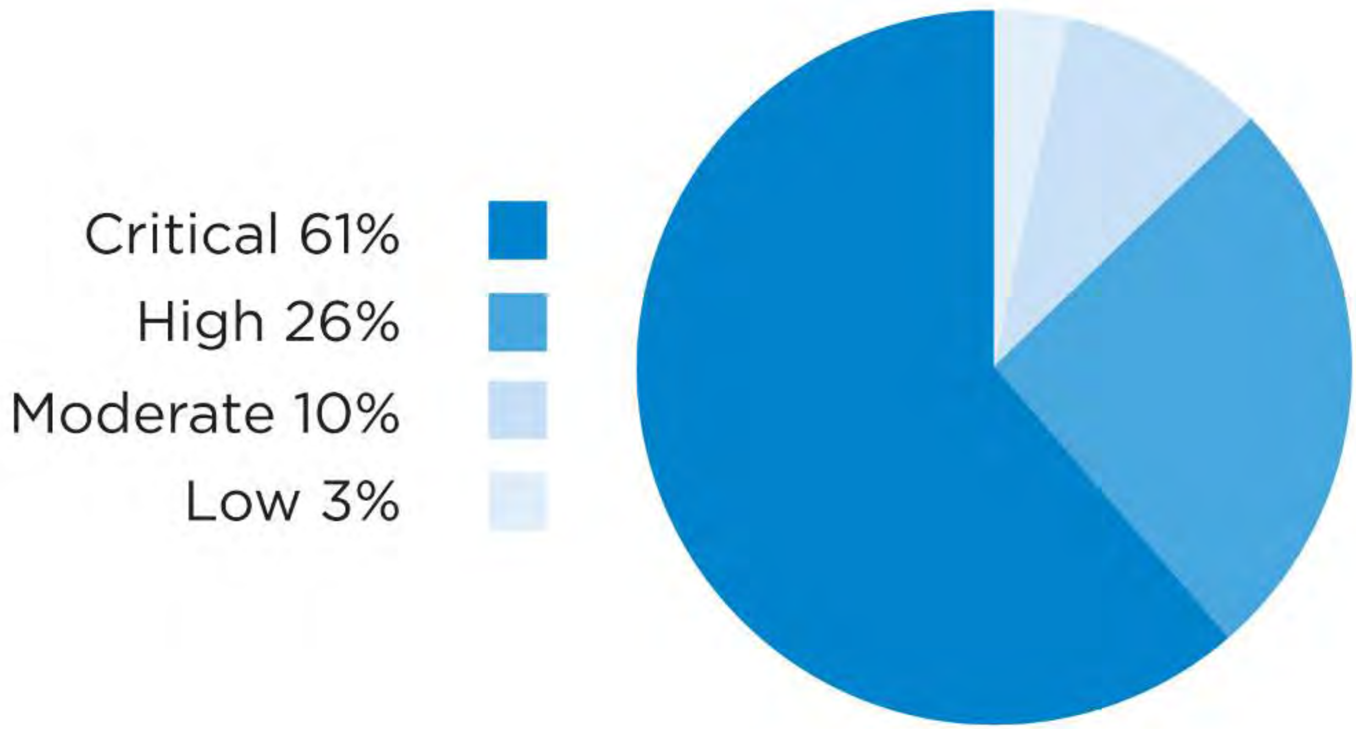
Status of California salmonids; 21 anadromous species and 11 inland species.

Anadromous species include all salmon, steelhead and Coastal Cutthroat trout. Inland species include all trout (with the exception of Coastal Cutthroat and Bull trout) as well as Mountain Whitefish.

Levels of Concern: 2008 vs. 2017



Climate Change: Overarching Threat



Climate change threat score (%) for California's 31 remaining salmonids.

Anthropogenic Threats: Anadromous vs. Inland

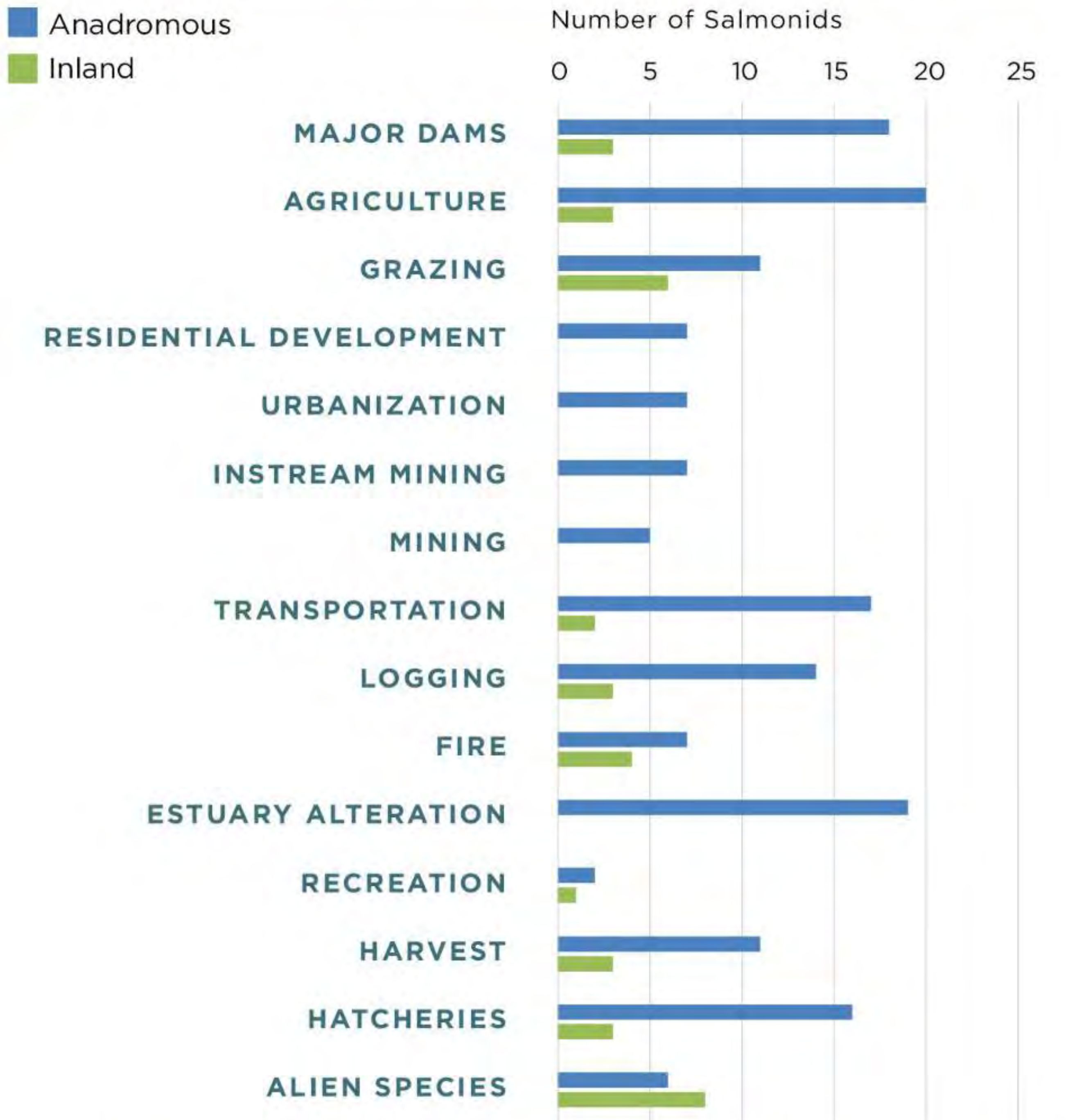


Figure 6. Number of anadromous and inland salmonids with critical, high

Themes

- Resiliency of species
- Improved information
- Abundance down
- Hot drought
    - low flows, high temperatures, anchor ice
- Summer, spring-run fish at high risk

Most Imperiled


M. Wier/CalTrout


G. Revel


J. Garwood/CDFW


M. Humling/USFWS


C. Ballenger/CalTrout

Bounce-Back Candidates

Return to Resilience

PLACES:

- Protect strongholds
- Focus on source waters
- Restore once productive, altered habitats

STRATEGIES:

- Mimic natural processes in altered landscapes
- Improve habitat connectivity and passage
- Update hatchery operations to improve genetic management


M. Hernandez - Kern Riv


CalTrout - Burney Falls

Downstream

- Glossy report released May 16
- Resource library/multimedia: caltrout.org/sos/
- *State of the Salmonids: Status of Emblematic Fishes, Second Edition* - online in June

- Inform, direct/leverage funding, guide management and recovery

Acknowledgments

caltrout.org/sos/
watershed.ucdavis.edu/

and many others...

Is habitat restoration targeting ecological needs for endangered species? Using Pacific Salmon as a case study

Katie A. Barnas[1], Stephen L. Katz[2], David Hamm[3], Monica Diaz[1], and Chris Jordan[1]

[1]Conservation Biology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA
[2] School of the Environment, Washington State University, Pullman, WA
[3] Hamm Consulting, Seattle, WA

20 Years of salmon recovery

- 5 species, 28 ESU/ DPS of Pacific Salmon are listed as threatened or endangered in WA, OR, ID and CA (Listed 1991-2007)

- Billions of dollars spent on habitat restoration over the last 20+ years

- Lots of available data

Mine data to:

(1) Understand patterns in restoration project type and placement

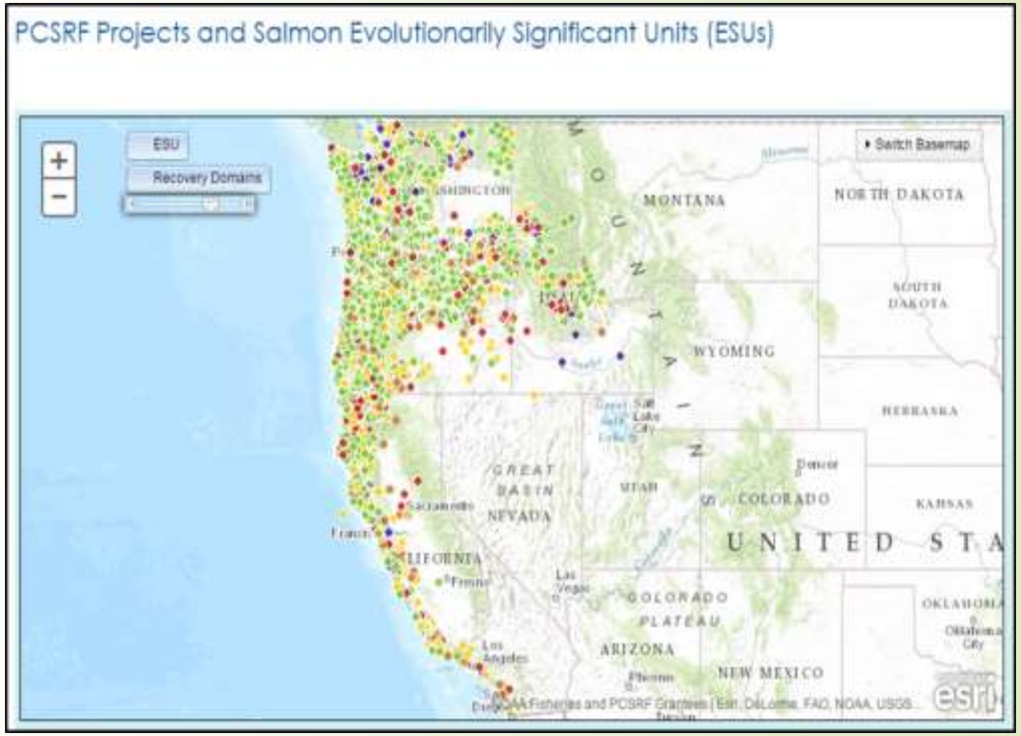
(2) Develop metrics to identify whether habitat needs have been met by the accumulation of implemented restoration

(3) Use these metrics to prioritize future restoration

Data Sources : Habitat Restoration - California

Pacific Coast Salmon Recovery Fund

- NOAA matching funds to states and tribes
- For Southern Oregon and California projects grantees include CDFW and Tribes (Cow Creek, KRITFWC, Round Valley)
  - 5000 worksites where restoration is each unique combination of location and project type
  - Funded 2000-2016
- *Not the only funder of CA projects*

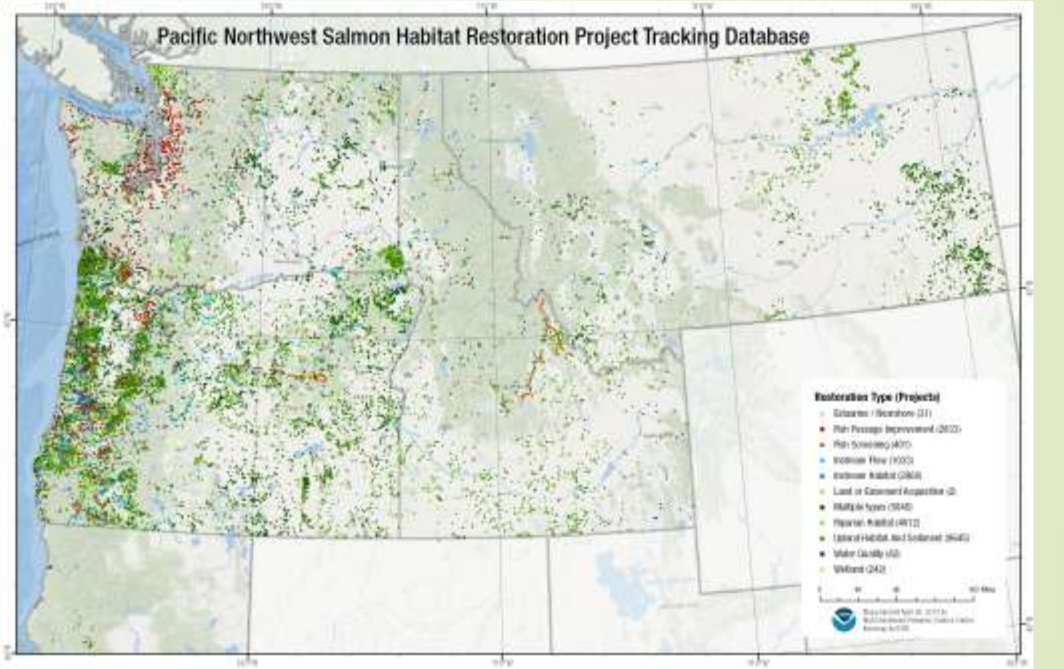


http://webapps.nwfsc.noaa.gov/pcsrf

Data Sources : Habitat Restoration - WA/OR/ID

Pacific Northwest Salmon Habitat Project Database

- 28 data sources, PCSRF + other federal (BLM, BPA, BOR, FWS, FS, NOAA Restoration Center) and local sources (Water Trusts, SWCD etc.)
  - 60,000 restoration locations
  - queried for projects completed 1992-2016 to match ESA listings
- Over $1billion spent to date
- Project type is standardized across both PNSHP and PCSRF databases



http://webapps.nwfsc.noaa.gov/pnshp

Data Source – Habitat Concerns

ESA Recovery Plans

- Completed 2007- 2016
- Consistent scale - population within an ESU/ DPS
- Describe habitat concerns
- Habitat concerns buried in text or tables
  - Read looking for major, or most limiting habitat problems

Geographic Area	Recovery Domain	ESU/DPS Name	Recovery Plan?
Northern Pacific Coast	Puget Sound	Ozette Lake Sockeye ESU	YES
		Hood Canal Summer-run Chum ESU	YES
		Puget Sound Steelhead DPS	NO
		Puget Sound Chinook ESU	YES
	Willamette/ Lower Columbia	Columbia River Chum ESU	YES
		Lower Columbia River Chinook ESU	YES
		Upper Willamette River Chinook ESU	YES
		Lower Columbia River Steelhead DPS	YES
		Lower Columbia River Coho ESU	YES
		Upper Willamette River Steelhead DPS	YES
	OR Coast	Oregon Coast Coho ESU	YES
Interior Columbia Basin	Interior Columbia	Snake River Sockeye ESU	YES
		Upper Columbia River Spring-run Chinook ESU	YES
		Snake River Fall-run Chinook ESU	YES
		Snake River Spring/Summer-run Chinook ESU	YES
		Upper Columbia River Steelhead DPS	YES
		Middle Columbia River Steelhead DPS	YES
		Snake River Basin Steelhead DPS	YES
California and Southern Oregon	S. OR/N. CA Coast	S. Oregon/N. California Coast Coho ESU	YES
	Central Valley	Sacramento River Winter-run Chinook ESU	YES
		California Central Valley Spring-run Chinook ESU	YES
		California Central Valley Steelhead DPS	YES
	N. Central California Coast	California Coastal Chinook ESU	YES
		Northern California Steelhead DPS	YES
		Central California Coast Coho ESU	YES
		Central California Coast Steelhead DPS	YES
	S. Central/S. CA Coast	S. Central California Coast Steelhead DPS	YES
		Southern California Steelhead DPS	YES

Relating ecological need to restoration

Need to find a common language

- Recovery plans identify 'concerns' (diagnosis)
- Restoration projects treat 'concerns' (treatment)

No consistent language to describe these 'problems'

Limiting factor

Threat

Impairment

Alteration

Stressor

Condition

Problem

Priority survival factors

Risk

Create a tool= data dictionary of **ecological concerns**

- Based on existing lists compiled by state and federal agencies and a survey of habitat assessments from throughout the region

Step 1: Define a common language

Ecological Concern:

Changes to the ecological conditions essential for maintaining the long-term viability of a given population of salmonids, which cause mortality, injury, reduced health or reduced reproduction.

Categories

1 Habitat Quantity

2 Injury and Mortality

3 Food

4 Riparian Condition

5 Peripheral and Transitional Habitats

6 Channel Structure and Form

7 Sediment Conditions

8 Water Quality

9 Water Quantity

(Hamm, 2012)

The Data Dictionary

ID	Ecological Concern	Definition	Included Categories	ID	Ecological Concern-Sub Category	Definition	Included Categories
5	Peripheral and Transitional Habitats	Loss and/or degradation of the peripheral habitat of streams and rivers, including standing water, connected channels and areas that are periodically inundated during high flows.	High quality over-winter rearing habitat, Summer rearing habitat, Peripheral Habitat, Habitat Diversity, (Key) Habitat Quantity/Quality, Refugia Habitat	5.1	Side Channel and Wetland Conditions	Degradation, elimination and loss of access to peripheral freshwater habitat, including side-channels and freshwater wetlands.	Side Channels, Loss of peripheral habitat, Freshwater Wetlands, Swamp, Oxbows, Ponds, Alcoves
				5.2	Floodplain Condition	Degradation, elimination and loss of access to the over or beyond bank habitat, of streams and rivers that is periodically inundated during high flows.	Floodplain, Bank condition, Overbank area, Diking
				5.3	Estuary Conditions	Loss and degradation of saltwater transition zone	Estuary, Salt-water transition zone, Lagoon, Estuary plume, Delta, Slough, Pocket estuary
				5.4	Nearshore Conditions	Loss and degradation of shallow water nearshore habitat	Beaches, Tidal flats, Eelgrass beds, Eelgrass meadows, Kelp forest, Baitfish spawning grounds

(Hamm, 2012) data dictionary available at http://webapps.nwfsc.noaa.gov/pnshp

Step 2: Compare

Restoration Database

"Fish Passage Improvement – Culvert Installed or Replaced"

Recovery Plan

"Passage barriers, culverts"

Wish list
Spatially referenced habitat assessments

- Define habitat projects in terms of the concerns they address via a standard crosswalk
- A single project type can address many concerns
- Multiple project type- subtypes may address the same concern

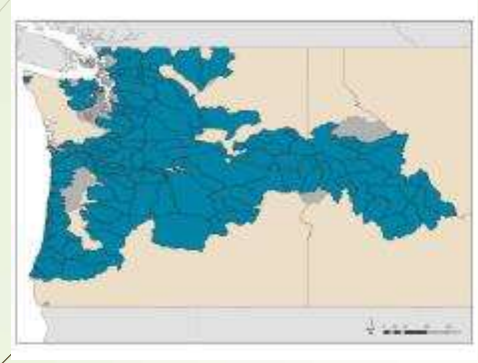
Ecological Concerns Data Dictionary

Habitat Quantity - Anthropogenic Barriers
=
Habitat Quantity - Anthropogenic Barriers

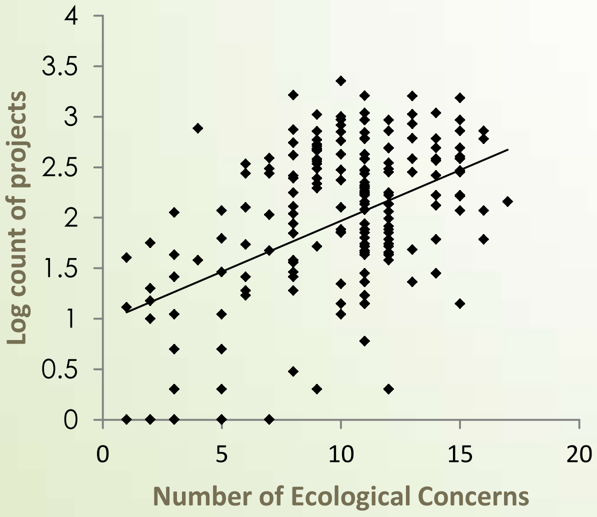
Presence/Absence Comparison using:
- correlations of need and project frequencies
- a metric relating habitat need to restoration

Ecological Threats to Worktypes aka "Goldilocks Crosswalk"
http://webapps.nwfsc.noaa.gov/pnshp

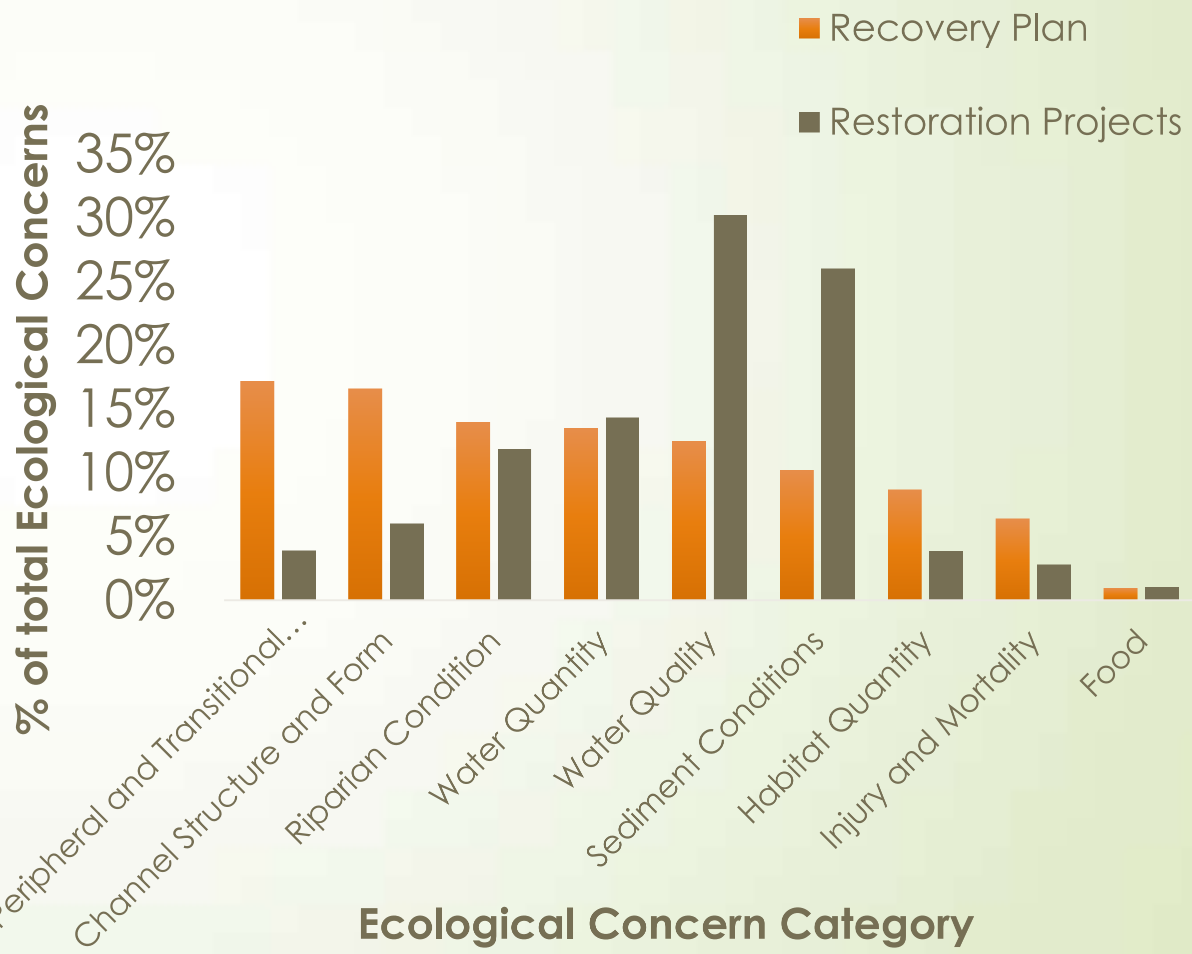
In aggregate what is the relationship between habitat need and restoration type?



271 Populations



(r^2 = 0.20, p = $2.8 \cdot 10^{-12}$)



(Barnas et al. 2015)

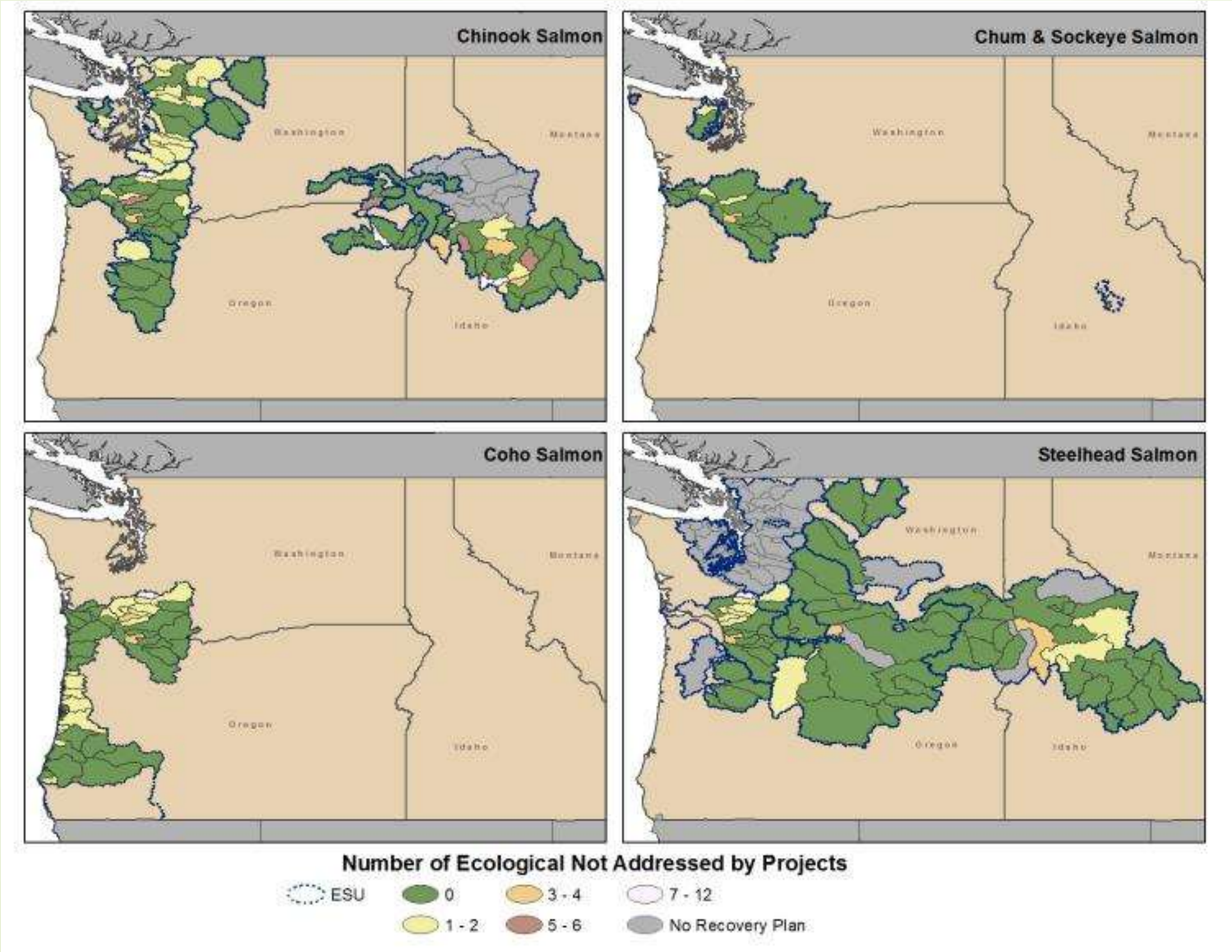
Population level Ecological Concerns comparison

Ecological Concerns	Habitat Quantity	Injury and Mortality	Food	Riparian Condition	Peripheral and Transitional Habitats	Channel Structure and Form	Sediment Conditions	Water Quality	Water Quantity
Recovery Plan	NO	YES	NO	YES	YES	YES	YES	YES	YES
Projects	YES (3 projects)	YES (1)	NO	YES (8)	YES (10)	YES (5)	YES (15)	NO	YES (3)

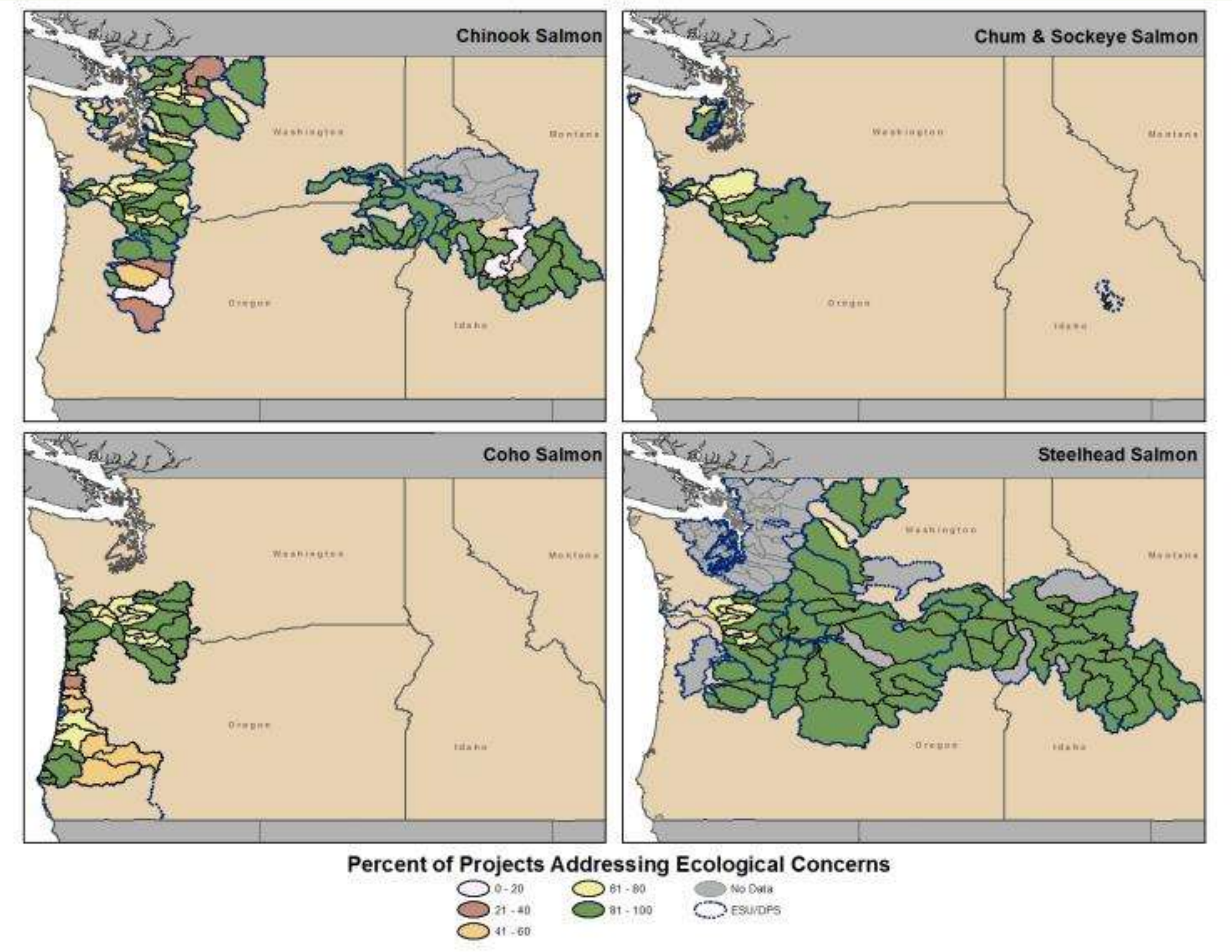
1) Are any Ecological Concerns not addressed by restoration?
   Yes, Water Quality

2) Do any restoration projects not address an Ecological Concern?
   Yes, 3 projects address Habitat Quantity which was not identified as a concern in the recovery plan

Number of Ecological Concerns not addressed by PNSHP project(s)



% of PNSHP projects that address one or more Ecological Concerns



Are ecological needs being targeted for restoration at the population level?

Ecological Concerns	Habitat Quantity	Injury and Mortality	Food	Riparian Condition	Peripheral and transitional habitats	Channel Structure and Form	Sediment Conditions	Water Quality	Water Quantity
Recovery Plan	NO	YES	NO	YES	YES	YES	YES	YES	YES
Projects	YES (3 projects)	YES (1)	NO	YES (8)	YES (10)	YES (5)	YES (15)	NO	YES (3)

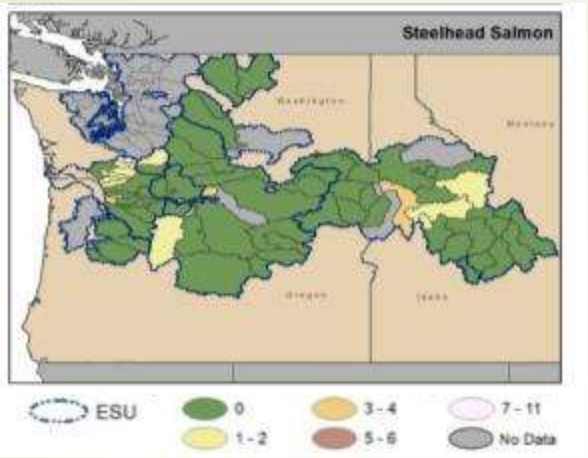
1) Are any Ecological Concerns not addressed by restoration?
   Yes, Water Quality
2) Do any restoration projects not address an Ecological Concern?
   Yes, 3 projects address Habitat Quantity

3)SHAPE Metric = (EC Addressed/Total EC) – (Projects not addressing EC/Total Projects)
Example Population = (6/7)- (3/42)=.785
Ranges from 1 (good) to -1 (needs a closer look)

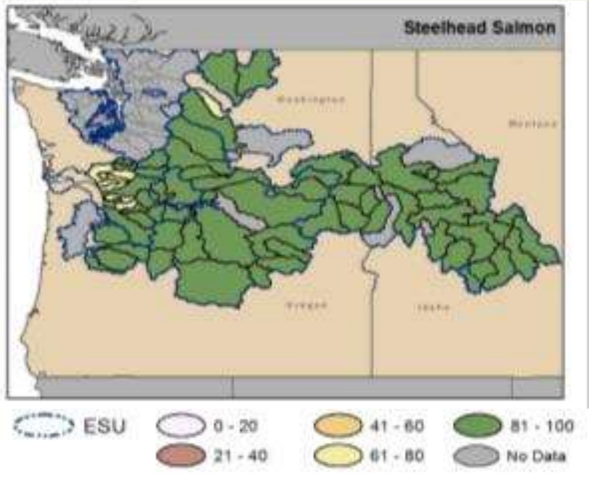
Rules:
No projects, SHAPE = 0

No ECs, Yes Projects: SHAPE = -1

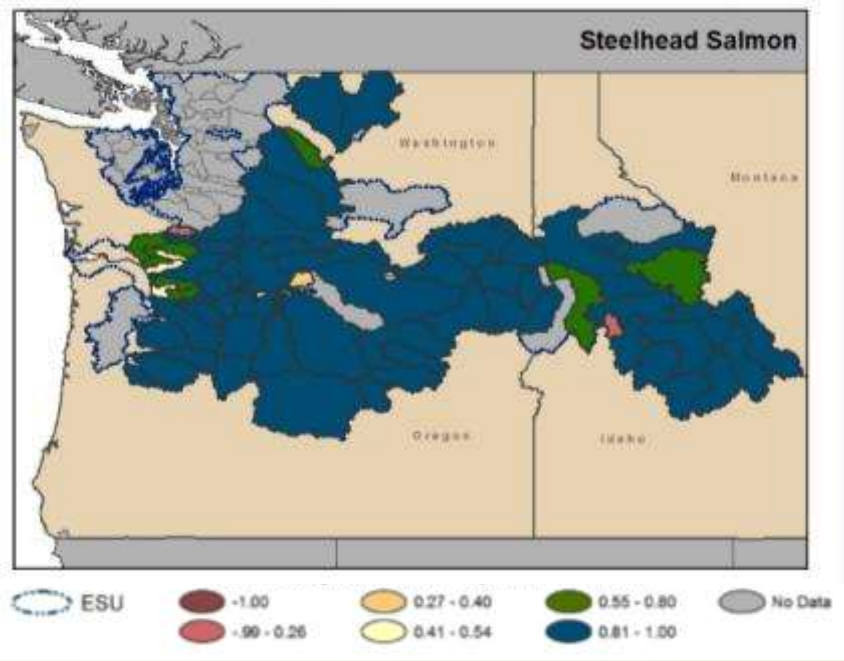
Ecological Concerns



Projects

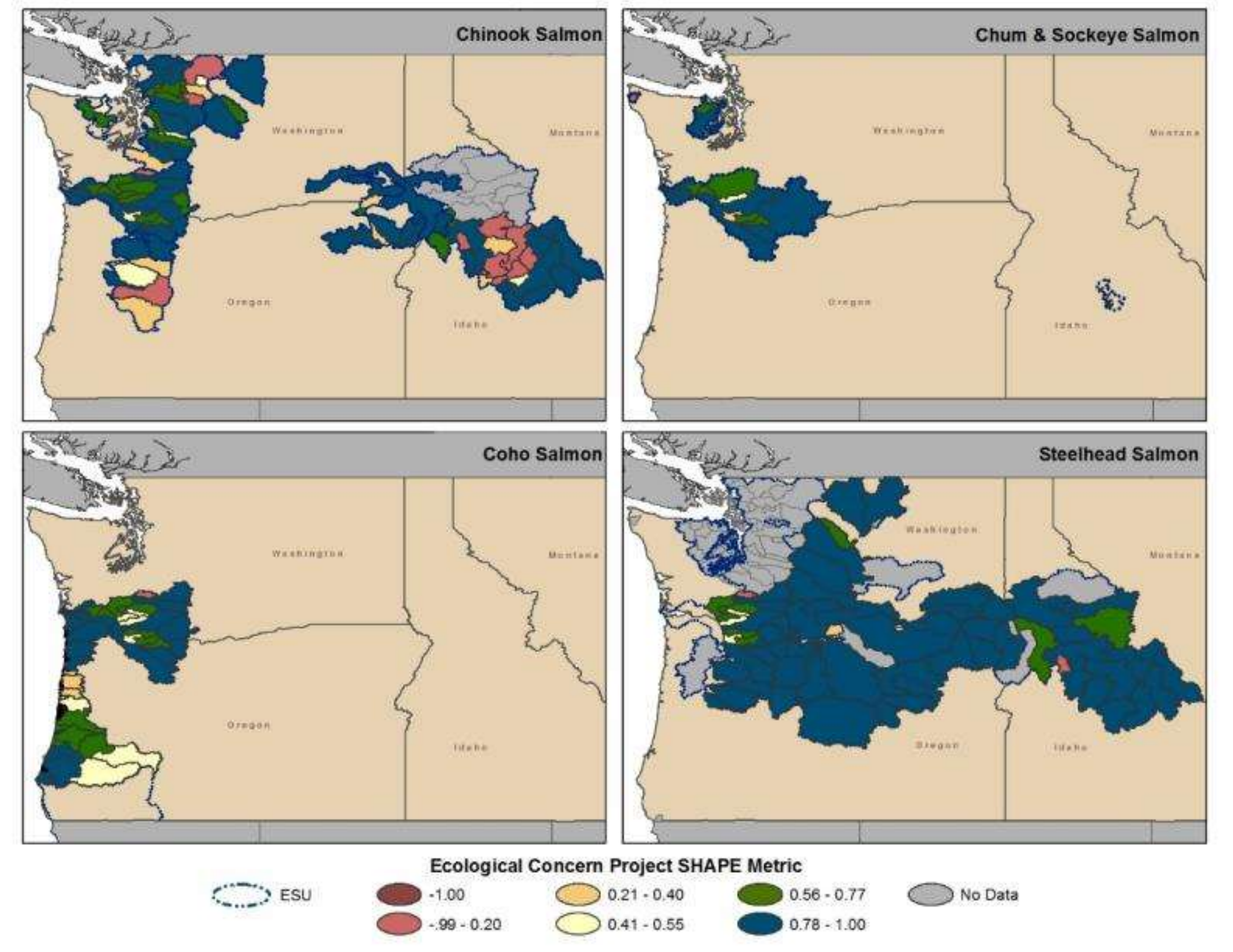


SHAPE Metric



Salmon Habitat Assessment Project Evaluator

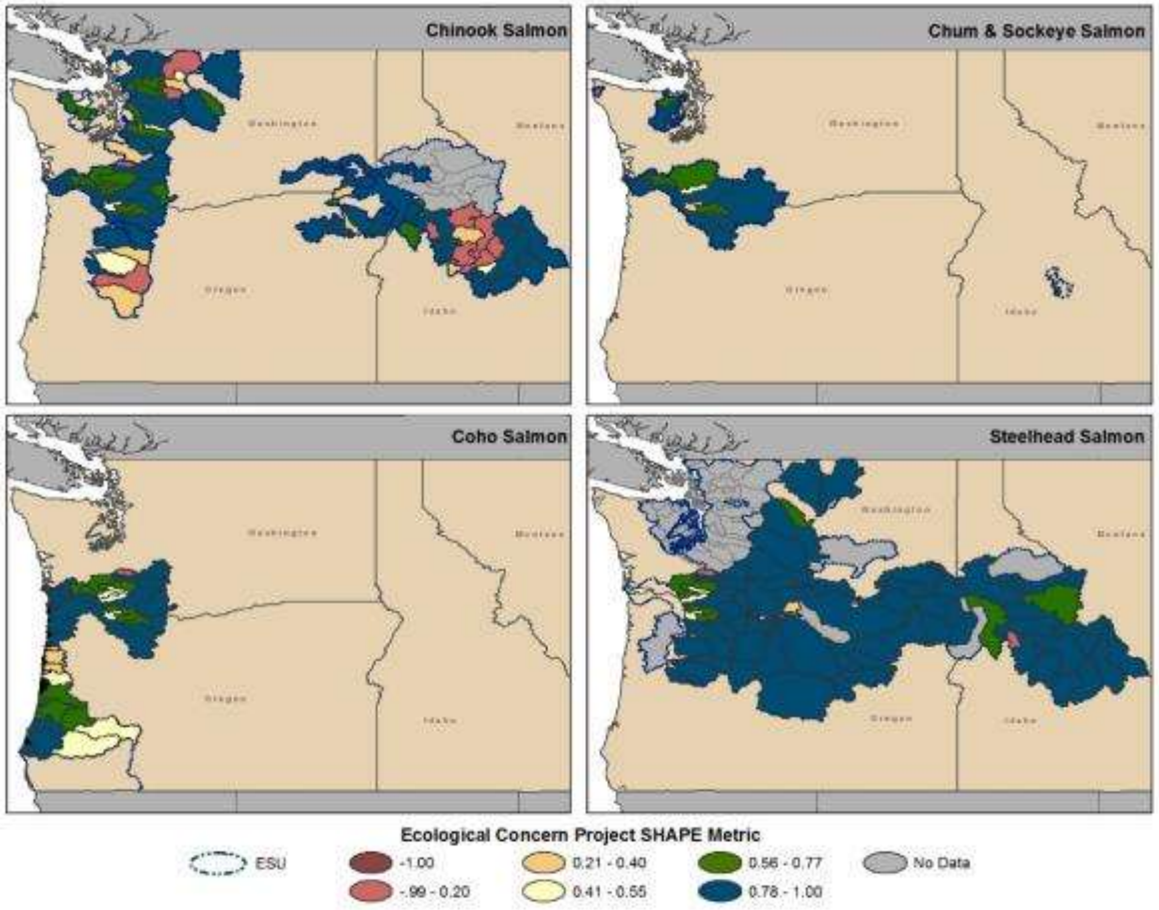
SHAPE = (Concerns Addressed/Total Concerns) – (Projects without an EC Match/Total Projects)



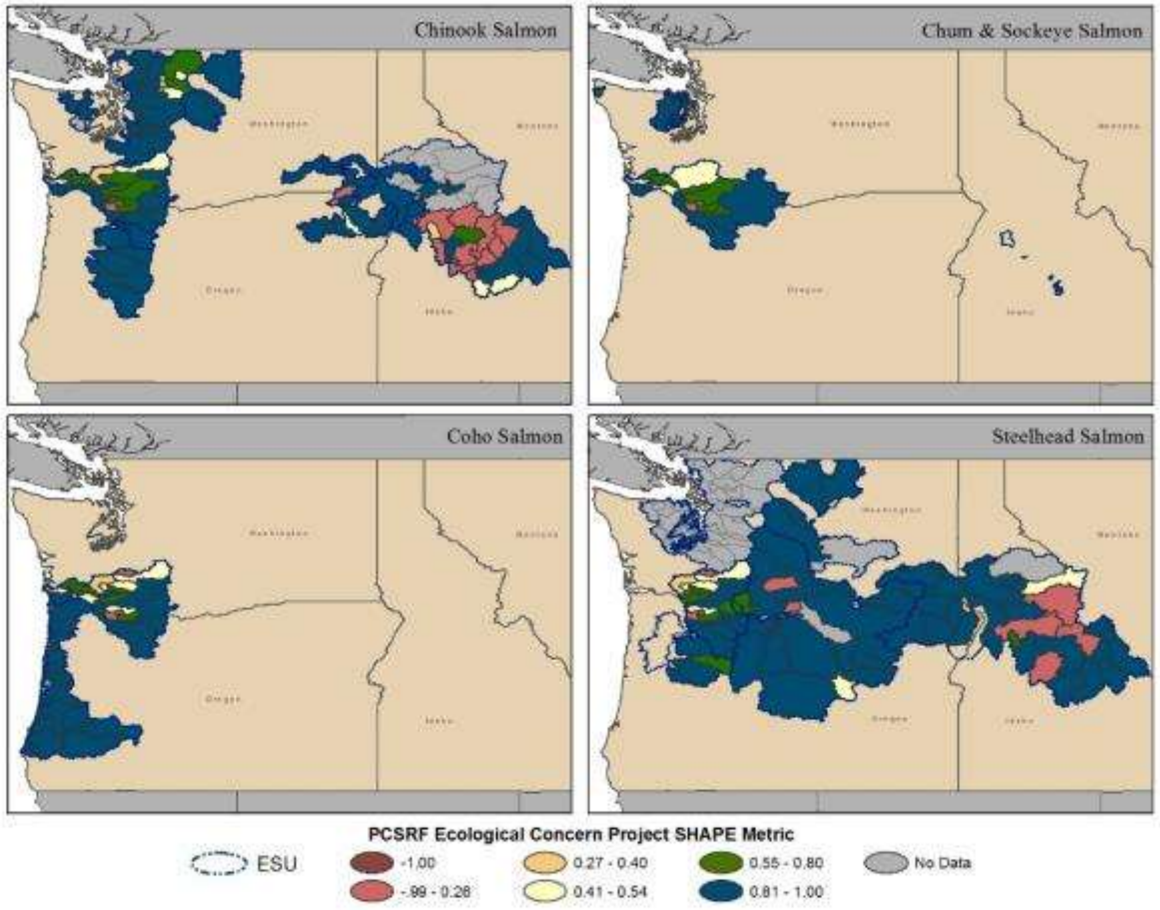
- A blue population doesn't mean all needed restoration is done
- Red/ Orange/ Yellow point out places to look first, dig deeper
- Tool to help inform decision making

Different restoration datasets, different results

PNSHP (60,000 unique worksite-project type)

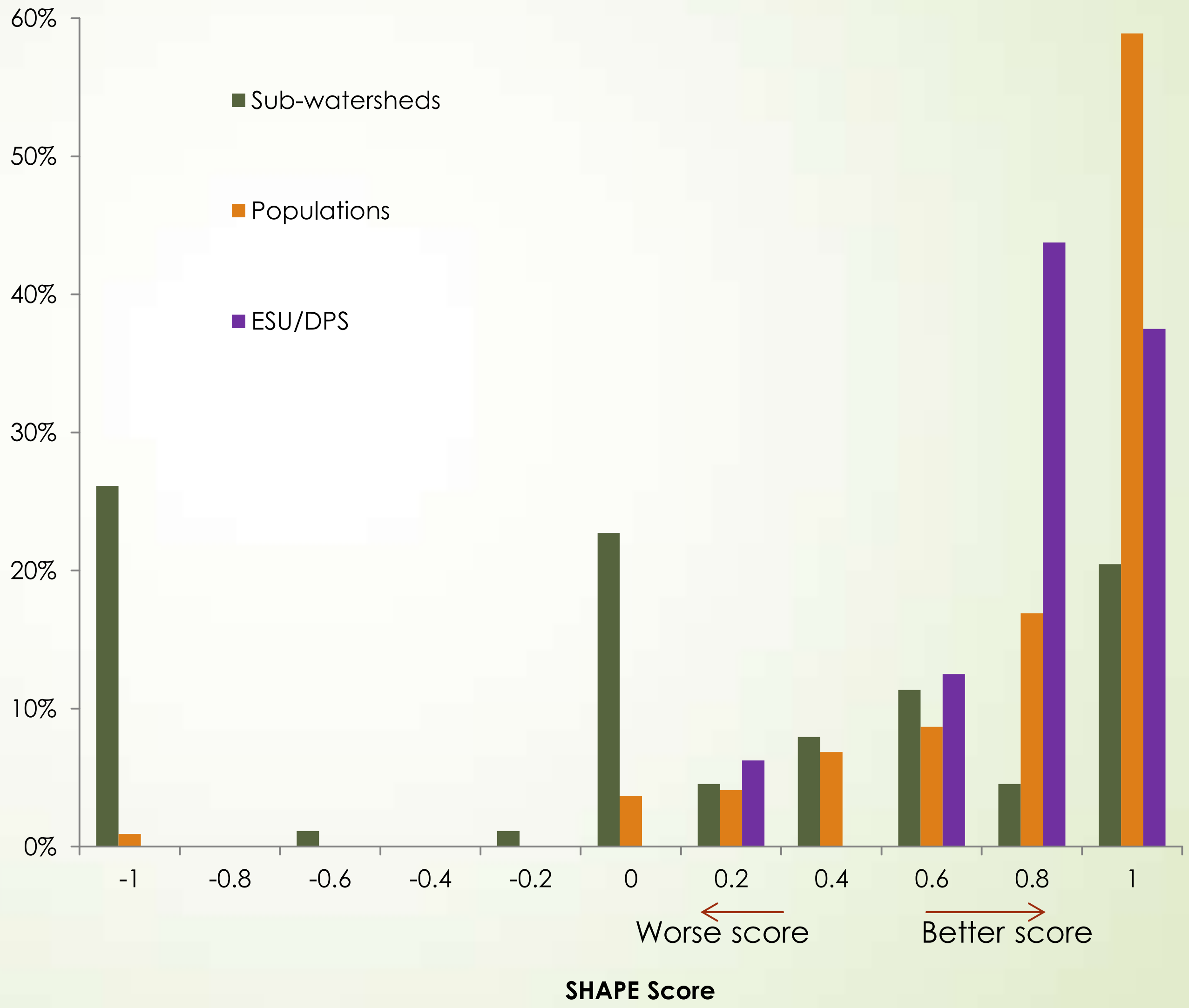


PCSRF (13,000 unique worksite-project type)



SHAPE metric and analysis unit size

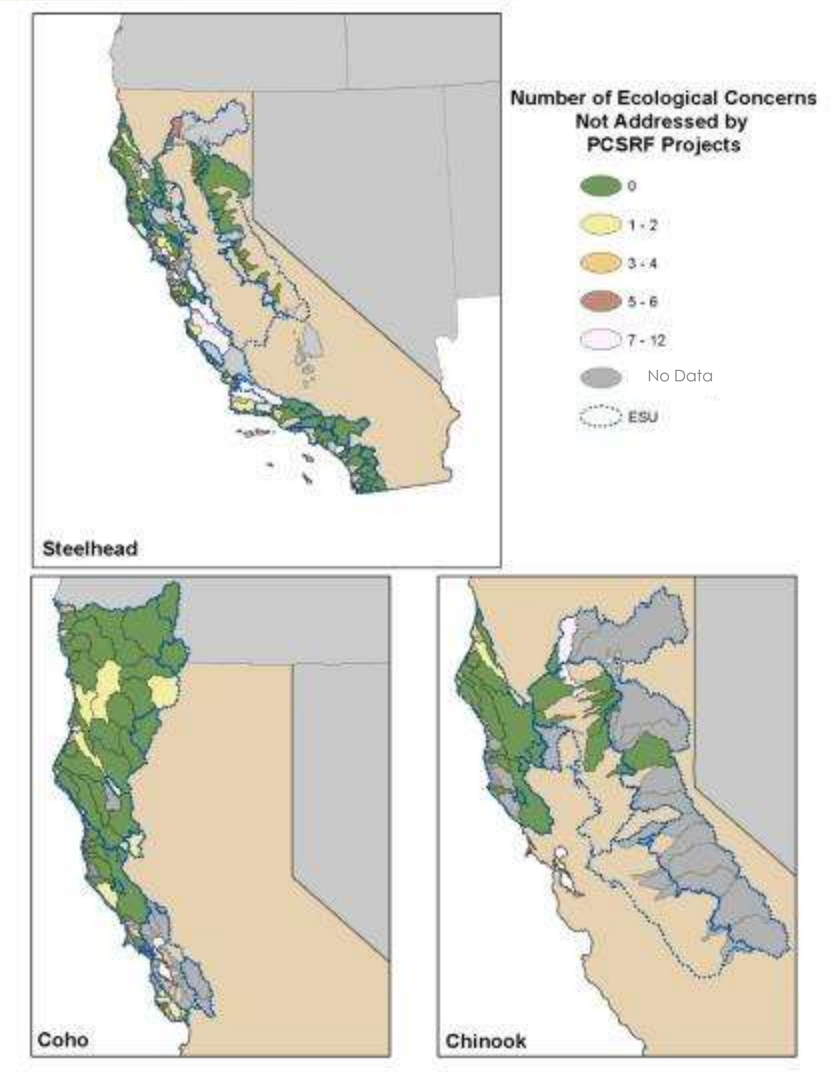
S = (Concerns Addressed/Total Concerns) – (Projects without a Match/Total Projects)



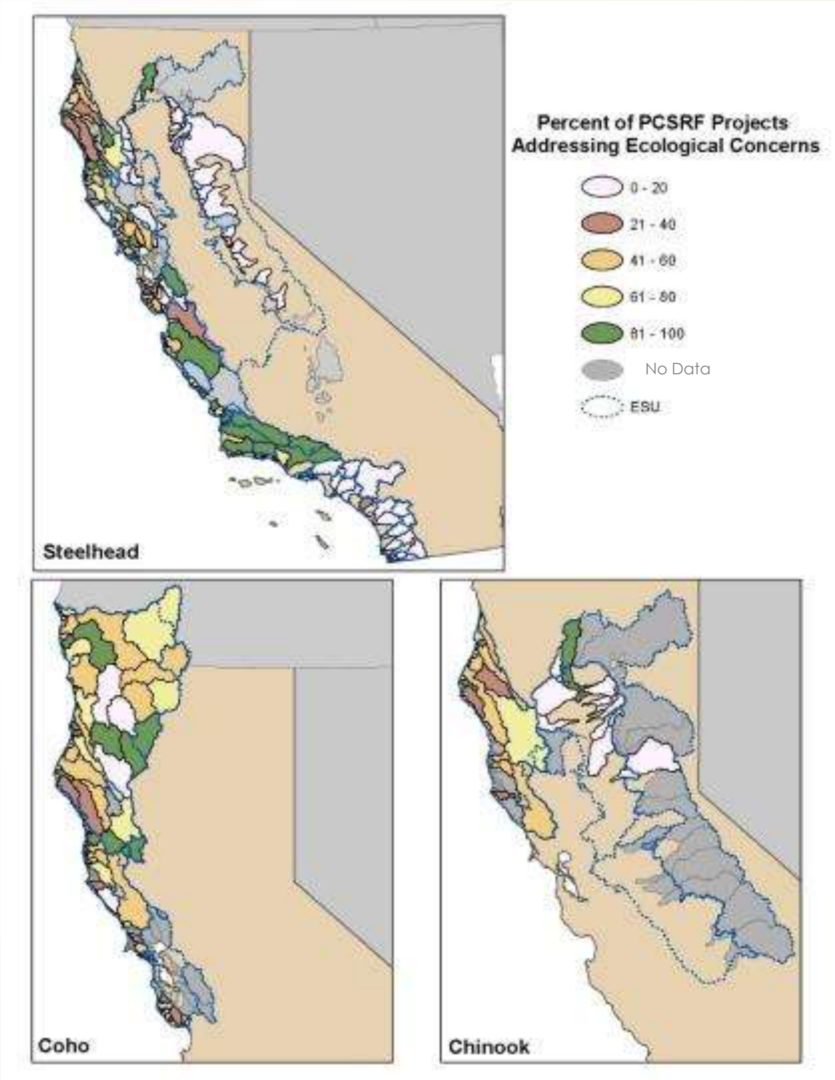
(Barnas et al. 2015)

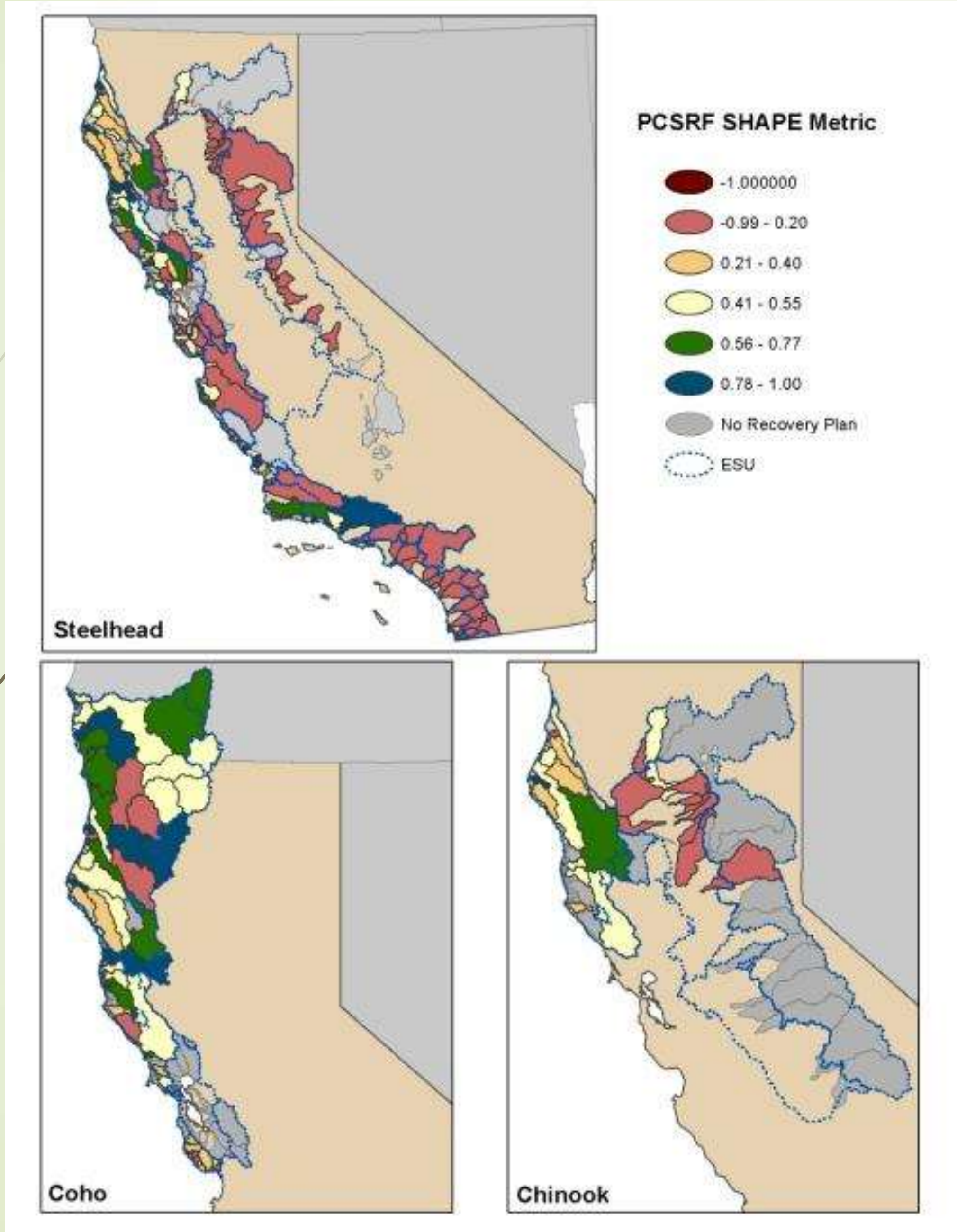
California

Number of Ecological Concerns not addressed by PCSRF project(s)



% of PCSRF projects that address one or more Ecological Concerns





- Tool to help inform decision making
- A blue population doesn't mean all needed restoration is done
- Red/ Orange/ Yellow point out places to look first, dig deeper
- Some discrepancies may be easily explained (project type for one species vs. another, some project types covered by a different funder etc.)

Considering socioeconomic factors

- A common suite of projects are implemented for salmon recovery throughout the West: Sediment, Riparian and Fish Passage (Katz et al, 2007, Christian-Smith and Merenlender, 2010, Barnas et al, 2015)
  - No change in most common project types of the past two decades of Salmon Recovery in the PNW (Kendall's $\tau = 0.82$, $p = 0.0001$)
  - Why? Cheap, land owner buy-in

- Fish Screens and Instream Flow have the best match to ecological need
  - Why? No incentive to put a fish screen or buy water rights where one isn't needed, very expensive

Prioritizing future restoration

- Tool to help inform decision making and prioritization by funding and planning entities
  - Ask questions at any scale
    - Are there ecological concerns that are not being treated by restoration? If yes, why?
    - Are projects being implemented in locations where they don't directly treat an Ecological Concern? If yes, why?
  - Method applicable to any species with restoration and habitat assessment data

Relevant Publications

Barnas, K., D. Hamm, M. Diaz, S. Katz, and C. Jordan. 2015. Is Habitat restoration targeting relevant ecological needs for Pacific Salmon across the Pacific Northwest? Ecosphere 6: 1-42.

Hamm, D.E., 2012. Development and Evaluation of a Data Dictionary to Standardize Salmonid Habitat Assessments in the Pacific Northwest. Fisheries 37: 6–18

Katz S., K. Barnas, R.V. Hicks, J. Cowen, and R. Jenkinson. 2007 Freshwater habitat restoration actions in the Pacific Northwest: a 10-year census. Restoration Ecology 15:494-505.

Websites

https://www.webapps.nwfsc.noaa.gov/pnshp

- Ecological Concerns Data Dictionary
- "Goldilocks Crosswalk" of restoration type to Ecological Concern type
- PNW restoration data

https://www.webapps.nwfsc.noaa.gov/pcsrf

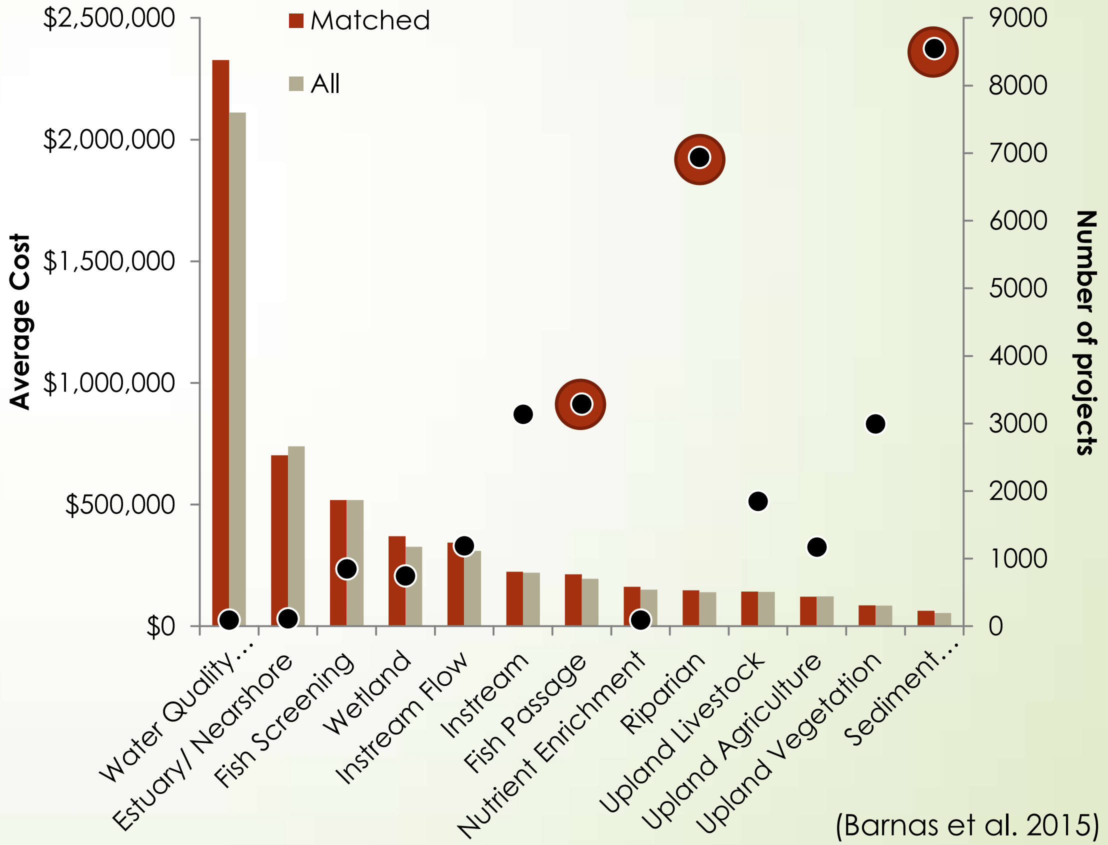
- Restoration data

Project type and cost

Do project types change over time as salmon recovery has progressed?

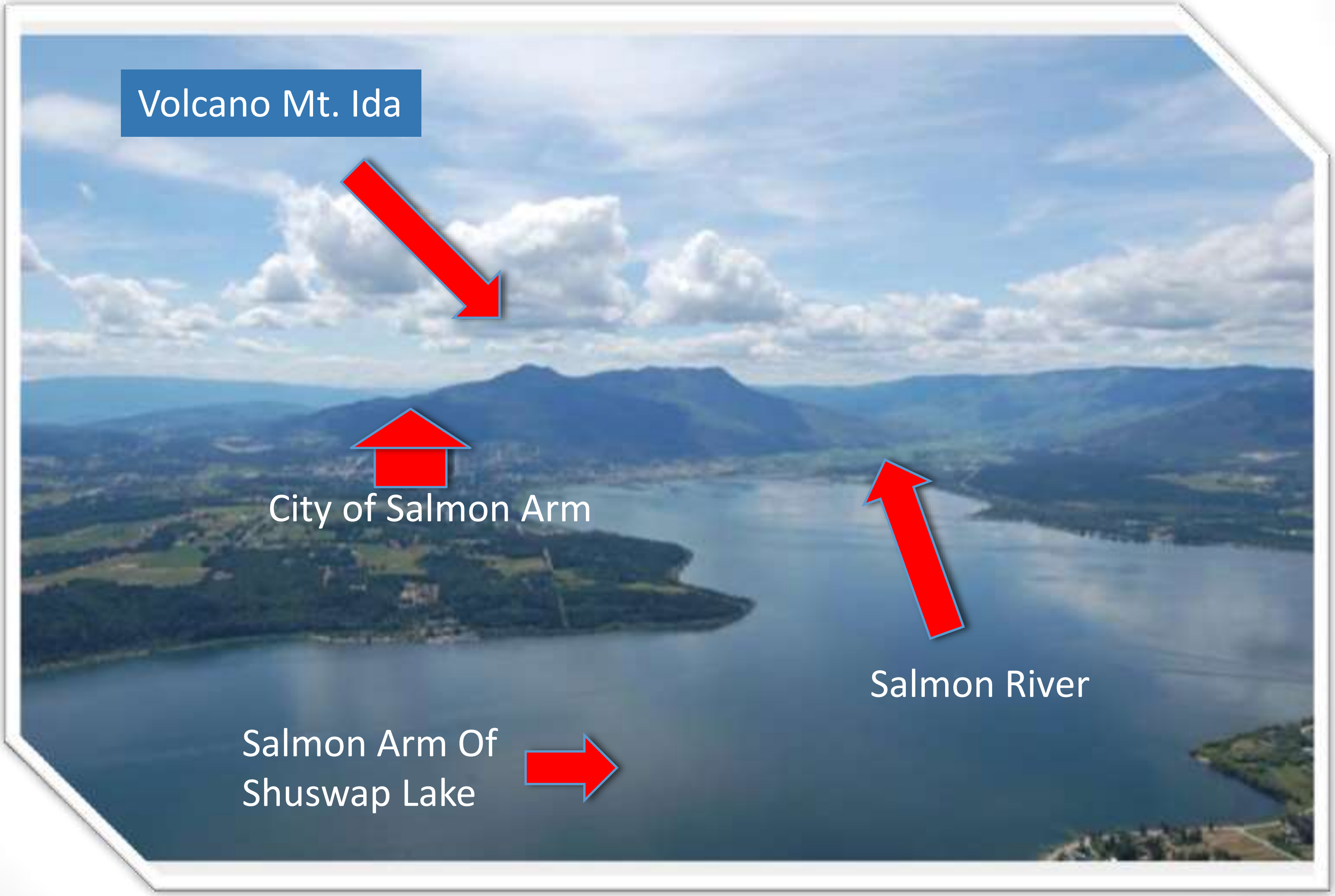
- No change 1990s vs 2000s, Kendall's τ = 0.82, *p* =0.0001
- The most common types are consistently Riparian, Sediment Reduction, Fish Passage, Instream and Upland

(Katz et al, 2007, Christian-Smith and Merenlender, 2010, Barnas et al, 2015)



(Barnas et al. 2015)

Managing Landscape Cumulative Effects Using Innovative Technology & Process



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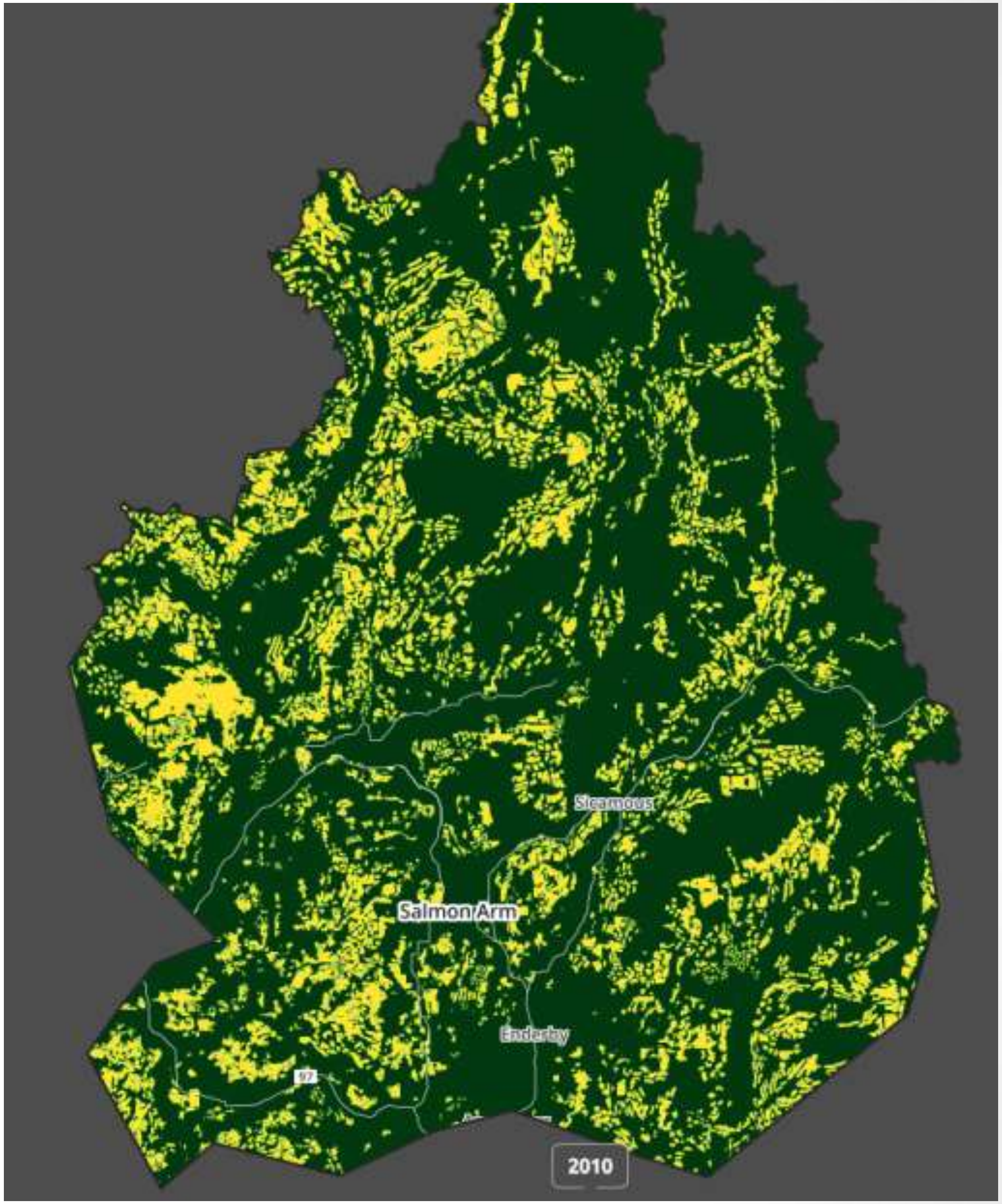
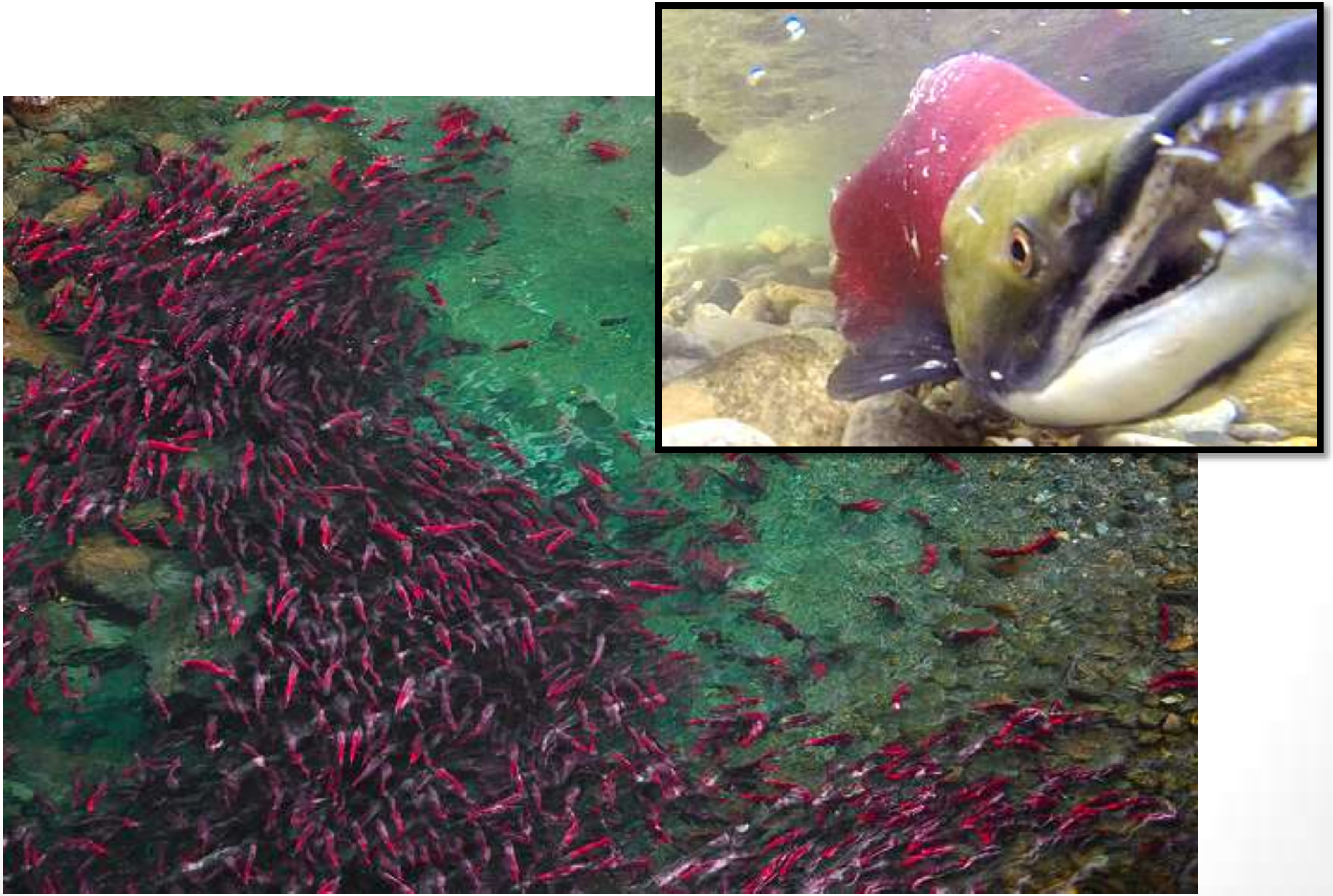
Shuswap

- 3200 km Trails
- 25,000 km Roads
- 531 km^2 Footprint
- 2,364 km^2 Cutblocks
- 38,000 people
- 18,000 cattle
- 3-day boat count in 2010 13,416



Adams River Sockeye Run



Cali & BC

Area	**164 K mi²**	**2.2 X ←**	**365 K mi²**
Population	**39.3 million**	**8.5 X →**	**4.6 million**
GDP	**2.4 trillion USD**	**25 X →**	**187 billion USD**
Biodiversity	**Highest in USA**		**Highest in Canada**

CE Playbook

teach us what we've learned in the past
show us what the future could be

CE Playbook
Planning To Win

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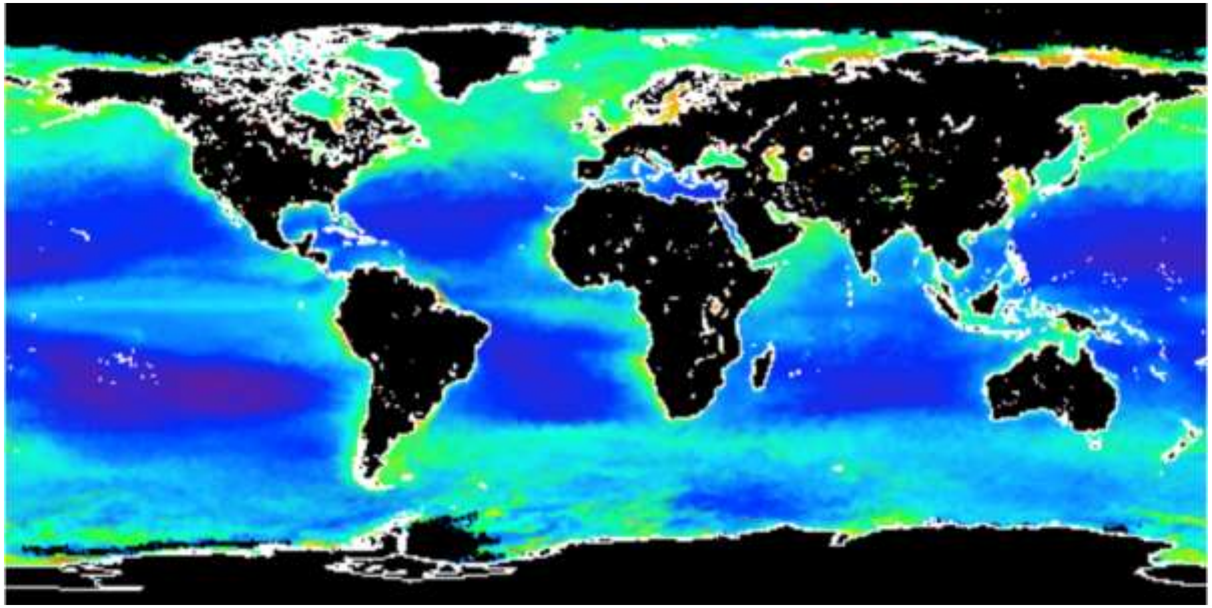
Anthropocene

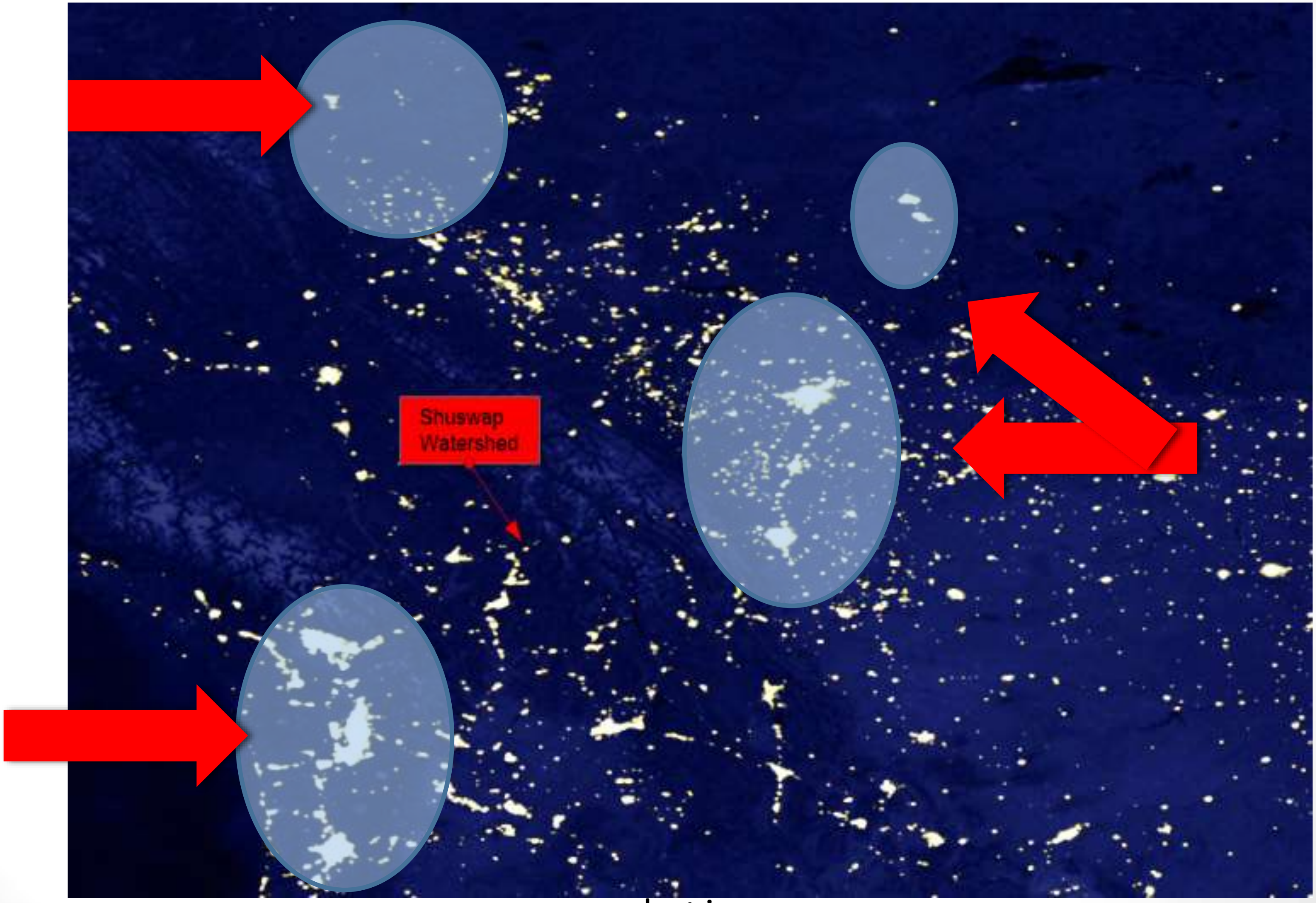
A term describing the period in which human activities have had a significant global impact on the Earth's ecosystems



The Great Acceleration

Global Connectedness

Local land use challenges are linked to activity locally and abroad



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Land Use The Dominant Driver In BC

RBC forecasts BC economy to lead Canada's growth rate this year at 3.1% and 2.9 % in 2017.

Premier Clark :
"It means sticking to our guns on LNG. Site C, we're going to make sure that happens"

B.C. Premier Christy Clark says Canada is depending on the province for job growth. (Photo: Darryl Dyck/The Canadian Press)

> **"Canada really is depending on B.C. to perform because none of the other provinces are really able to make big contributions in terms of jobs and national revenues."**

Many Simultaneous Pressures On Natural Systems

- primary resource extraction (timber, minerals, etc.)
- Service industries
- Settlement
- Agriculture
- Transportation
- Energy
- Tourism
- Recreation

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EIA – what it is

Canada:

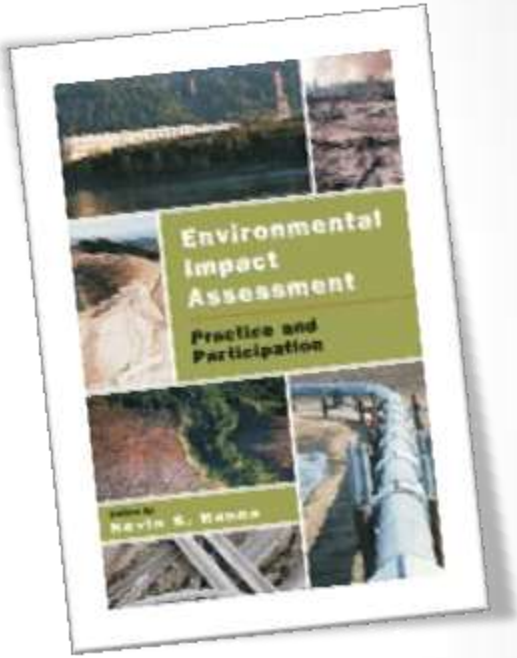
"Environmental assessments support sustainable development by helping to **eliminate or reduce a project's potential impact** on the environment before it begins and ensuring that mitigation measures are applied once the project is initiated."

http://www.ceaa-acee.gc.ca

B.C.:

environmental assessment process provides a mechanism for **reviewing major projects to assess their potential impacts**."

http://www.eao.gov.bc.ca/ea_process.html



"Minimize the harm"

Delta Tunnels

EIA – what it isn't - yet

There is a growing recognition of the need for a **holistic approach** to managing growth and development in combination with agents of **natural disturbance** that accounts for the environmental, social and economic implications at a range of scales **BEYOND INDIVIDUAL DEVELOPMENTS**.

Issue Specific Policy Responses

- BC:
  - Infrastructure
  - Residential growth
  - Mountain pine beetle
  - Climate change
  - Water quality / quantity
- Canada:
  - Sustainable Development Strategy
  - Canada's Economic Action Plan
  - Mountain pine beetle
  - EcoAction
  - Asia-Pacific
- First Nations
  - Title & Rights

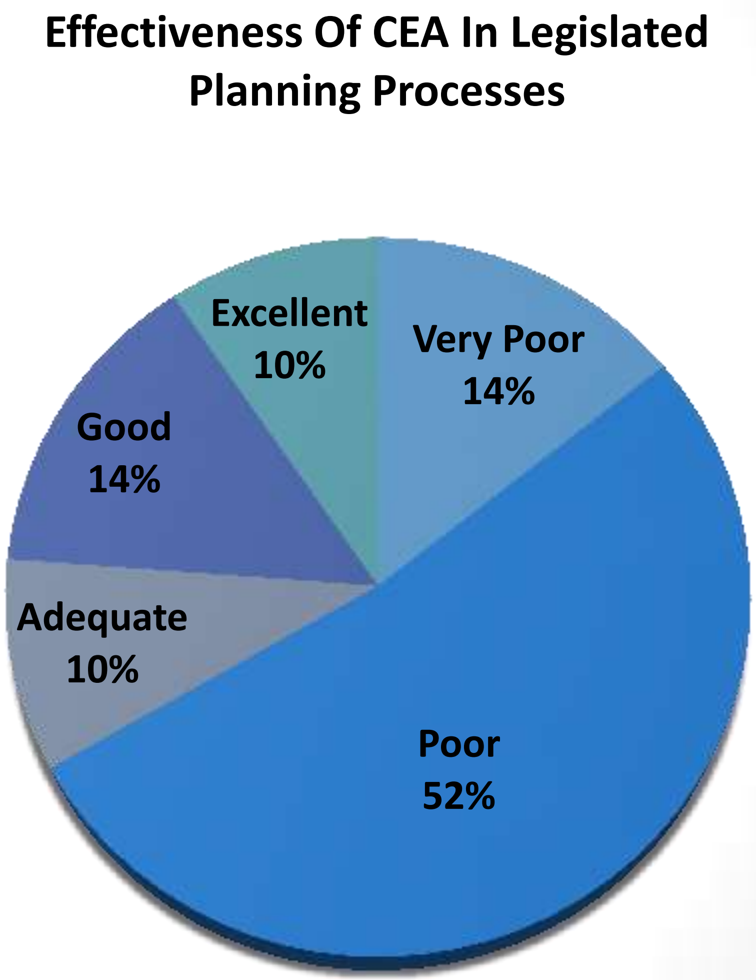
It's Time To Stop Admiring The Problem

Surveyed my CEA Group on Linked In ….

2/3's say existing processes are Very Poor or Poor

Secwépemc also saying this

We need a better way



Cumulative Effects

the changes, both good and bad,

caused by our actions today in combination with

other past and reasonably foreseeable

human and natural disturbances

Rethink the tug of war

as a delicate balance

Imagine Our Future and Write Our Own Story

- Plan FOR what we want
- As landscapes continue to get busier, collaboration becomes more important

"No innovator works alone. And the most innovative of all collaborate not only within their institutions but also with others across the country and around the world."

Aled Edwards, PhD

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The Story Of Cumulative Effects

Elements of Landscape Change (disturbance)

Natural
Disturbance

Forest harvesting
Agriculture
Urban Expansion
Infrastructure
Recreation/Touris
m
Energy
Forestry

Economic Indicators

- GDP
- Royalties and Rents
- Direct and Indirect Employment
- Commodity Production
- Property Value and Taxes

Social Indicators

- Quality of Life
- Recreation
- Traditional Land Use
- Liveable Community

Environmental Indicators

- Water Quality/Quantity
- Landscape Fragmentation
- Wildlife Habitat
- Ecosystem Representation

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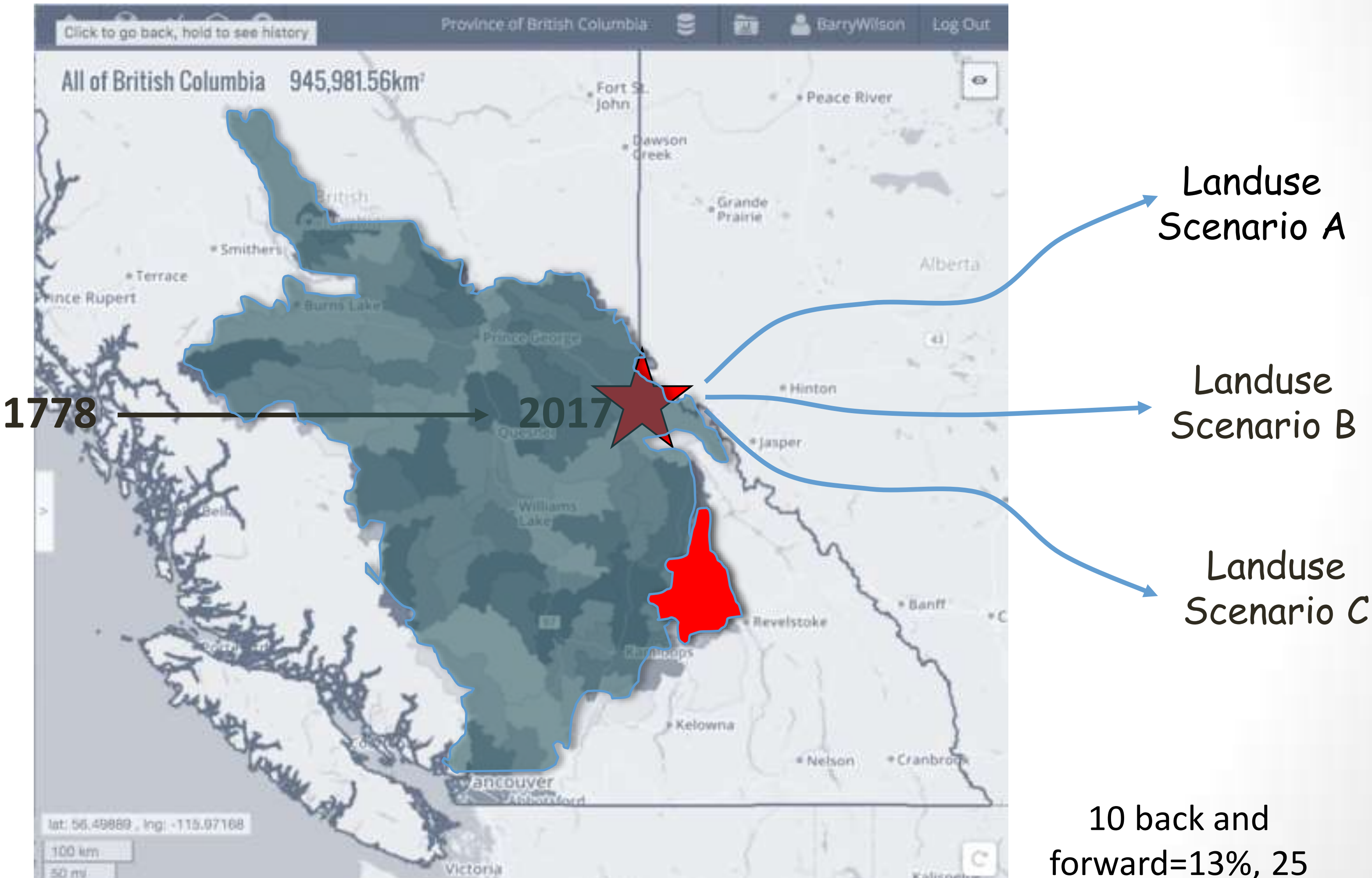
Meaningful Time & Space



10 back and forward=13%, 25 forward=17%

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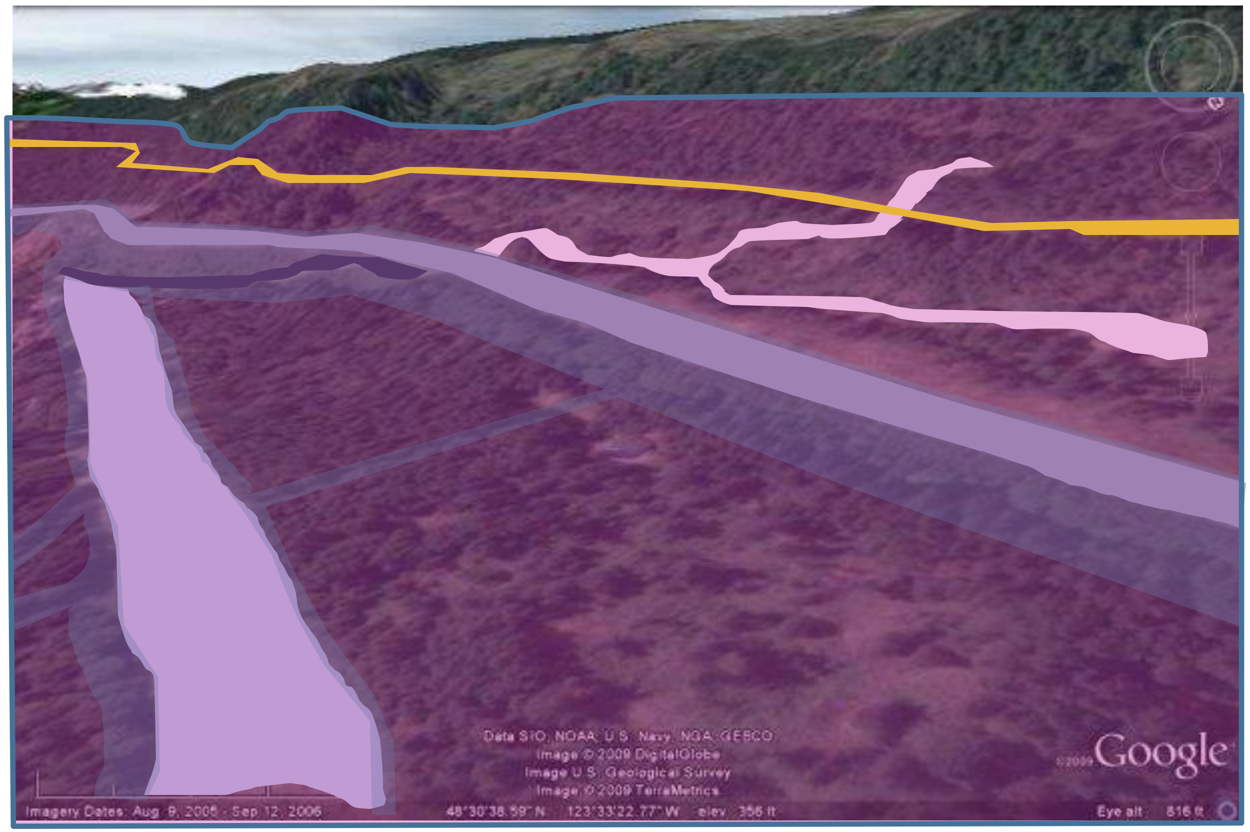
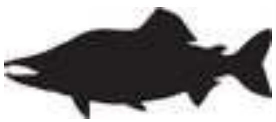
Zone Of Influence





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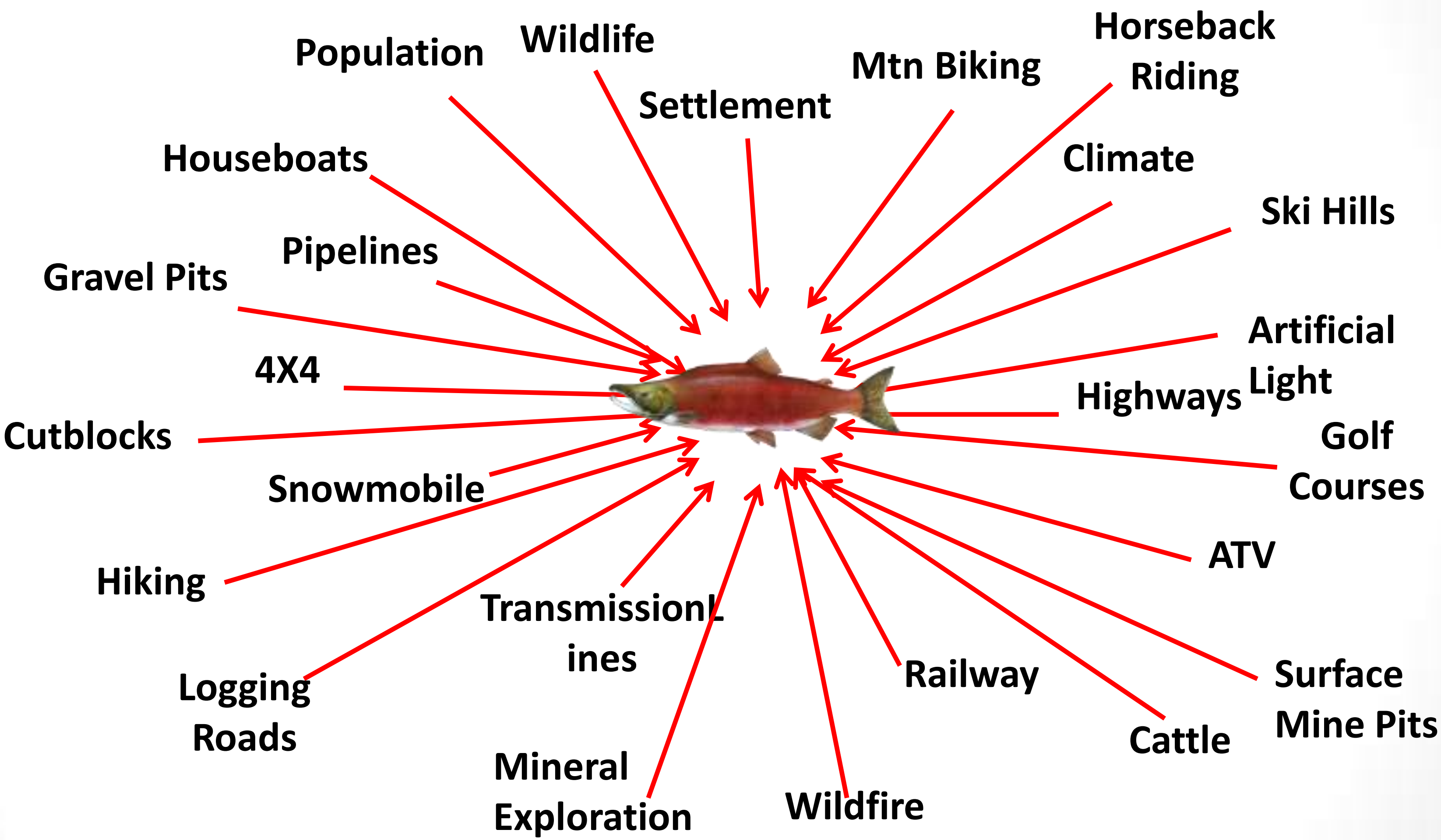
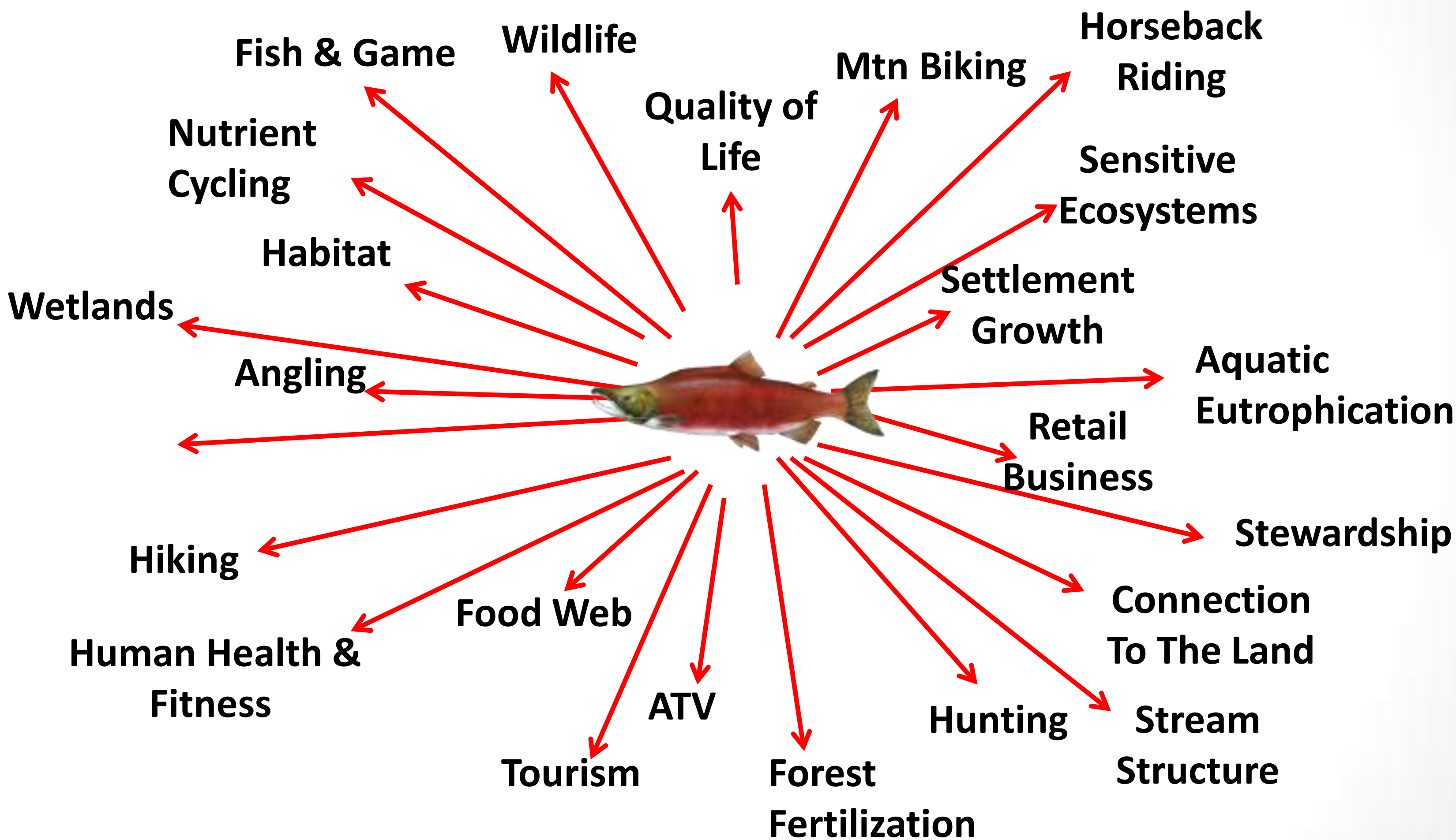
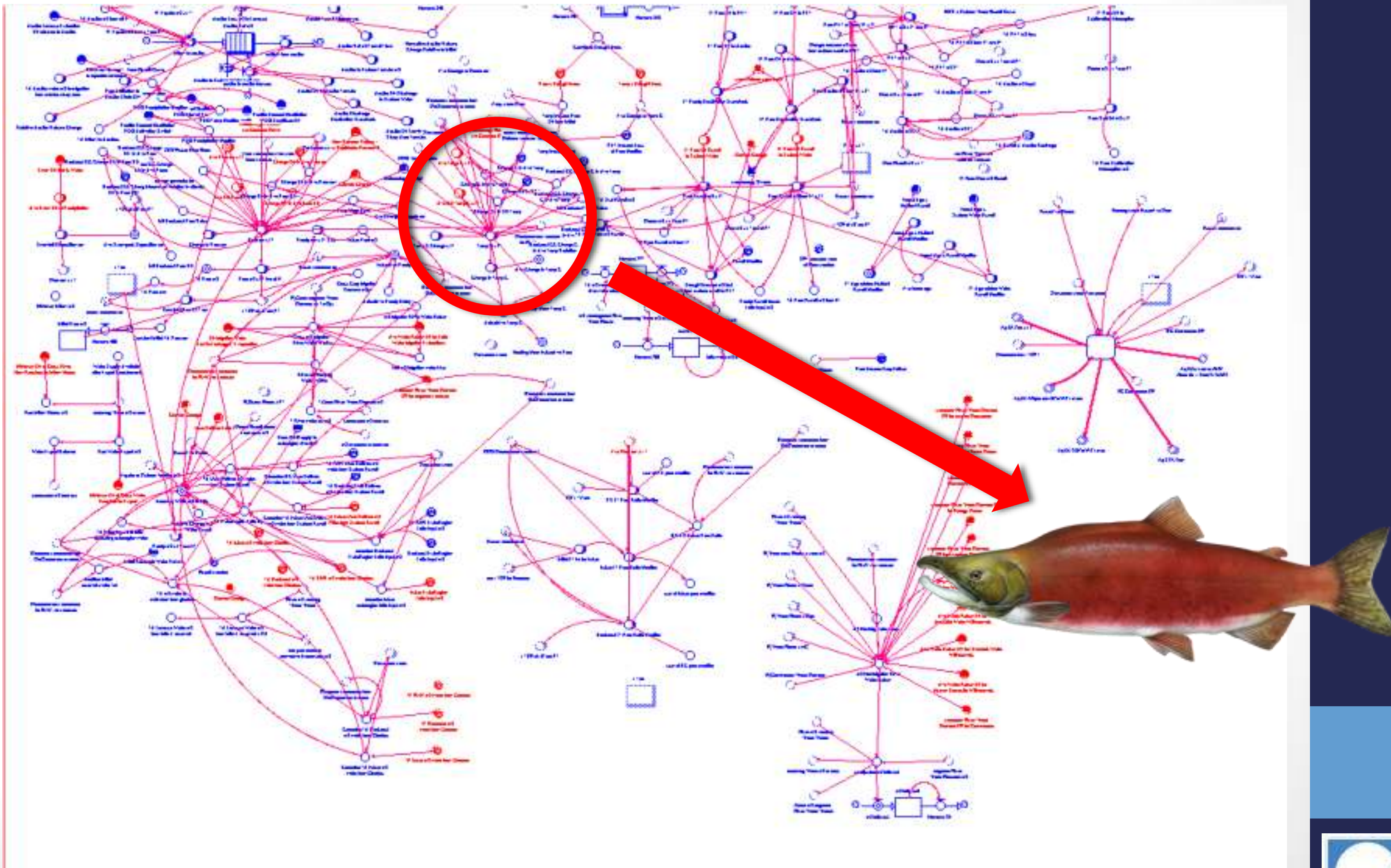
things that affect salmonids



things that salmonids affect



Salmonids are part of a complex system



ALCES Online Helps Us Do The Math And:

Visualize

- Map through time how land use has changed
- Explore "What-If" scenarios to learn about your area's system dynamics

Customize

- adjust land use rates & practices
- Evaluate natural disturbance and climate change

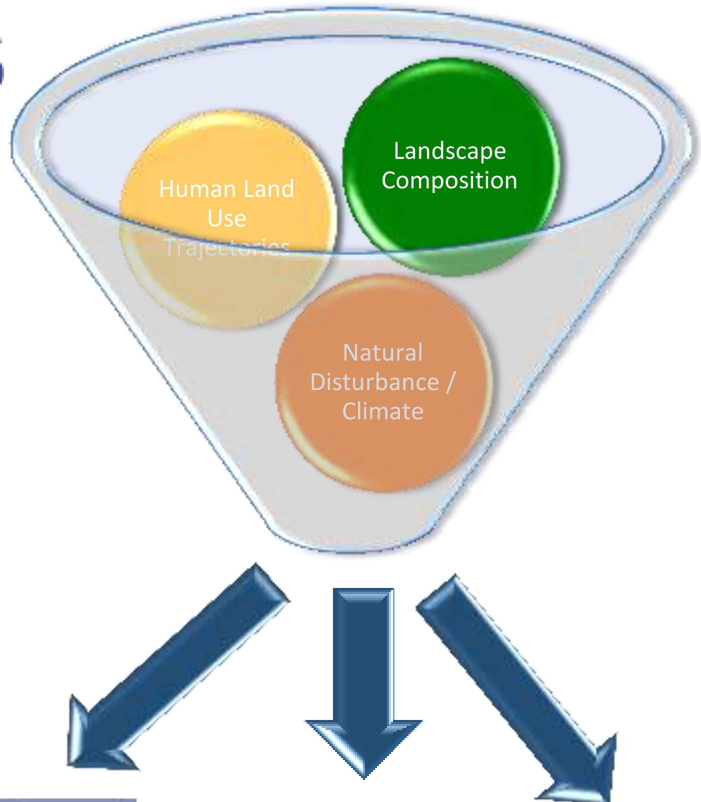
Compare & Collaborate

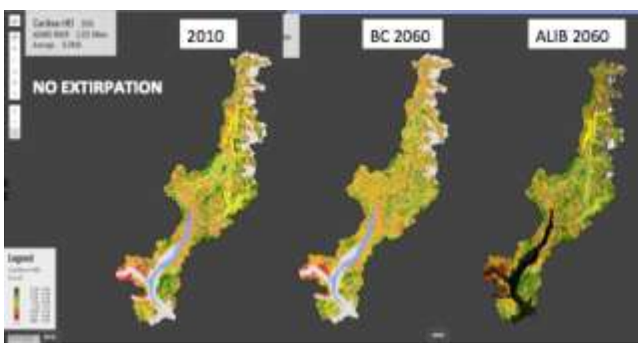
- Contrast alternative strategies
- Evaluate the best path forward

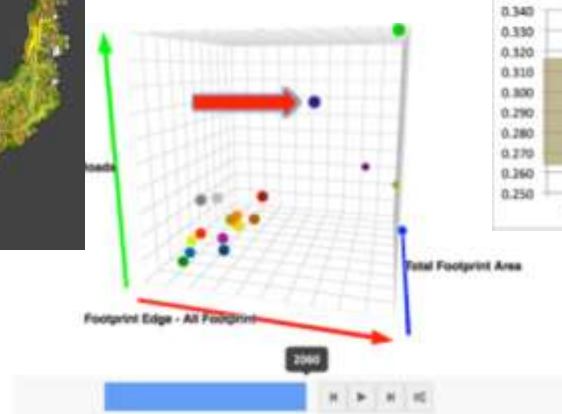
Tell Good Stories

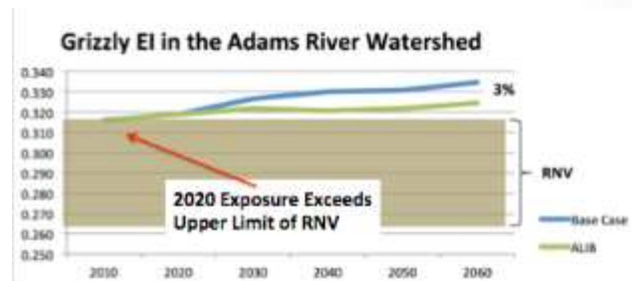
Convey ideas, concepts values and objectives through visual and audio media

ALCES









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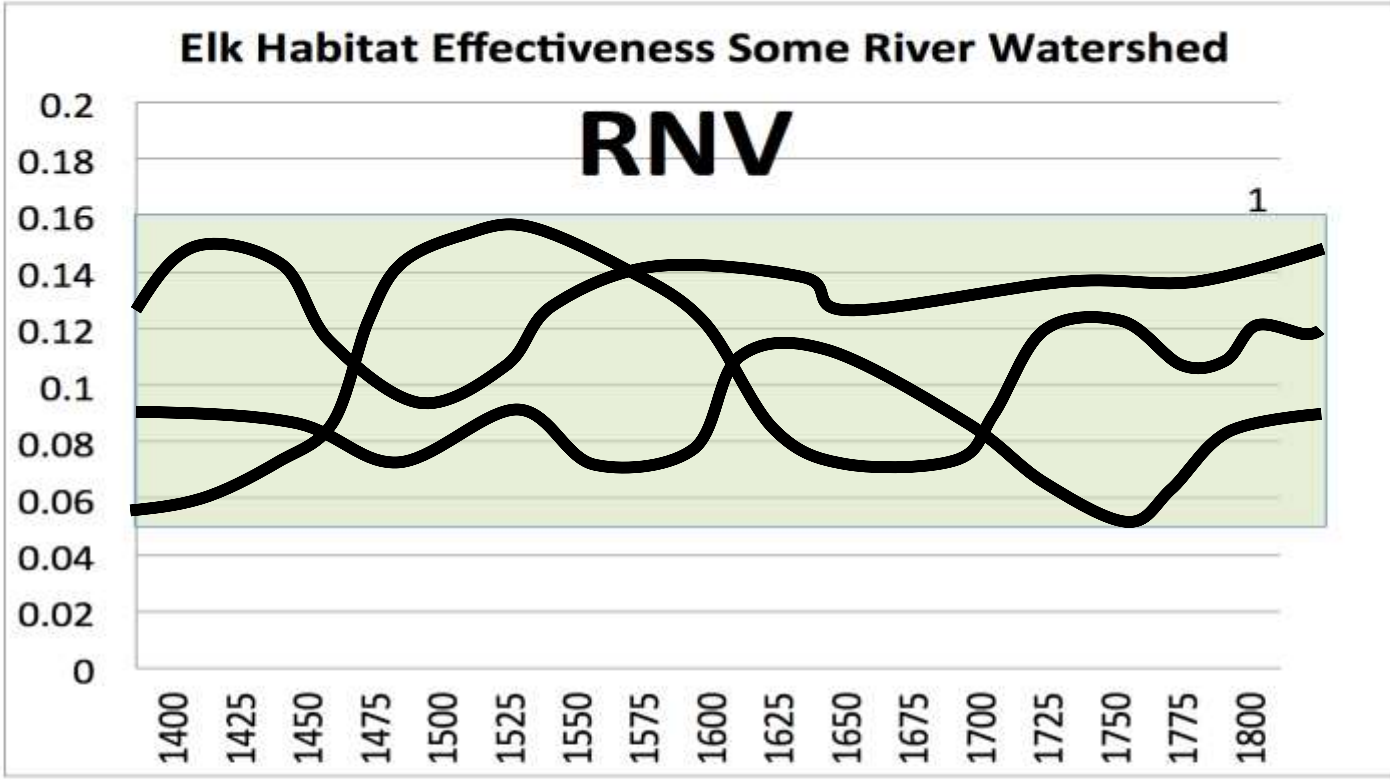
Range of Natural Variation (RNV)

- Derived using a Monte Carlo approach in ALCES®
- Captures inter-annual variation of random fire, drought, insects, etc.
- Computed “defendable” variation that approximates natural pre-european contact.
- **≅4000 yrs of pre-contact simulation to determine the range**



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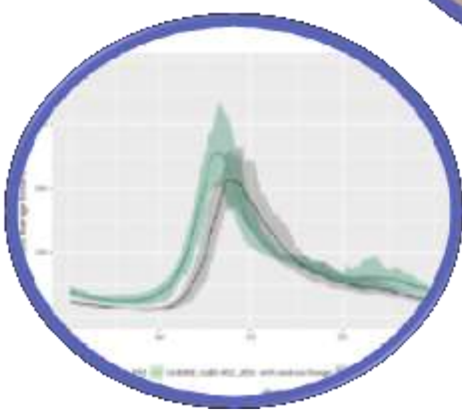
Stories from Secwépemc Cumulative Effects Work

Roads



Climate Change

Gravel Pits

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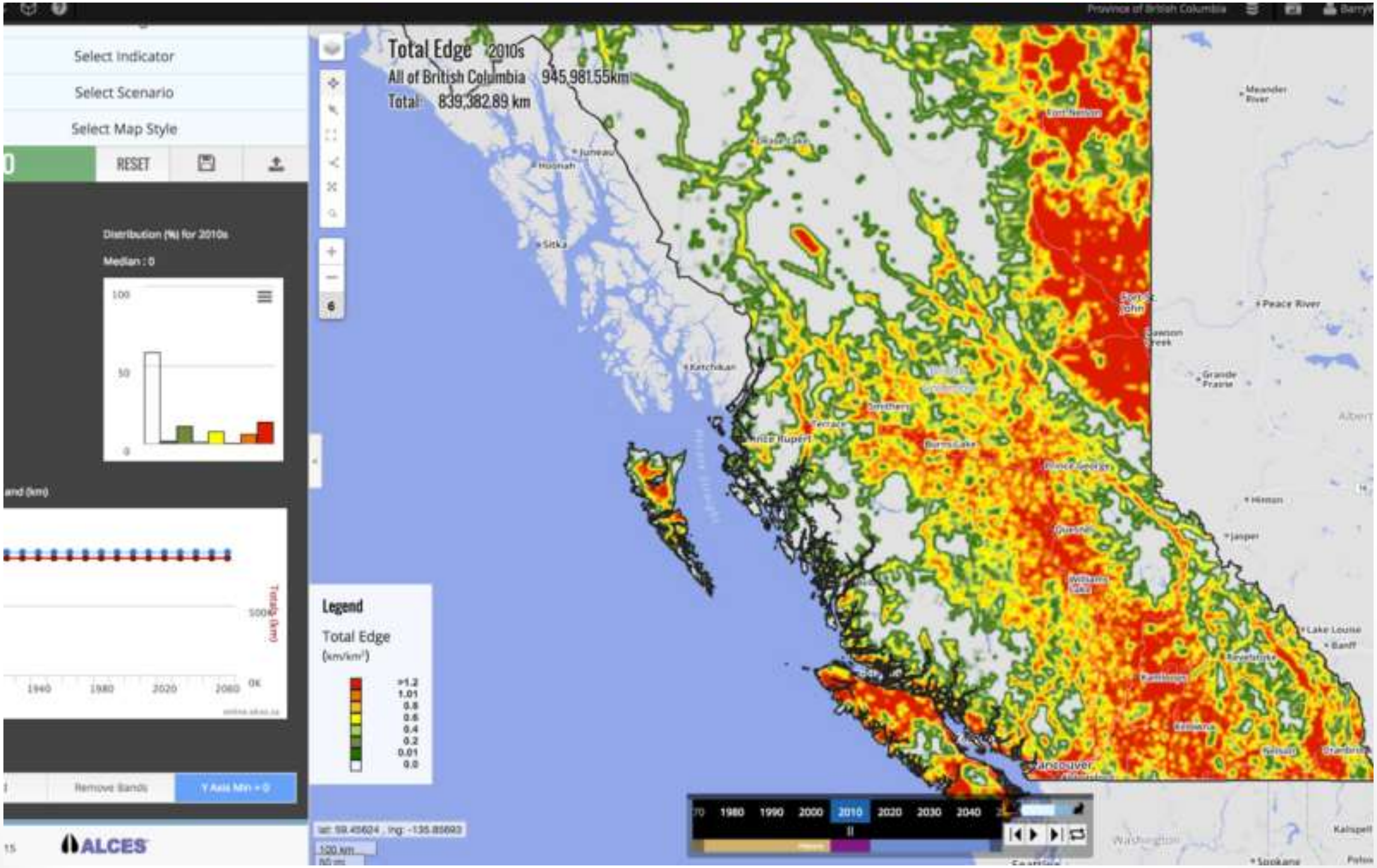
Examples of the potential Negative Effects of Roads

- Water Dynamics
  - Discontinuity
  - Sediment/Nutrient transfer
  - Flashier response
- Predator corridor
- Invasive Weeds
- Hunting, fishing & ATV pressure
- Viewscapes

Examples of the potential Positive Effects for 2 legged ones of Roads

- Economics
  - Employment
  - GDP
  - Royalties/Stumpage/Taxes
- Improved Access To Goods & Services
- Easier opportunity for hunting, fishing & outdoor recreation
- Quality Of Life

Linear Edge Density Red is twice or more than Max Grizzly Threshold



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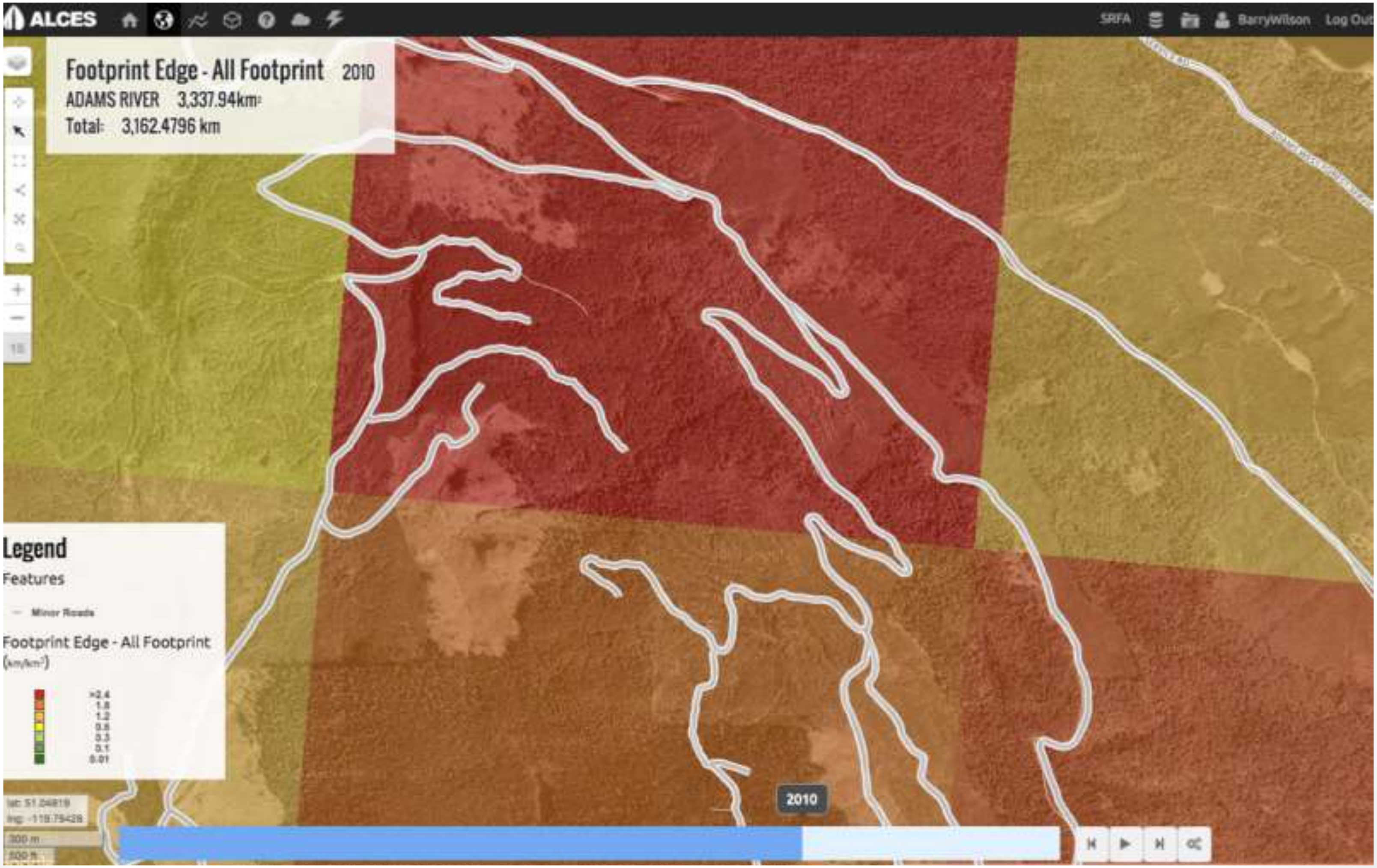
Logging Road Edge – Red is 4X Grizzly Threshold



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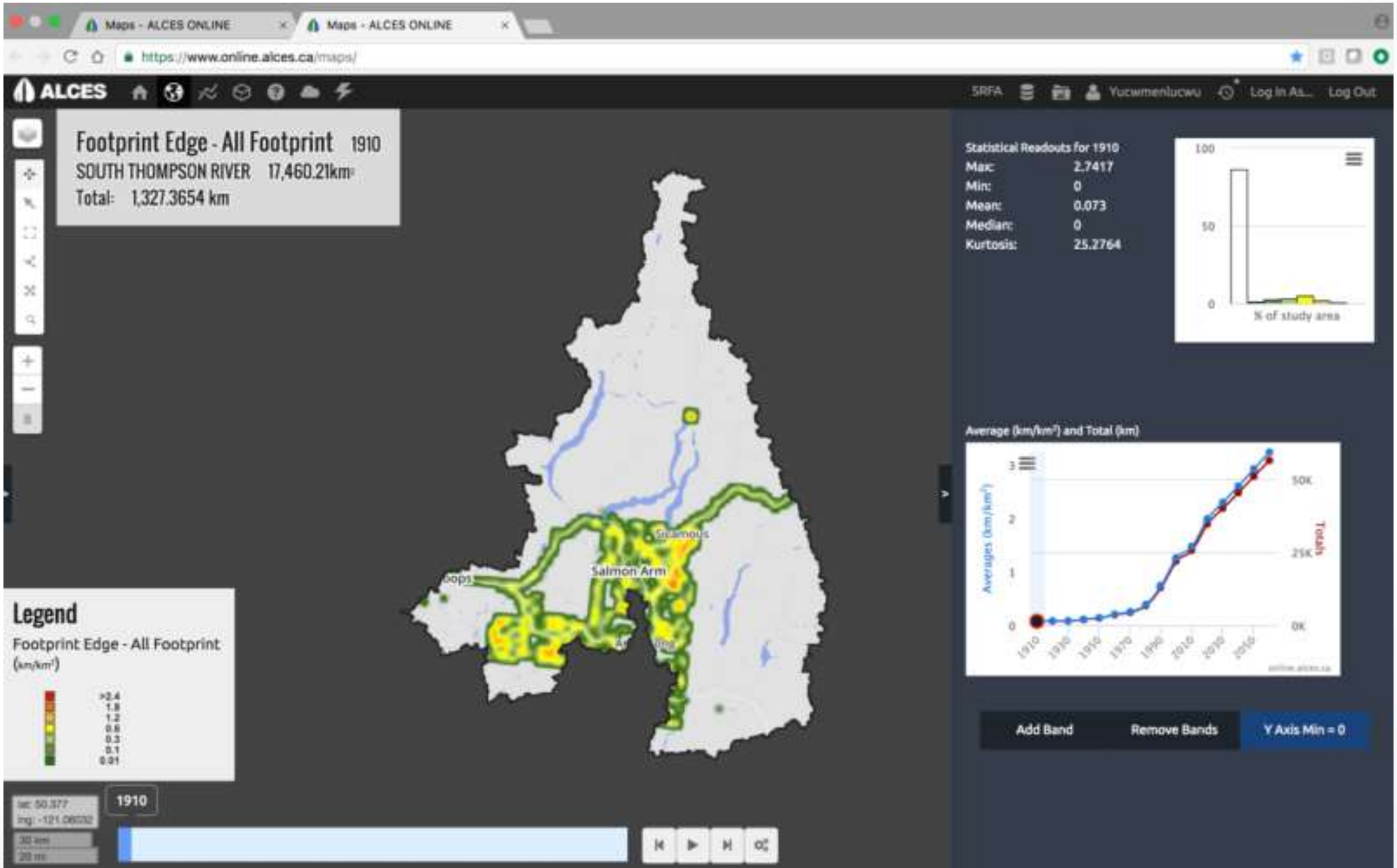
Grizzly Bear Threshold Yellow



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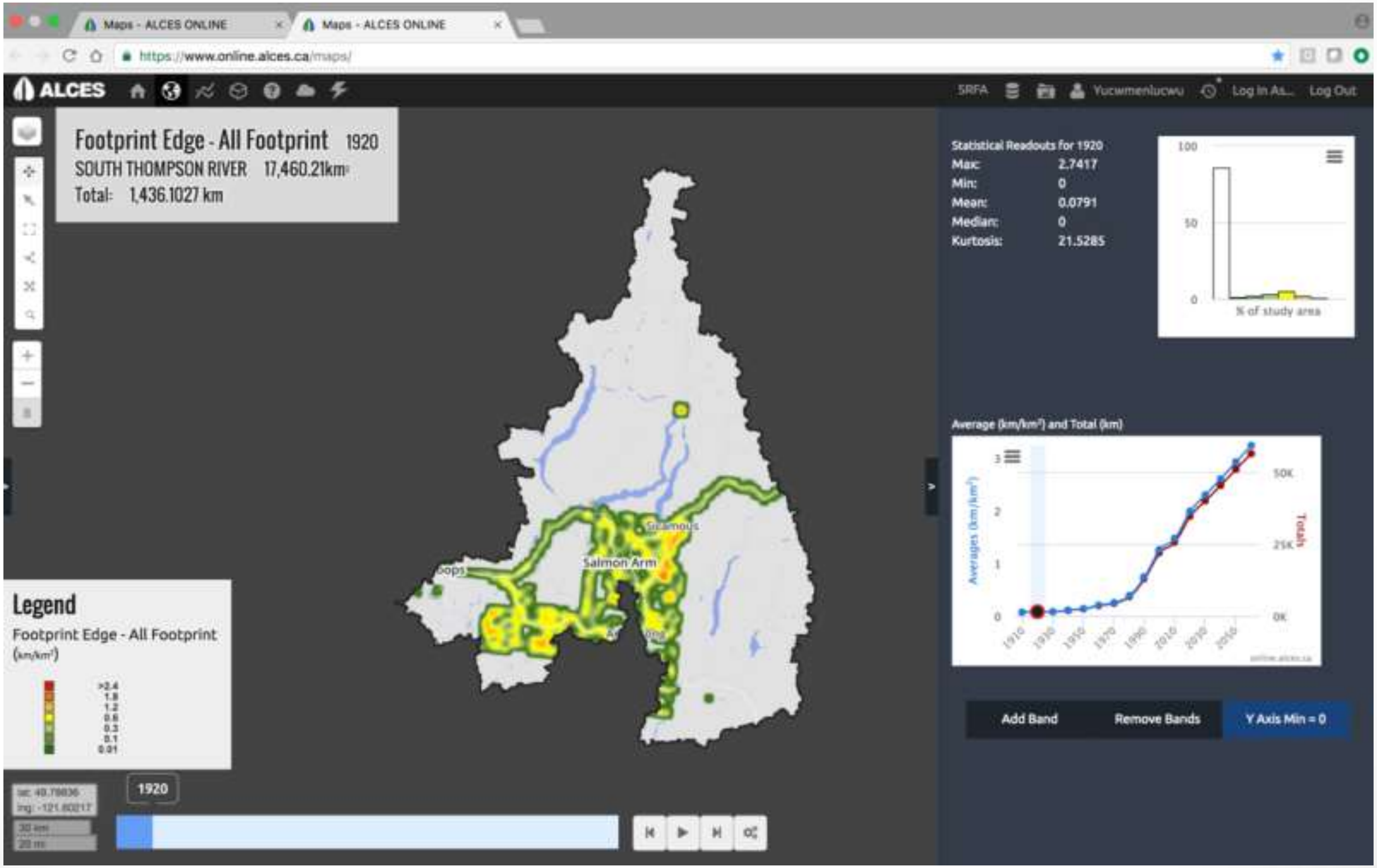
Grizzly Bear Threshold Yellow



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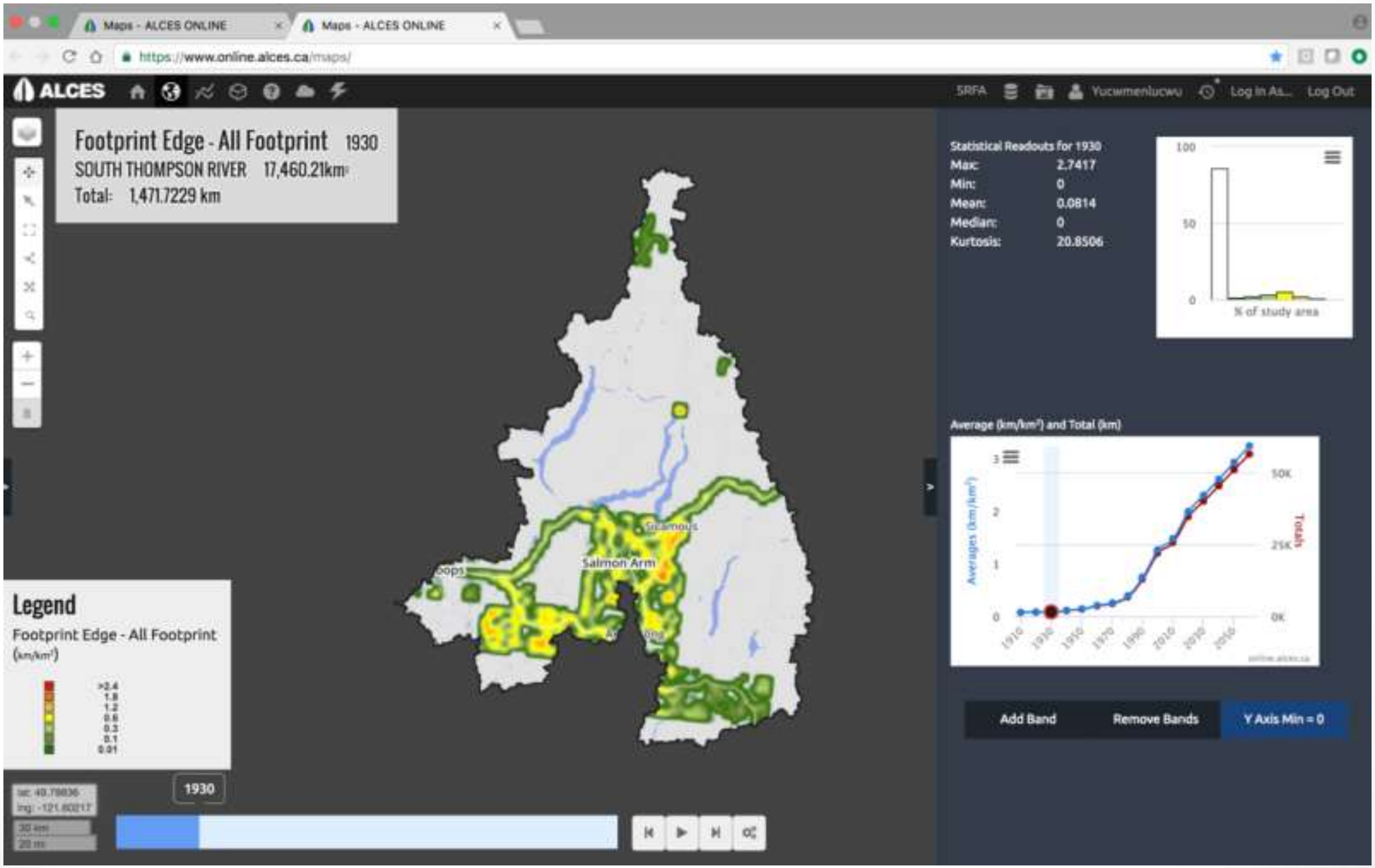
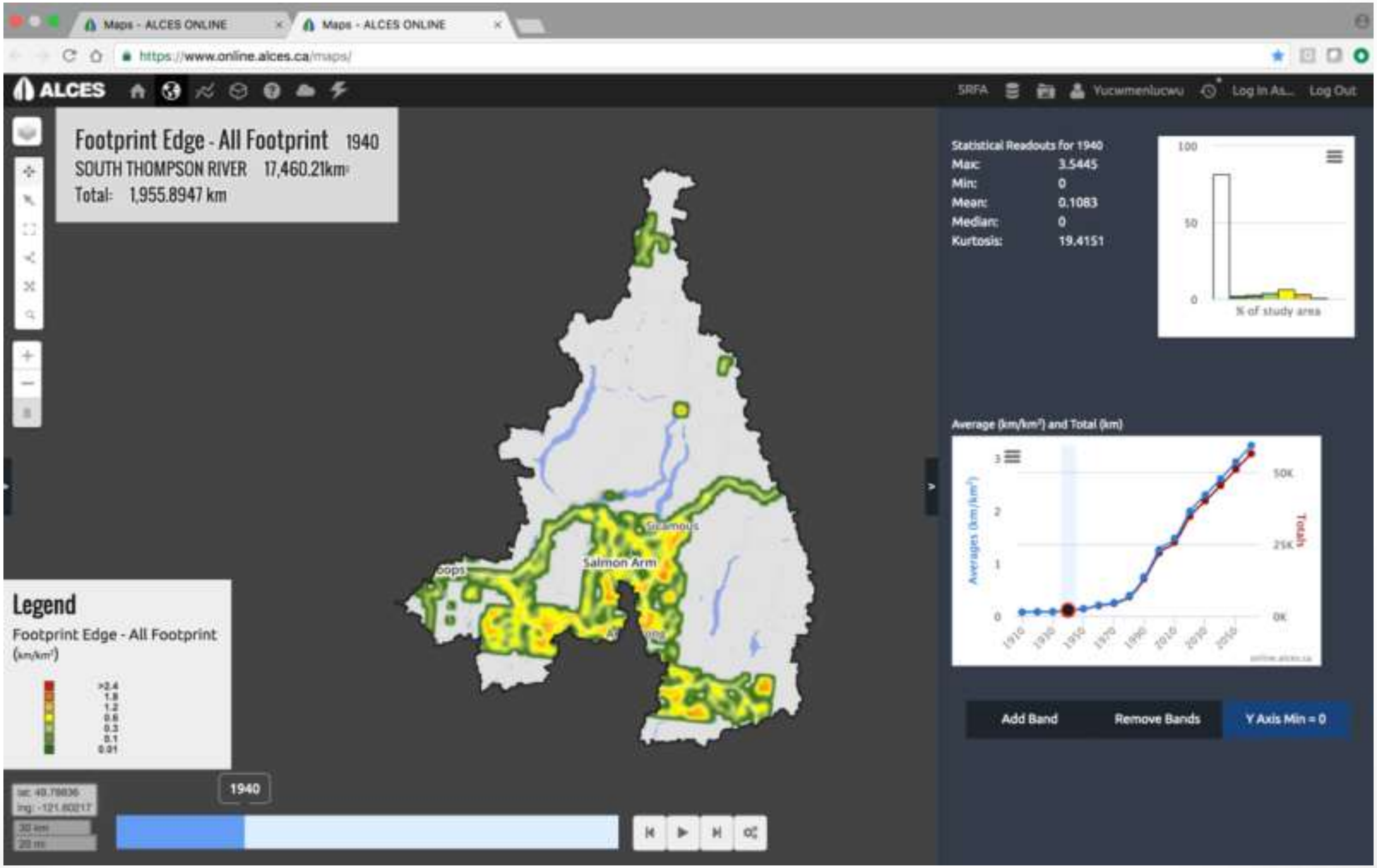
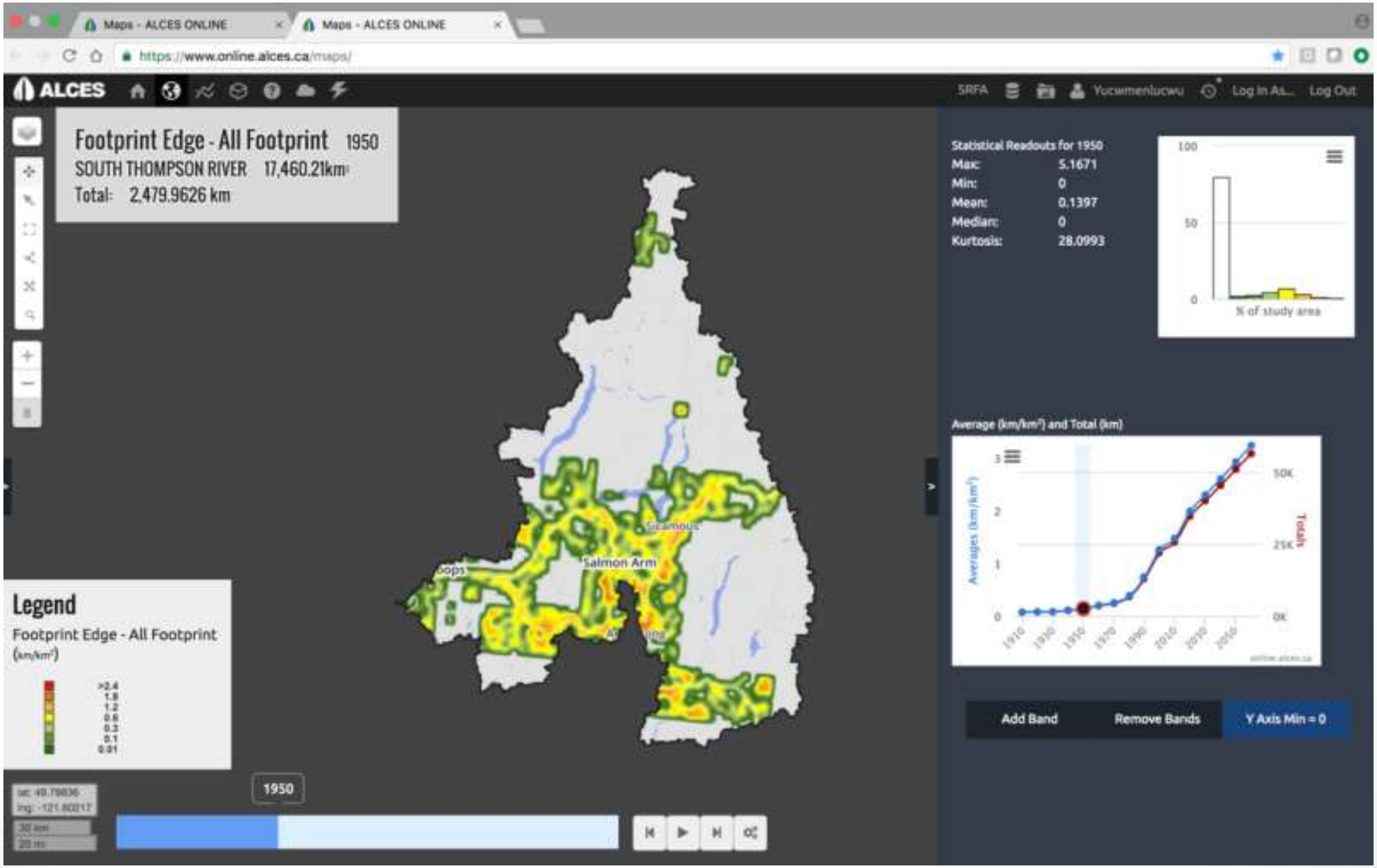
Grizzly Bear Threshold Yellow



Grizzly Bear Threshold Yellow



Grizzly Bear Threshold Yellow



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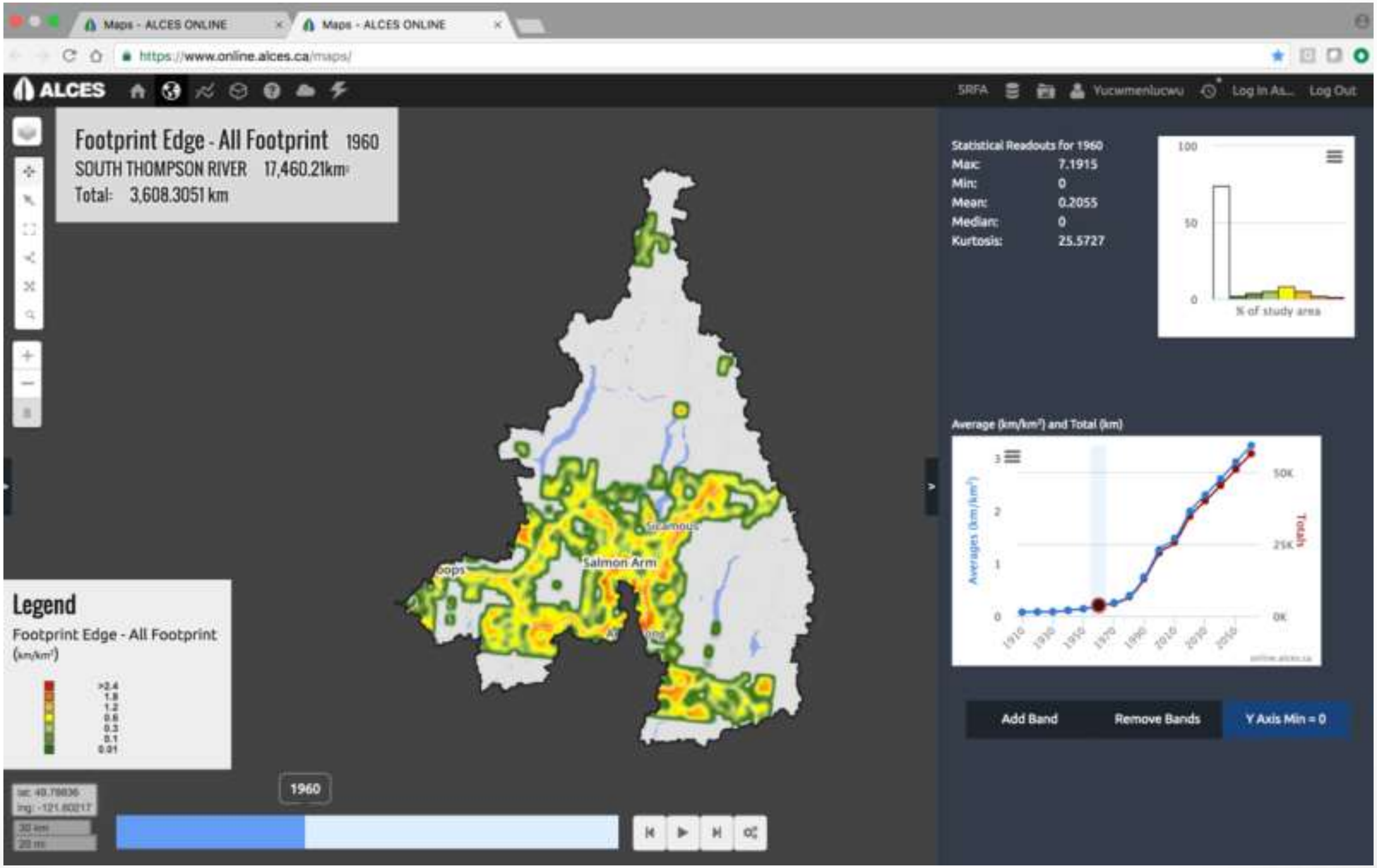
Grizzly Bear Threshold Yellow



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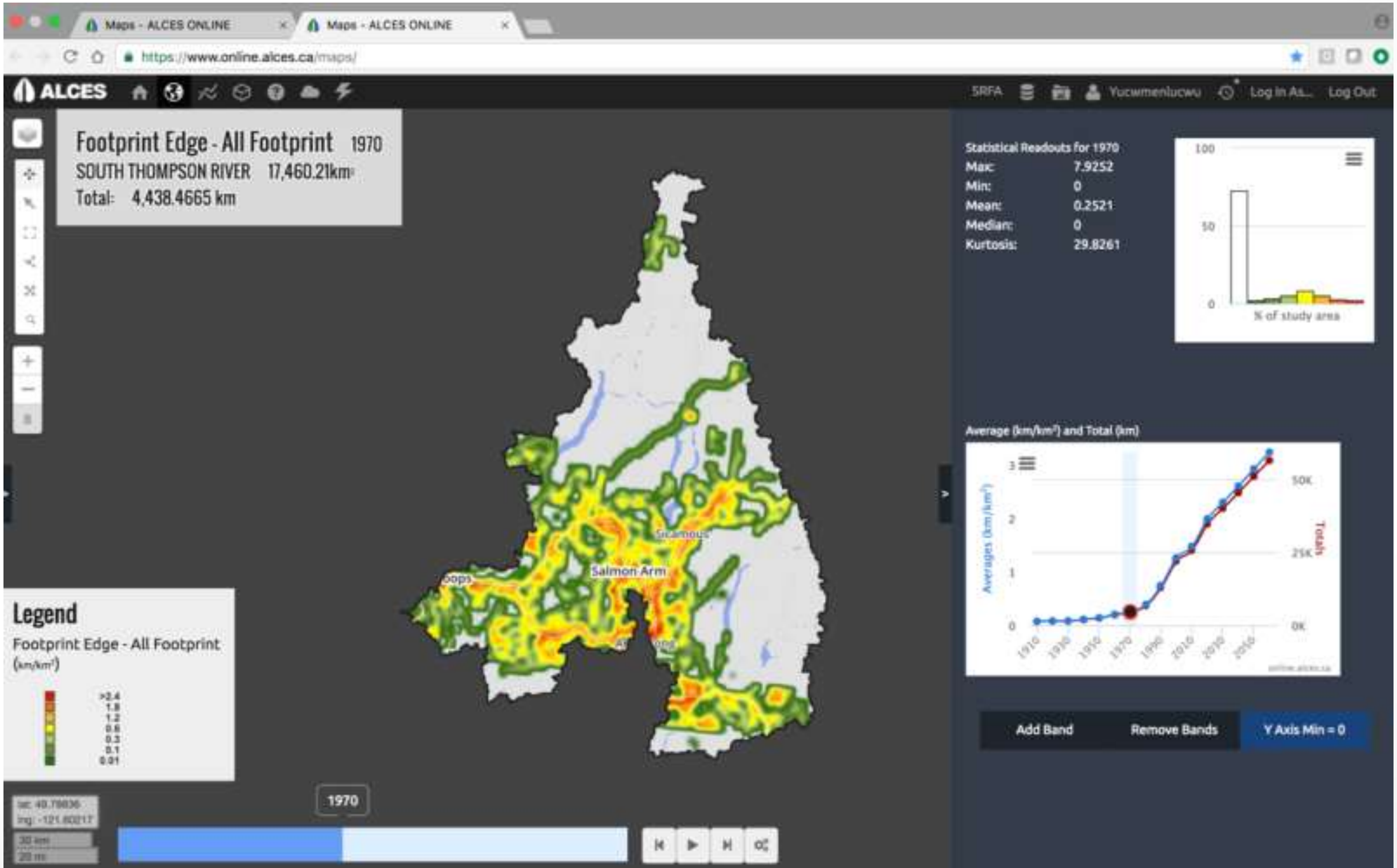

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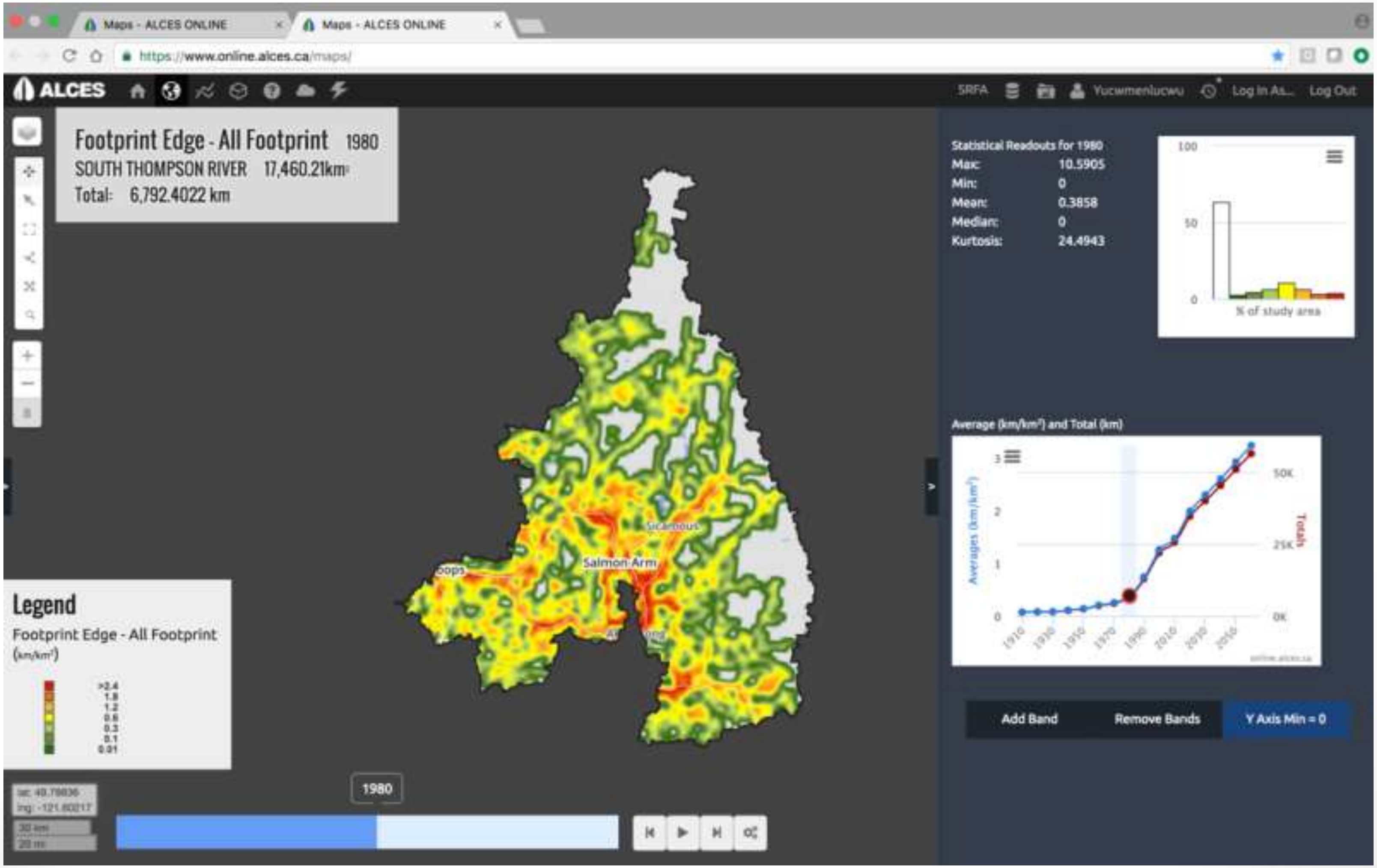
Grizzly Bear Threshold Yellow



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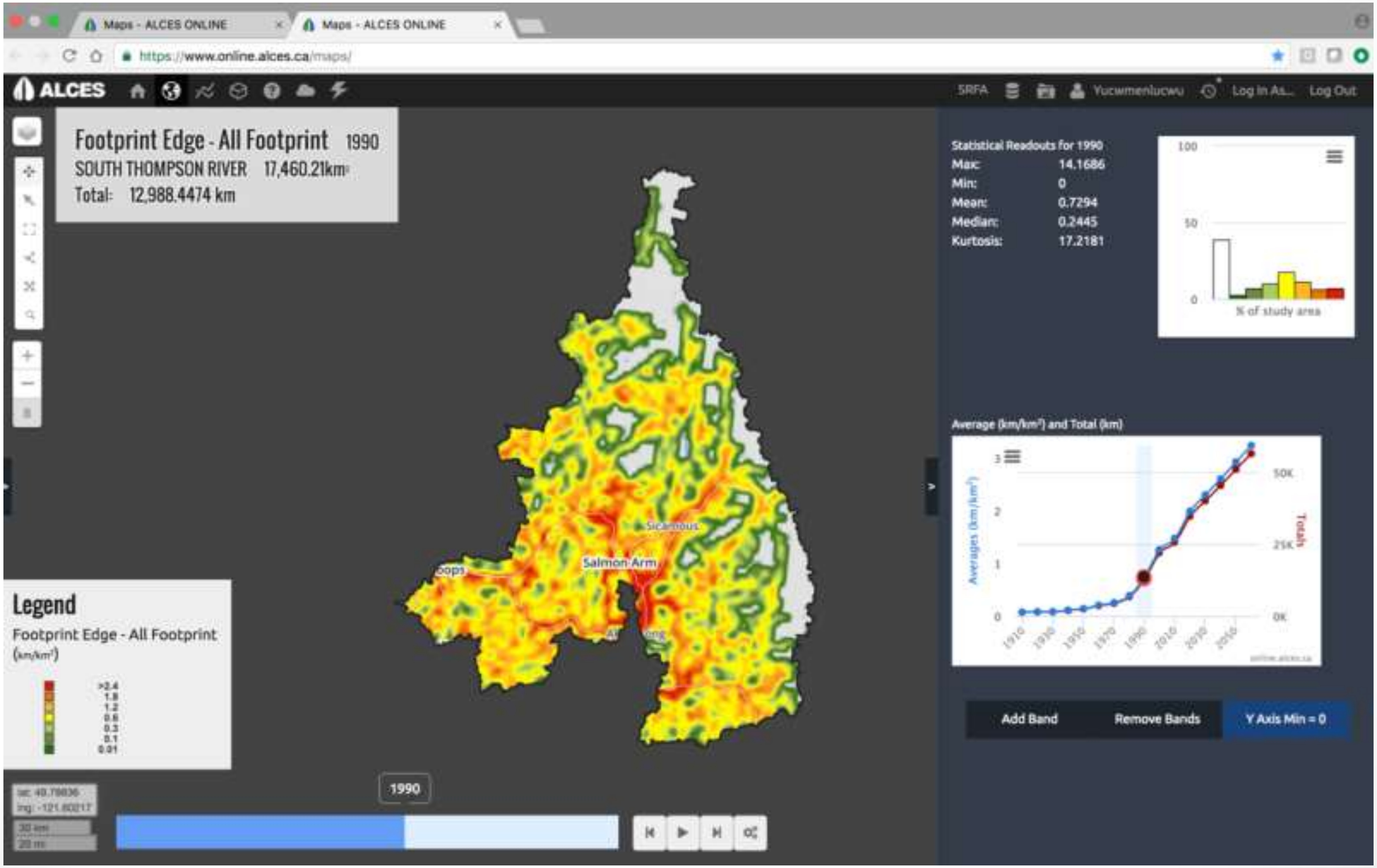

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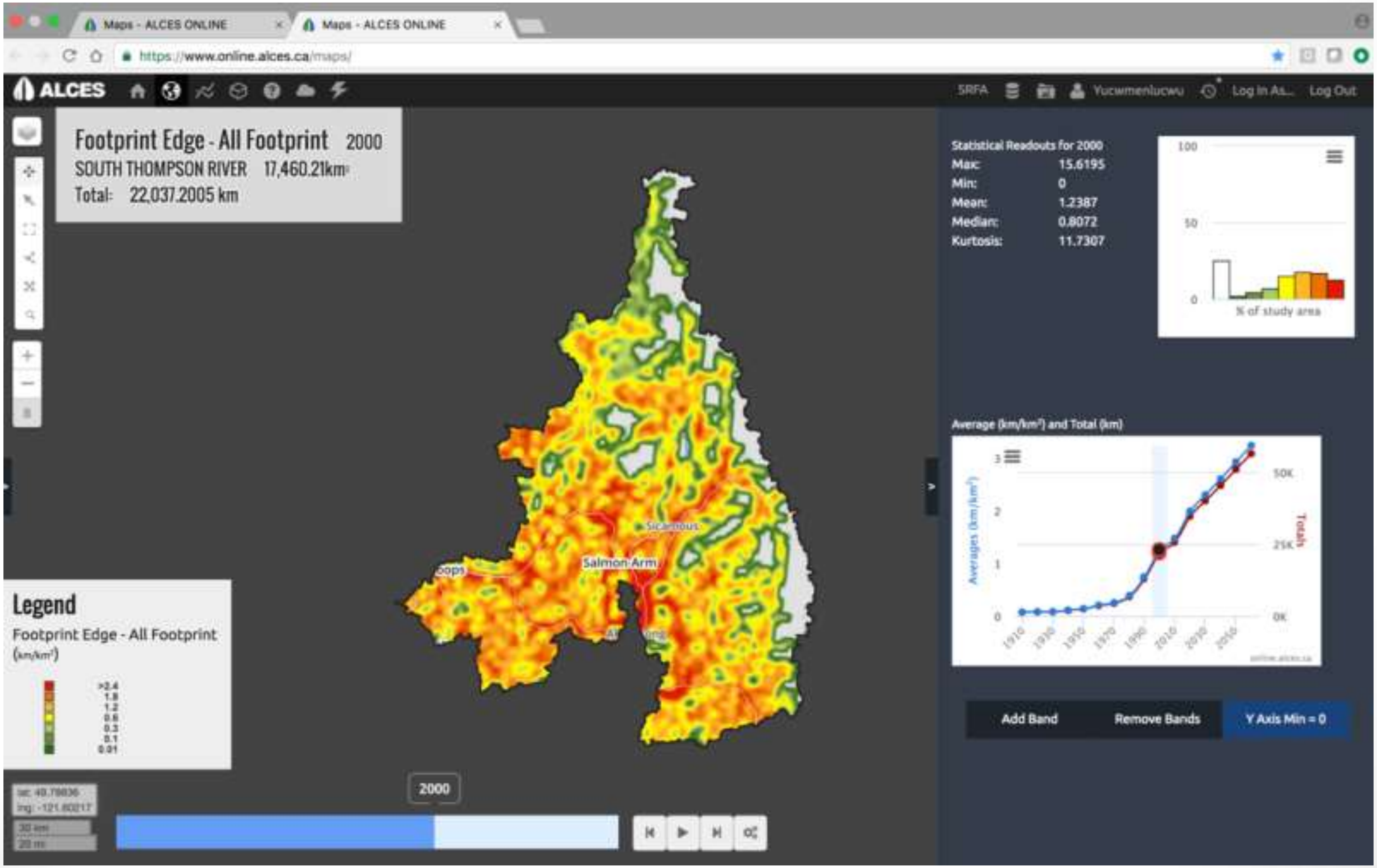

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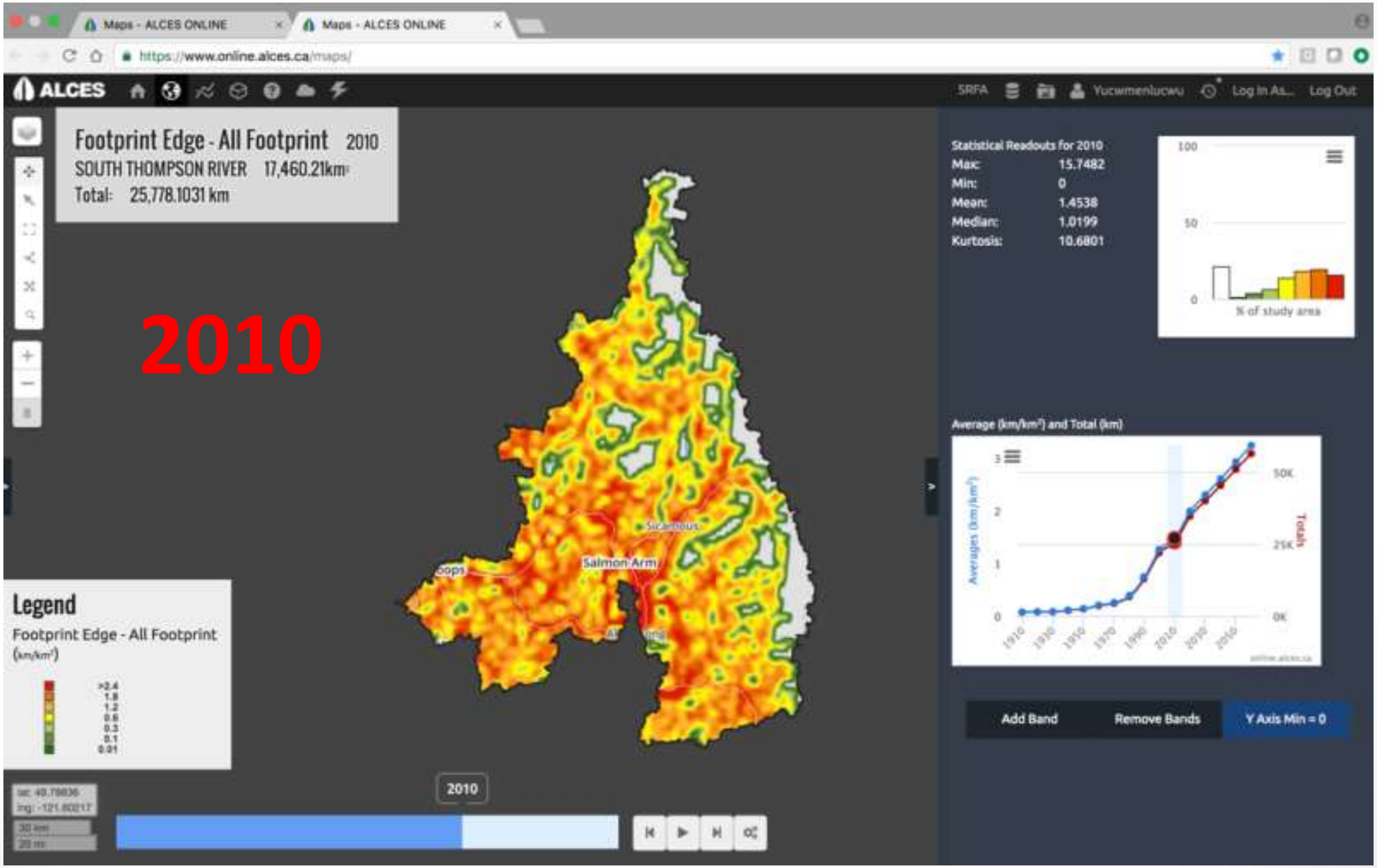

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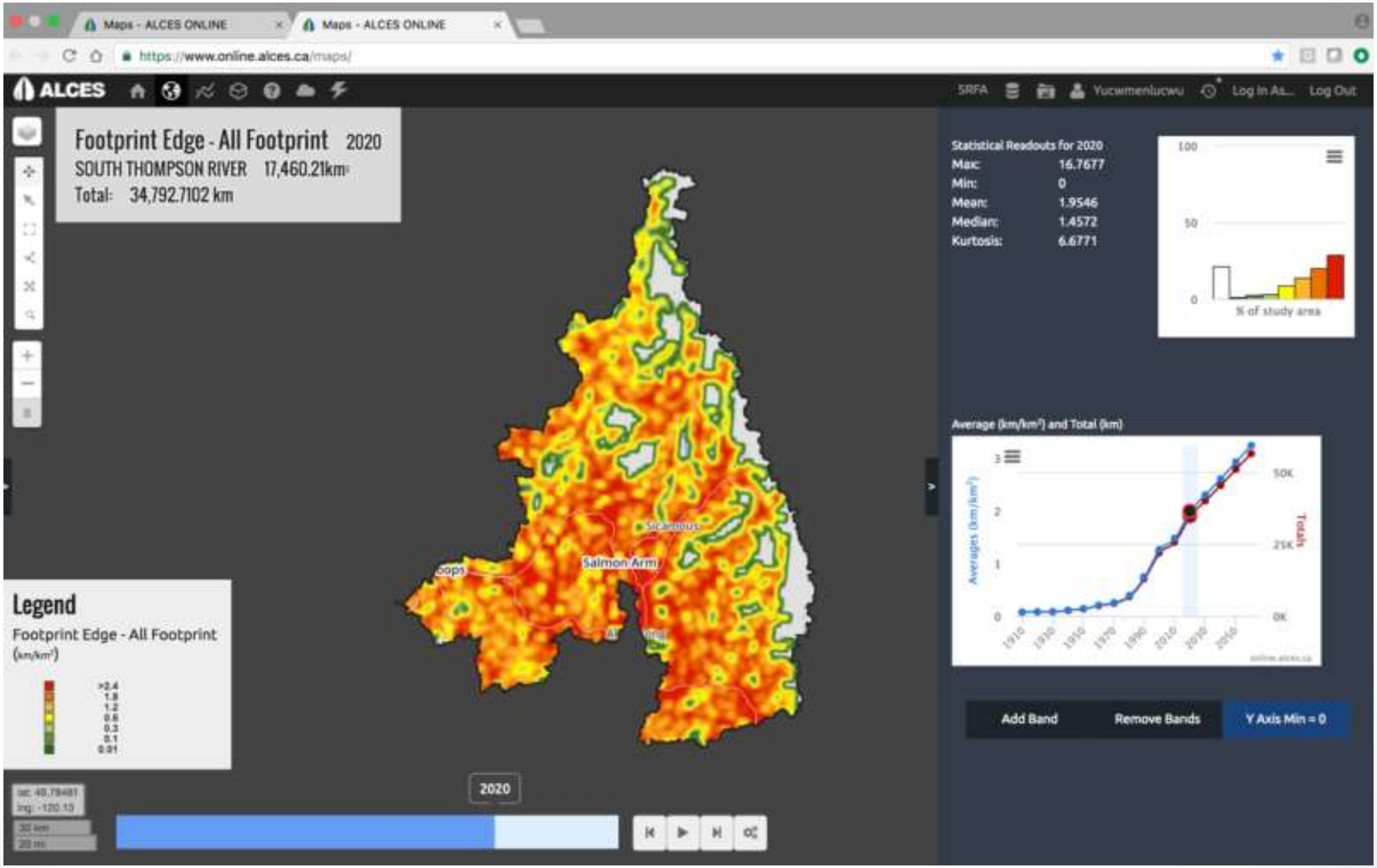

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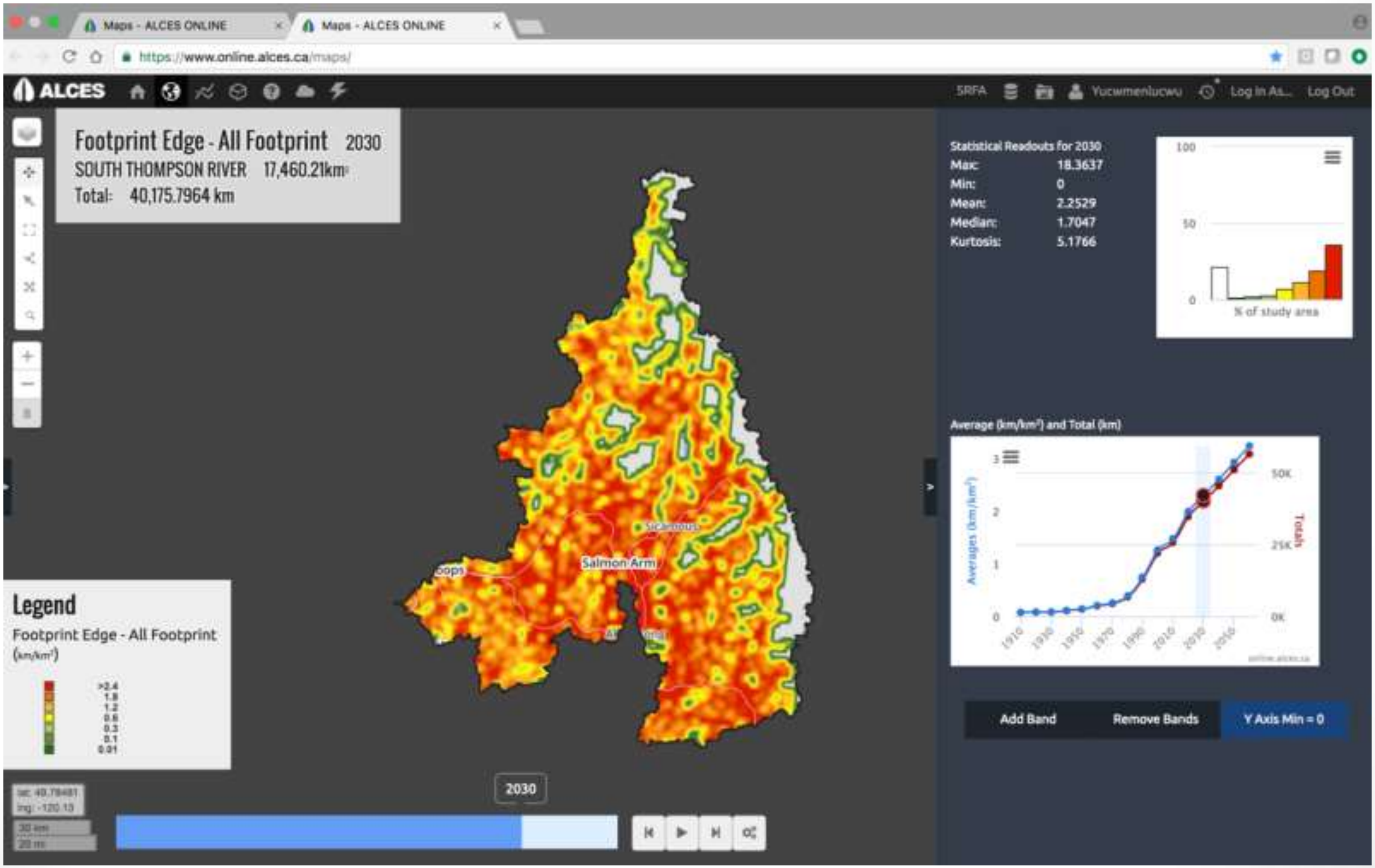

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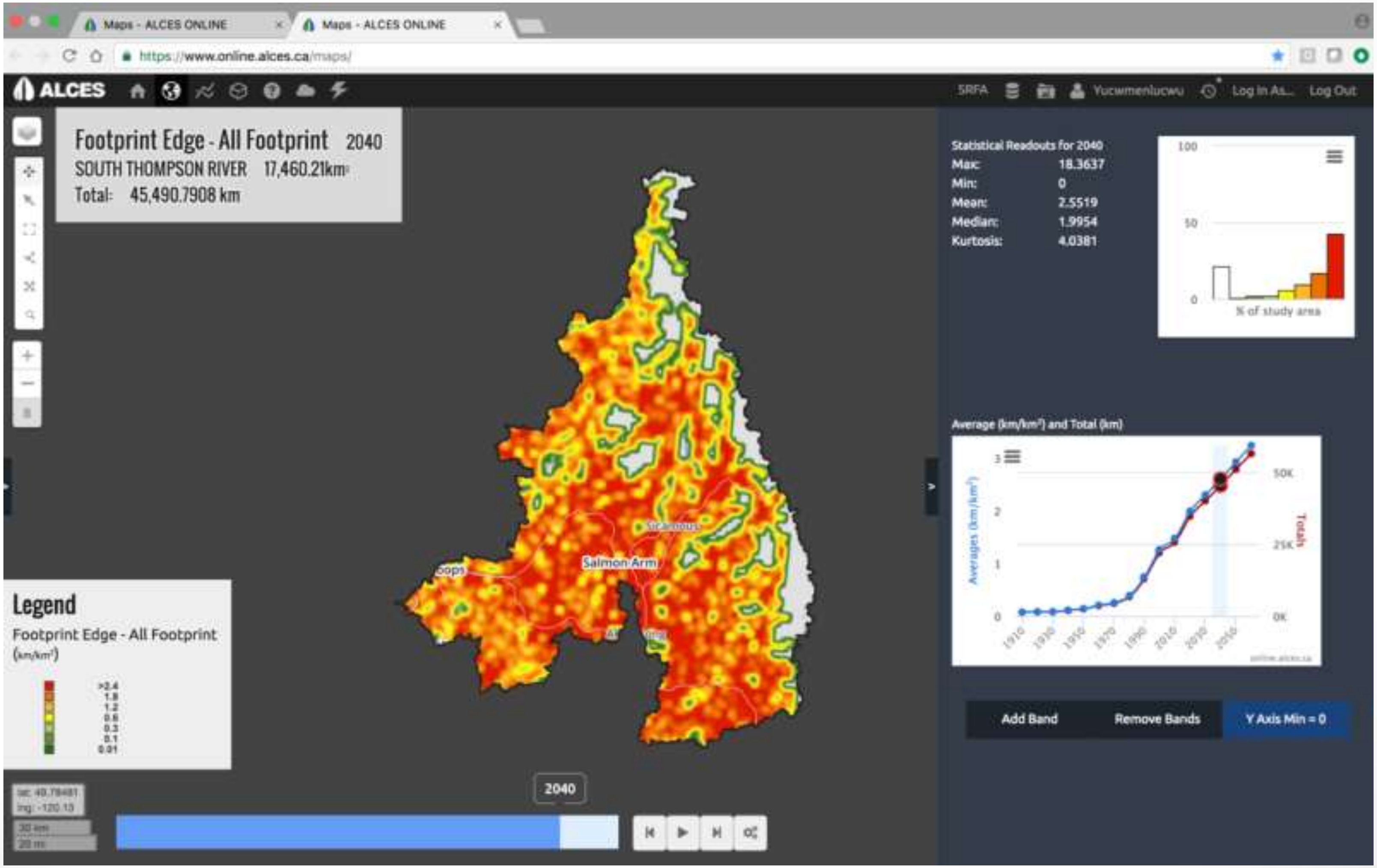

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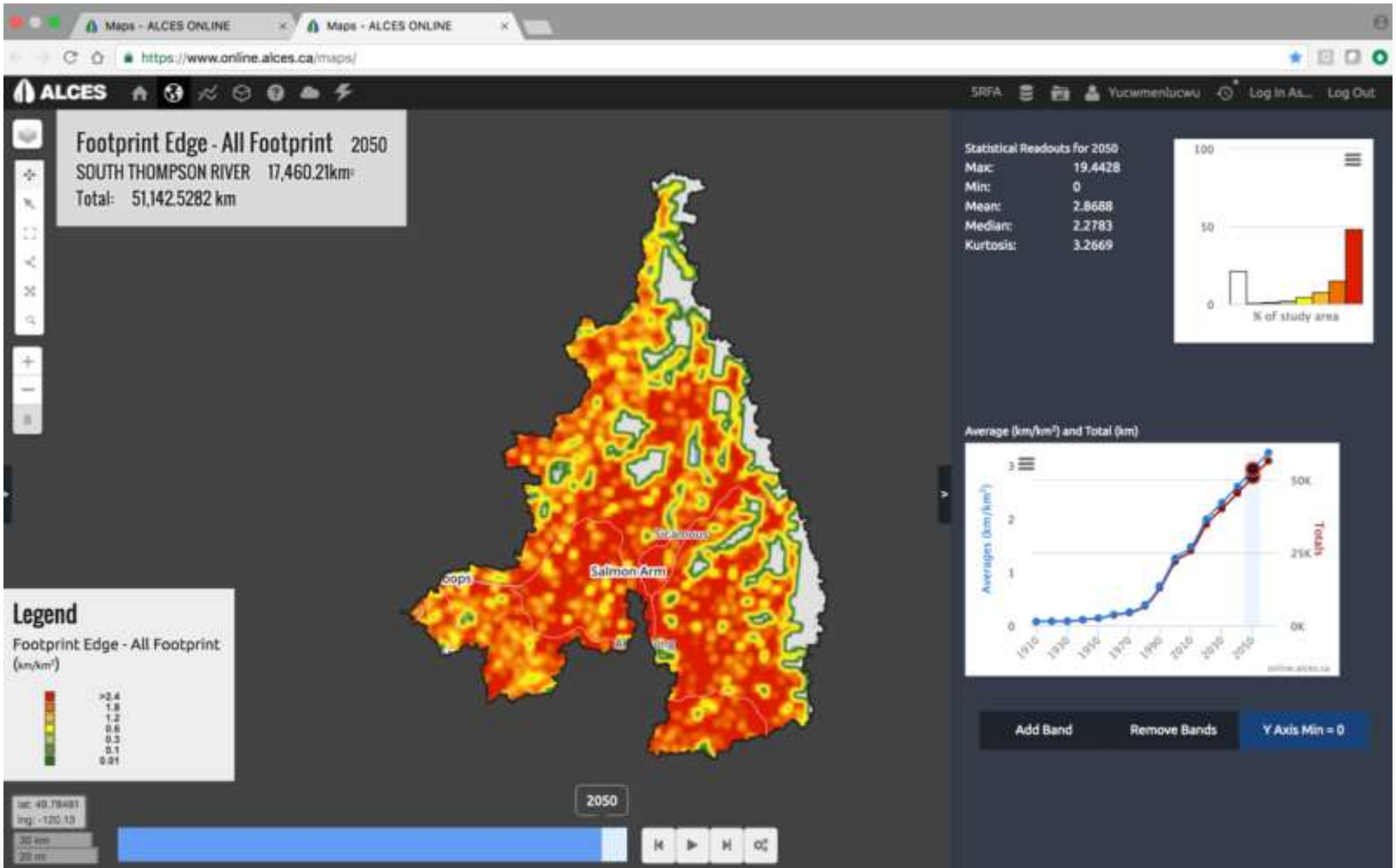
Grizzly Bear Threshold Yellow



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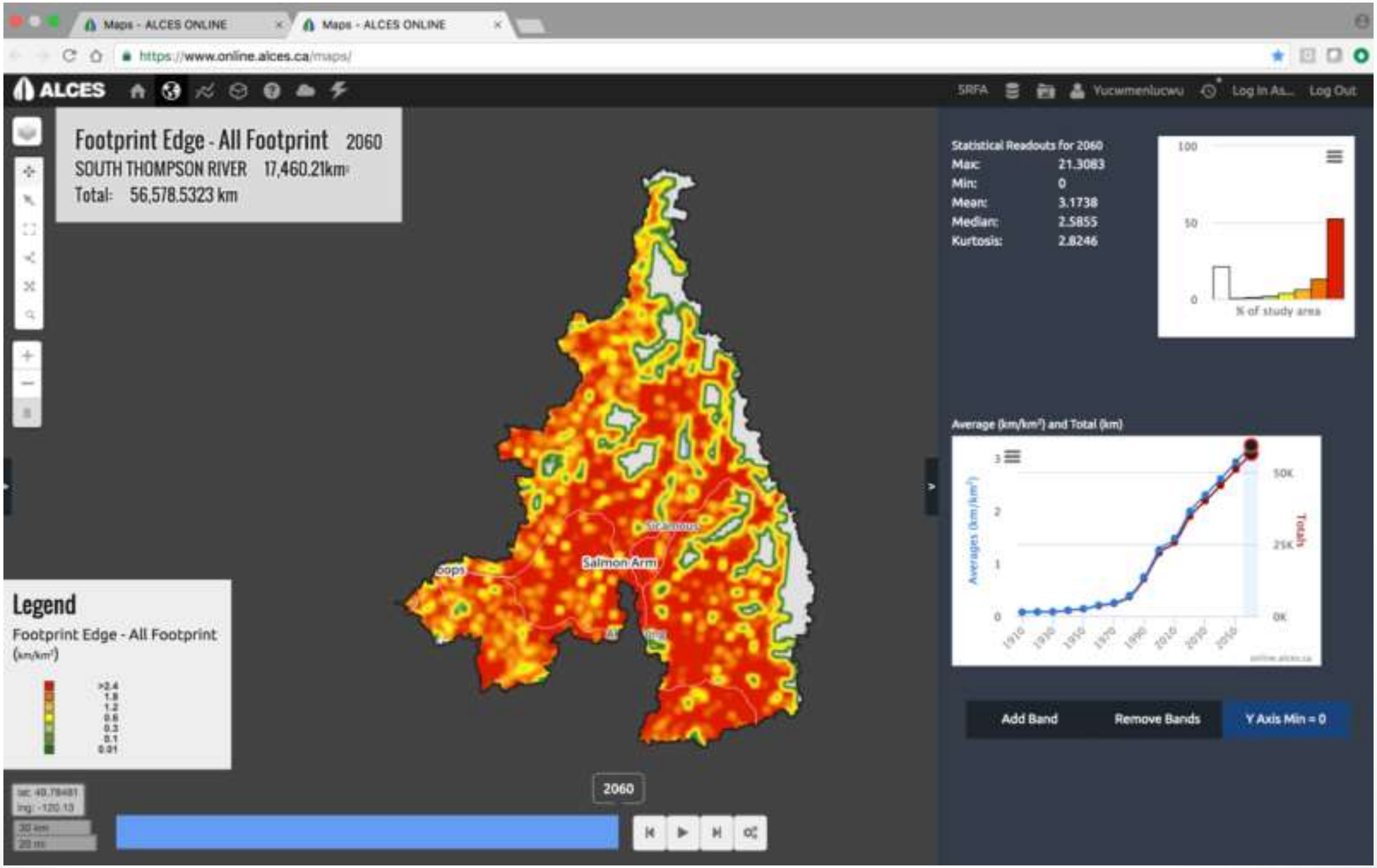

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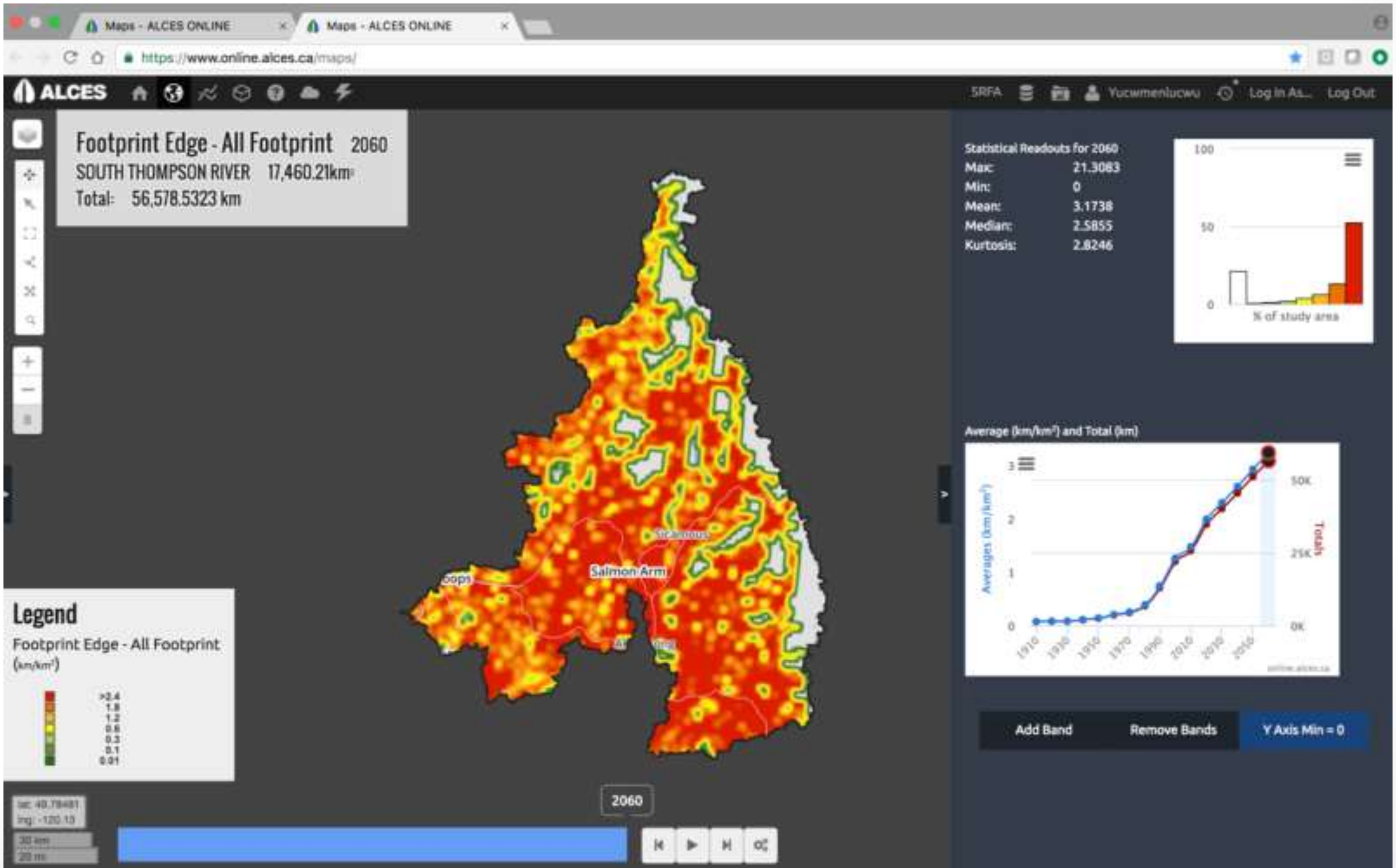
Grizzly Bear Threshold Yellow



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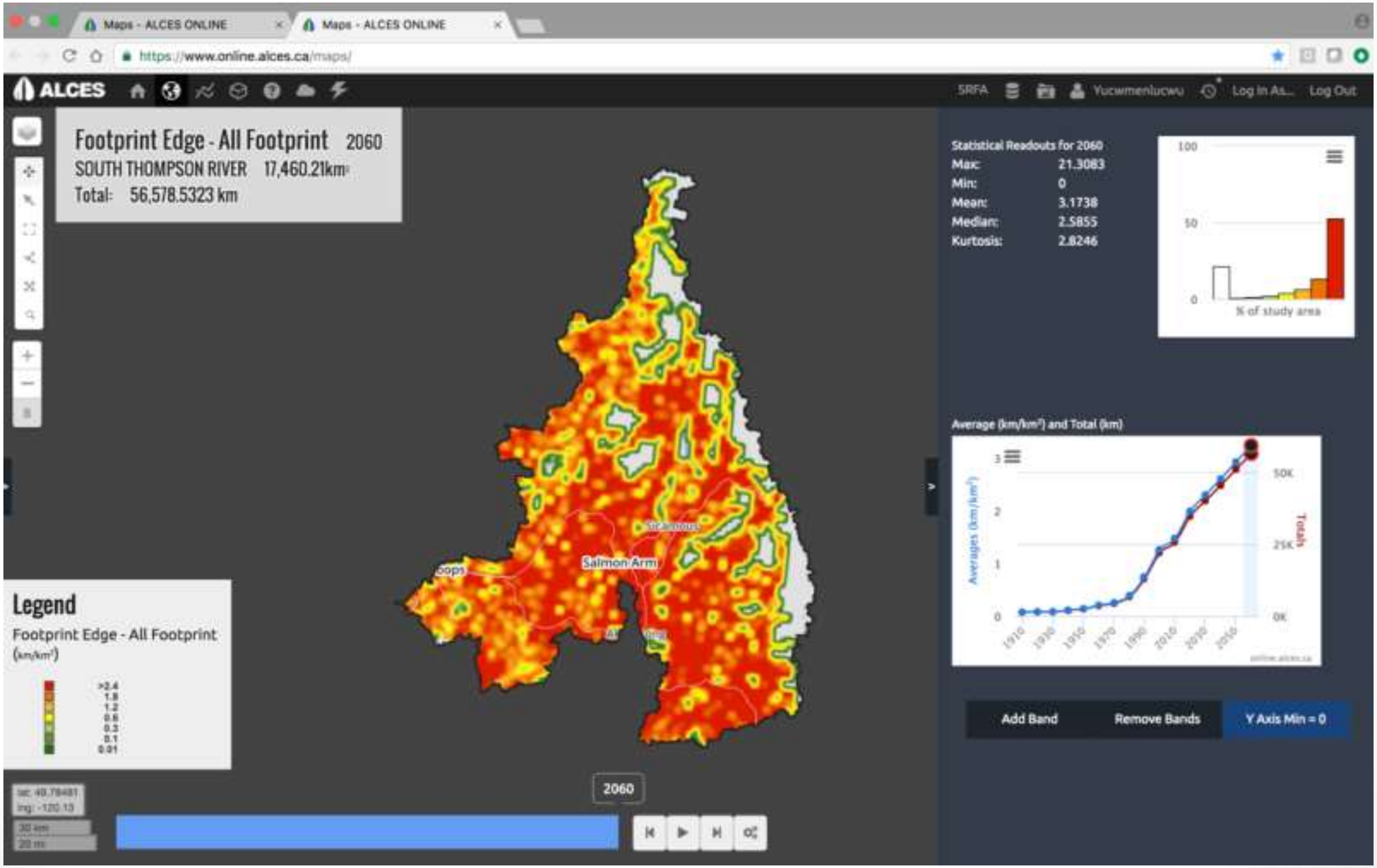
Grizzly Bear Columbia/Shuswap Population



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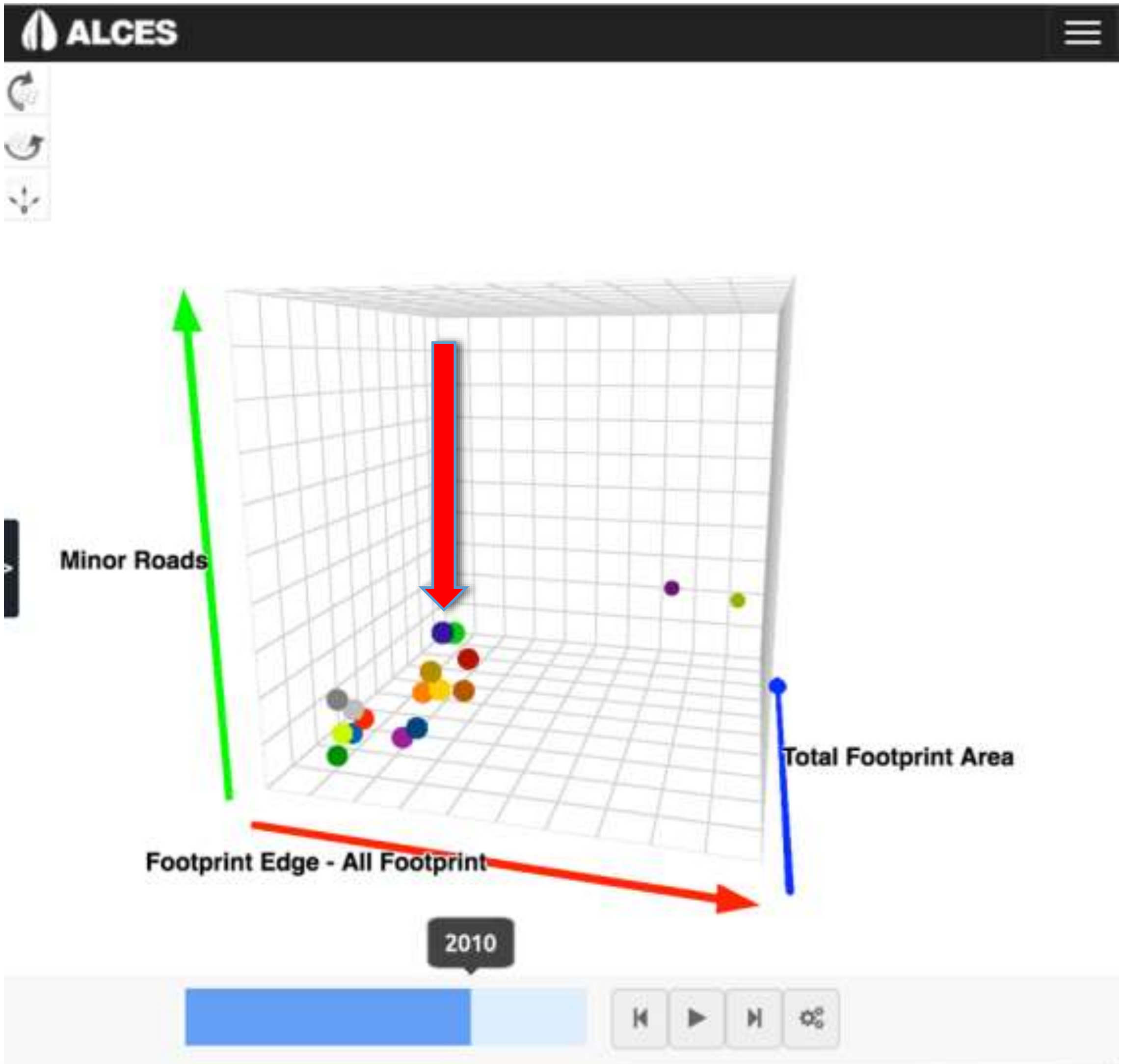

Grizzly
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Is The

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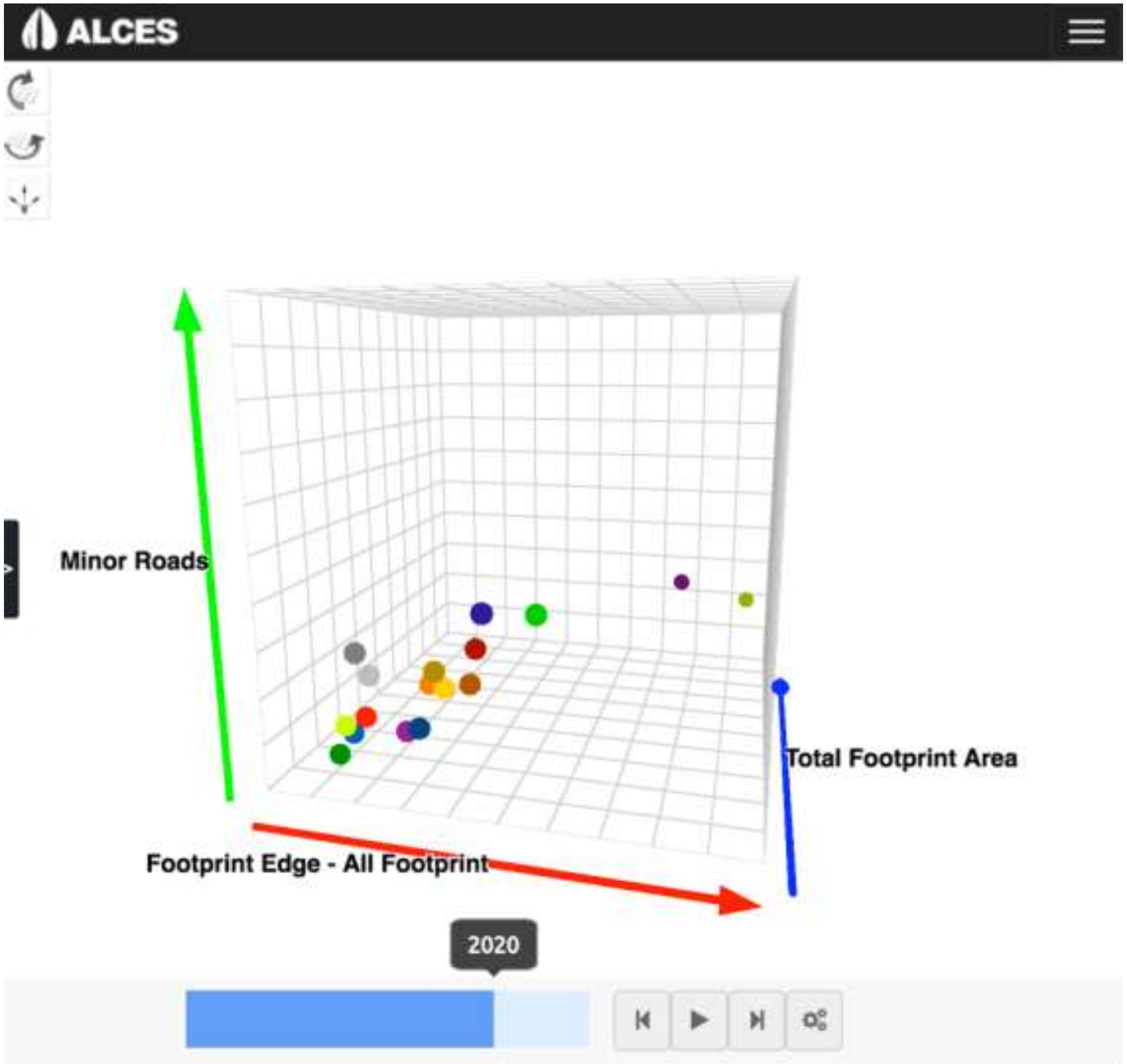

Grizzly Bear Columbia Shuswap Population

Is The

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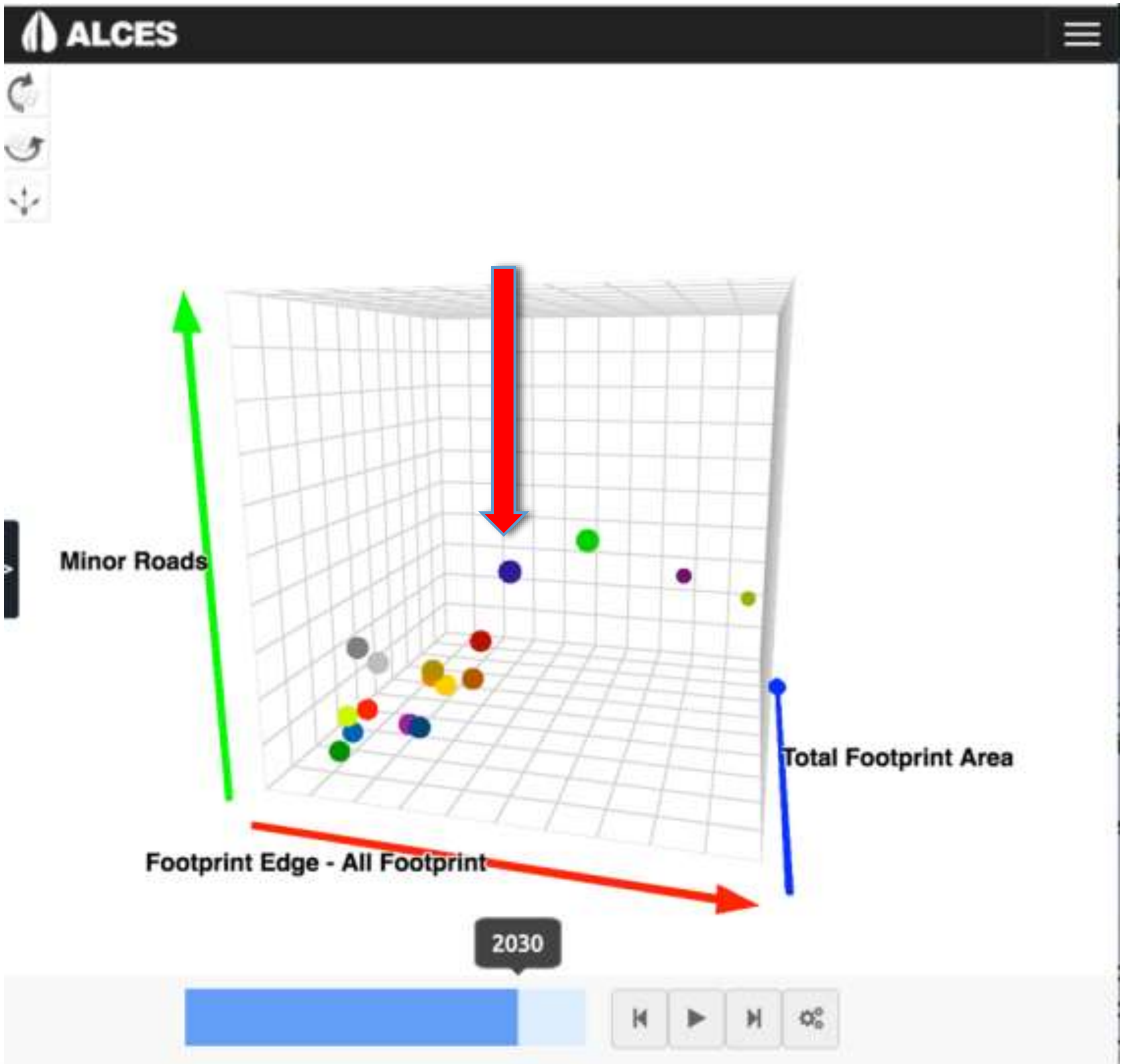

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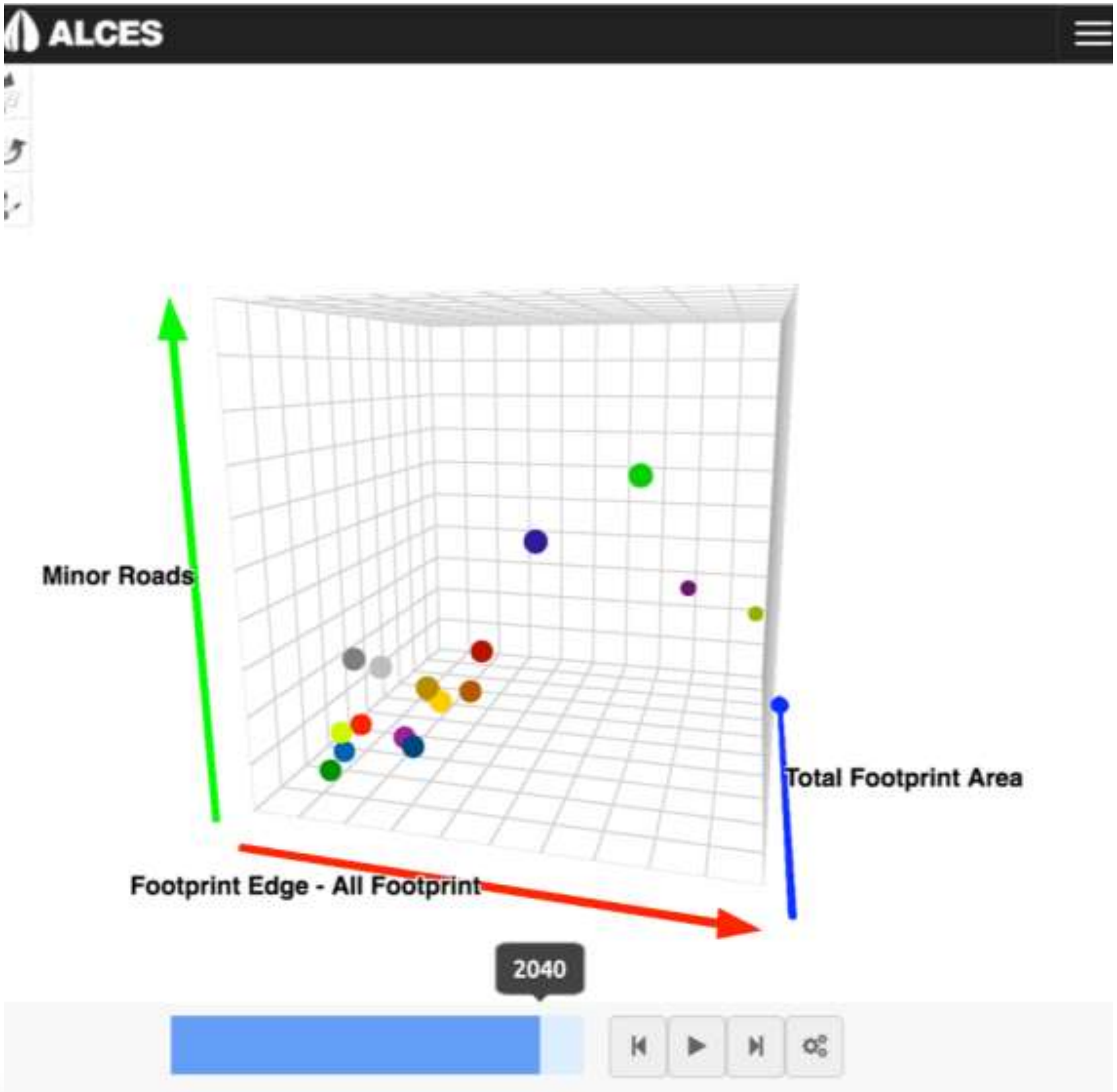

Grizzly Bear Columbia Shuswap Population

Is The

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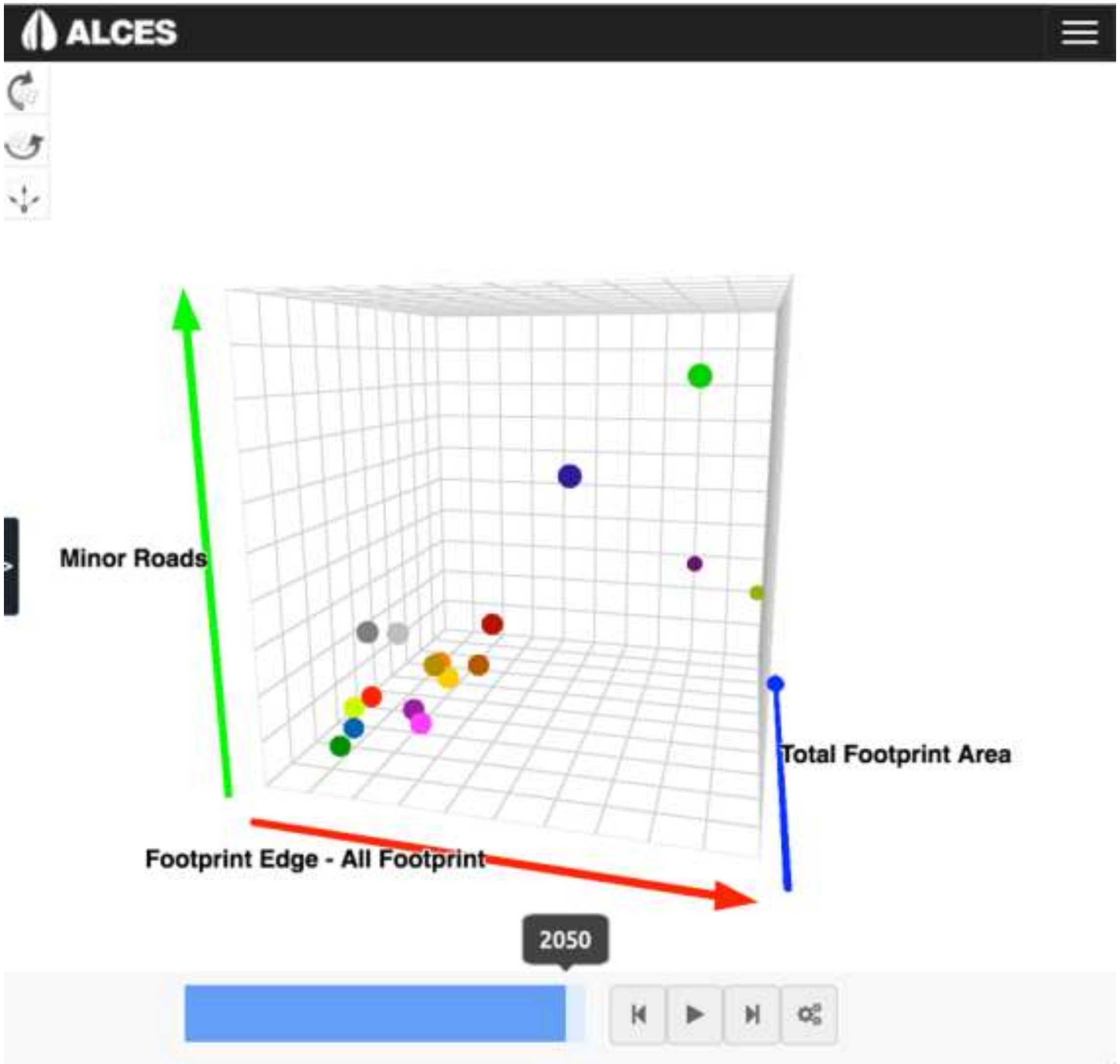

Grizzly Bear Columbia Shuswap Population

Is The

Navy Blue Dot

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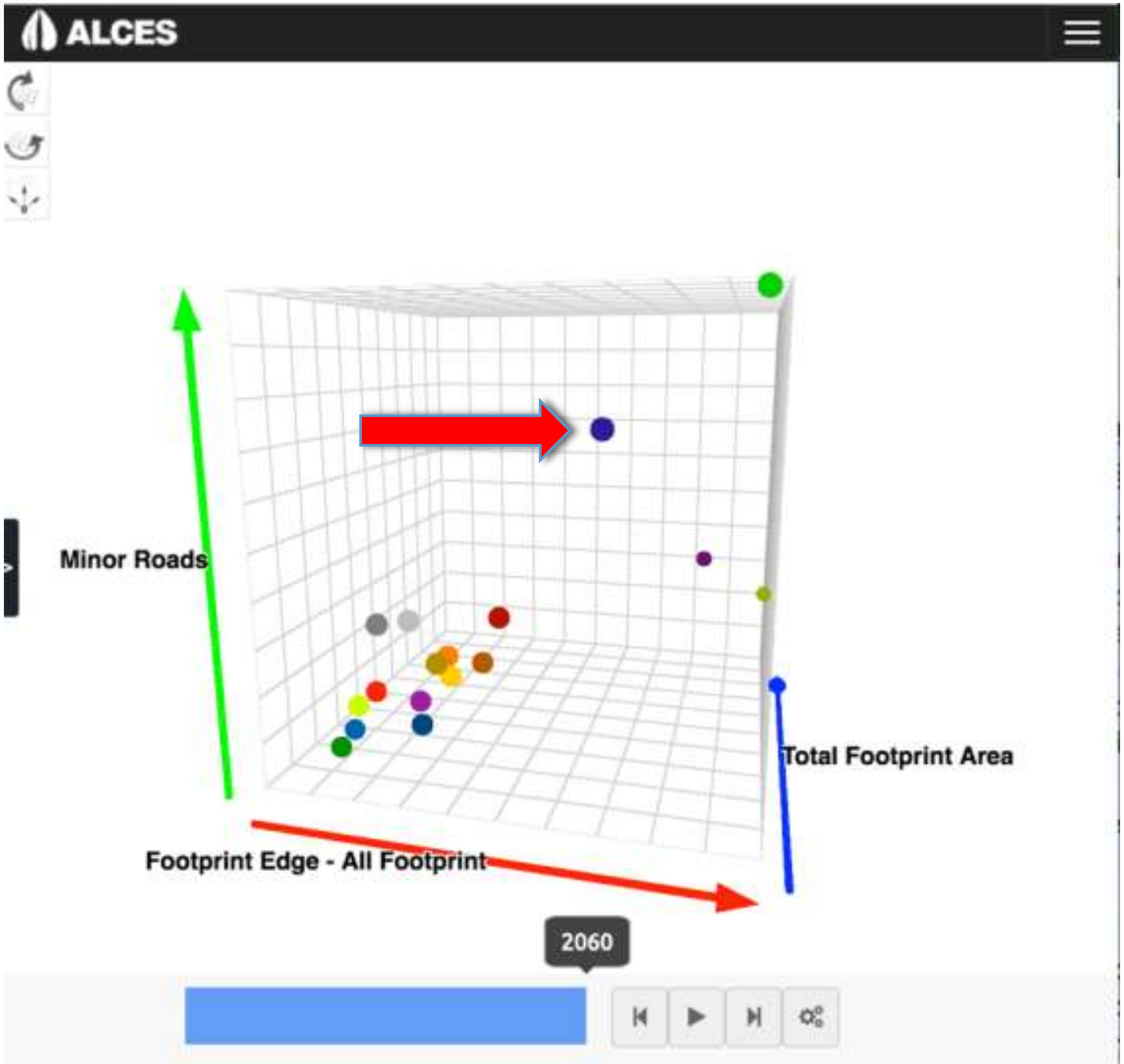


Grizzly Bear Columbia Shuswap Population

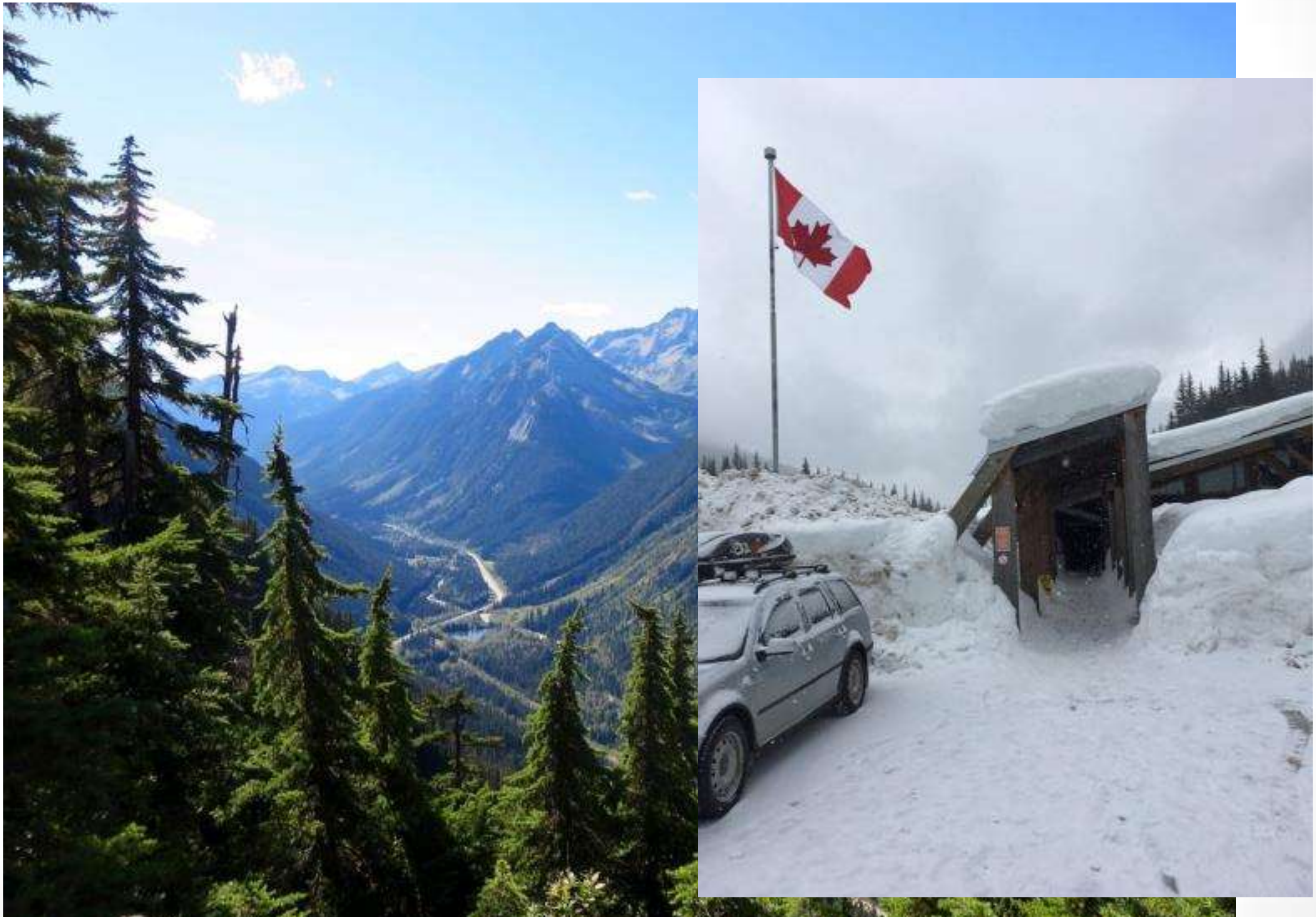
Is The

Navy Blue Dot

Mitigation Measures Being Considered

- Multi-stakeholder Process;
- Access Management Planning;
- Further Information and Data Analysis;
- Zoning or Temporal Harvest Aggregation;
- Fiscal Instruments;
- Communication and Education; and
- Management Framework

Twinning the TCH ↑ Traffic



Illecillewaet Destination Traffic

Indicator	Lower Limit RNV	2010	Midpoint RNV - 2010 Change	2060 BC	2060 TCH	BC - TCH @ 2060 Change
Mule Deer HEI	0.24	0.26	-5%	0.30	0.29	-3%
Moose HEI	0.19	0.16	-25%	0.21	0.20	-7%
Elk HEI	0.0633	0.0661	1%	0.0644	0.0458	-28%
Mountain Caribou HEI	0.50	0.52	-2%	0.49	0.44	-11%
Marten	0.24	0.54	39%	0.46	0.46	0%
Nitrogen Runoff kg/yr	N/A	335,939	N/A	393,092	418,645	7%
Phosphorous Runoff kg/yr	N/A	54,726	N/A	58,173	58,990	1%
Sediment Runoff kg/yr	N/A	820,841	N/A	1,500,650	1,570,961	5%

Traffic Flow - Platooning

Even Flow Traffic

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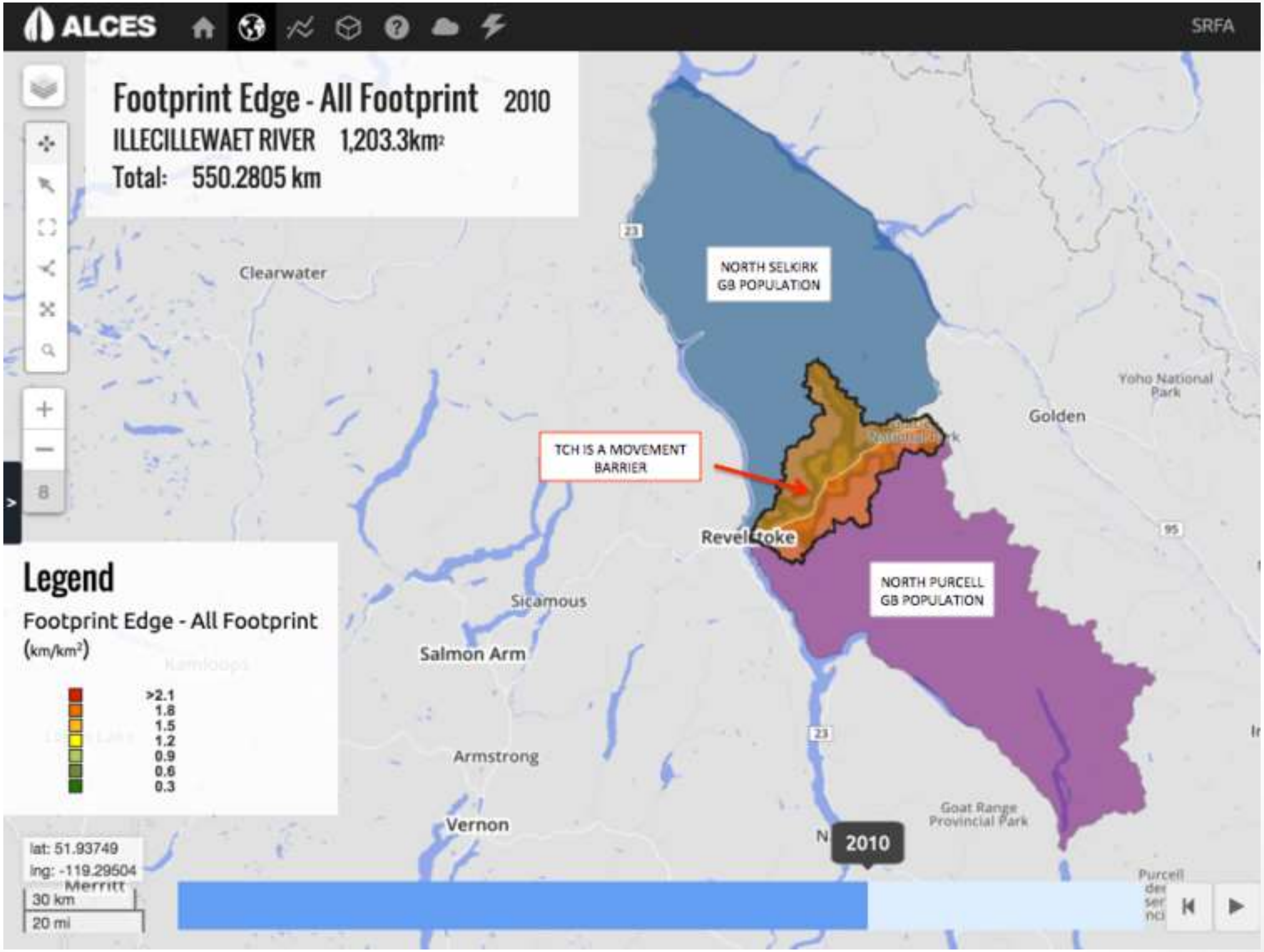
Traffic Flow Barrier



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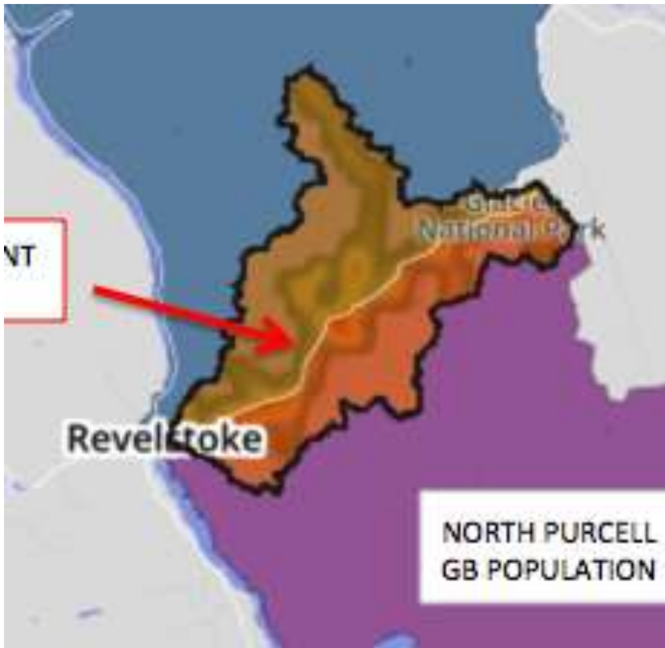
Animal Traffic Overpass



Avalanche Natural Disturbance

Mt. Fidelity
46 ft snow/year

ceanalytic

Avalanches Are Inconvenient

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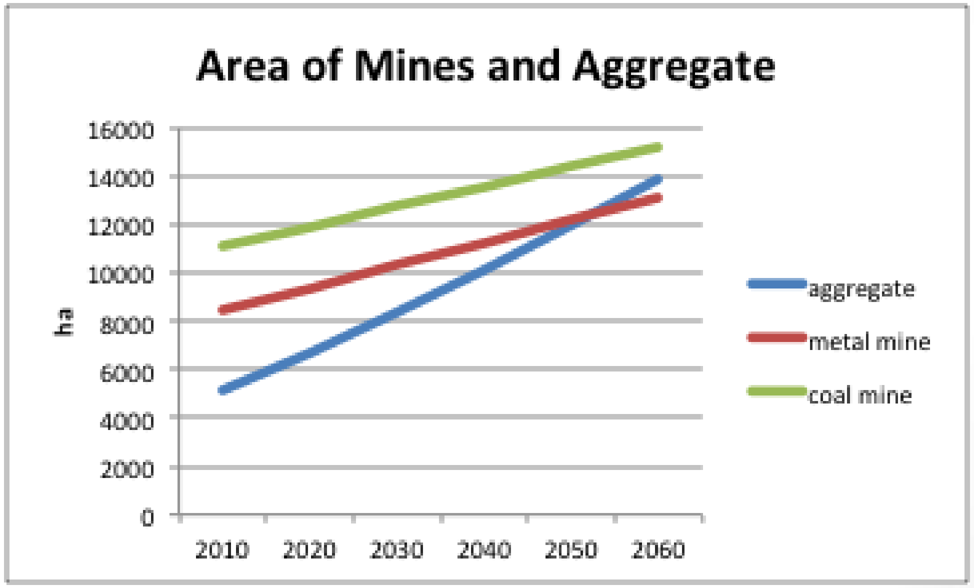
Aggregate Mining A Dark Horse?

Probability of Impact increases with area

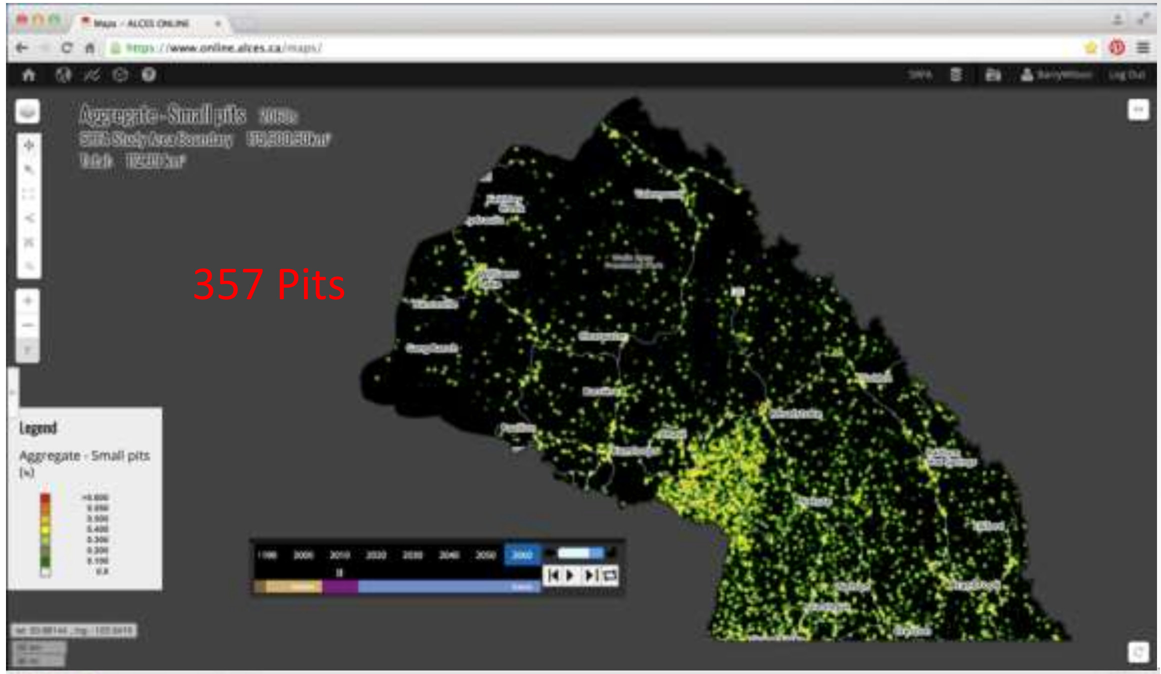
Forecast suggest:

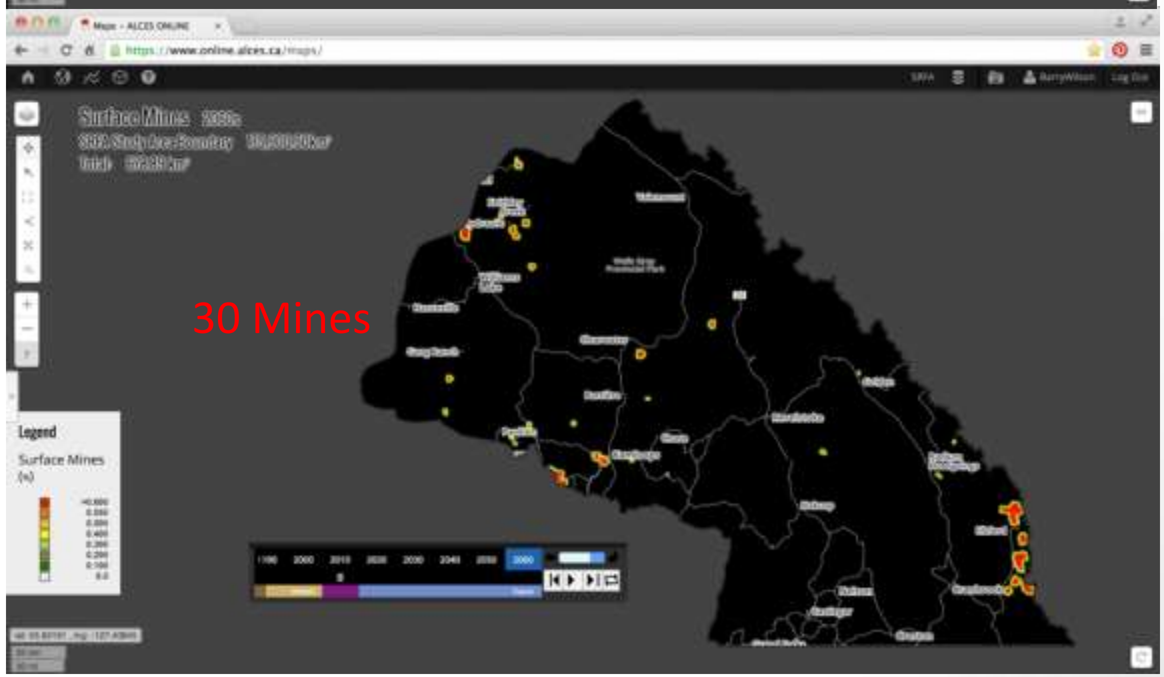
- **By 2050 Aggregate Pits > Metal Mine Area**
- **By 2070 Aggregate Pits > Coal Mine Area**

Probability of Effect /Risk Can Δ with Time



Probability of Impact increases with frequency





Watch Out For Unintended Consequences

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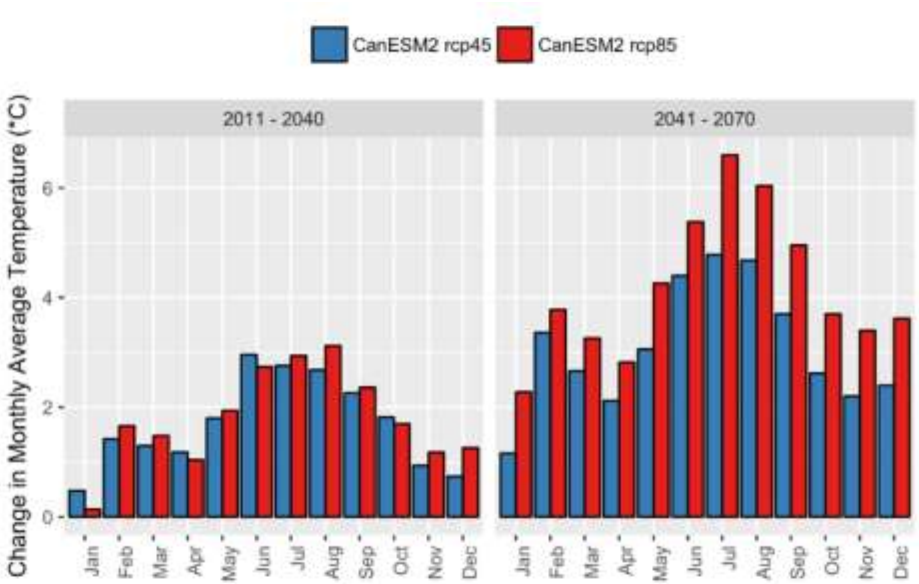
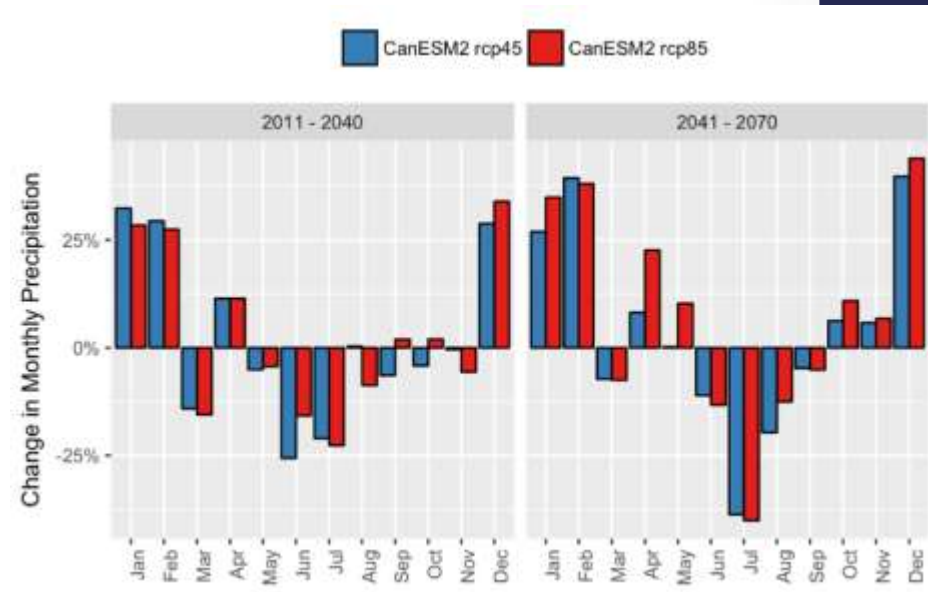
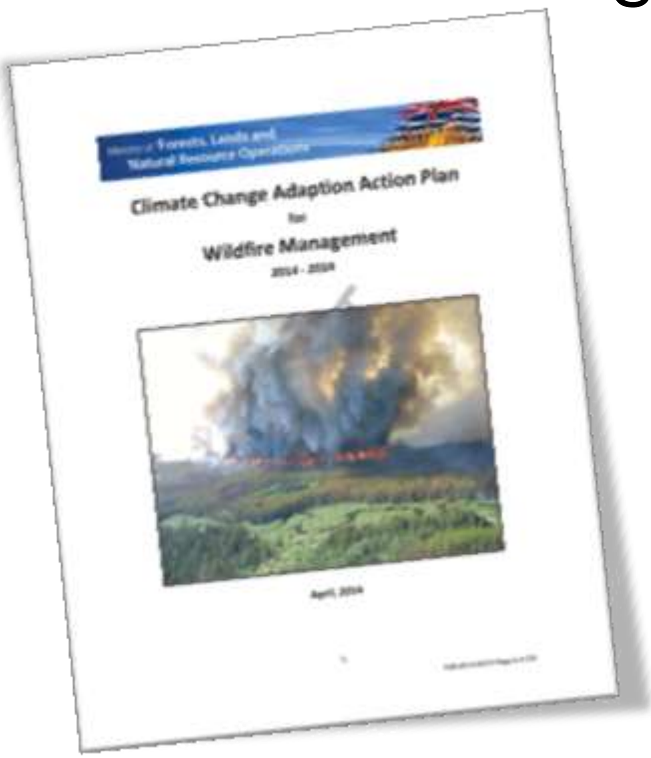
Climate Change

- Increases in air temperature
- Increases in winter precipitation, decreases in the summer





Climate Change Affects Wildfire



Southern BC increase of 4^0C by 2080

- 🔥 🡅avg fire size doubling to 200 km2;
- 🡅40% in spring
- 🔥 🡅95% in summer
- 🔥 🡅30% in fall;
- 🔥 🡅30% fire season length
- 🔥 🡅30% fire frequency fire
- 🔥 severe fire behaviour 🡅7%
- 🔥 decrease in fire free areas by 39%

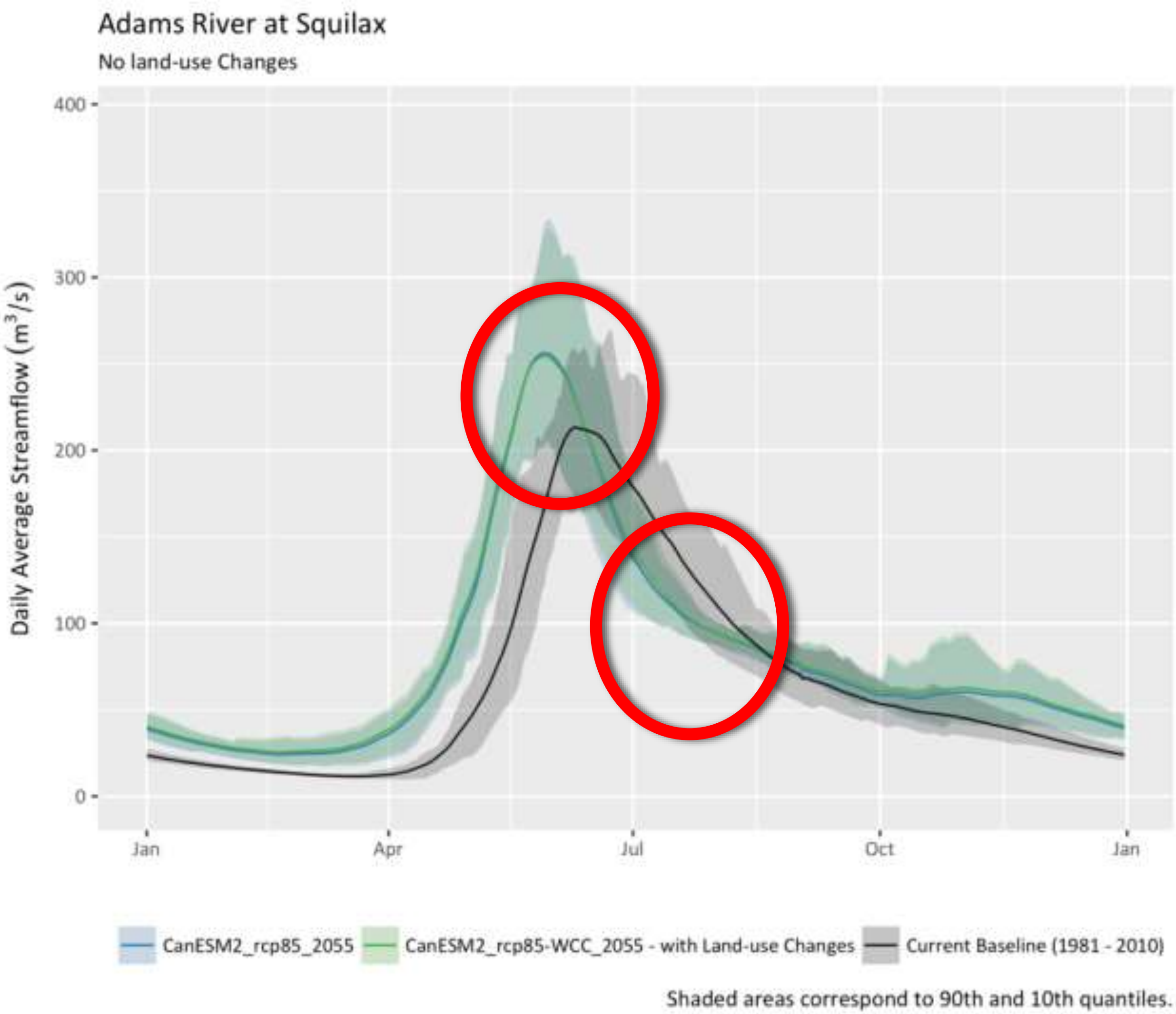
Insurance Bureau of Canada predicts that the incidence of severe wildfires will increase in B.C. by 50% or more by 2050.

🡅risk to timber supply, public safety and critical habitat like old seral for caribou.

Adams River response to land use and climate change (2050s)

Annually

- Climate has a large effect on streamflow
- Land use effect < than climate
- ↑ spring streamflow
- ↓ summer streamflow



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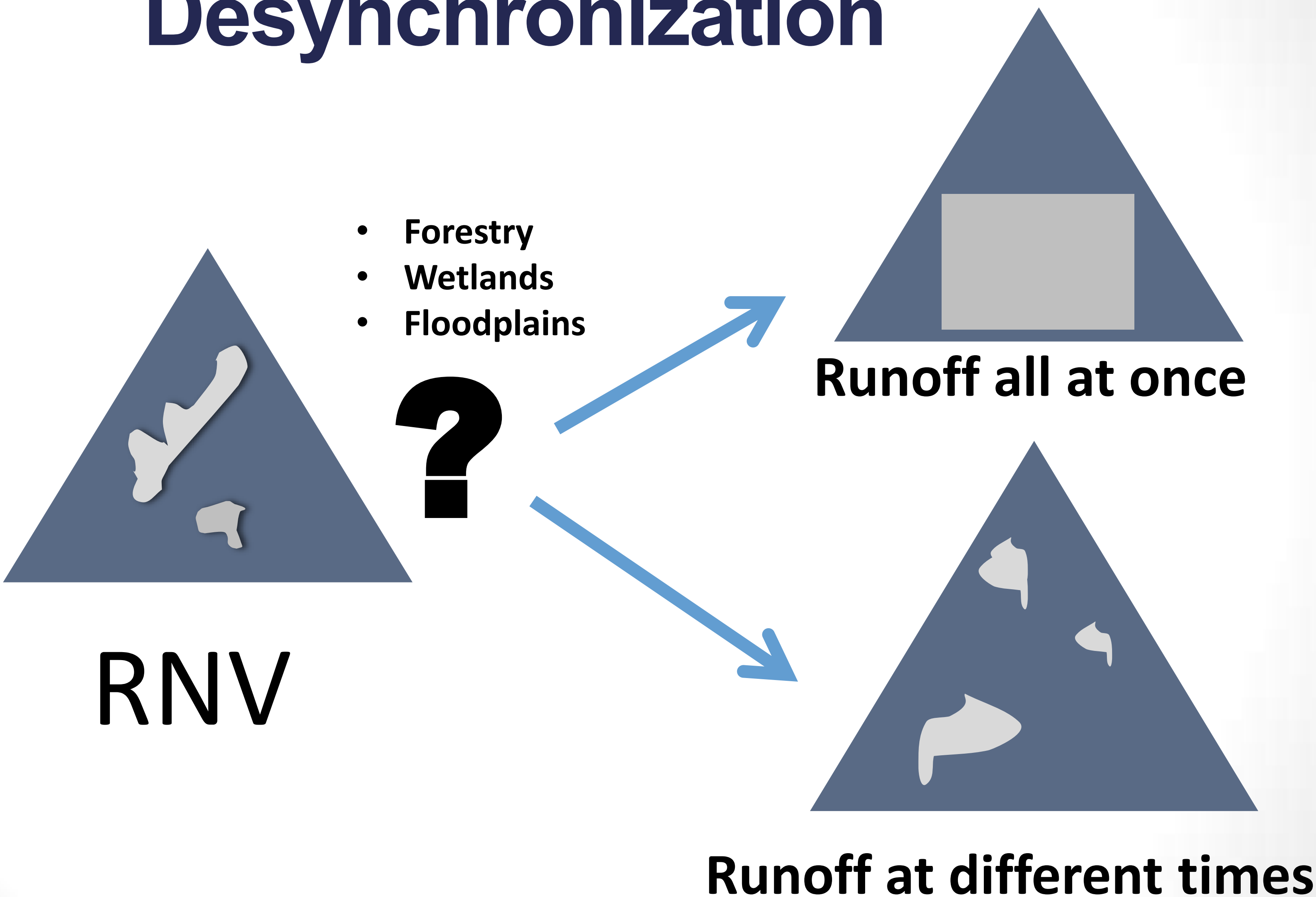
Runoff Desynchronization



Key Drivers

- Scenario planning allows a better understanding of the primary change agents
- Often key drivers, their magnitude or pace of change will emerge that we did expect unintended consequences
- Systems dynamics analytics help us to target our efforts to the best places
- Identify how important what we don't know is and direct scarce research resources to biggest ROI

Risk Management

- assists decision makers with understanding the implications of risk and uncertainty under different management approaches (hazard x consequence)
- Help to uncover management combinations that minimize risk in the face of uncertainty
- Quantitative approach – scientific, transparent , credible & proven

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salmonid restoration federation 17-03-29

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Garcia River Watershed and Monitoring Program – Overview, Status and Trends

Jonathan Warmerdam
North Coast Water Board

and

Jennifer Carah
The Nature Conservancy

March 31, 2017

Presentation Topics

1. Garcia River Watershed Overview
2. TMDL and Recovery Actions
3. Garcia River Monitoring Program
4. Data and Trends
5. Conclusions

Garcia River Watershed
Boonville
Point Arena
Mountain View Road
Hathaway Creek
North Fork Garcia River
Larmour Creek
Inman Creek
Signal Creek
Mill Creek
Fish Rock Road
1
128
N
S
E
W
5
0
5
10 Miles


Jonathan Warmerdam









Photo credits: Larry Serpa, TNC and Stephen Bargsten, NCRWQCB

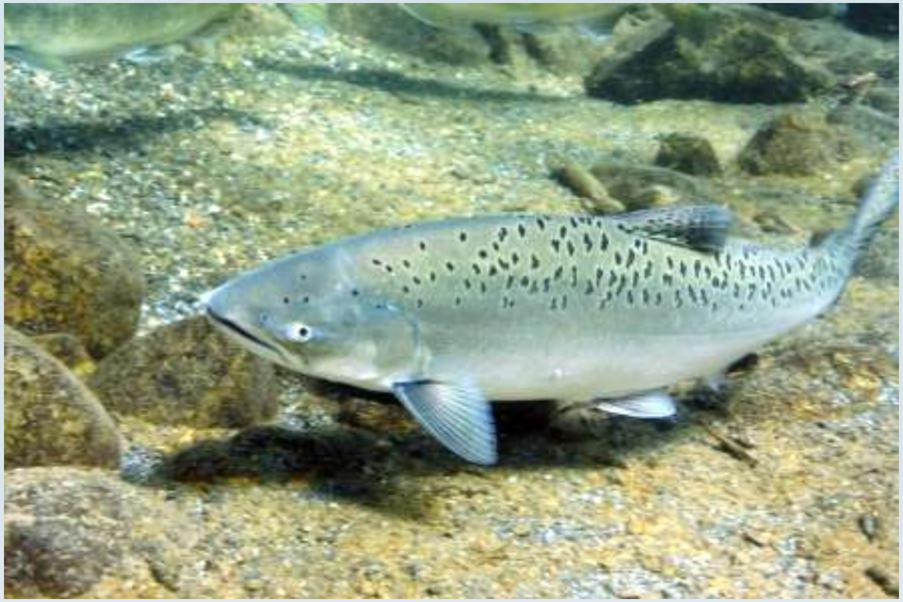
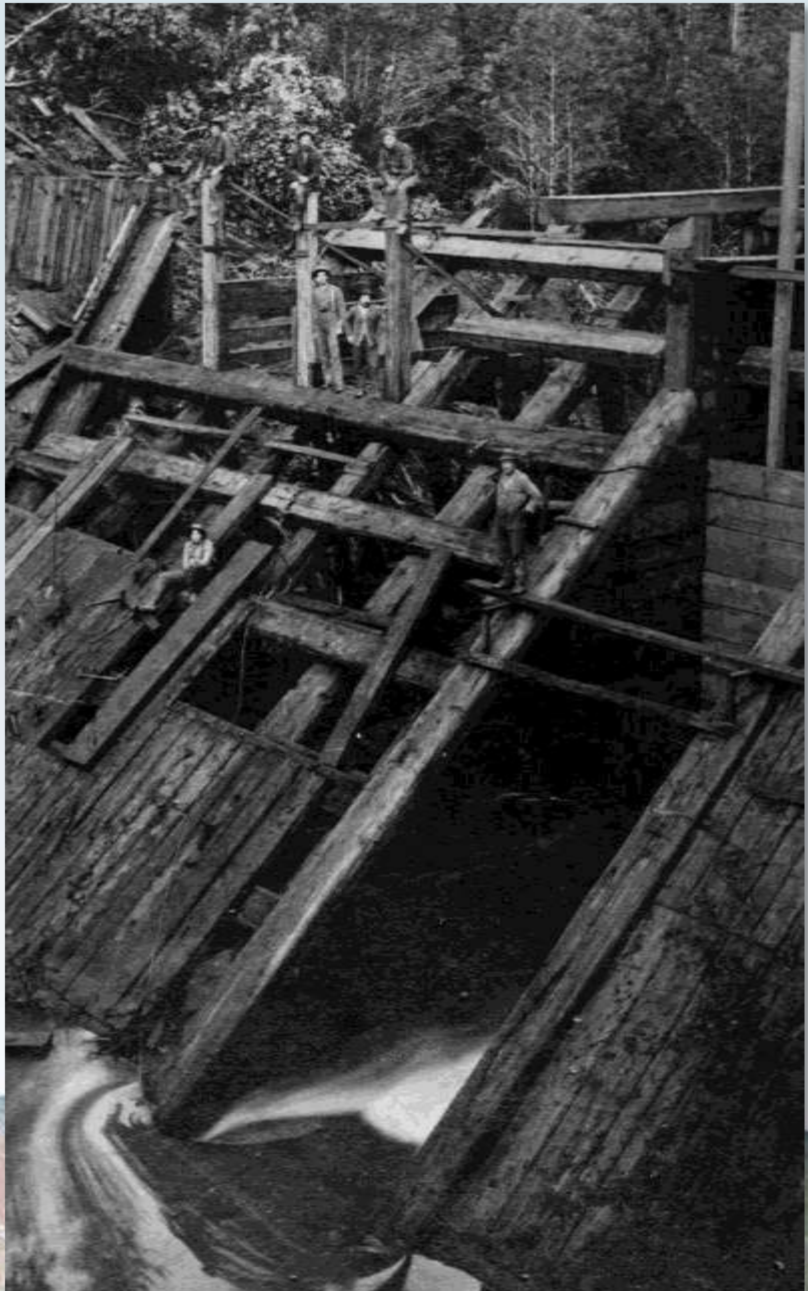
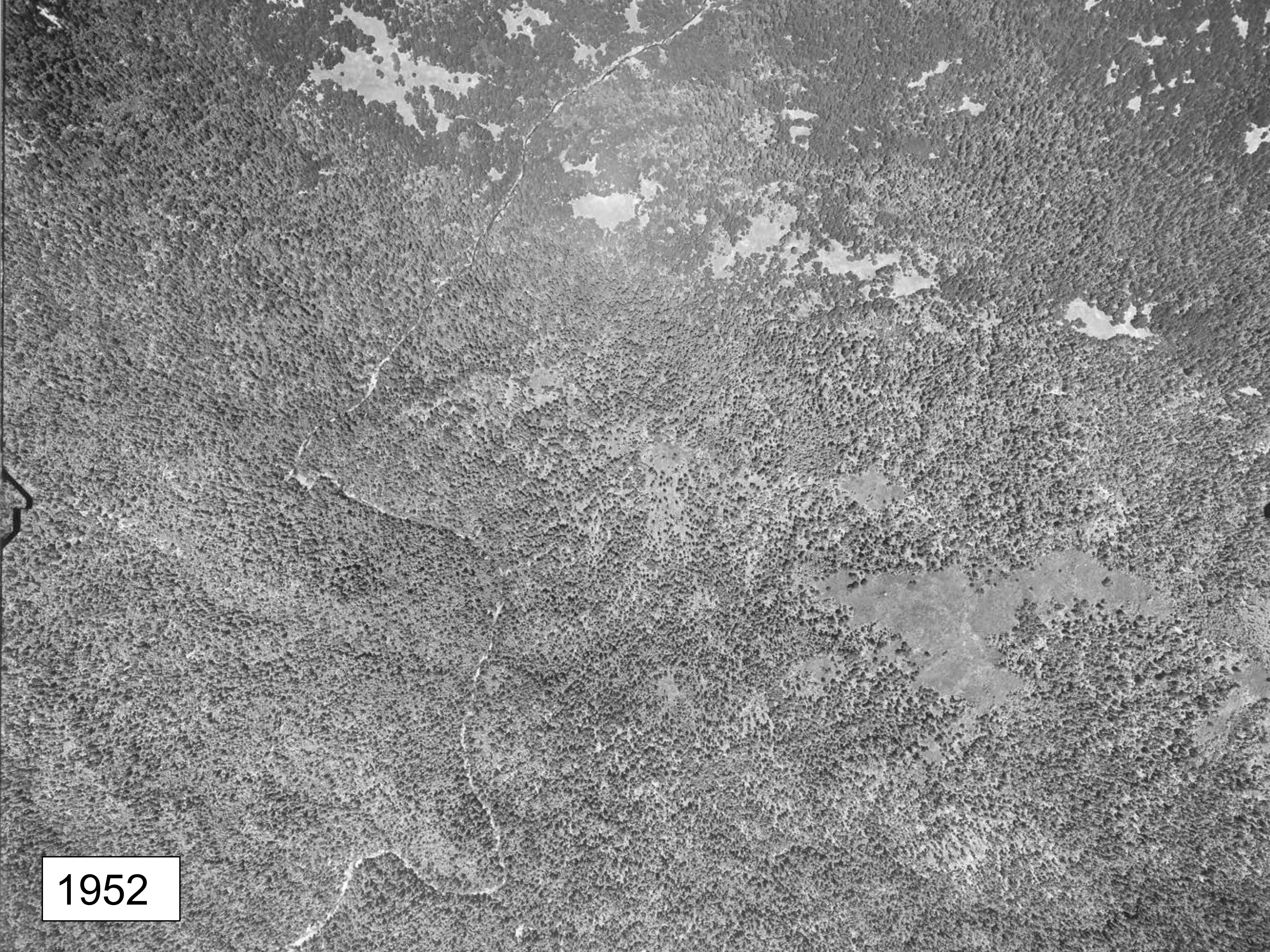


Photo credits: ©Thomas Dunklin (Spotty Chinook) and ©Robin Loznak (Coho Pair)

Early Logging Period (1860s - 1915)



Post-WWII Logging Era (1940-70s)


1952


1963

Other Land Use Impacts

- Renewed logging (1980-1990s)
- Agricultural Activities
- Gravel Mining (1960s - 1990s)
- Cannabis Cultivation

Cumulative Effects

1. Aggraded stream channels
2. Simplified aquatic habitats
3. Finer substrate composition
4. Increased turbidity levels
5. Decreased large wood debris volumes
6. Depleted riparian forests
7. Elevated water temperatures
8. Decreased dissolved oxygen
9. Degraded biology

What types of actions are being made to improve the health of the Garcia River watershed?

II. TMDL Implementation and Recovery Actions

Conservation and Restoration Actions

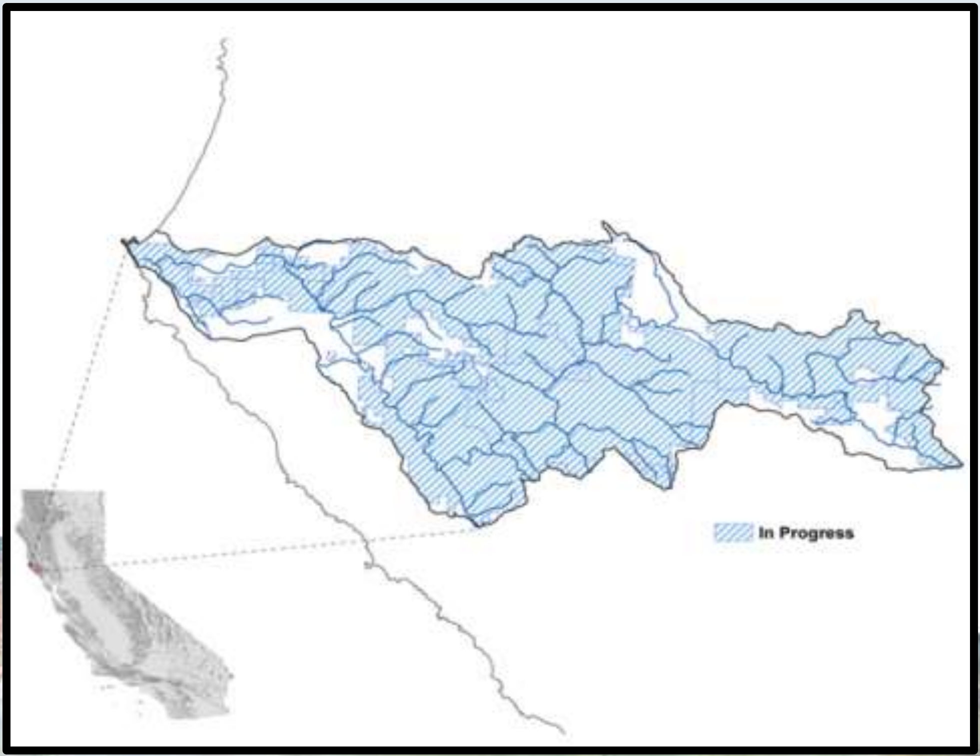
1954 - Mailliard Ranch Conservation Easement
1970s - Clean Water Act, Endangered Species Act
1970s - Forest Practices Act and Forest Practice Rules
1980s - Friends of the Garcia
1980s - Craig Bell and California Conservation Corps
1992 - Garcia River Watershed Enhancement Plan
1996 - Sierra Club Legal Defense Fund lawsuit
1999 - South Fork Garcia Watershed Erosion Control
2002 - Garcia TMDL Action Plan
2004 - Garcia River Forest Acquisition
2005 - Stornetta Public Lands Acquisition
2008+ Large wood restoration projects
2014 - CA Coastal National Monument Declaration
2016 - Mailliard Ranch Conservation Easement

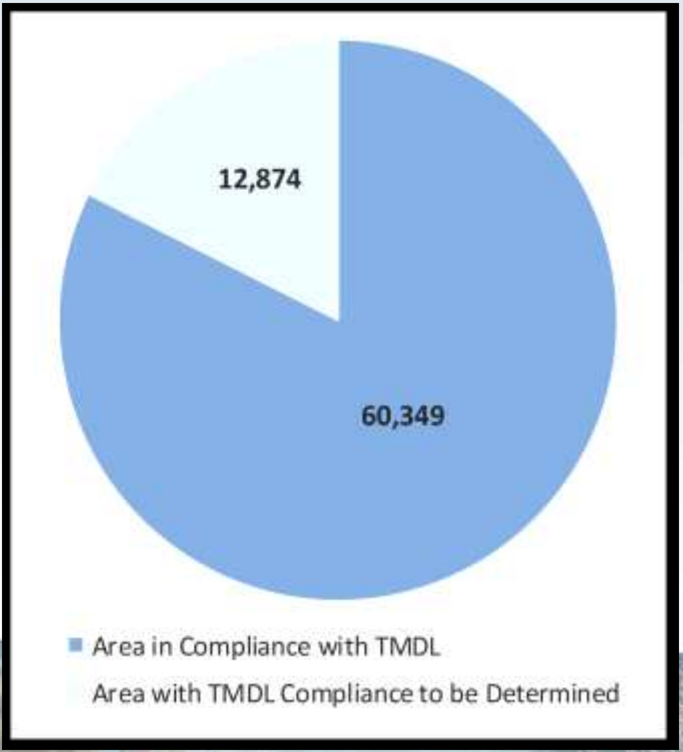
Garcia River Watershed Sediment Total Maximum Daily Load

- Adopted into North Coast Basin Plan in January 2002
- First sediment TMDL with an action strategy
- <u>GOAL</u>: Reduce the amount of controllable sediment delivery into the watershed

TMDL Accomplishments

- 80% of watershed participating
- 300 miles of road upgrades
- 1,800 sediment delivery sites treated
- 250,000 yds³ of episodic erosion saved
- 65,000 yds³/decade of chronic erosion arrested





Accelerated Wood Recruitment

- Twelve miles of stream treated since 2008
- The Nature Conservancy, The Conservation Fund, Mendocino Redwood Co., Trout Unlimited

Are the conditions - *physical, chemical, biological* - of the Garcia River watershed improving?

III. Garcia River Monitoring Program (GRMP)

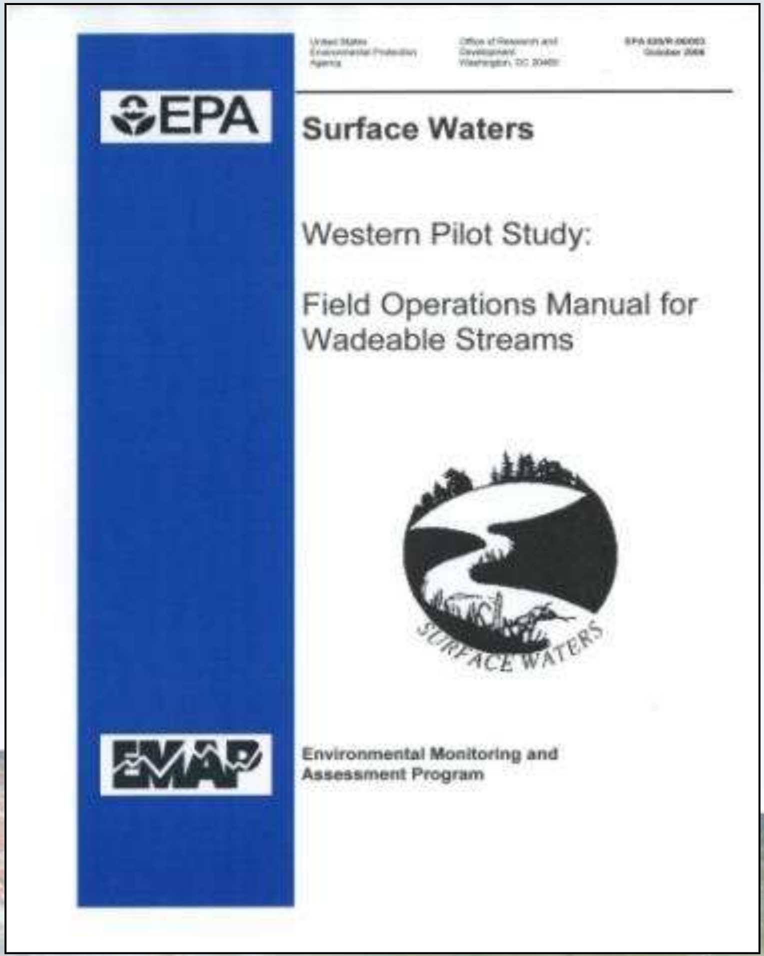
GRMP Genesis

- RWQCB needed a program to assess watershed conditions over time per the TMDL Numeric Targets

- TNC needed a program to assess management objectives and strategies per the Garcia River Forest Management Plan

Garcia River Monitoring Program

Environmental Monitoring and Assessment Program (EMAP–West)



EPA

Surface Waters

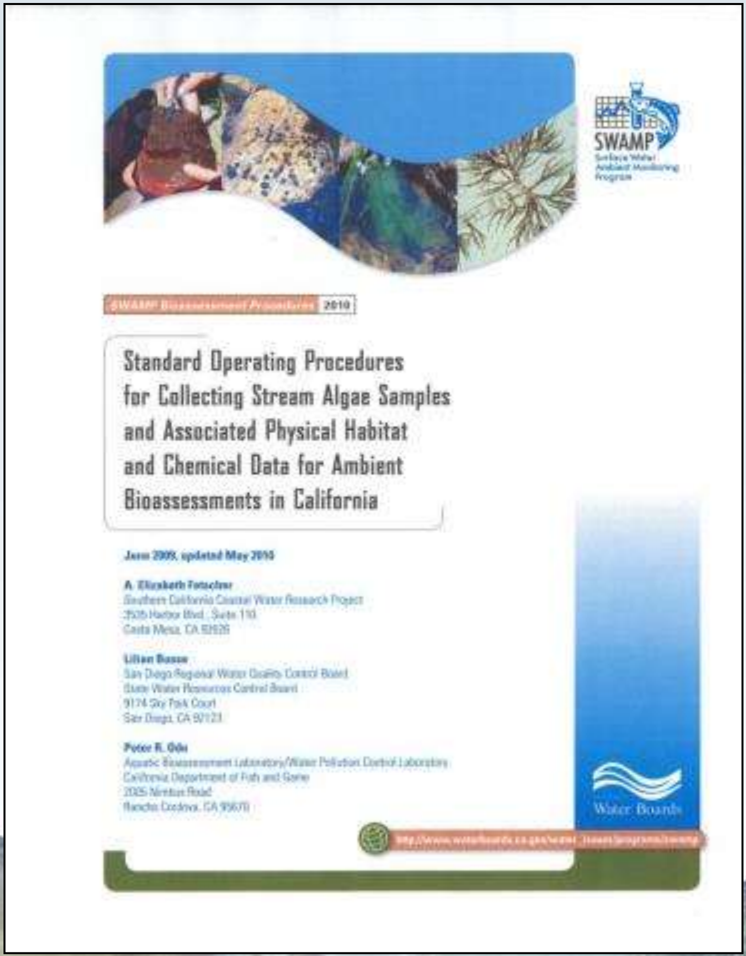
Western Pilot Study:

Field Operations Manual for Wadeable Streams

EMAP

Environmental Monitoring and Assessment Program

Surface Water Ambient Monitoring Program (SWAMP**)**

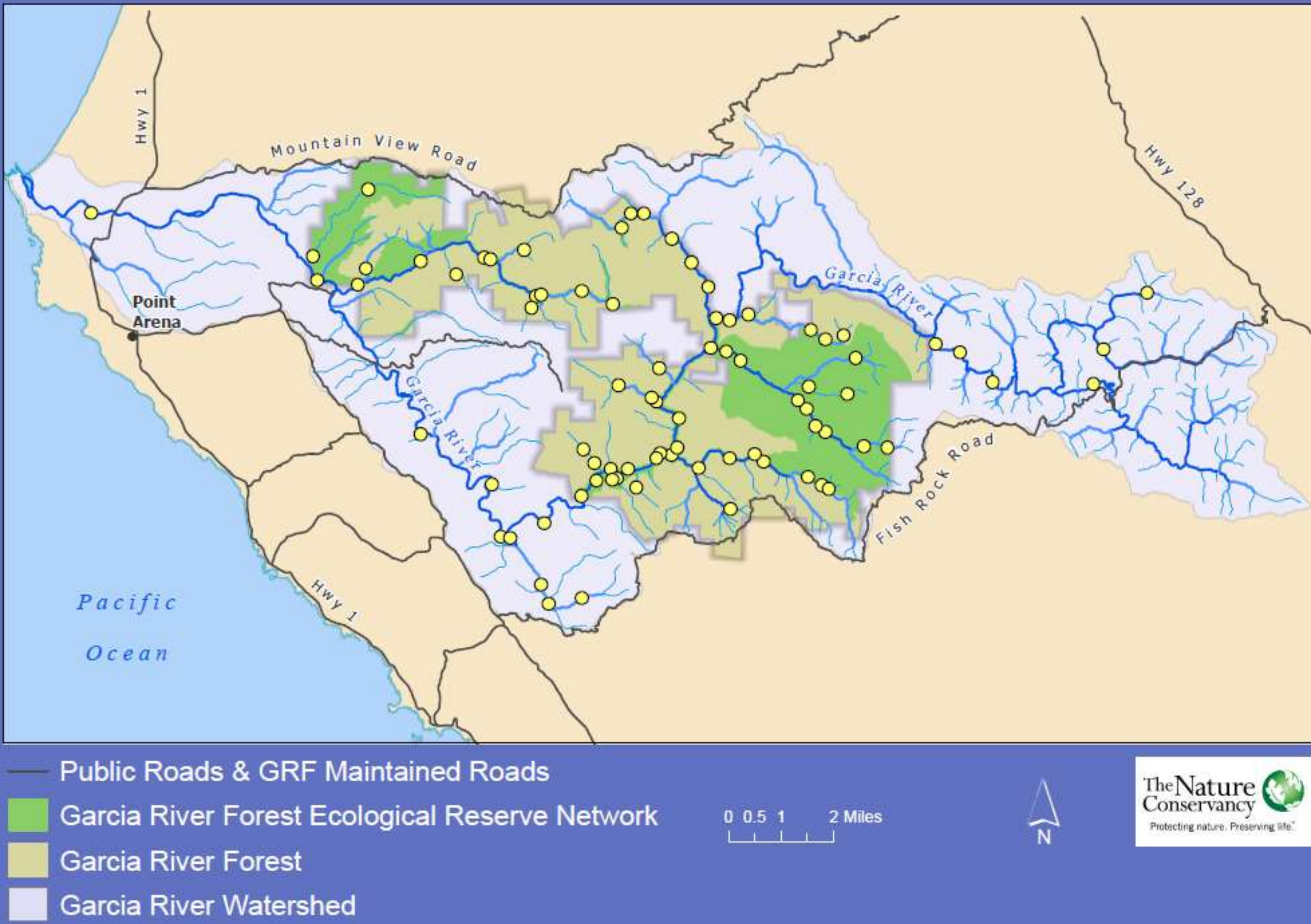


SWAMP

2010

Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California

Random Probabilistic Survey Design (GRTS)



Monitoring Metrics

GRMP

- Embeddedness
- Substrate composition
- Median particle size (D50)
- Large woody debris
- Width x depth ratio
- Canopy measurements
- No. residual pools ≥50 cm
- Thalweg profile

- Mean thalweg depths
- Mean residual depths
- Mean wetted widths
- Mean bankfull widths
- Percent pools
- No. residual pools ≥20 cm
- % of reach residual depths

- Geomorphology (slope, sinuosity)
- Relative bed stability
- Large woody debris areal cover
- Instream channel cover
- Riparian canopy cover
- Riparian tree composition
- Water temperature
- Chemistry
- Flow
- Benthic macroinvertebrates
- Aquatic vertebrate surveys
- Salmonid distribution
- Periphyton

IV. Data and Trends

What does *recovery* look like to me?

Data Collection

- Baseline conditions established for 80 reaches 2007-2010
- Short-term trend analysis conducted for 65 reaches that were surveyed in 2007/08, and resurveyed in 2012
- TNC hired full time summer crew for 2008 and 2012
- NCRWQCB conducts annual surveys of 6-9 reaches
- GRMP rough cost estimates
- Future monitoring cost estimate

Data Organization

- Results aggregated across three stream types:
  1. Garcia River mainstem reaches
  2. Low-gradient tributaries (≤3% slope)
  3. High-gradient tributaries (>3% slope)
- Achievements of **numeric targets** detailed as available
- Trend analyses: **positive change** vs. **negative change**

Tributary streams appear to be getting deeper and more complex, providing better rearing habitat

Channel Morphology: Trends

Statistically Significant Results

- 22% **increase** in **mean thalweg depths** in high-gradient tributaries ($p=0.01$)

- 6% **increase** in **variability of thalweg depths** in low-gradient tributaries ($p=0.05$)

Nearly Significant Results

- 14% **increase** in **thalweg depths** in low-gradient tributaries ($p=0.08$)

- 11% **increase** in **residual depths** on low-gradient tributaries ($p=0.09$)

Substrate composition in tributaries have recovered but continue to fluctuate. Mainstem reaches are still impaired.

Substrate Composition: Baseline

- **Median-size particle diameter (D50)** by stream category:
  - Garcia River mainstem (28 mm)
  - Low-gradient tributaries (42 mm)
  - High-gradient tributaries (54 mm)

- **Percent sand and fines** in high-gradient tributaries (8.6%) and low-gradient tributaries (10.0%) **meet the biologically-based numeric targets** for macroinvertebrates (≤10%) and aquatic vertebrates (≤13%) (Bryce et al. 2010)

- **Percent sand and fines** in Garcia River mainstem reaches (15.4%) **exceed the numeric targets**

Substrate Composition: Trends

Statistically Significant Results

- 15% increase in **percent fine gravel, sand, and fines** (≤ 16.0mm) in high-gradient tributaries ($p=0.04$)

- 22% decrease in **geometric mean substrate diameter** in high-gradient tributaries ($p=0.03$)

Hypothesis Testing

- Tested hypothesis as to whether erosion/sediment control efforts increased percentage of smaller substrate into high-gradient tributaries ($n=25$). Test inconclusive.

Large wood and instream channel cover is lacking, but restoration actions are increasing volume and habitat

Large Woody Debris & Instream Channel Cover

Statistically Significant Results

- 44% increase in **LWD volume per 100m** in the Garcia Mainstem ($p=0.04$)

- 42% decrease in **LWD volume per 100m** in low-gradient tributaries ($p=0.01$) and 43% decrease in high-gradient tributaries ($p=0.02$)

- 18% decrease in **large and small woody debris, brush, overhanging boulders, and undercut banks** in high-gradient tributaries ($p=0.01$)

Large Woody Debris & Instream Channel Cover

Additional Hypothesis Testing

Tested hypotheses to determine whether large wood restoration increased residual depths and LWD volumes following treatments:

- 29% **increase** in **mean residual depths** in treated vs. non treated low-gradient tributaries
- 225% **increase** in **LWD volume per 100m** following wood treatment (p=0.04)

Water temperatures are high in the mainstem and some tributaries, but canopy cover is improving.

Canopy Cover and Riparian Vegetation Structure

- Baseline mean percent canopy midstream greatest in the tributaries (76-90%) and least in mainstem (45%)

Statistically Significant Results

- 8% **increase** in **mean percent canopy midstream** in the Garcia River mainstem (p=0.01)

- 34% **increase** in **total riparian canopy** in Garcia River mainstem (p=0.01)

- 22% **increase** in **riparian woody cover** (trees) in Garcia River mainstem (p=0.02)

Water Temperature

- Temperatures (max weekly maximum) on the Garcia mainstem **exceed numeric targets** ≤16° C for optimal rearing habitat (Carter 2008)
- Temperatures on several tributaries (North Fork Garcia, Signal Creek, Graphite Creek, and Olsen Gulch) **currently meet the numeric targets** ≤16 ° C for optimal rearing habitat (Carter 2008)
- Temperatures on most Garcia River reaches **exceed numeric targets** ≤18 ° C for presence of coho salmon (Welsh et. al 2001)
- Temperatures on several tributaries and some Garcia River reaches **currently meet the numeric targets** ≤18 ° C for presence of coho salmon (Welsh et. al 2001)

The tributaries are healthy according to the bugs. Salmon and trout are found in every subwatershed, albeit in low numbers.

Benthic Macroinvertebrates:
California Stream Conditions Index (CSCI)

- Low-gradient tributary scores (0.96) and high-gradient tributary scores (0.99) **met the numeric targets** (>0.92) and were considered **"likely intact" (**Rehn et al. 2015)

- Garcia mainstem reach scores (0.79) **did not meet the numeric targets** and fell within upper end of the **"likely altered condition"** range (0.79 to 0.63)

- CSCI scores remained nearly the **same** in 2012; small changes were not statistically significant

Salmonid Distribution

- Salmonids spawning and rearing widely but in small numbers
- Coho salmon maintaining all three cohorts (2014,-15,-16)
- Steelhead trout widely distributed throughout watershed
- Spawning Chinook salmon found by CDFW (2012,-14,-16)
- Pink salmon occasionally found in lower Garcia River

V. Conclusions

Garcia Mainstem

- Mainstem reaches need more time to recover
  - Excess sediment still being vacated
  - Pools and residual depths **not yet improving**
  - Large wood volumes **lacking**
  - Canopy cover **improving**
  - Temperatures still **exceed targets**
  - Benthic macroinvertebrates **not meeting targets**
  - Continued salmonid spawning and rearing

Tributaries

- Tributaries are improving or meeting targets
  - Thalweg depths and variability **increasing**
  - Residual depths **increasing**
  - Substrate composition **meeting targets**
  - Canopy cover **improving**
  - Large wood restoration **increasing** habitat
  - Benthic macroinvertebrates **meeting targets**
  - Continued salmonid spawning and rearing

Lessons Learned

- The Garcia River's impairment took a long time to occur. Similarly, recovery is on a multi-decade time scale.
- Tracking watershed recovery requires a robust, scientifically-based, sustained, and well-funded monitoring program.
- Unable to assess fisheries response to habitat improvements
- The GRMP allows us to evaluate whether conservation and restoration practices are working, and therefore…is a surrogate for other watershed recovery strategies.

The End

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jcarah@tnc.org


What does habitat monitoring data mean to salmonids? Creating status, trend, and recovery information of information from field data.
Sean. P. Gallagher
California Department of Fish and Wildlife

Acknowledgements

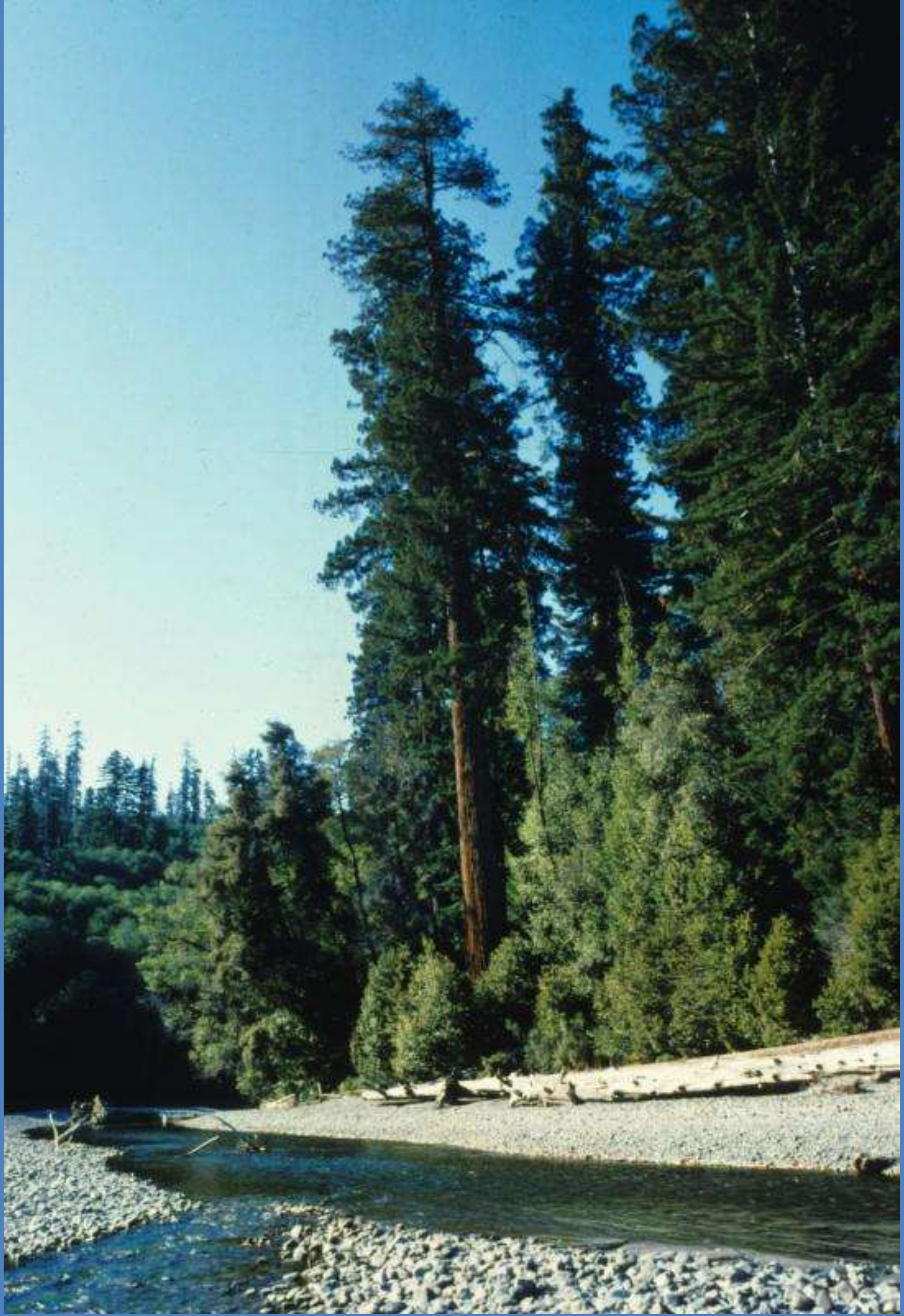
Matt Colmen

Christina Barrineau, Mellisa Berry, Brigitte Bondoux, Craig Comen, George Neilleands, Alex Pappas, John Richardson, Morgan Knechtle, Mike Morrison, Scott Harris, Wendy Jones, Jon Hendrix, Tommy Williams, Pete Adams, Brian Spence, L B Boydstun, Trent McDonald, Eric Bjorkstedt, John Hannon, Sarah Giovannetti, Glen Zerlong, Tami Camper, Scott Fuller, Marin Savage, Fred Schuler, Jeremy Wright, Dave Wright, John Yanez, Marrisa Calloway, Andy Hepokoski, Kristi Knechtle, Mike McNeal, Debra Parthree, Emma Womack, Jeromy Neal, Steve Turek, Gary Stacey, Heidi Fish, Steve Gough, Sarah Greene, Cynthia Ledoux, Alan Palacios, Andy Pothast, Derek Lanuete, Forest Cntrell, Natalie Lohi, Chris Szejk, Colin Gallagher, Adam Wagshagel, Brett Redfern, Jay Rowen, Erik Larson, Mike Maahs, Mark Gard, Sean Hayes, Seth Ricker, Doug Killam, Matt Goldsworthy, Joe Pertrach, Chris Blencoe, George Pess, Jennifer Carah, Johnathan Watterdam, Shaun Thompson, Americorps, Amy Roberts, Stan Allen, Ben Schliefer, Alan Renger, Scott Downie, Barry Collins, Stephen Levesque, Ryan Aresenault, Chris Hannon, Wendy Holloway, Dylan Wright, Amber Villalobos, Justin Garwood, Chris Bell, Ulrich Lund, Doug Albin, Doug Burch, Matt Haworth, Nathan Cooley, Sam Parker, Andy McClary, Nick Bankstun, Jordan Green, Phillip Barrington, Katrina Nystrum, Colinda Gutierrez, Jake Smotherman, Mellisa Renenski, Laura Miller, Ann Sigiura, Emmily Lang, Phillip Roni, Jerrick Graves, Ryan Thompson, Amada Piscitelli, Asa Spade, Brian Storms, Sarah Wolf, Curtis Milliron, Coralee Winsett, David Ulrich, Elke Jacobsen, Iris Koski, Jennifer Johnson, John Hollis, Josh Pope, Katie Webster, Lisa Bolton, Megan Balter, Robyn Swann, Mendocino High and Rob Jambocian, Samatha Kannry, Sara Hauk, Chris Morrism, Mitch Bosman, Juile Coombs, Catherine Fong, Chris Bell, JJ Brunner, Mike Zontos, Chris Jordan, Andy MCClarry, Greg McClarry, Elizabeth MacKey, Katlyn Jordan, Jonathan Warmerdam, Chris Chavez, Stan Allen, Joe Ferreira, FRGP, The CMP team, Steven Bennett, Natalie Oaken, and many others …..

Lyme Redwood Forest Company

Mission Statement

The Mission of the Department of Fish and Wildlife is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.

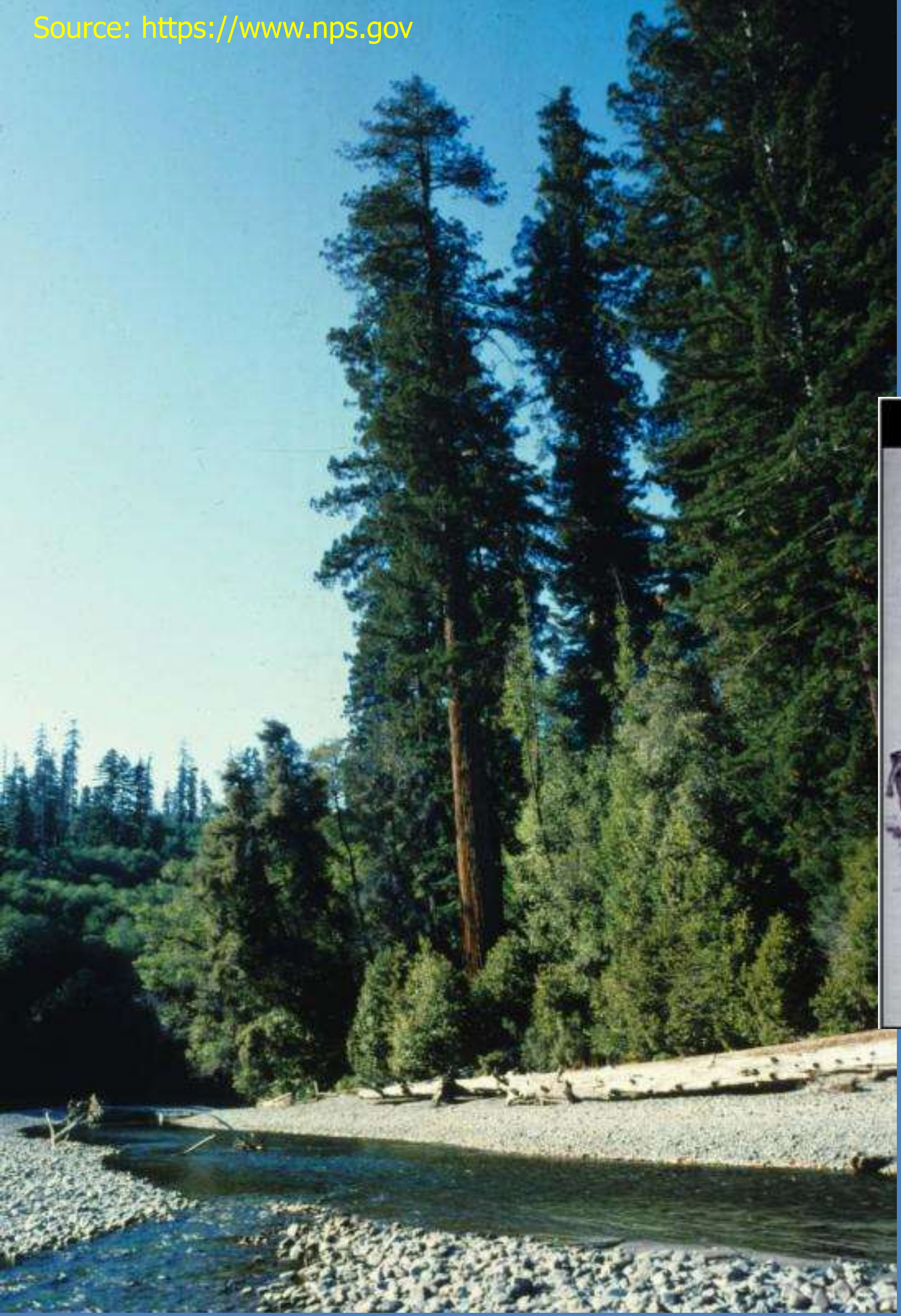


Source: https://www.nps.gov

Summer 1850 the brig Folic struck a reef near Point Cabrillo. Historians have dubbed it *"the most significant shipwreck on the west coast"*

Source: Layton, Thomas N., The Voyage of the Frolic: New England Merchants and the Opium Trade, Stanford, 1997

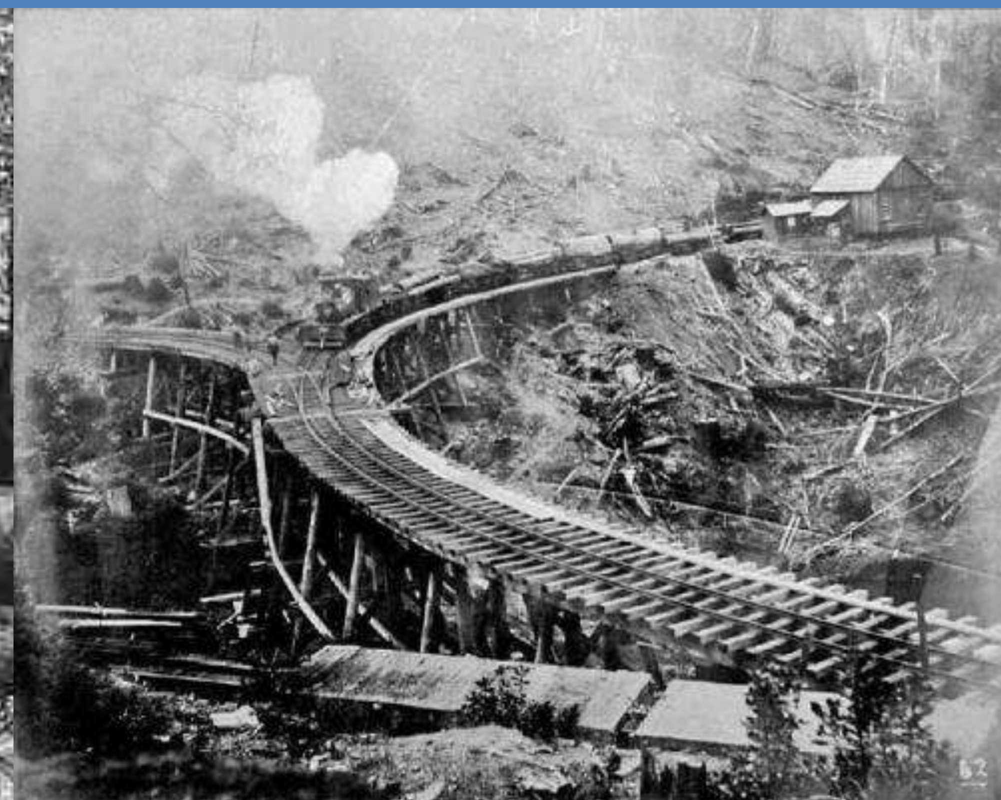
Source: https://www.nps.gov



Source: Source: Layton, Thomas N., The Voyage of the Frolic: New England Merchants and the Opium Trade, Stanford, 1997

Severance horse team getting out piling on the Noyo River. Some of this piling is 123 feet long. Walter Severance is to the left of the team holding a goad stick.

Source: http://krisweb.com/krisnoyo



Source: http://www.mendorailhistory.org

Source: http://krisweb.com/krisnoyo

Source: http://krisweb.com/krisnoyo

California Department of Fish and Game

Stream Survey

FILE FORM NO.............

STREAM NAME Kass Creek **COUNTY** Mendocino

STREAM SECTION FROM mouth **TO** headwaters **LENGTH** Aprx. 4 mi

TRIBUTARY TO South Fork of Noyo River **TWP.** 18N **R** 17W **SEC** 13 & 14

OTHER NAMES None **RIVER SYSTEM** Noyo

SOURCES OF DATA General observation

NAME OF SURVEYOR John Gallagher **DATE** 10 August 1957

FISHES PRESENT AND SUCCESS – Steelhead and silver salmon 1 and 3 in. Very abundant and good success.

OTHER VERTEBRATES – Frogs and salamanders

FISHING INTENSITY – None

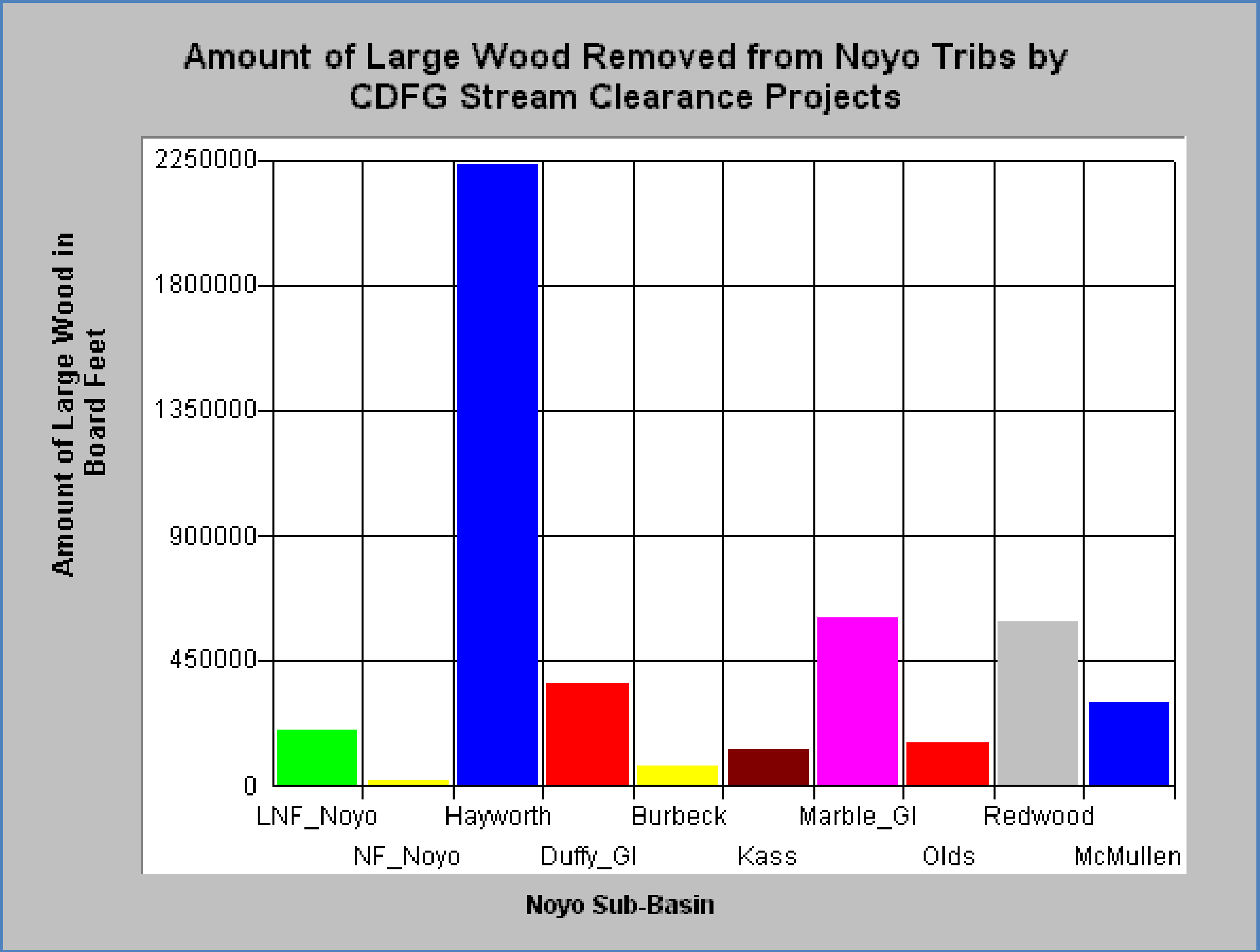
OTHER RECREATIONAL USE – None

ACCESSIBILITY – By road or by foot.

OWNERSHIP – Lot of the land is owned by the Union Lumber Company and also one Mr. Westert

POSTED OR OPEN – Posted by Mr. Westerberg.

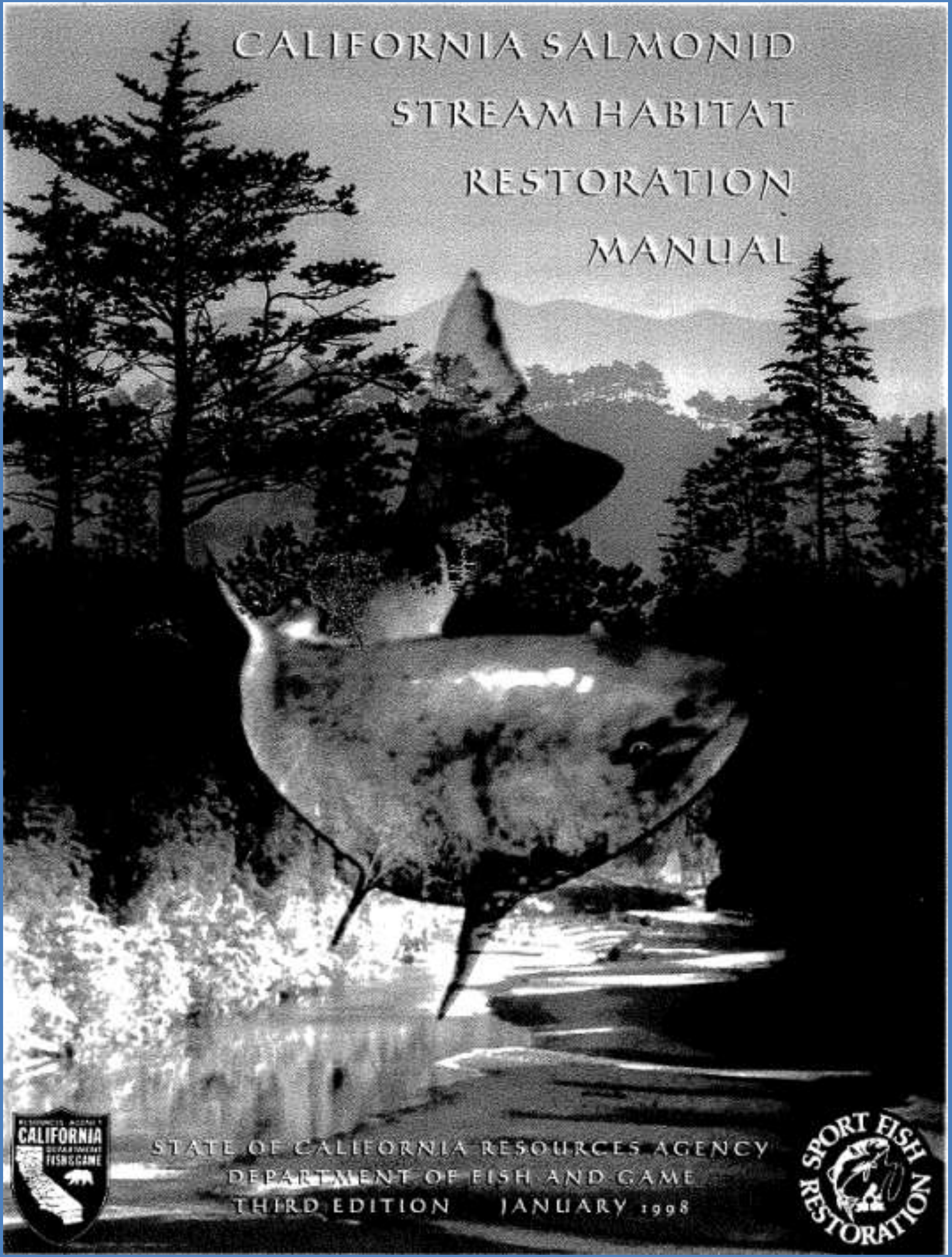
IMPROVEMENTS – Stream is not clear and full of debris ans small log jams. These could be removed.



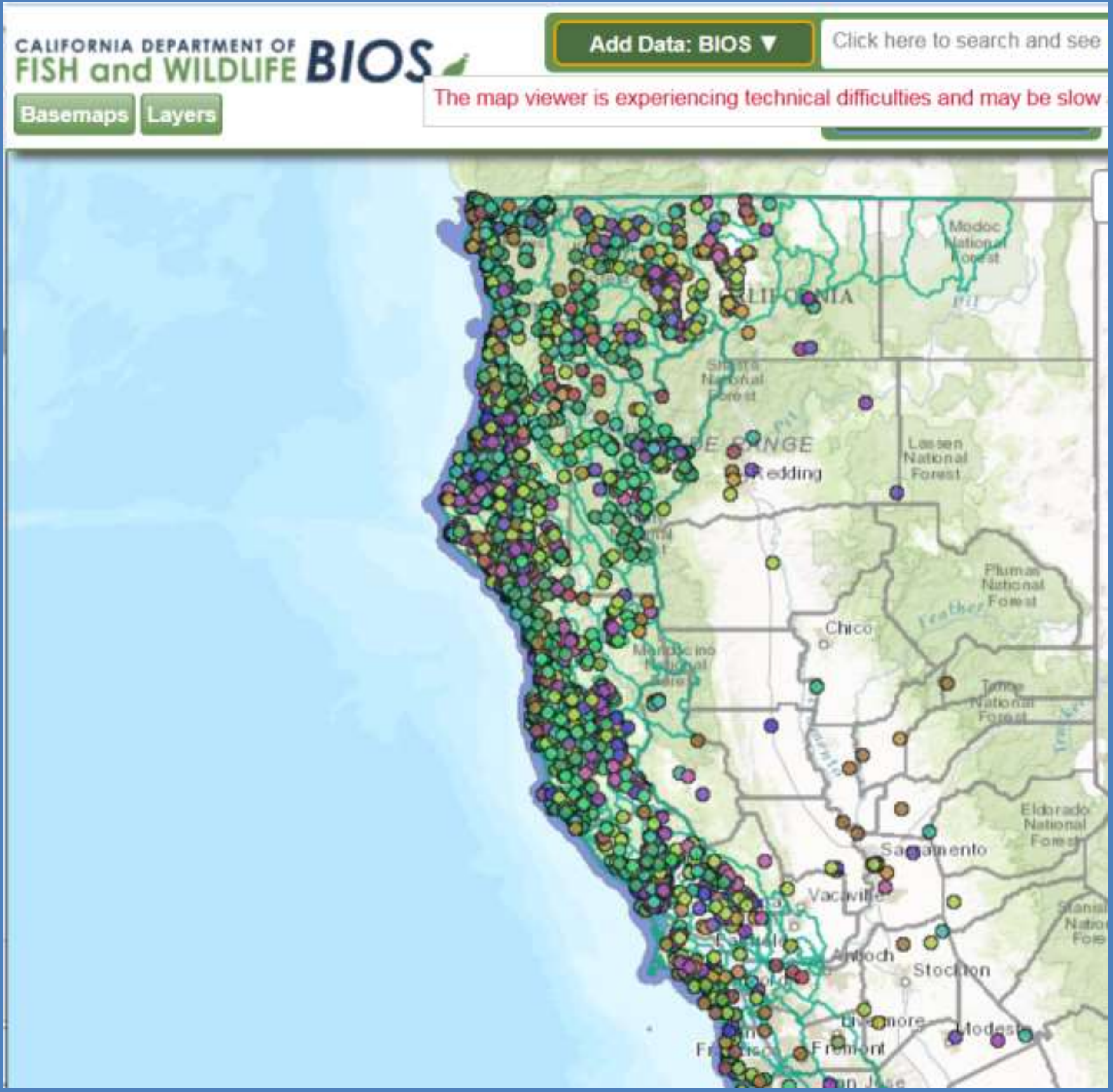
Noyo River wood removal late 1950s through the early 1980.

Source: http://krisweb.com/krisnoyo

CALIFORNIA SALMONID STREAM HABITAT RESTORATION MANUAL



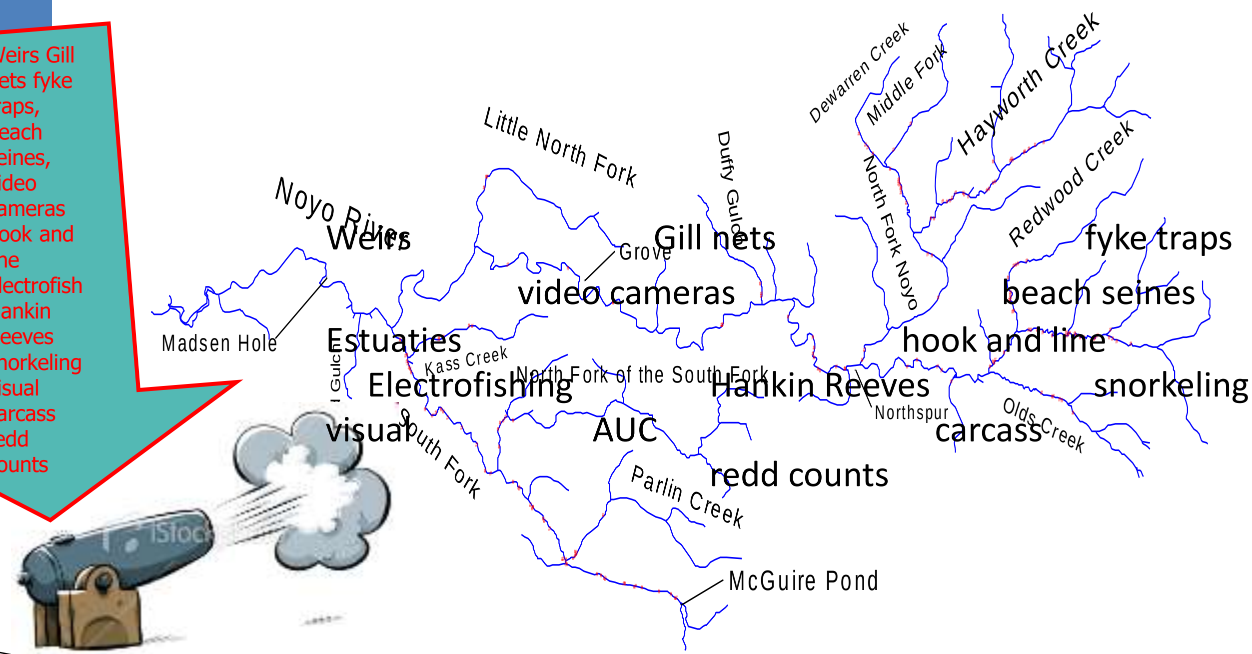
STATE OF CALIFORNIA RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
THIRD EDITION JANUARY 1998



Fisheries Restoration Grants Program Projects 1999 to 2016

Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units (Busby et al. 2000)

Weirs Gill nets fyke traps, beach seines, video cameras hook and line electrofish Hankin Reeves snorkeling visual carcass redd counts



[Oregon Plan for Salmon and Watersheds](#)

State of California
The Natural Resources Agency
Department of Fish and Game

FISH BULLETIN 180

CALIFORNIA COASTAL SALMONID POPULATION MONITORING: STRATEGY, DESIGN, AND METHODS

By

Peter B. Adams [1]

L.B. Boydstun [2]

Sean P. Gallagher [3]

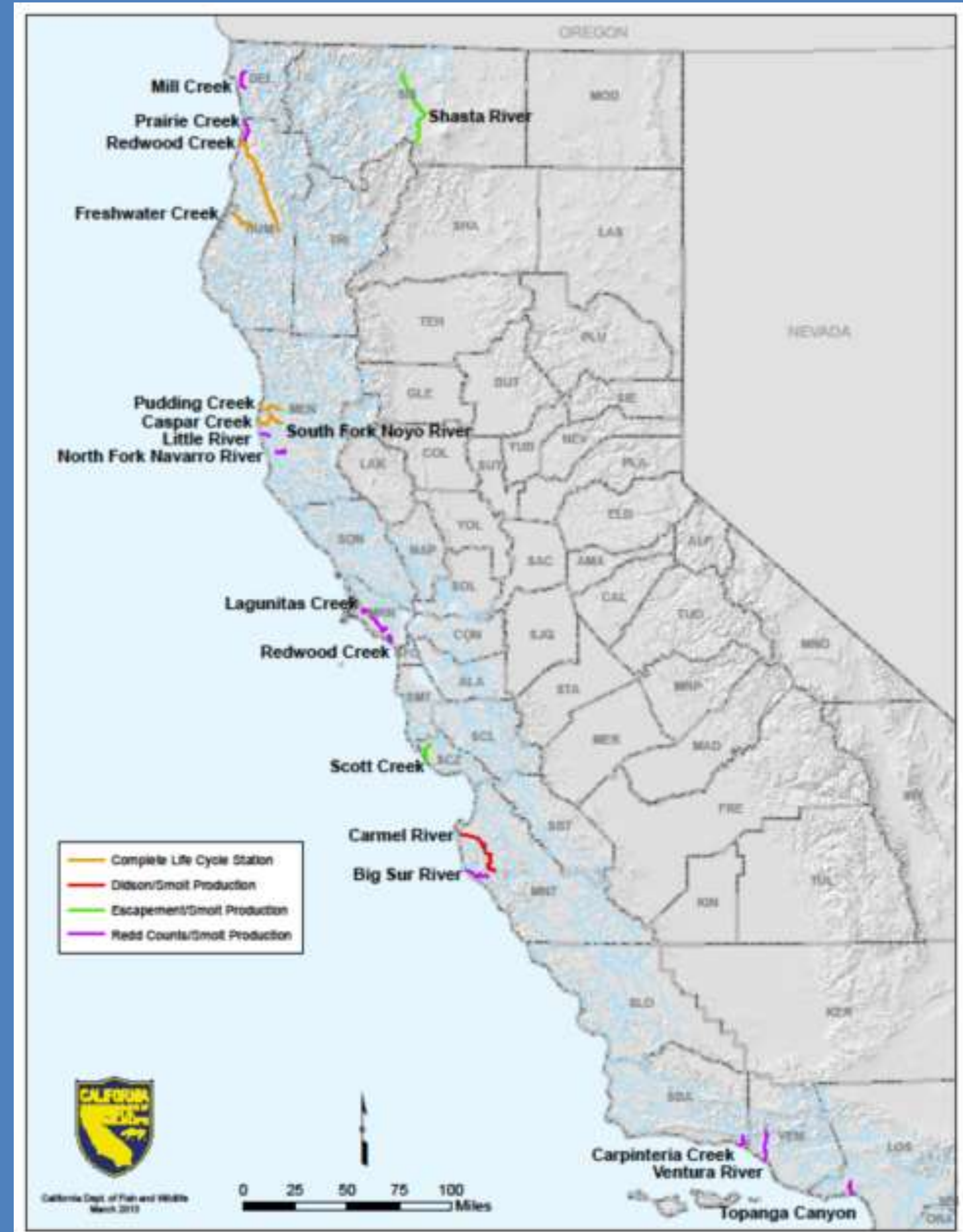
Michael K. Lacy [4]

Trent McDonald [5]

and

Kevin E. Shaffer [4]

2011

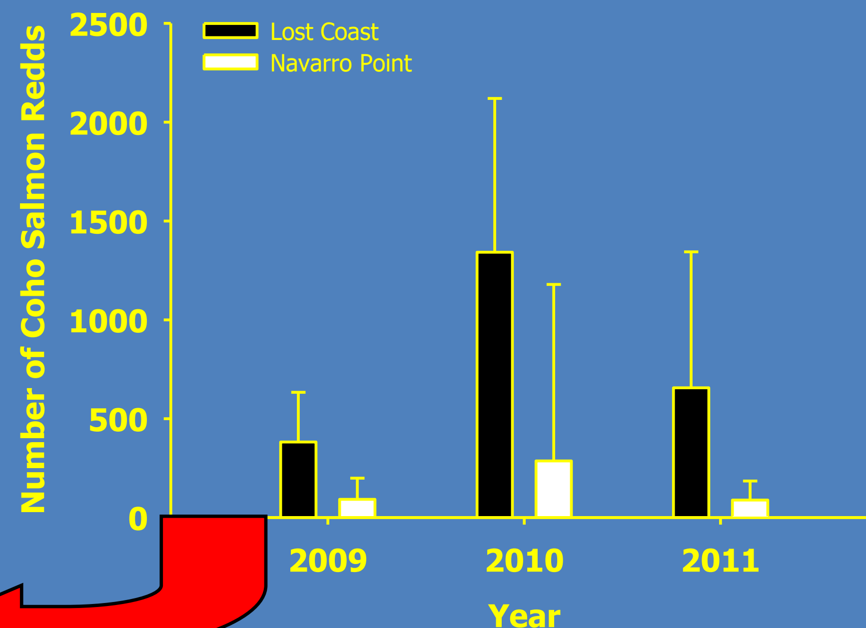


Regional Monitoring

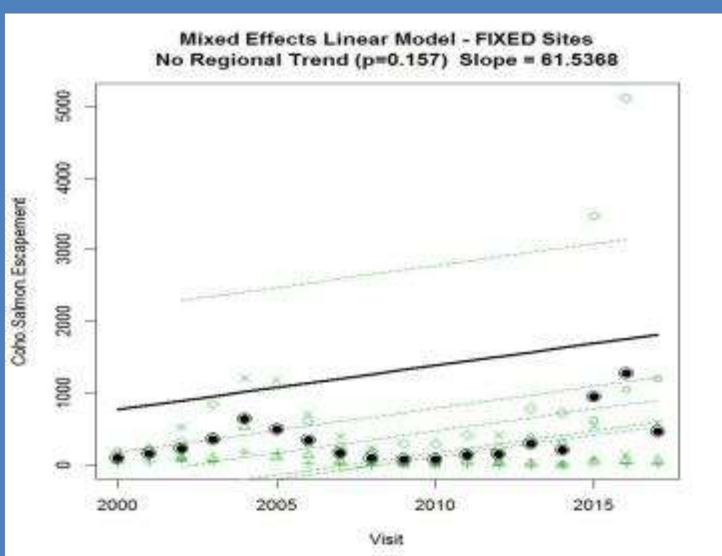
Life Cycle Monitoring

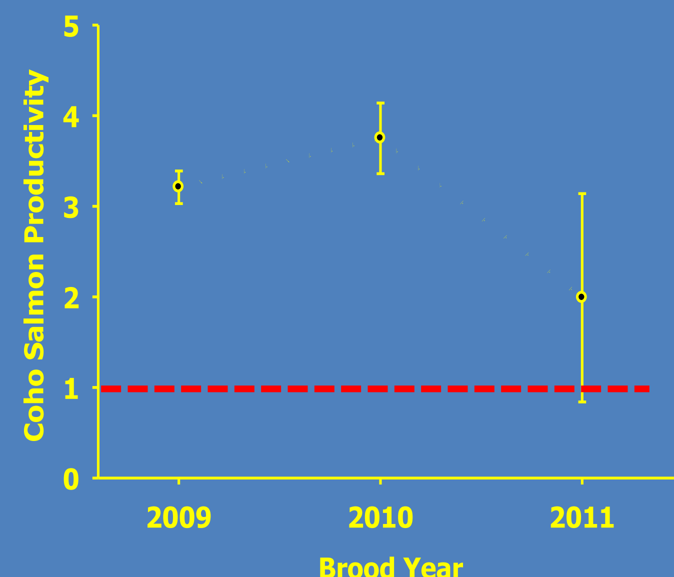
DATA

METRICS



INFORMATION





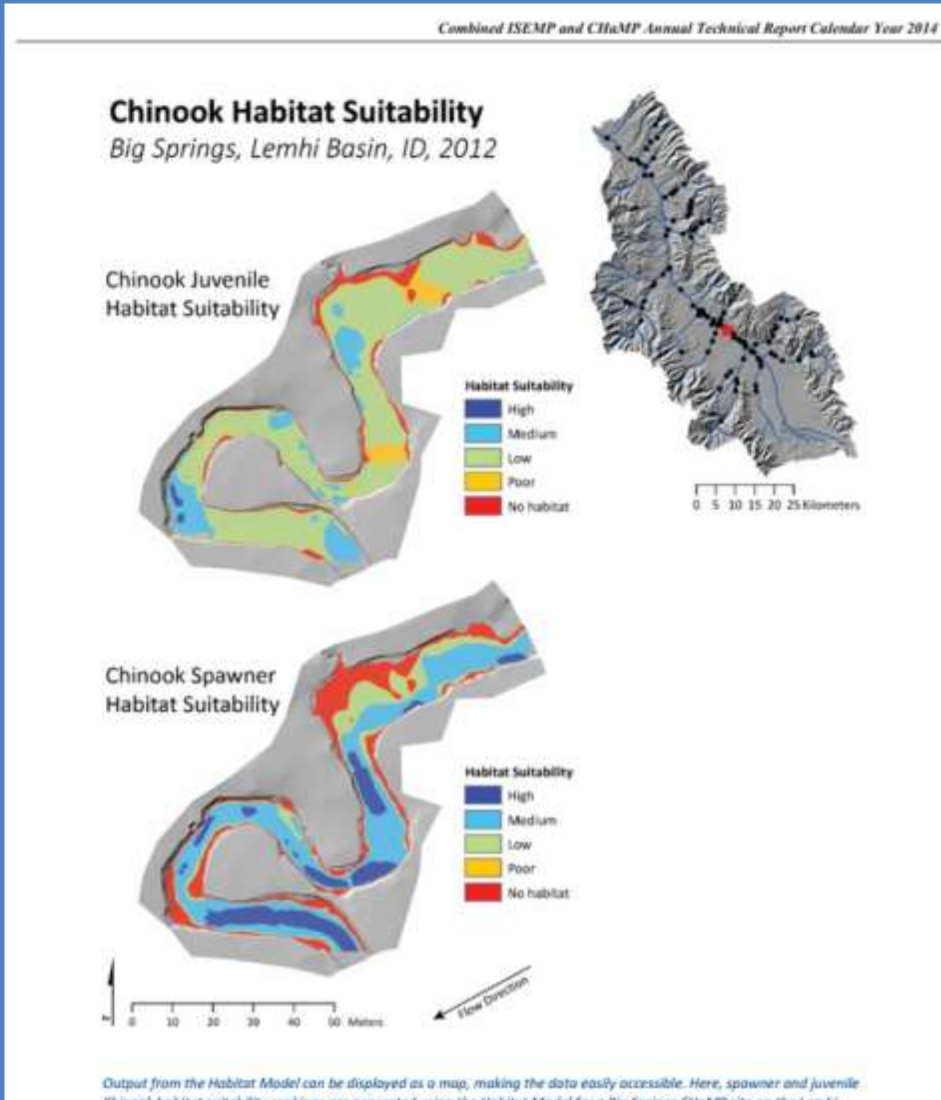
CHaMP

Columbia Habitat Monitoring Program Protocol

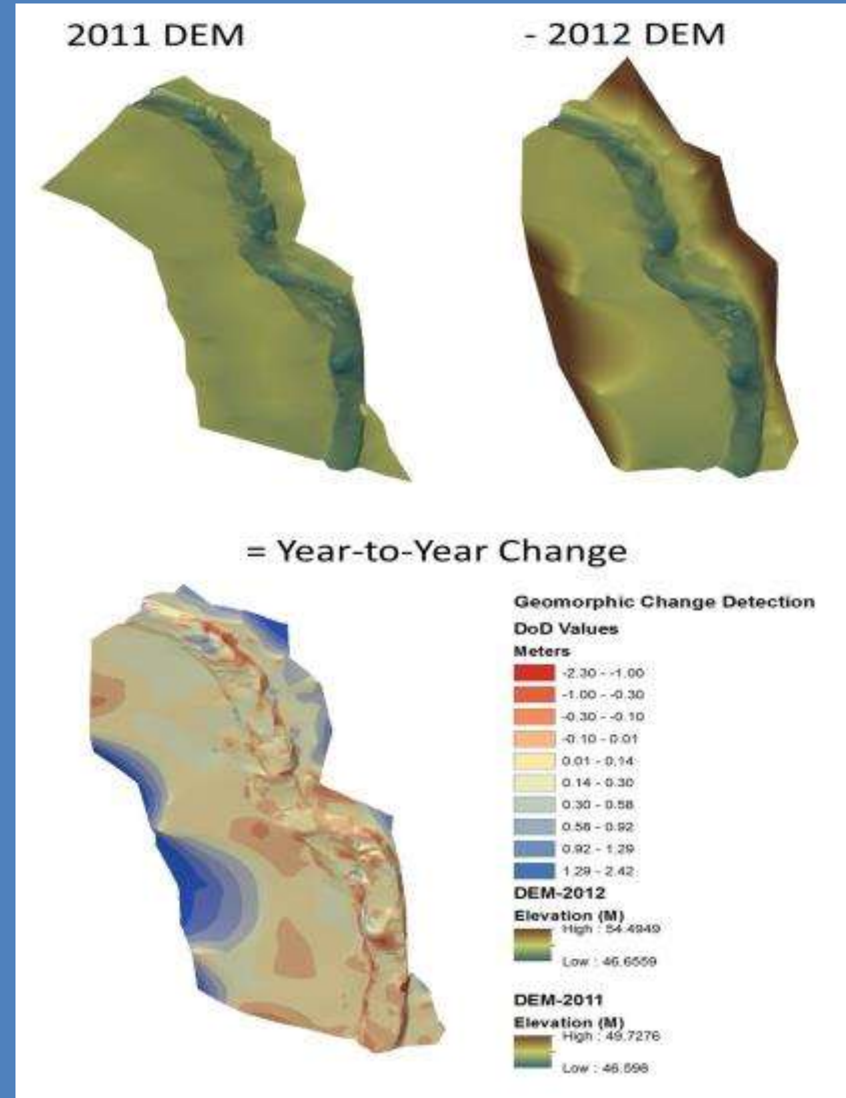
Topographic Data

Auxiliary Habitat Data

"The goal of CHaMP is to generate and implement a standard set of fish habitat monitoring (status and trend) methods in up to 26 watersheds across the Columbia River Basin." Bouwes et al. (2011).



Combined ISEMP and CHaMP Annual Technical Report Calendar Year 2014
Chinook Habitat Suitability
Big Springs, Lemhi Basin, ID, 2012
Chinook Juvenile
Habitat Suitability
Habitat Suitability
High
Medium
Low
Poor
No habitat
0 5 10 15 20 25 Kilometers
Chinook Spawner
Habitat Suitability
Habitat Suitability
High
Medium
Low
Poor
No habitat
0 10 20 30 40 50 Meters
Flow Direction
Output from the Habitat Model can be displayed as a map, making the data easily accessible. Here, spawner and juvenile Chinook habitat suitability rankings are generated using the Habitat Model for a Big Springs CHaMP site on the Lemhi.



2011 DEM
- 2012 DEM
= Year-to-Year Change
Geomorphic Change Detection
DoD Values
Meters
-2.30 - -1.00
-1.00 - -0.30
-0.30 - -0.10
-0.10 - 0.01
0.01 - 0.14
0.14 - 0.30
0.30 - 0.58
0.58 - 0.92
0.92 - 1.29
1.29 - 2.42
DEM-2012
Elevation (M)
High : 54.4949
Low : 46.6559
DEM-2011
Elevation (M)
High : 49.7276
Low : 46.598

NOAA

Guidance for Monitoring Recovery of Pacific Northwest Salmon & Steelhead listed under the Federal Endangered Species Act

Guidance to salmon recovery partners concerning prioritizing monitoring efforts to assess the viability of salmon and steelhead populations protected under the Federal Endangered Species Act

Idaho, Oregon and Washington

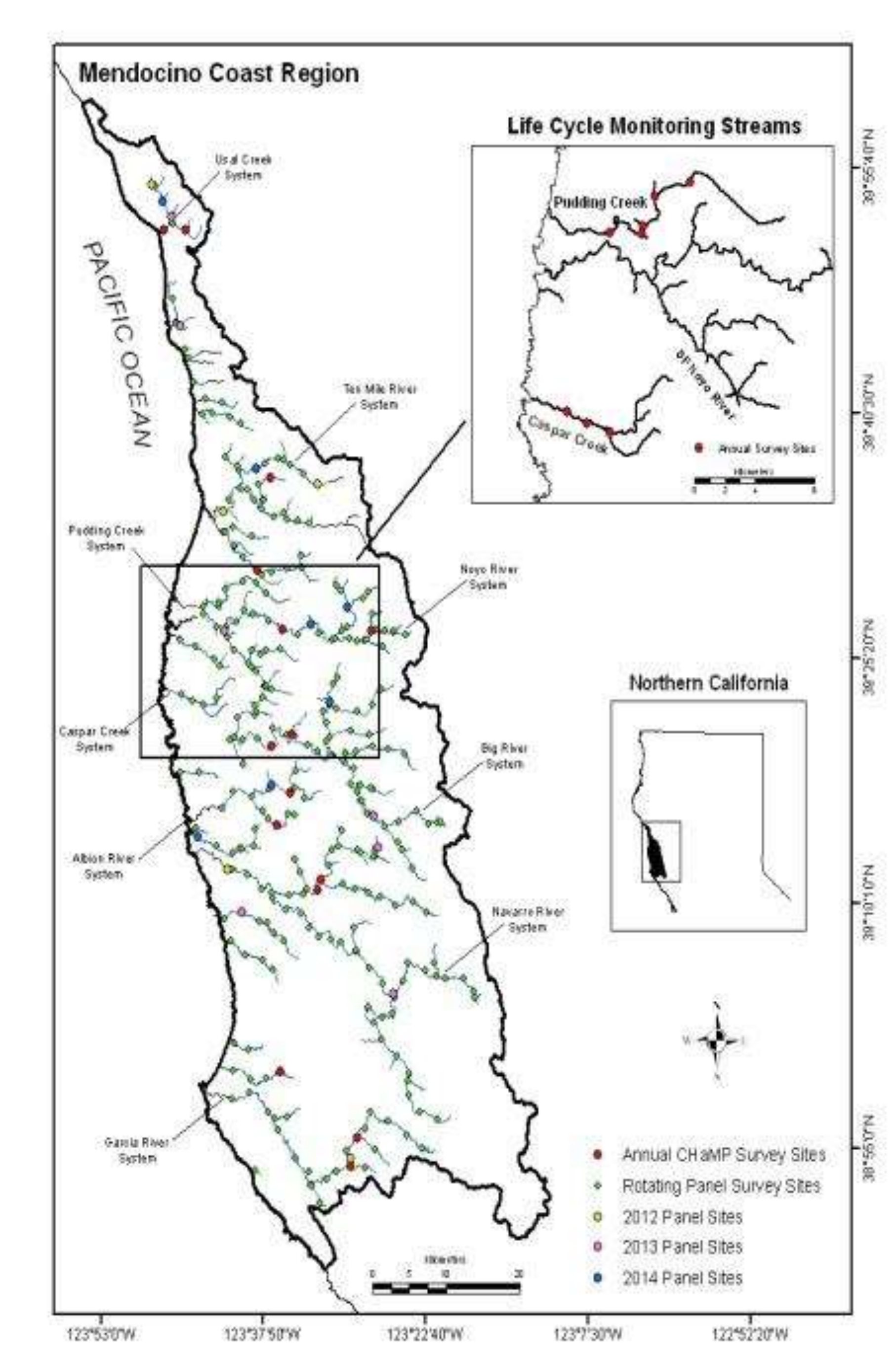
January 2011

Bruce A. Crawford and Scott M. Rumsey

Recommendations for Monitoring Threats Due To Loss of Habitat

Implement a GRTS habitat status/trend monitoring program incorporating on the ground protocols coupled with remote sensing of land use…
Coordinate and correlate habitat status/trend monitoring with fish in and fish out monitoring wherever possible. Key Habitat Elements?

CHaMP 2011 to 2013



2011-

12 of 41 Sites

Murders and technical issues

Aquatic Invertebrates $$

EMAP Versus Reaches

$$$

2012-

19 of 42 Sites

Technological problems

CHaMP stops invert collections

$$$

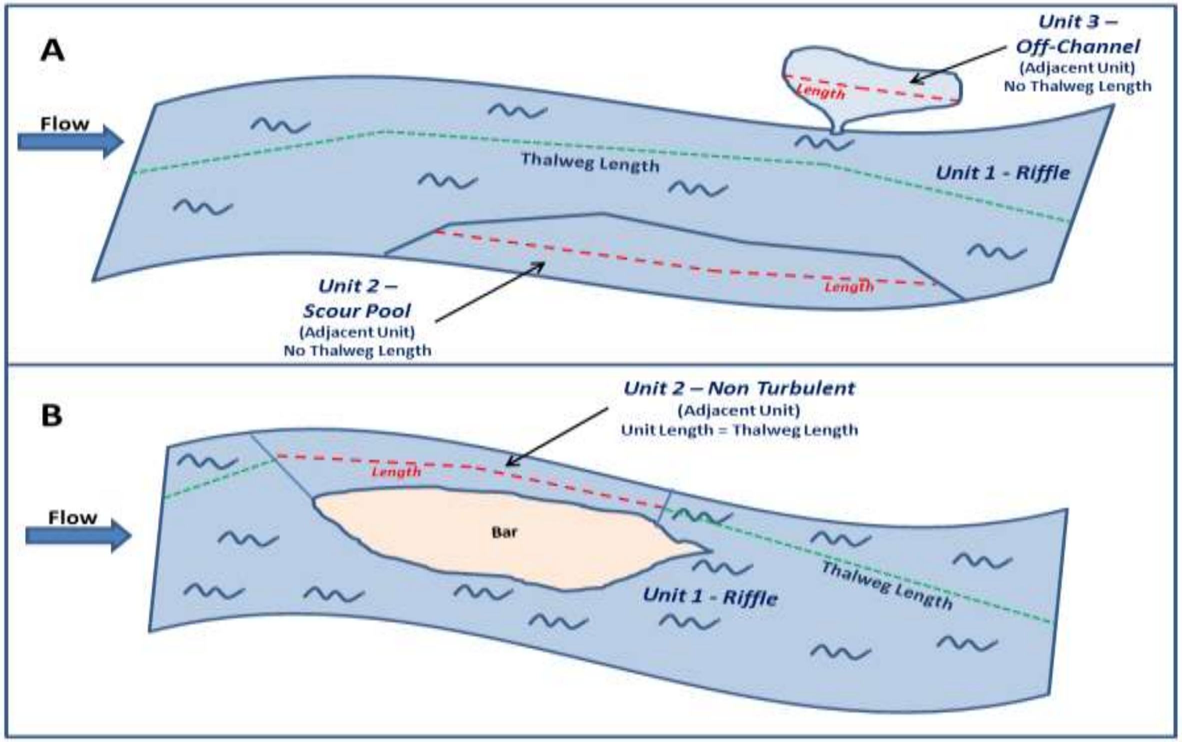
2013-

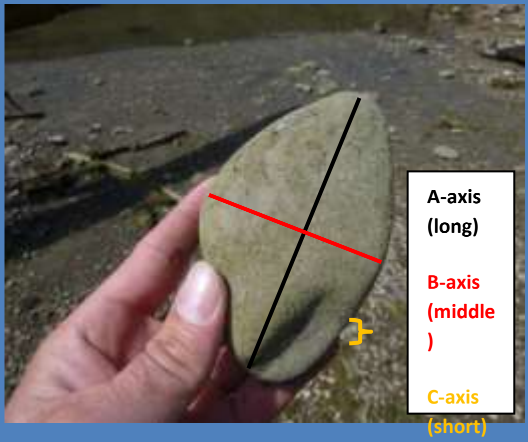
19 of 42 sites

Similar issues

$$$

HOLLOWAY, W., A. MCCLARY, AND S. P. GALLAGHER. 2014. Rapid Assessment of Salmonid Habitat: protocol version 3.0. California Department of Fish and Wildlife, Fort Bragg, USA.

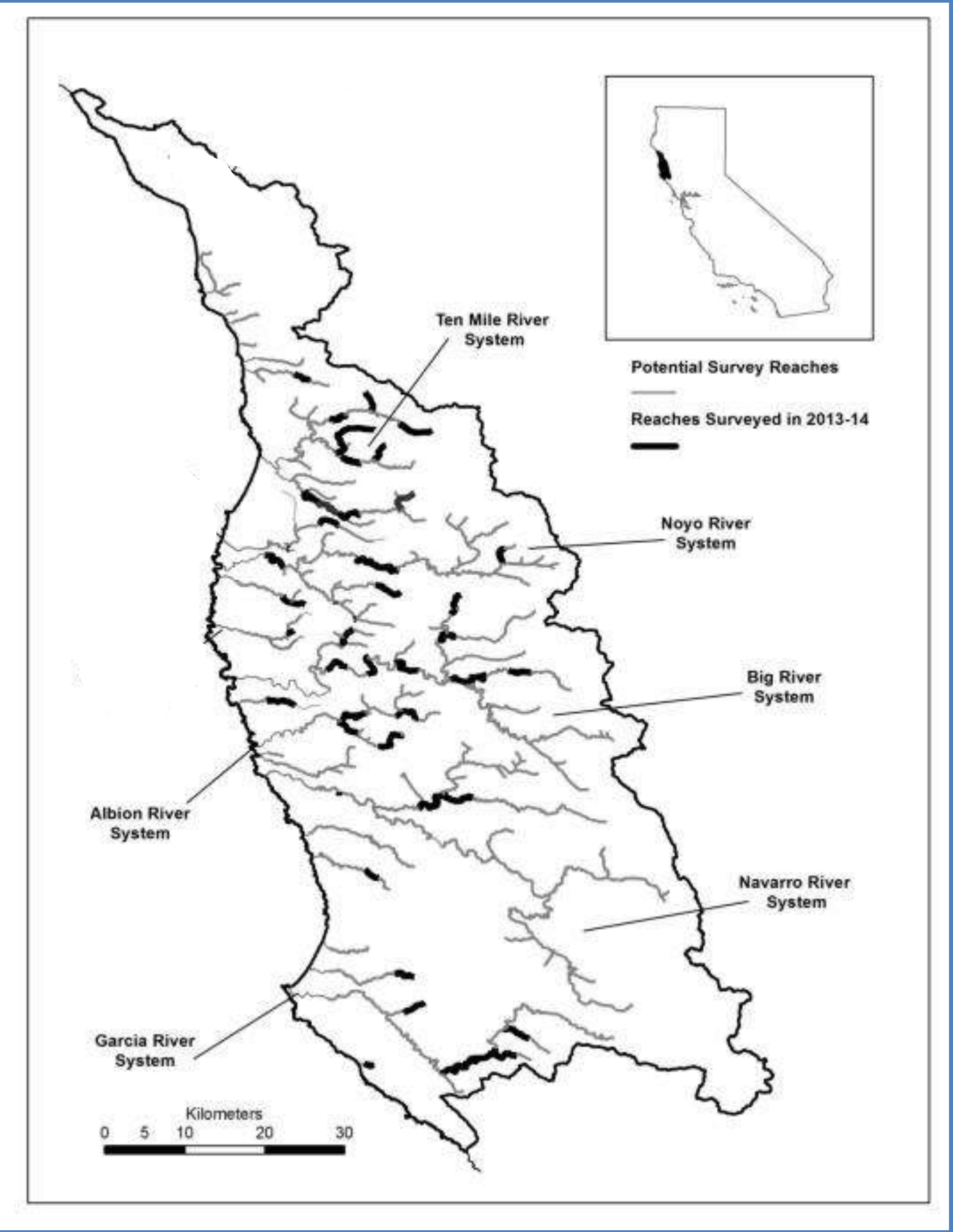




From Bouwes et al. (2012)

Figure 17. An example of channel unit delineations.

Regional RASH 2014 to 2016



Salmonid habitat variables associated with Coho Salmon and Steelhead abundance 2015.

Variable	Albion River	Big River	Garcia River	Navarro River	Noyo River	Ten Mile River	Caspar Creek	Pudding Creek
Boulders	2.9 (1.8)	3.6 (1.2)	12.0 (3.8)	2.2 (0.8)	3.7 (2.6)	1.8 (1.2)	1.6 (0.8)	2.0 (0.9)
Cobbles	11.5 (4.2)	17.9 (3.7)	**24.5 (1.6)**	11.9 (3.0)	19.7 (2.9)	16.2 (3.1)	9.7 (3.4)	**4.7 (1.7)**
Course gravel	**21.9 (2.9)**	32.6 (3.1)	25.1 (1.6)	30.4 (3.4)	29.8 (2.5)	31.9 (4.9)	25.5 (3.7)	**35.0 (2.0)**
Fine Gravel	30.5 (4.1)	26.8 (3.1)	23.0 (3.5)	29.6 (2.3)	23.5 (2.7)	32.7 (5.9)	32.4 (3.2)	29.0 (2.0)
Sand	15.5 (1.6)	14.7 (1.3)	10.4 (1.4)	20.3 (3.5)	16.1 (3.4)	15.3 (4.9)	23.0 (2.2)	22.9 (3.2)
Fines	10.9 (6.3)	**0.2 (0.07)**	**0.2 (0.2)**	2.6 (1.4)	1.7 (0.8)	1.0 (1.7)	**6.9 (2.0)**	5.3 (1.3)
Dry large wood abundance	3.2 (1.1)	2.4 (0.8)	3.5 (0.9)	2.4 (0.4)	3.4 (0.8)	5.1 (0.5)	2.1 (0.3)	2.5 (0.3)
Wet large wood abundance	4.5 (1.8)	2.8 (1.0)	1.3 (0.7)	4.0 (0.6)	3.4 (1.3)	4.7 (0.8)	2.7 (0.5)	2.7 (0.5)
Overhanging vegetation	15.6 (4.4)	12.0 (1.9)	9.4 (1.9)	15.7 (2.8)	9.4 (1.7)	9.9 (1.5)	9.9 (1.5)	6.6 (1.5)
Woody debris	13.1 (1.6)	5.1 (1.3)	8.9 (1.7)	5.8 (1.3)	9.6 (2.8)	11.6 (1.2)	11.5 (0.7)	9.9 (1.1)
Undercut	2.4 (0.5)	0.7 (0.2)	0.7 (0.3)	0.7 (0.1)	3.5 (2.2)	1.3 (0.5)	0.9 (0.1)	2.0 (0.5)
No cover	66.9 (7.0)	77.1 (2.9)	76.4 (4.1)	67.7 (6.2)	76.8 (2.2)	79.2 (2.0)	77.4 (2.0)	79.9 (2.6)
Habitat volume	70.5 (38.4)	205 (75.6)	110.2 (72.2)	494.7 (199.4)	237.8 (97.3)	100.8 (6.4)	11.0 (6.0)	15.5 (6.0)

Table 1. EPA temperature thresholds for Pacific migratory salmonid species and life stages.

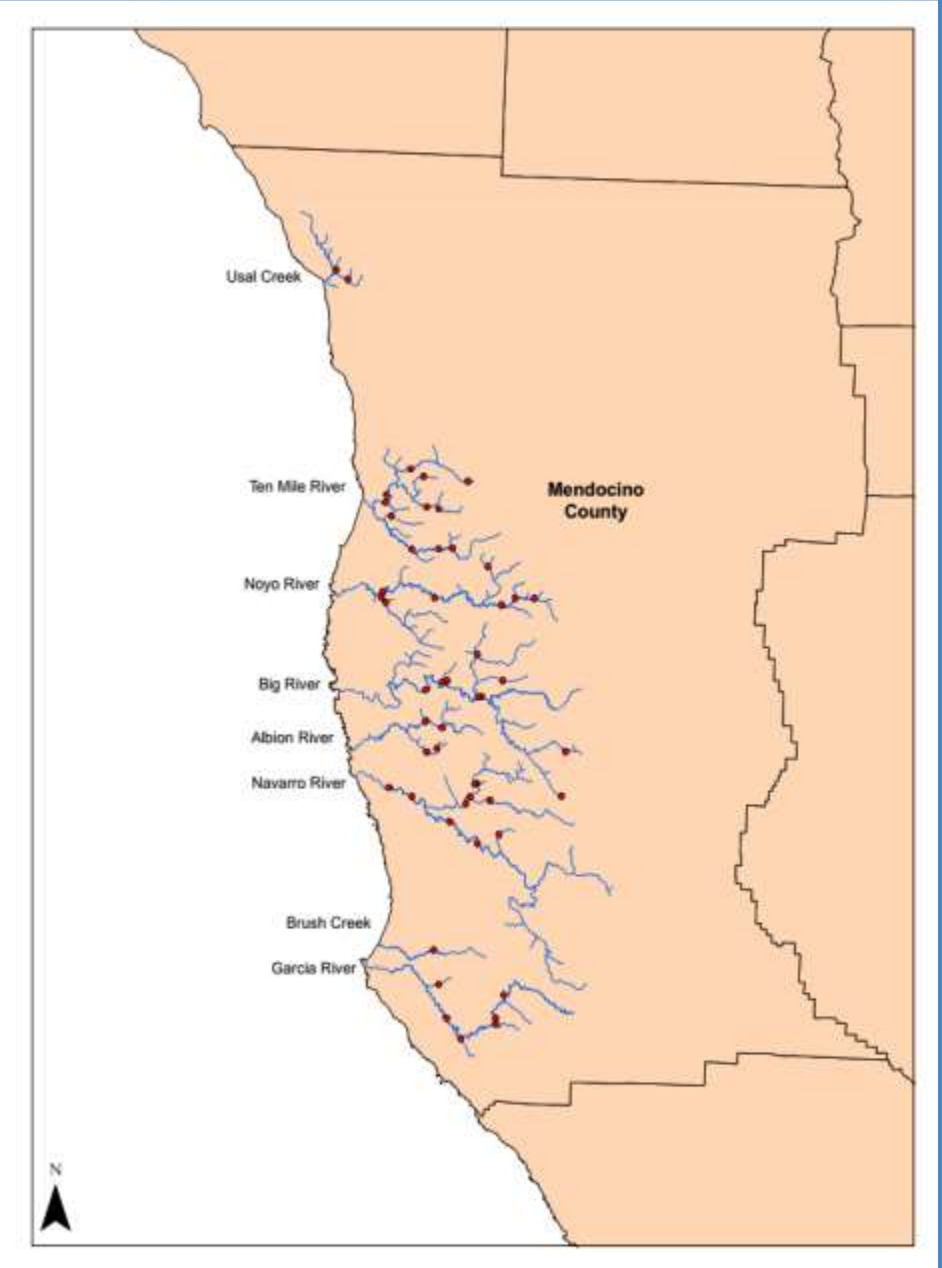
Salmonid Life History Phase Terminology	EPA-based Recommended Temperature Thresholds to Protect Salmon and Trout[1] (Criteria are based on the 7-day average of the daily maximum values)
	emergence
Juvenile rearing (early year)	<61°F (<16°C) for salmon "core" juvenile rearing - generally in the mid- to upper part of river basins
Smoltification	<59°F (<15°C) for salmon smoltification <57°F (<14°C) for steelhead smoltification (for composite criteria steelhead conditions are applied)
Juvenile rearing (late year)	<64°F (<18°C) for juvenile salmon and steelhead migration plus non-Core Juvenile Rearing - generally in the lower part of river basins

[1] Water temperature thresholds taken from: United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. 49 pp. April. The EPA identified temperature unit is: Seven day average of the daily maximum water temperature (7DADM).

SWRCB. 2006. Desired salmonid freshwater habitat conditions for sediment…

Table 1
Salmonid Freshwater Habitat Desired Conditions for Sediment-Related Indices

Parameter	Desired Condition Value	Applicability	Monitoring/Sampling Notes
The following parameters are direct measurements of sediment in a stream channel.			
Embeddedness	Increasing trend in the number of locations where gravels and cobbles are ≤ 25% embedded.	All wadeable streams and rivers.	Monitoring should occur according to the protocols found in the *California Salmonid Stream Habitat Restoration Manual, Third Edition* by Flosi et al. (2004).
Substrate Composition – % fines	≤ 14% fines < 0.85 mm in diameter. ≤ 30% fines < 6.40 mm in diameter.	Wadeable streams and rivers with a gradient < 3%.	Monitoring should use a McNeil sediment core sampler similar to the specifications found in *Success of Pink Salmon Spawning Relative to Size of Spawning Bed Materials* by McNeil and Ahnell (1964), except the diameter of the sampler's core should be at least 2-3 times larger than the largest substrate particle usually encountered. Monitoring should occur according the protocols found in *Stream Substrate Quality for Salmonids: Guidelines for Sampling, Processing, and Analysis* by Valentine (1995), and use the methodology for the redd or pool/riffle break sampling universe. A 0.85 mm and a 6.40 mm sieve should be used during sample processing. The wet volumetric method is recommended with the use of the wet volumetric method and the dry gravimetric method on 10% of the samples.
V*	≤ 0.21 (21%)	3rd order streams with slopes between 1% and 4% that drain watersheds geologically composed of the Franciscan Formation.	Monitoring should occur according to the protocols found in *Measuring the Fraction of Pool Volume Filled with Fine Sediment* by Hilton & Lisle (1993).
The following parameter measures the impacts of sediment on a salmonid food source and water quality in general.			
Benthic Macroinvertebrate Assemblage	≥ 18 Index Score per the Russian River Index of Biological Integrity (IBI). See Table 3 for the Russian River IBI.	1st, 2nd, and 3rd order wadeable streams and rivers.	Monitoring and calculation should occur in the spring according to the protocols found in the *California Stream Bioassessment Procedure* by the CA Department of Fish and Game (2003).



Temperature monitoring locations 2016

Remote land surface temperature stream temp modeling. Kristina McNyset NOAA

Interpreting Physical Habitat and Biological Inventories and Relating this Information to Critical Habitat Needs

Critical habitat needs must be met for a species or community to exist or prosper in a specified environment. A habitat inventory conducted to assess the need for stream channel improvements should provide sufficient detail to enable the investigator to identify these needs.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 2 - SUMMARY OF HABITAT TYPES AND MEASURED PARAMETERS — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS #	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT OCCURRENCE %	MEAN LENGTH ft.	TOTAL LENGTH ft.	TOTAL LENGTH %	MEAN WIDTH ft.	MEAN DEPTH ft.	MAXIMUM DEPTH ft.	MEAN AREA sq.ft.	TOTAL AREA EST. sq.ft.	MEAN VOLUME cu.ft.	TOTAL VOLUME EST. cu.ft.	MEAN RESIDUAL POOL VOL cu.ft.	MEAN SHELTER RATING	MEAN CANOPY %
100	11	LGR	30	18	1828	21	5	0.2	0.7	93	9270	21	2149	0	6	99
1	1	HGR	0	8	8	0	8	0.1	0.3	45	45	5	5	0	10	100
2	1	CAS	1	32	64	1	10	0.5	1.1	420	840	210	420	0	70	92
41	6	RUN	12	21	860	10	7	0.4	0.9	179	7357	60	2462	0	12	97
56	4	SRN	17	53	2959	34	6	0.4	0.7	158	8828	61	3440	0	63	99
3	1	TRP	1	57	170	2	6	1.0	2.6	366	1098	366	1098	183	10	100
84	12	MCP	25	23	1915	22	8	0.8	2.7	162	13645	141	11858	113	40	98
4	2	LSL	1	20	81	1	10	1.1	2.3	212	848	224	898	171	38	100
5	2	LSR	2	21	105	1	7	1.0	2.1	136	680	173	866	157	40	100
2	1	LSBk	1	26	51	1	8	0.7	1.9	224	448	157	314	134	5	100
23	3	PLP	7	14	331	4	6	0.8	2.3	91	2101	76	1746	63	35	98
6	2	BPL	2	18	108	1	8	0.7	1.9	184	1104	143	859	102	48	98
5	0	DRY	2	15	74	1	0	0.0	0.0	0	0	0	0	0	0	0
1	0	CUL	0	38	38	0	0	0.0	0.0	0	0	0	0	0	0	0
TOTAL	TOTAL				LENGTH						AREA		TOTAL VOL.			

Flosi et al. 1998. California Salmonid Stream Habitat Restoration Manual. CDFW, Sacramento, CA.

Historical Reference Condition

Table 3.13 Summary of three general approaches to estimating reference condition.

Method	Description	Citations
Historical data	Reference condition estimated from historical maps, notes or photos, and often field verified by evidence of their prior locations	Beechie *et al.* 1994; Collins & Montgomery 2001; Hohensinner *et al.* 2005
Reference site data	Collect data from relatively natural or undisturbed sites to estimate reference condition	Hughes *et al.* 1986; Harris 1999; Stoddard *et al.* 2006
Models	Model the reference condition based on first principles or data from a variety of natural sites	Pollock *et al.* 2004; Kilgour & Stanfield 2006

Table 3.14 Examples of methods for estimating historical or reference abundances of various habitat types used in analysis of habitat change in the Skagit River basin, USA (modified from Beechie *et al.* 2003b).

Habitat type	Analysis methods	References
Reduced off-channel or wetland areas	Historical or reference habitat areas estimated from historical maps, notes or photos, and often field verified by evidence of their prior locations	Beechie *et al.* 1994; Collins & Montgomery 2001; Hohensinner *et al.* 2005
Lakes	Changes to lake areas measured directly from historical and current maps	Beechie *et al.* 1994
Beaver ponds	Pre-settlement or reference beaver pond areas estimated based on frequencies of beaver ponds in relatively pristine areas, or predictive methods using stream and valley characteristics	Pollock *et al.* 2004; Beechie *et al.* 2001
Tributary and mainstem blockages	Barriers to fish movement mapped using inventories of anthropogenic and natural barriers, as well as surveys of estimates of habitat upstream of migration barriers	Beechie *et al.* 1994; Sheer & Steel 2006
Altered pool abundance in tributaries	Based on measured pool areas in reference sites; may also use historical information where available	Beechie *et al.* 1994; Nickelson & Lawson 1998

Angelo Coast Range Reserve?

Prairie Creek?

Source: Roni and Beechie. 2013. Stream and Watershed Restoration…

Foster, S.C., C.H. Stein, and K.K. Jones. 2001. A guide to interpreting stream survey reports. *Edited by* P.A. Bowers. Information Reports 2001-06. Oregon Department of Fish and Wildlife, Portland.

Table 3. ODFW Aquatic Inventory and Analysis Project: Habitat Benchmarks.

	UNDESIRABLE	DESIRABLE
POOLS		
POOL AREA (% Total Stream Area)	<10	>35
POOL FREQUENCY (Channel Widths Between Pools)	>20	5-8
RESIDUAL POOL DEPTH (m)		
SMALL STREAMS (<7m width)	<0.2	>0.5
MEDIUM STREAMS (≥ 7m and < 15m width)		
LOW GRADIENT (slope <3%)	<0.3	>0.6
HIGH GRADIENT (slope >3%)	<0.5	>1.0
LARGE STREAMS (≥15m width)	<0.8	>1.5
COMPLEX POOLS (Pools w/ LWD pieces ≥3) / km	<1.0	>2.5
RIFFLES		
WIDTH / DEPTH RATIO (Active Channel Based)		
EAST SIDE	>30	<10
WEST SIDE	>30	<15
GRAVEL (% AREA)	<15	≥35
SILT-SAND-ORGANICS (% AREA)		
VOLCANIC PARENT MATERIAL	>15	<8
SEDIMENTARY PARENT MATERIAL	>20	<10
CHANNEL GRADIENT <1.5%	>25	<12
SHADE (Reach Average, Percent)		
STREAM WIDTH <12 meters		
WEST SIDE	<60	>70
NORTHEAST	<50	>60
CENTRAL - SOUTHEAST	<40	>50
STREAM WIDTH >12 meters		
WEST SIDE	<50	>60
NORTHEAST	<40	>50
CENTRAL - SOUTHEAST	<30	>40
LARGE WOODY DEBRIS* (15cm x 3m minimum piece size)		
PIECES / 100 m STREAM LENGTH	<10	>20
VOLUME / 100 m STREAM LENGTH	<20	>30
"KEY" PIECES (>60cm dia. & ≥10m long)/100m	<1	>3
RIPARIAN CONIFERS (30m FROM BOTH SIDES CHANNEL)		
NUMBER >20in dbh/ 1000ft STREAM LENGTH	<150	>300
NUMBER >35in dbh/ 1000ft STREAM LENGTH	<75	>200

* Values for Streams in Forested Basins

Fish-Habitat Relationships

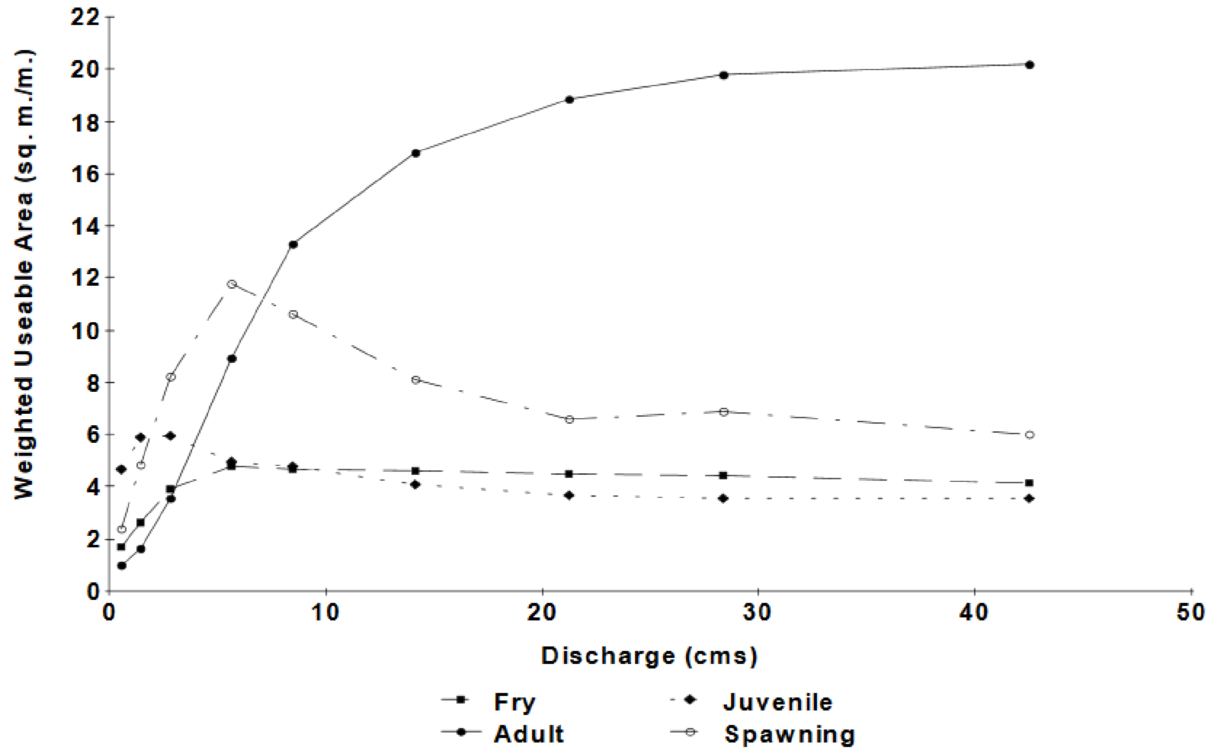
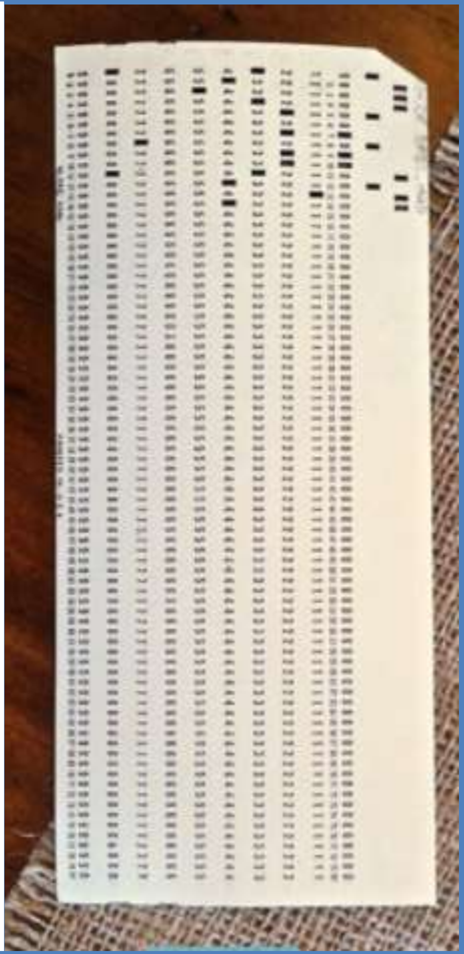


Figure 1. Habitat versus discharge functions for Smallmouth Bass in the Little Wabash River, central Illinois. (Data from the University of Illinois, 1978.)



Milhous, R.T. 1999. History, theory, use, and limitations of the physical habitat simulation system. Proceedings of the 3rd International Symposium on Ecohydraulics.

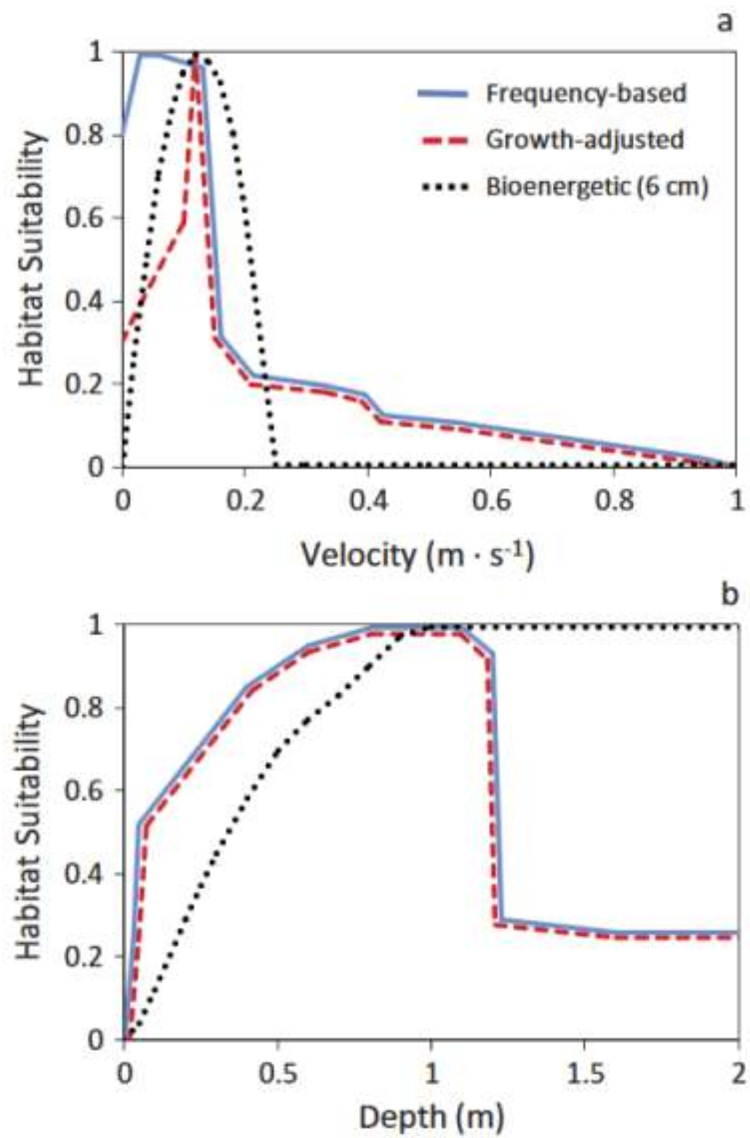
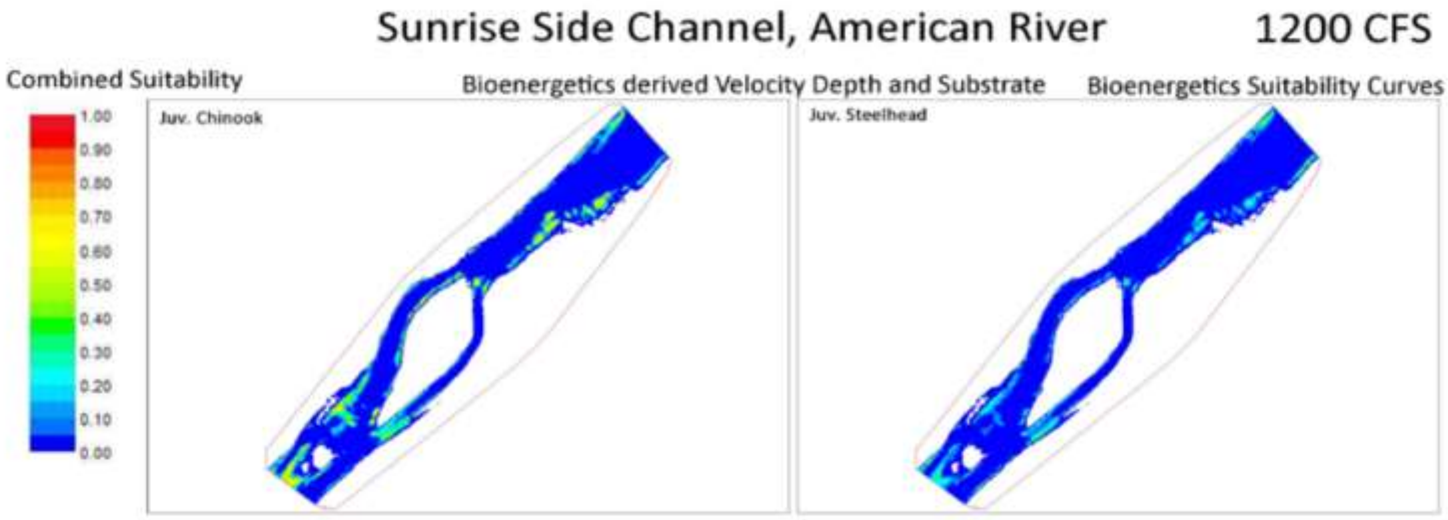


FIGURE 1. Habitat suitability curves (HSCs) for **(a)** velocity and **(b)** depth

net energy intake
habitat suitability

Rosenfeld, J., H. Beecher, and R. Ptolemy. 2016. Developing bioenergetic-based habitat suitability curves for instream flow models. North American Journal of Fisheries Management 36: 1205-1219.

Figure 13: American (1200CFS),) Combined Suitability Comparisons with Data Derived from a Bioenergetic-Based Model



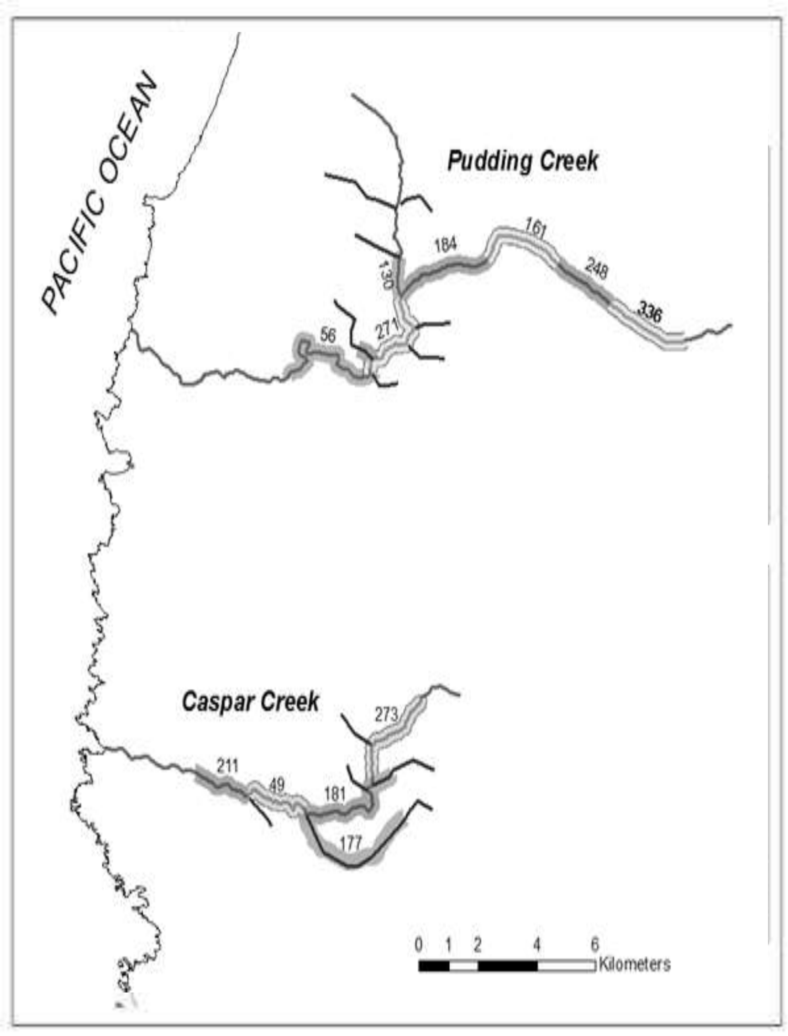
Note: Comparison of combined suitability for juvenile Chinook (left panel) and juvenile steelhead (right panel). These habitat criteria are derived from a bioenergetic-based model.

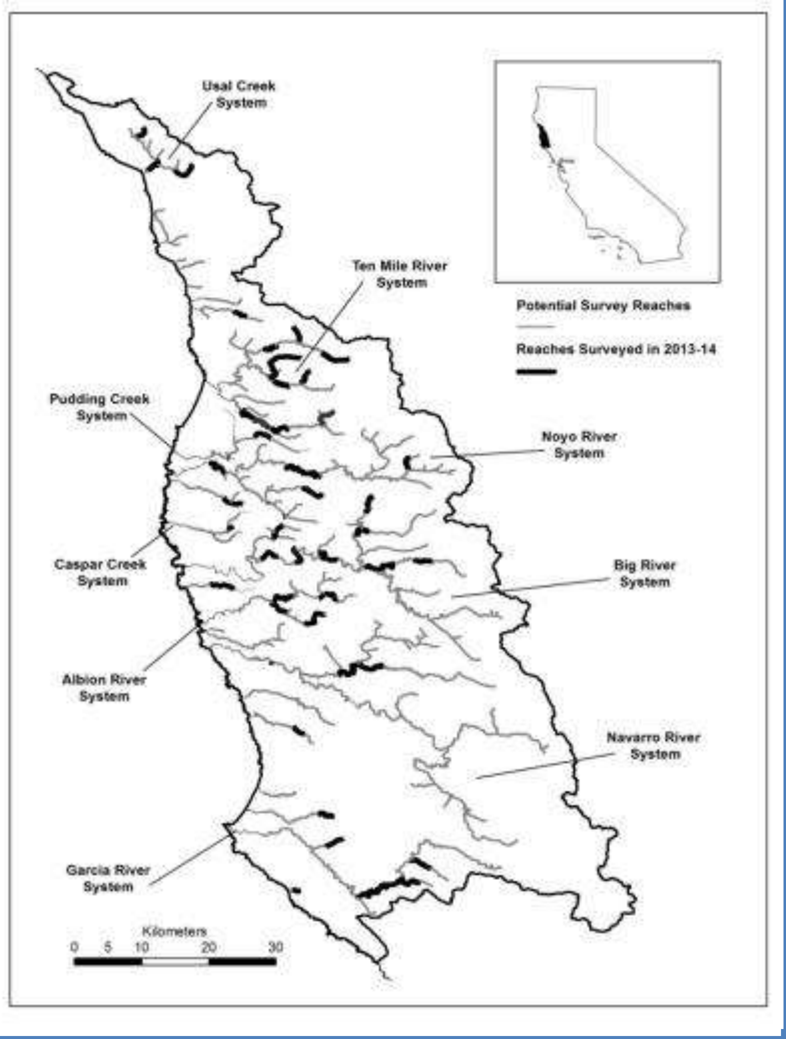
Moore, J.W., M. P. Beakes, N. Retford, S. Sogard and J.E. Merz. 2011. *Evaluating and predicting habitat suitability for California salmon: improving models through a holistic perspective.* California Energy Commission, PIER. CEC-500-2013-150.

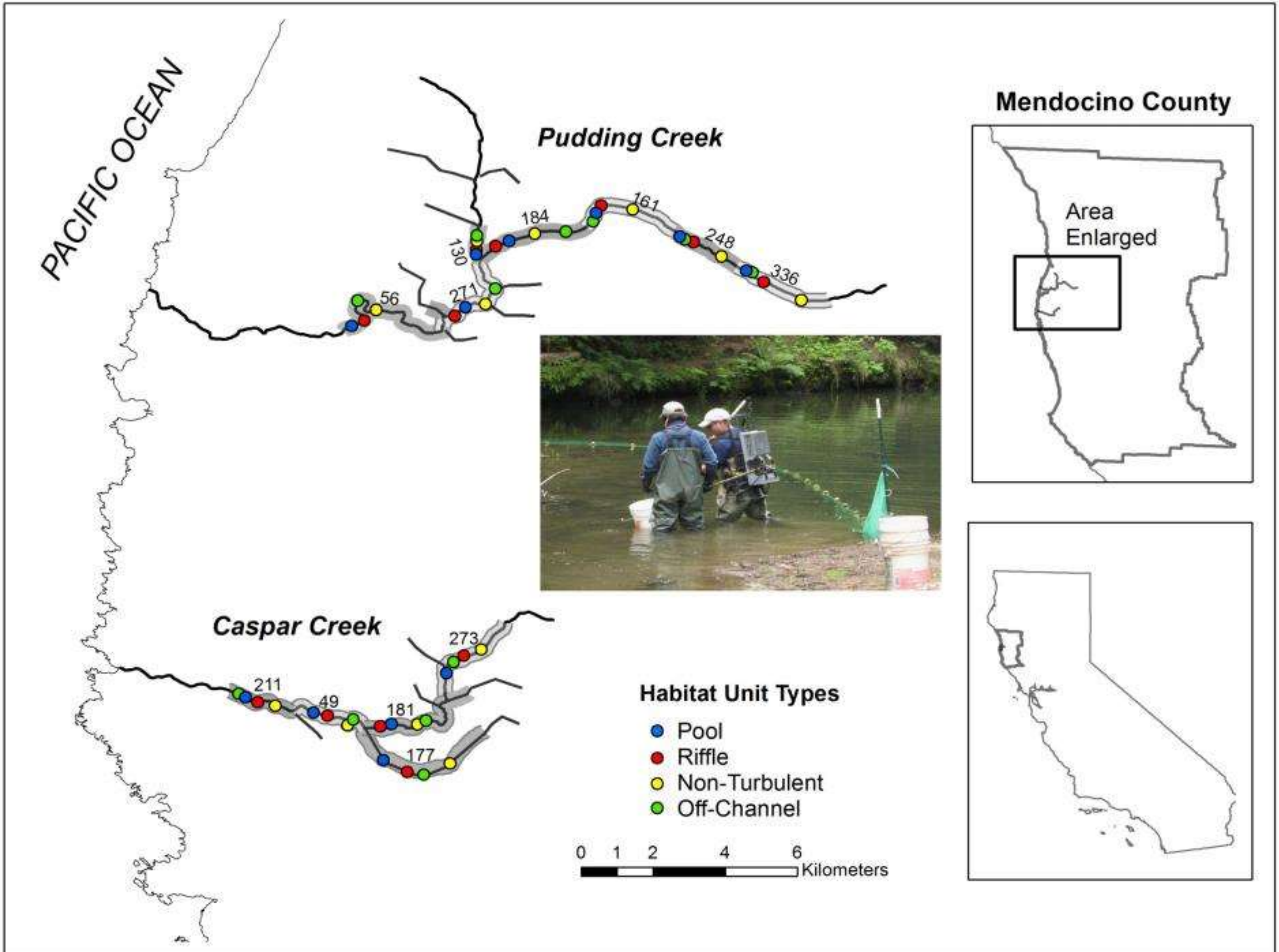
Crawford and Rumsey 2011

Implement a GRTS habitat status/trend monitoring program…

Coordinate and correlate habitat monitoring with fish monitoring





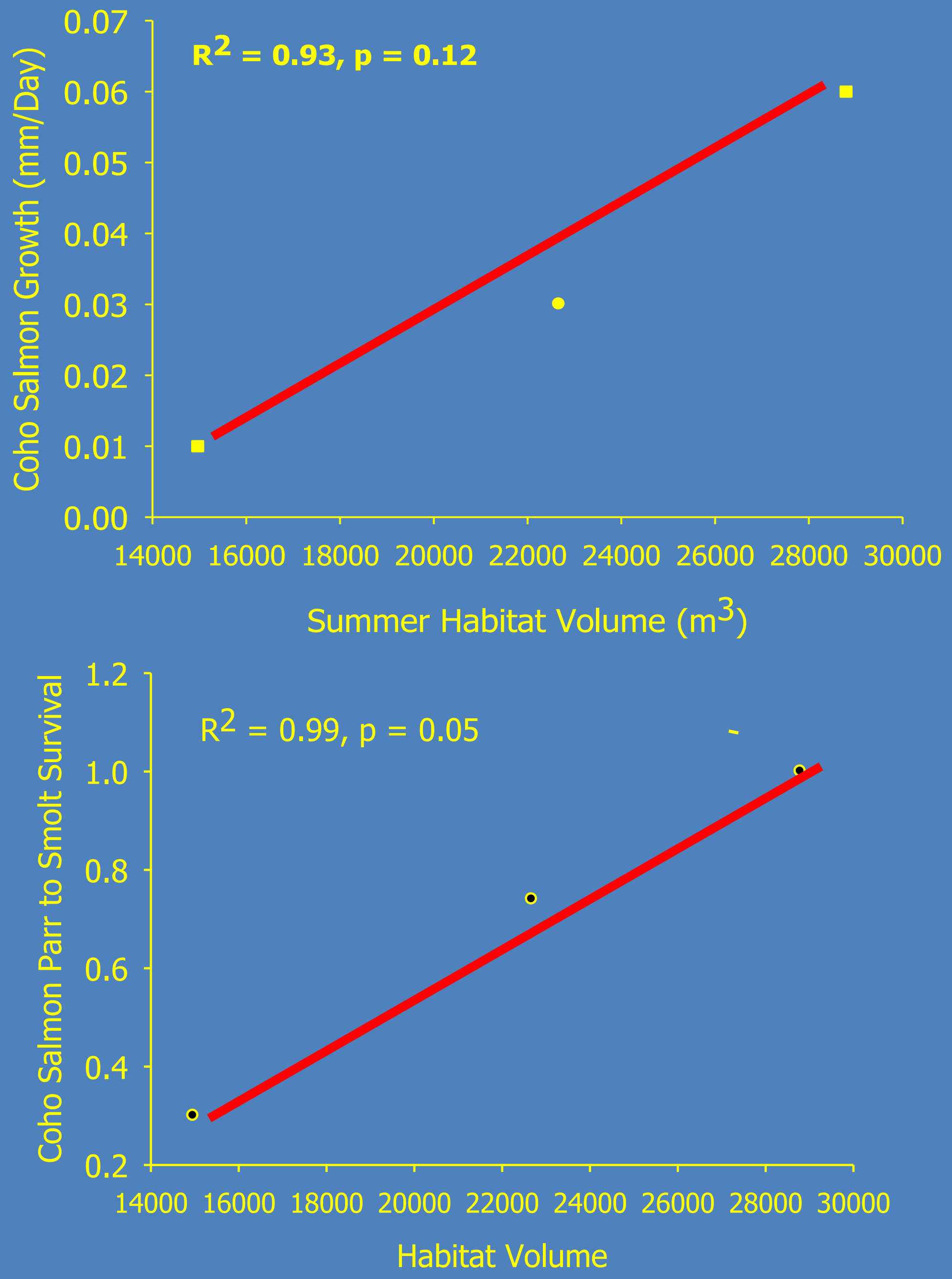


PACIFIC OCEAN
Pudding Creek
Caspar Creek
130
184
161
248
336
56
271
273
211
49
181
177
Mendocino County
Area Enlarged
Habitat Unit Types
Pool
Riffle
Non-Turbulent
Off-Channel
0 1 2 4 6 Kilometers

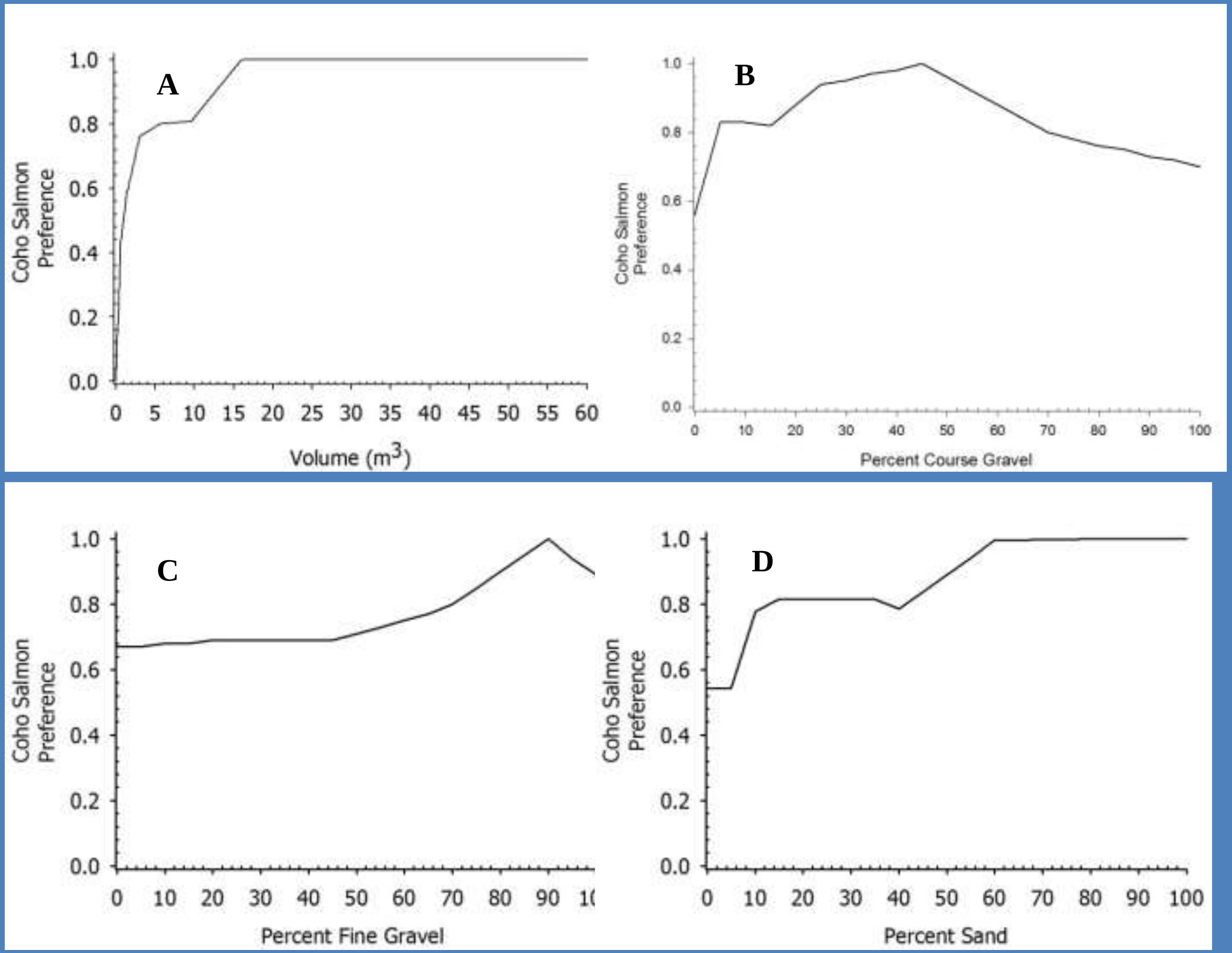
Gallagher, S.P., J. Ferreira, E. Lang, W. Holloway, and D.W. 2014. Wright. Investigation of the relationship between physical habitat and salmonid abundance in two coastal northern California streams. California Fish and Game. 100 (4):683-782.

Coho Salmon Abundance and Habitat Variables

Variable	Factor Names						
	Volume and Dry Large Wood	Wood	Overhead Vegetation	Turbulent Water Stream And Dry Large Wood	Slow Water Volume	Fast Water	Undercut Banks
Bedrock							
Boulders				**0.59**			
Cobbles				**0.89**			
Coarse Gravels					-0.38	**-0.74**	
Fine Gravels						**-0.46**	
Sand					**0.96**		
Fines						**0.64**	
Large Wood Wet		**0.75**					
Large Wood Dry	0.31	**0.47**		0.34			
Overhead Vegetation Cover			**0.76**				
Overhead Wood Cover		**0.72**					
Aquatic Vegetation Cover							
Undercut Banks							**0.98**
No Cover		**-0.43**	**-0.86**				
Unit Type							
Unit Volume	**0.79**				0.32		
Stream				**0.33**			



R^2 = 0.93, p = 0.12
Coho Salmon Growth (mm/Day)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
14000 16000 18000 20000 22000 24000 26000 28000 30000
Summer Habitat Volume (m3)
R^2 = 0.99, p = 0.05
Coho Salmon Parr to Smolt Survival
1.2
1.0
0.8
0.6
0.4
0.2
14000 16000 18000 20000 22000 24000 26000 28000 30000
Habitat Volume



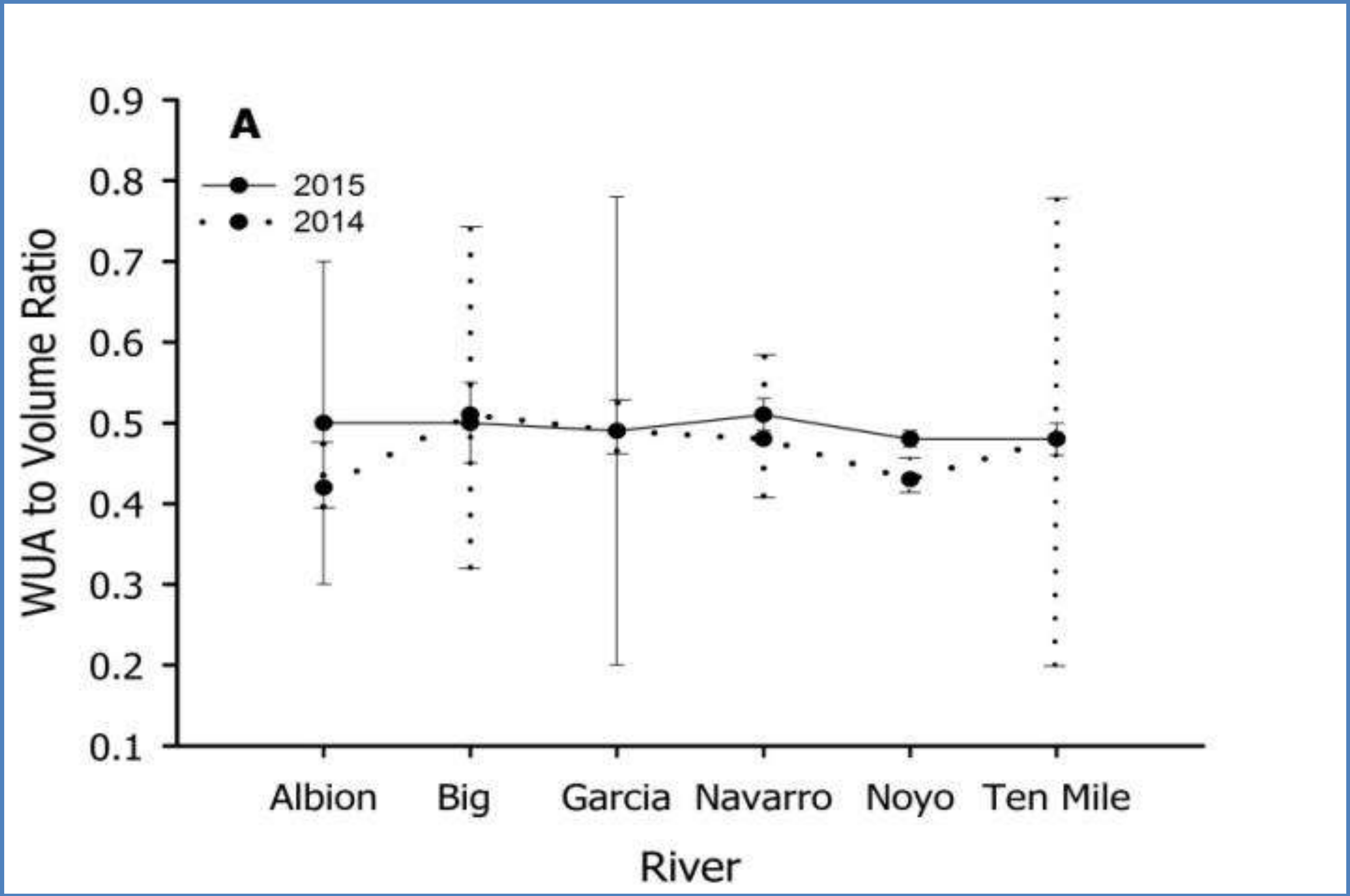
Habitat Preference Curves for Physical Variables

Temperature Trumps Sticks and Stones

Weighted Useable Volume.

River	Coho Salmon			
	2014		2015	
	Estimate	Precision	Estimate	Precision
Albion	10,524	0.76	55,107	0.77
Big	256,804	0.69	103,869	0.62
Garcia	106,145	0.67	77,050	1.70
Navarro	68,038	1.31	264,717	0.79
Noyo	126,646	0.97	309,462	0.59
Ten	64,750	0.80	136,360	0.84

High Level Indicators



Threats and stressors- road density, land use, urbanization, and so forth.

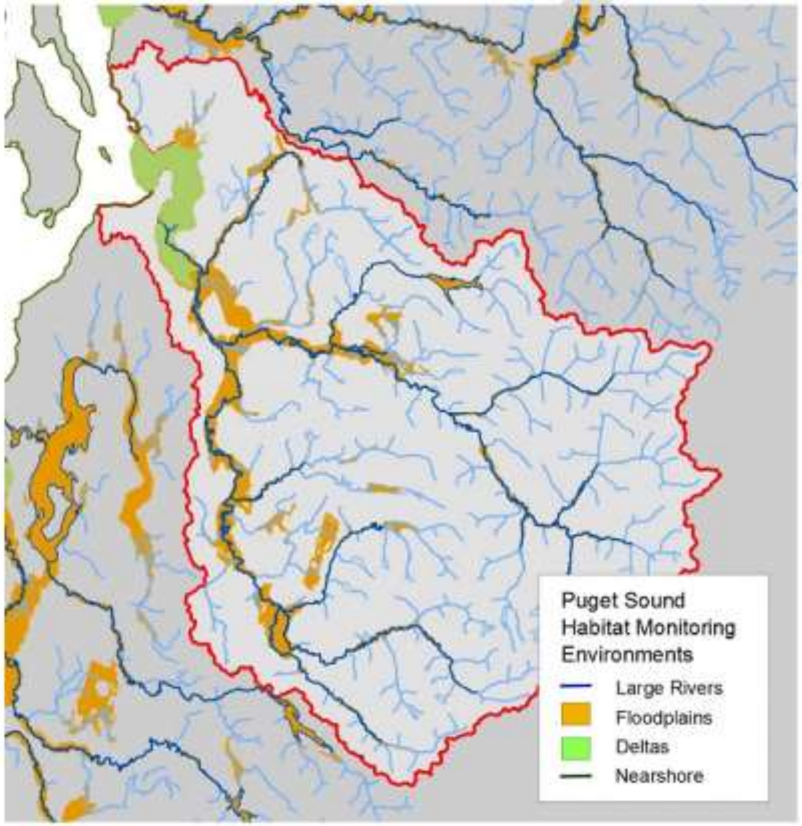


Figure 1. The four key salmonid spawning and rearing environments that will be sampled as part of the Puget Sound habitat status and trends monitoring effort. Map highlights the Snohomish River basin in Puget Sound.

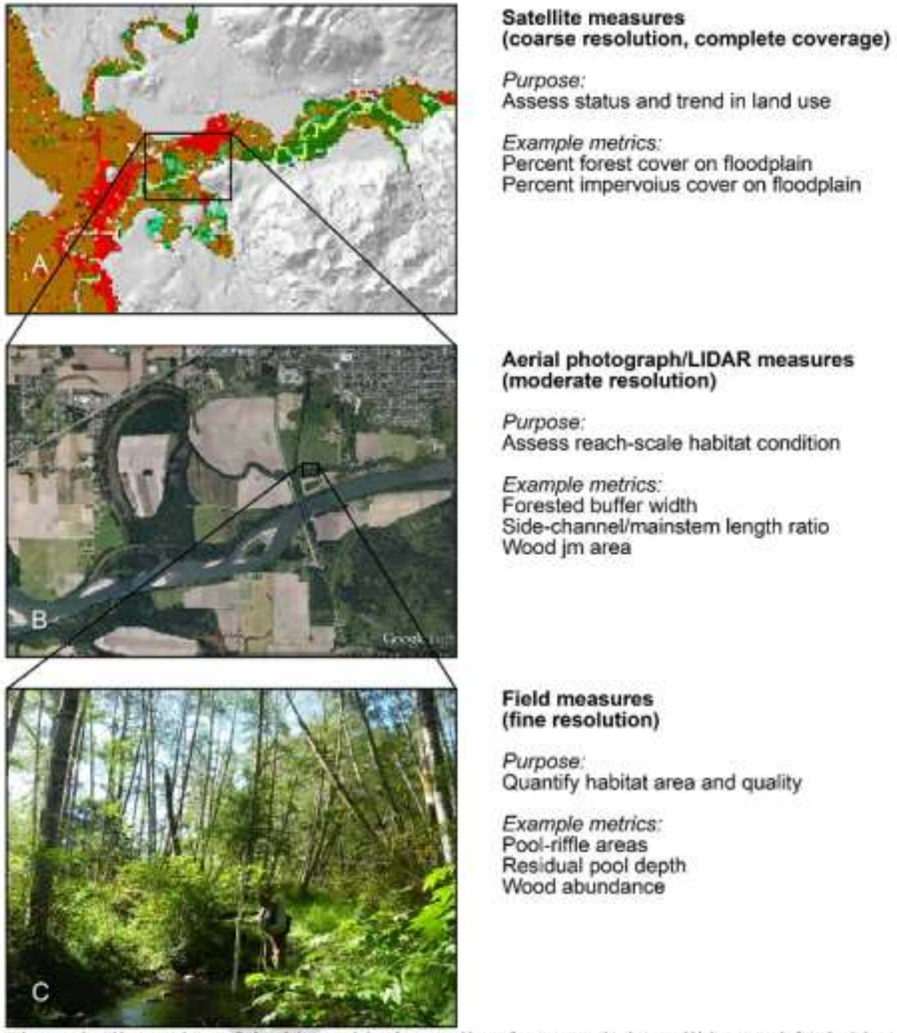


Figure 2. Illustration of the hierarchical sampling framework that will be used for habitat status and trend monitoring in the Puget Sound.

Source: Beechie et al. 2016. Monitoring habitat status and trends in Puget Sound: development of sample designs, monitoring metrics, and sampling protocols for nearshore, delta, large river, and floodplain environments. NOAA Technical Memorandum.

Building on CMP monitoring efforts to document insufficient streamflow as a bottleneck to salmonid survival in tributaries of the Russian River

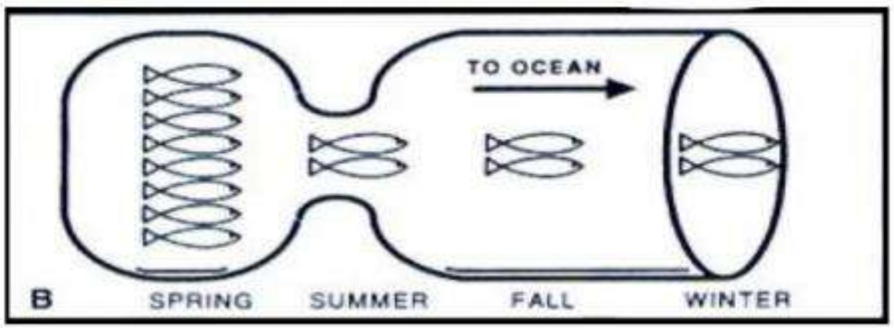
University of California Sea Grant and UC Cooperative Extension

Sarah Nossaman

Making it all happen: Mariska Obedzinski, Andrew Bartshire, Nick Bauer (UC)
Gregg Horton & Aaron Johnson (SCWA)
…and an amazing field crew (UC & SCWA)

1. Watershed overview and biological monitoring efforts
2. Method developed to document limiting factor
3. How information used to support recovery efforts

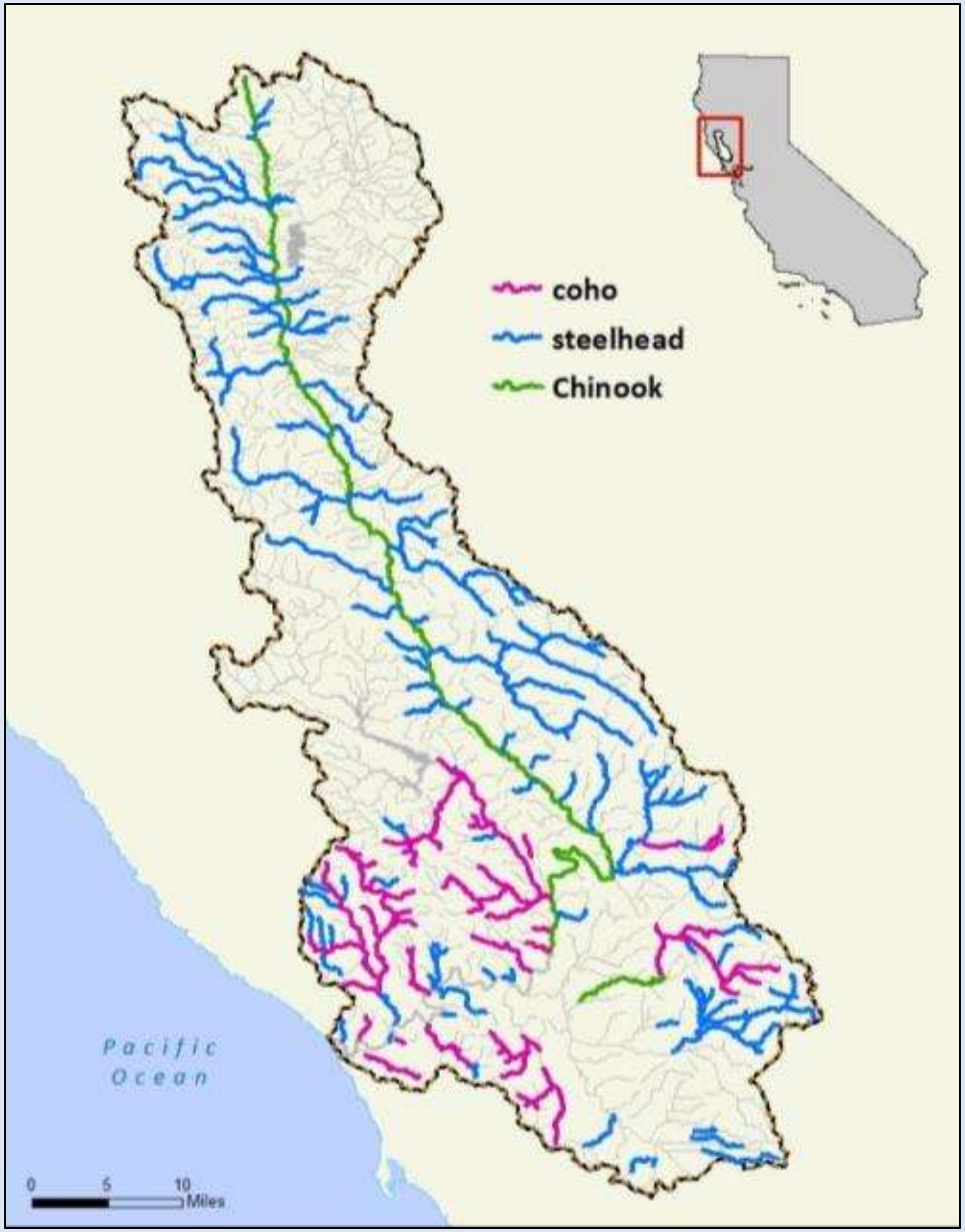
How can data we're collecting be used and/or expanded on to identify impediments to fish recovery?



Summer habitat bottleneck. Source: Reeves et al. 1991

Russian River Salmonid Populations

- **Endangered coho salmon**
- **Threatened steelhead trout**
- **Threatened Chinook salmon**



Salmonid Recovery in the Russian River Basin

- **Habitat enhancement projects**

- **Conservation hatchery program**

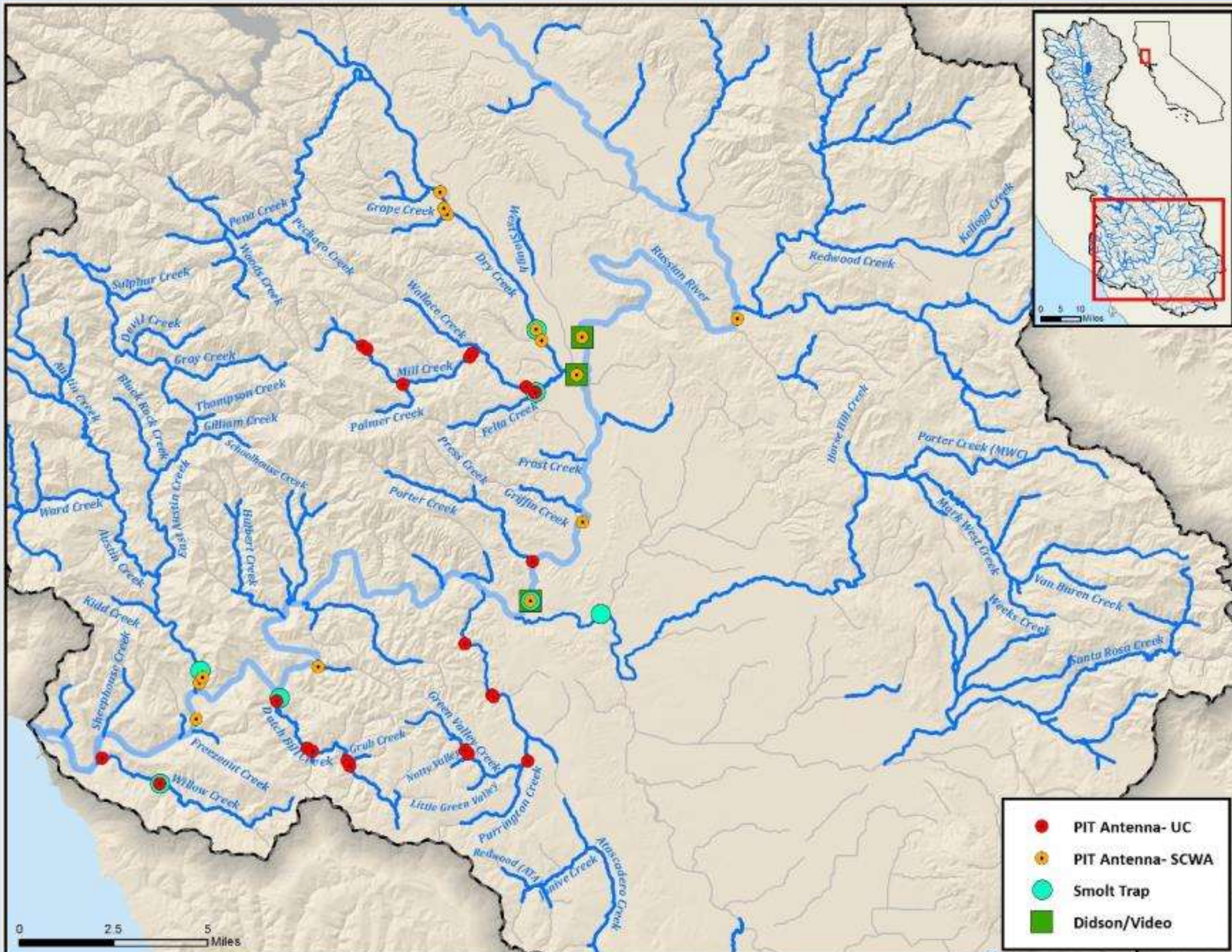
- **Water storage & conservation to improve summer streamflow**

Salmonid Monitoring in the Russian River Basin

- **Coho Salmon Conservation Program**
  a.k.a. Russian River Coho Salmon Captive Broodstock Program

- **California Coastal Monitoring Program**

- **Russian River Coho Water Resources Partnership**



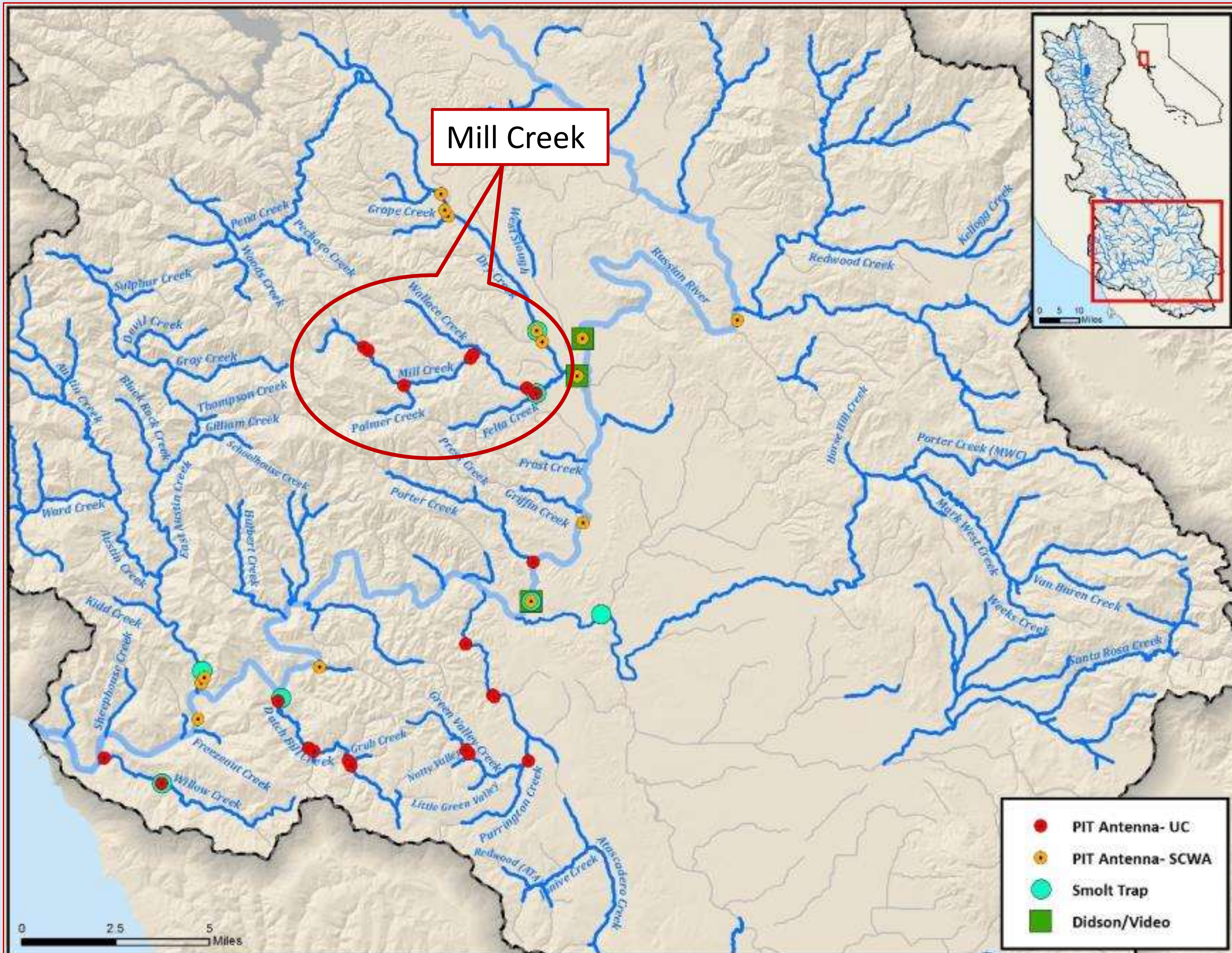
Pena Creek
Pechaco Creek
Grape Creek
West Slough
Dry Creek
Russian River
Redwood Creek
Kellogg Creek
Sulphur Creek
Woods Creek
Wallace Creek
Devil Creek
Gray Creek
Mill Creek
Thompson Creek
Palmer Creek
Felta Creek
Black Rock Creek
Gilliam Creek
Schoolhouse Creek
Press Creek
Frost Creek
Horse Hill Creek
Porter Creek (MWC)
East Austin Creek
Porter Creek
Griffin Creek
Mark West Creek
Ward Creek
Hulbert Creek
Austin Creek
Van Buren Creek
Weeks Creek
Kidd Creek
Santa Rosa Creek
Sheephouse Creek
Green Valley Creek
Dutch Bill Creek
Grub Creek
Freezeout Creek
Willow Creek
Little Green Valley
Purrington Creek
Redwood (ATA)
Atascadero Creek
0
2.5
5
Miles
0
5
10
Miles
PIT Antenna- UC
PIT Antenna- SCWA
Smolt Trap
Didson/Video

Biological Monitoring Activities

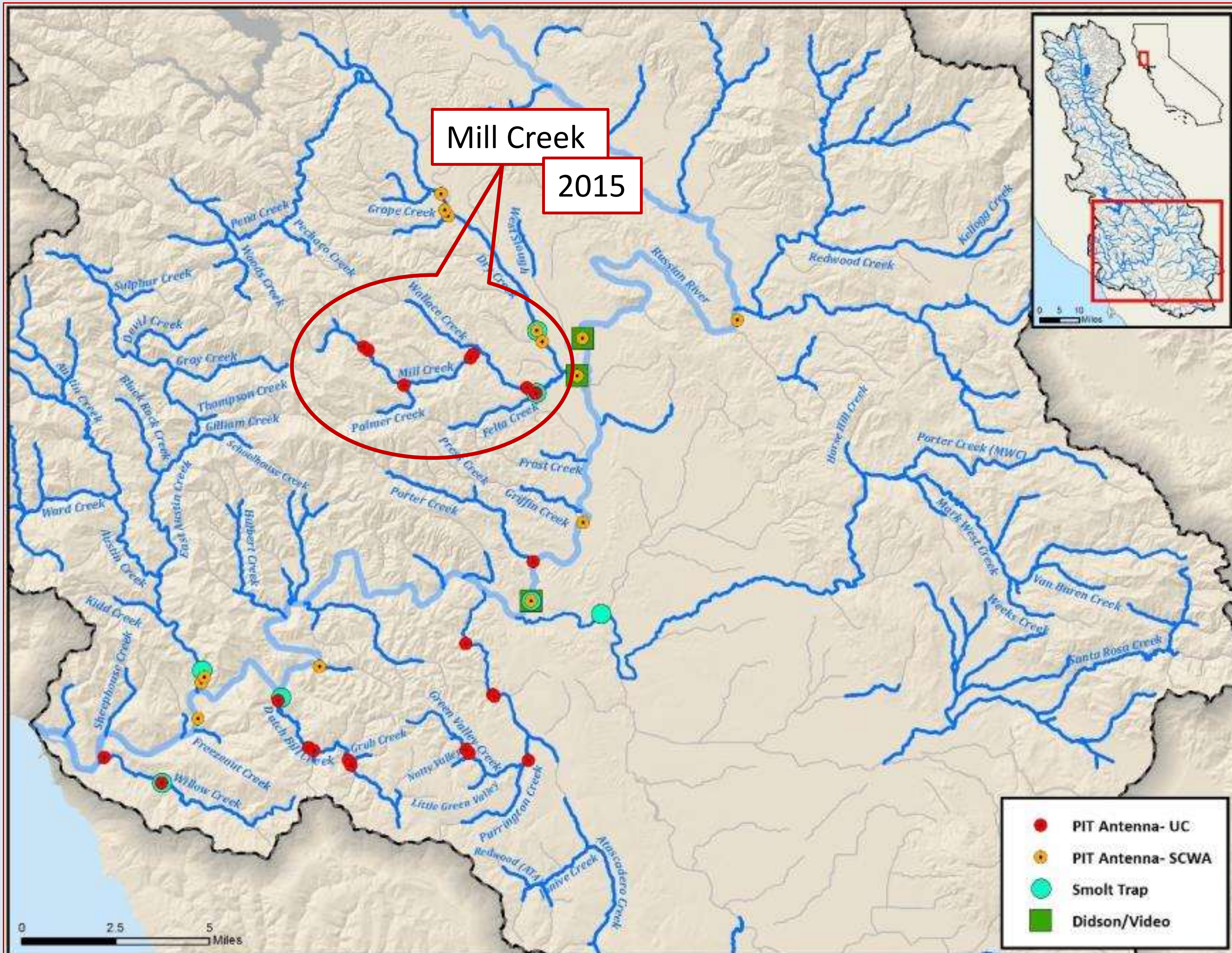
- PIT tag monitoring
- Spawner surveys
  - Adults
  - Redds
- Smolt trapping
- Snorkel surveys
- PIT tag wanding
- Electrofishing

Biological Monitoring Activities

- ~~PIT tag monitoring~~
- Spawner surveys
  - ~~Adults~~
  - Redds
- ~~Smolt trapping~~
- Snorkel surveys
- ~~PIT tag wanding~~
- ~~Electrofishing~~



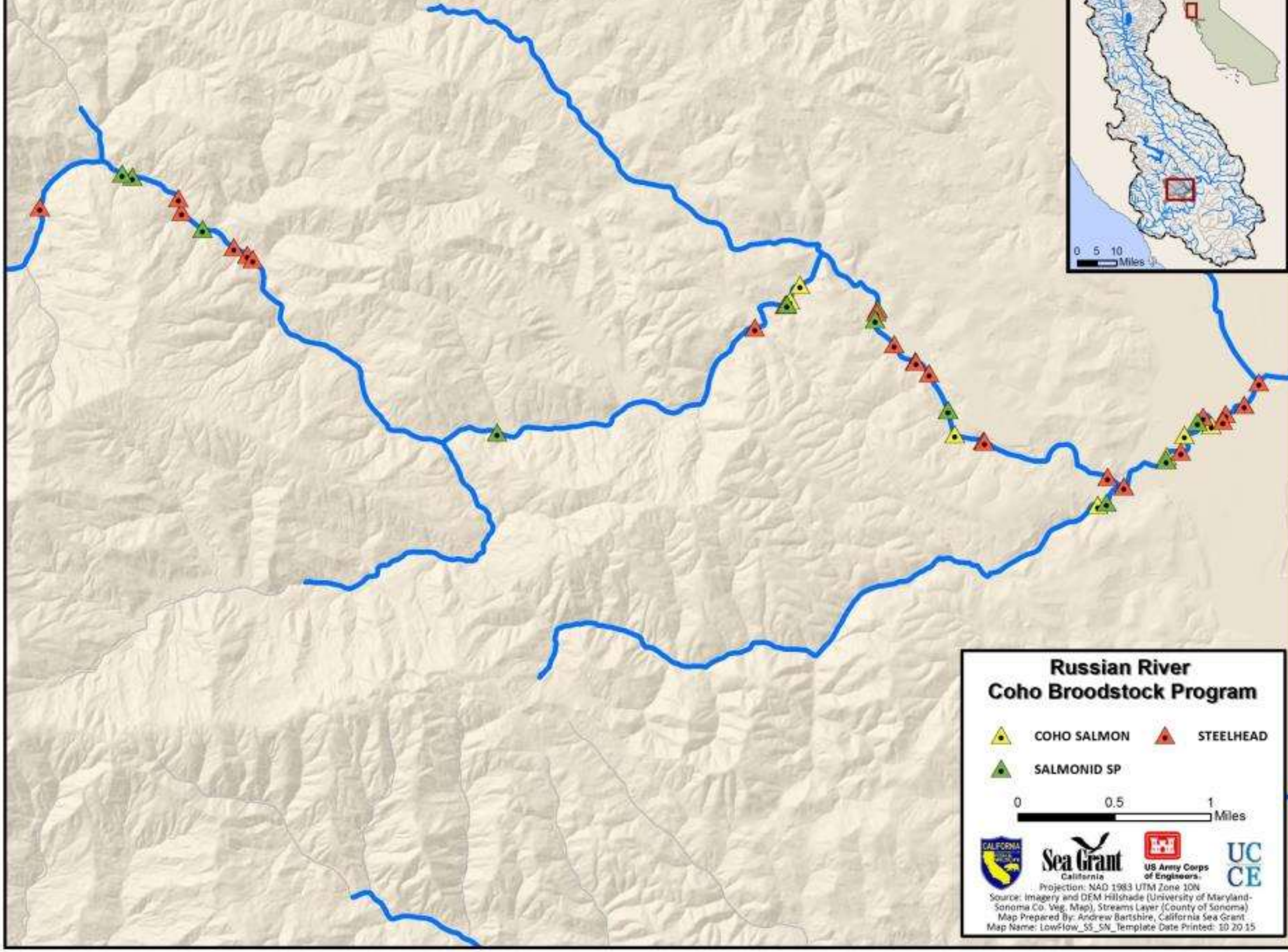
Mill Creek
Grape Creek
Pena Creek
Pechaco Creek
Woods Creek
Sulphur Creek
Devil Creek
Gray Creek
Thompson Creek
Gilliam Creek
Black Rock Creek
Schoolhouse Creek
East Austin Creek
Ward Creek
Austin Creek
Hulbert Creek
Kidd Creek
Sheephouse Creek
Freezeout Creek
Willow Creek
Dutch Bill Creek
Grub Creek
Green Valley Creek
Little Green Valley
Purrington Creek
Atascadero Creek
Wallace Creek
Mill Creek
Palmer Creek
Felta Creek
West Slough
Russian River
Redwood Creek
Kellogg Creek
Frost Creek
Griffin Creek
Porter Creek
Horse Hill Creek
Porter Creek (MWC)
Mark West Creek
Van Buren Creek
Weeks Creek
Santa Rosa Creek
PIT Antenna- UC
PIT Antenna- SCWA
Smolt Trap
Didson/Video
0 2.5 5 Miles


Mill Creek
2015
Grape Creek
Pena Creek
Pechaco Creek
Woods Creek
Sulphur Creek
Devil Creek
Gray Creek
Austin Creek
Black Rock Creek
Thompson Creek
Gilliam Creek
Schoolhouse Creek
East Austin Creek
Ward Creek
Austin Creek
Hulbert Creek
Kidd Creek
Sheephouse Creek
Freezeout Creek
Willow Creek
Dutch Bill Creek
Grub Creek
Green Valley Creek
Little Green Valley
Purrington Creek
Redwood (ATA)
Atascadero Creek
Wallace Creek
Mill Creek
Palmer Creek
Felta Creek
Porter Creek
Frost Creek
Griffin Creek
West Slough
Russian River
Redwood Creek
Kellogg Creek
Horse Hill Creek
Porter Creek (MWC)
Mark West Creek
Van Buren Creek
Weeks Creek
Santa Rosa Creek
0 2.5 5 Miles
0 5 10 Miles
PIT Antenna- UC
PIT Antenna- SCWA
Smolt Trap
Didson/Video

Redd surveys: CMP protocols

- **Count and ID redds to species (coho, steelhead, Chinook, salmonid sp)**

Mill Creek Redds 2014-2015



Snorkeling surveys: CMP protocols

- **Dive every second pool, ID and count salmonids**

Mill Creek Juvenile Salmonid Densities 2015

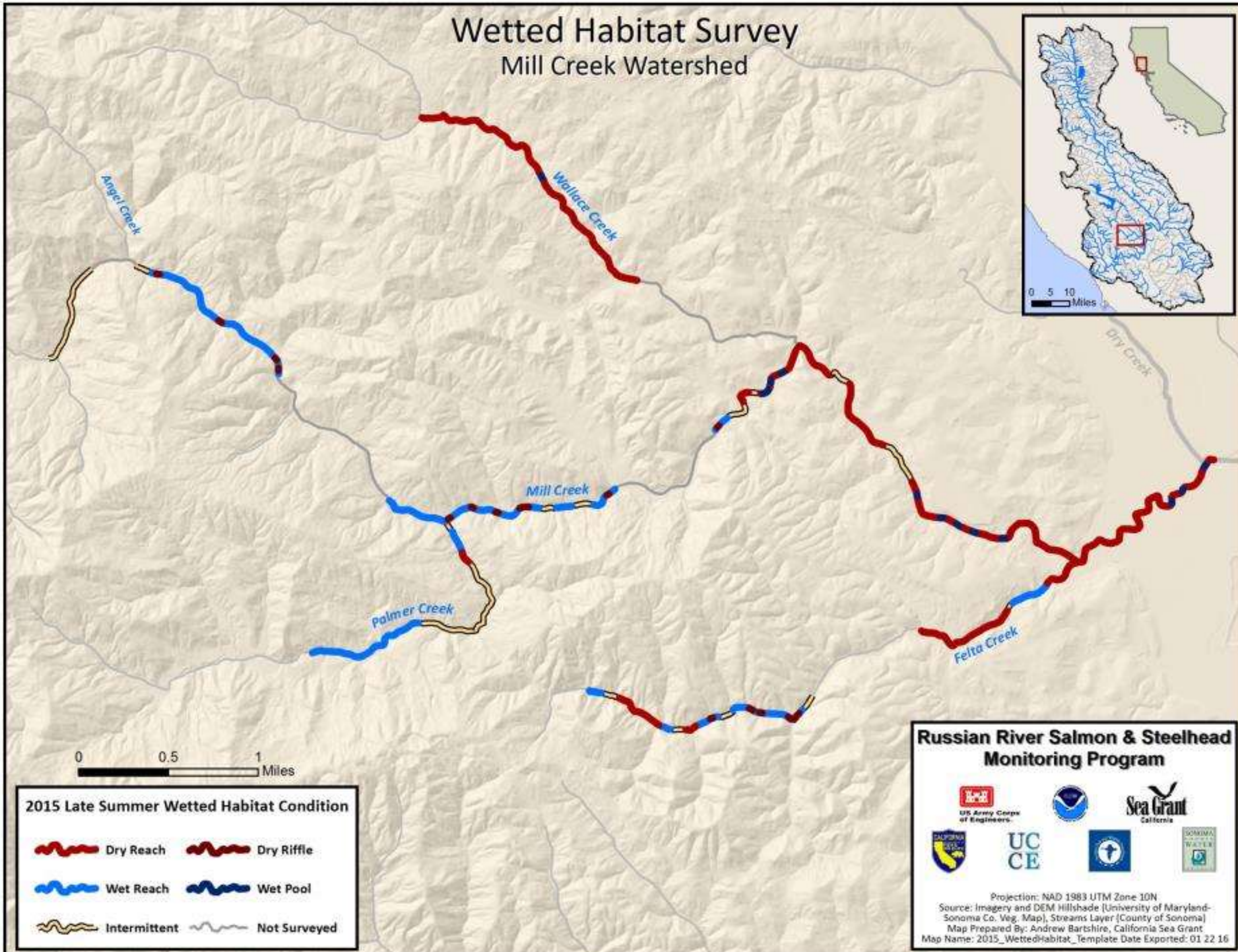
Mill Creek July 1, 2015

Mill Creek September 8, 2015

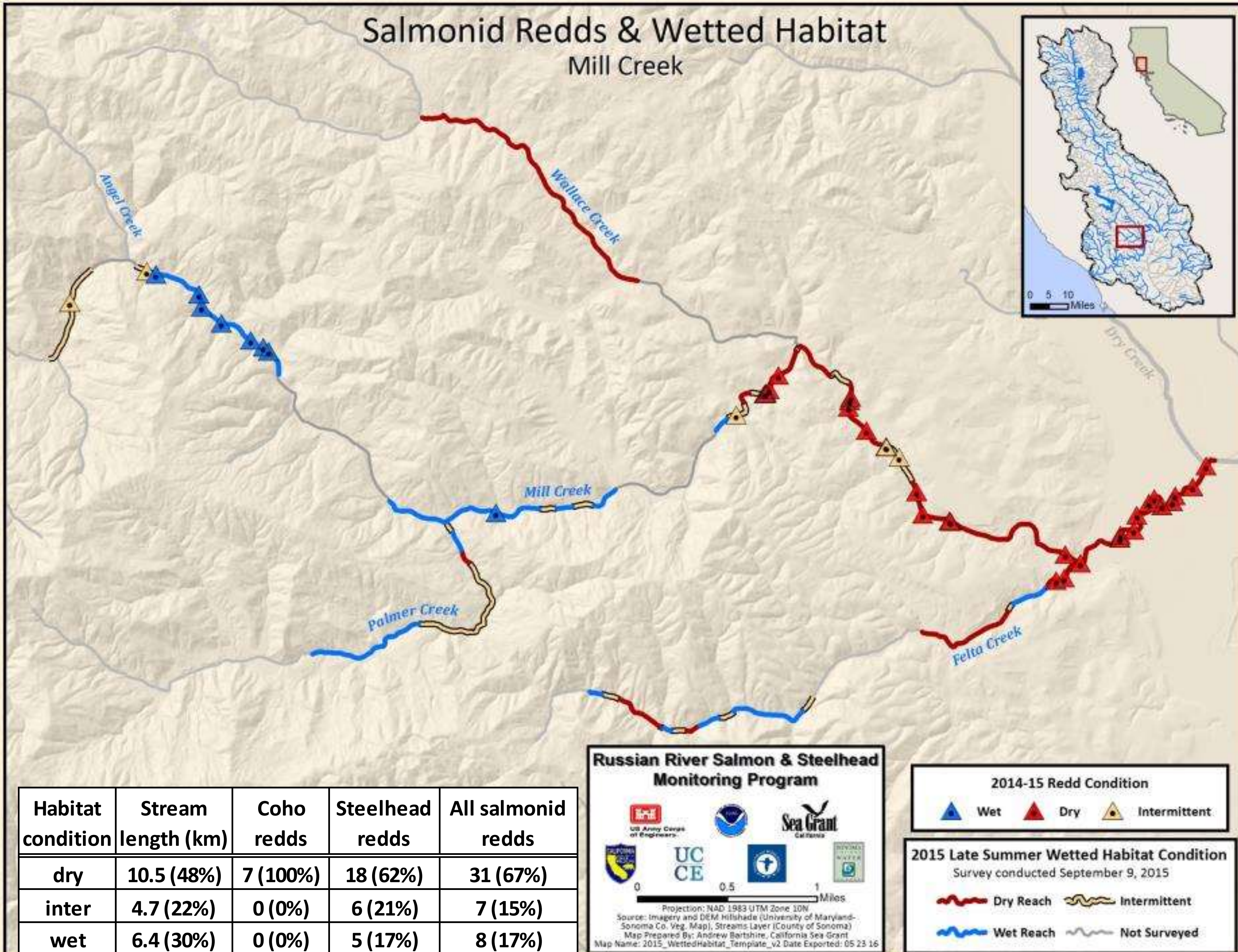
Wetted habitat surveys: wet/dry mapping

- Walk streams at driest time of year to document surface water conditions
- GPS start/stop point of each wet, dry or intermittent length of stream
- Measure DO and water temperature in wet/intermittent reaches

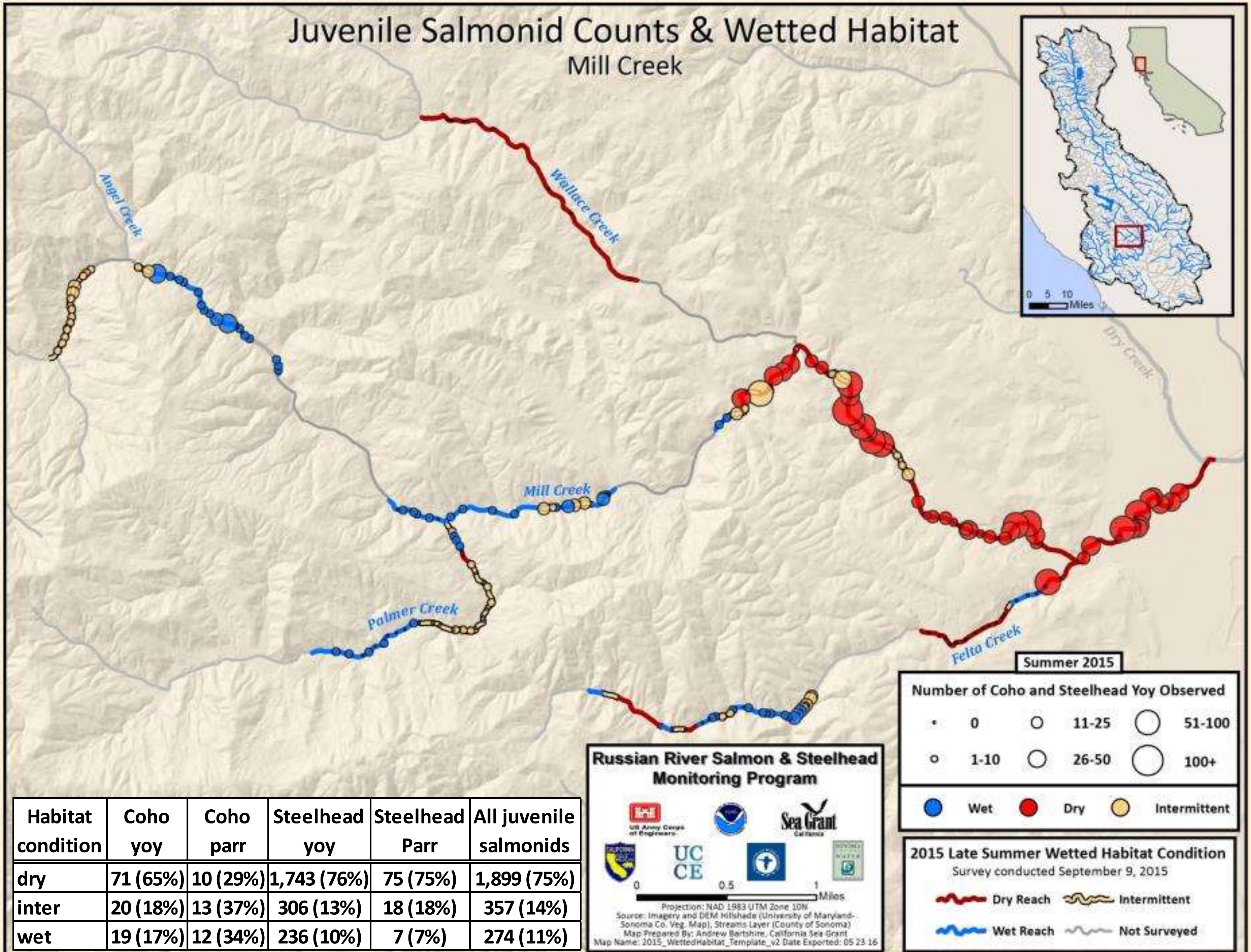


Wetted Habitat Survey
Mill Creek Watershed
Wallace Creek
Angel Creek
Dry Creek
Mill Creek
Palmer Creek
Felta Creek
0 5 10
Miles
0 0.5 1
Miles
2015 Late Summer Wetted Habitat Condition
Dry Reach
Dry Riffle
Wet Reach
Wet Pool
Intermittent
Not Surveyed
Russian River Salmon & Steelhead Monitoring Program
US Army Corps of Engineers
Sea Grant California
UC CE
Projection: NAD 1983 UTM Zone 10N
Source: Imagery and DEM Hillshade (University of Maryland-Sonoma Co. Veg. Map), Streams Layer (County of Sonoma)
Map Prepared By: Andrew Bartshire, California Sea Grant
Map Name: 2015_WettedHabitat_Template Date Exported: 01 22 16

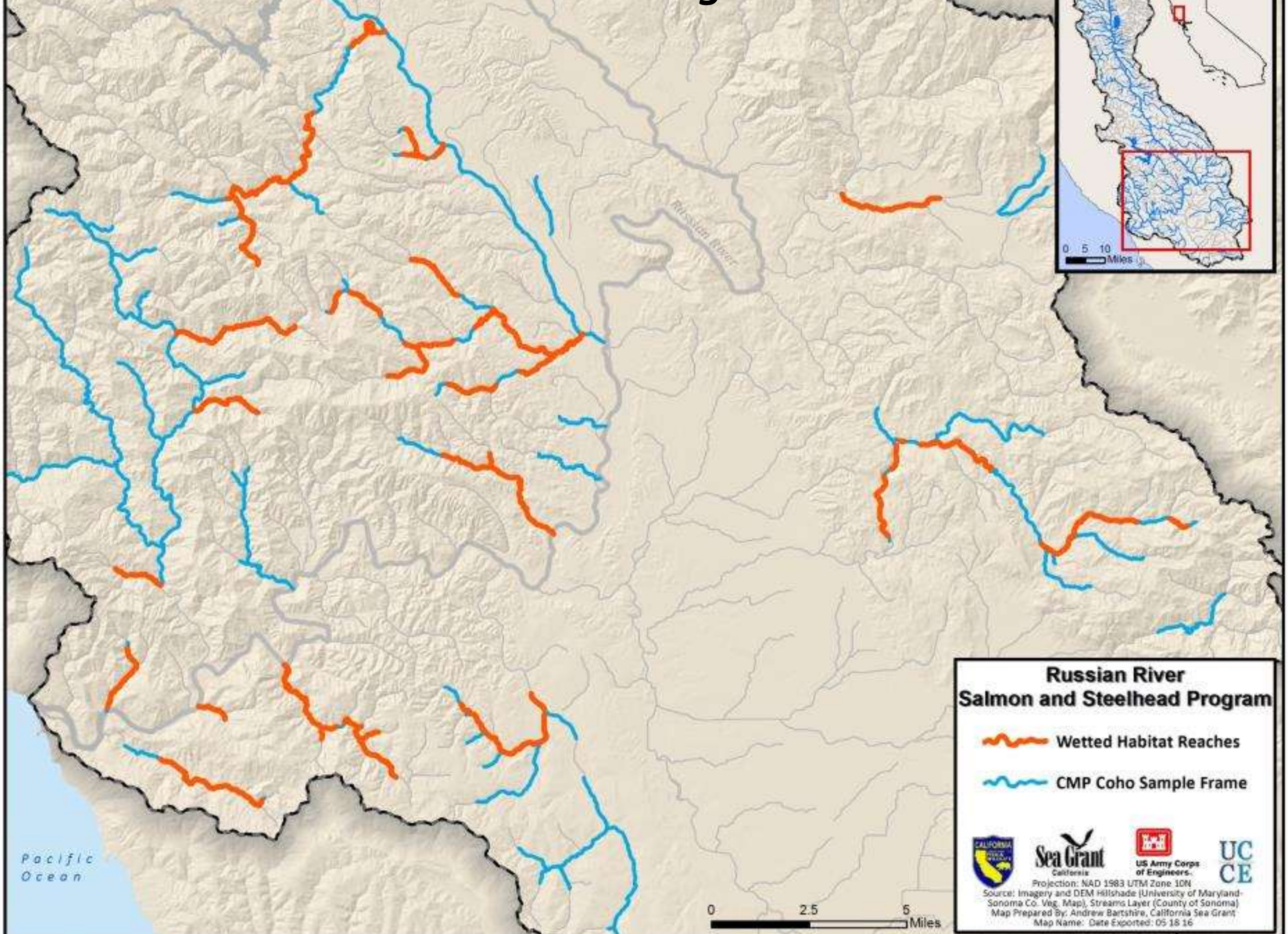


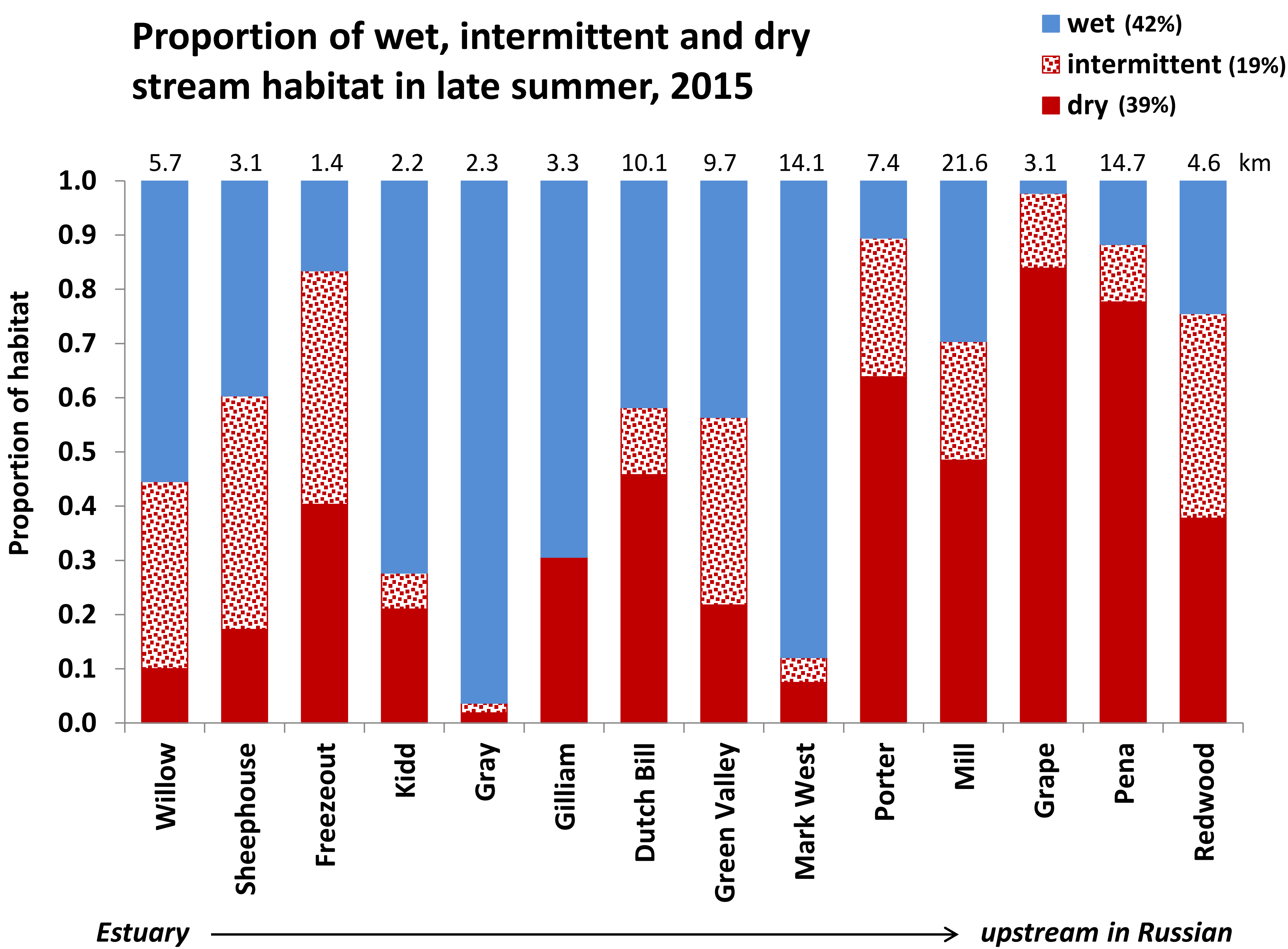
Habitat condition	Stream length (km)	Coho redds	Steelhead redds	All salmonid redds
dry	10.5 (48%)	7 (100%)	18 (62%)	31 (67%)
inter	4.7 (22%)	0 (0%)	6 (21%)	7 (15%)
wet	6.4 (30%)	0 (0%)	5 (17%)	8 (17%)



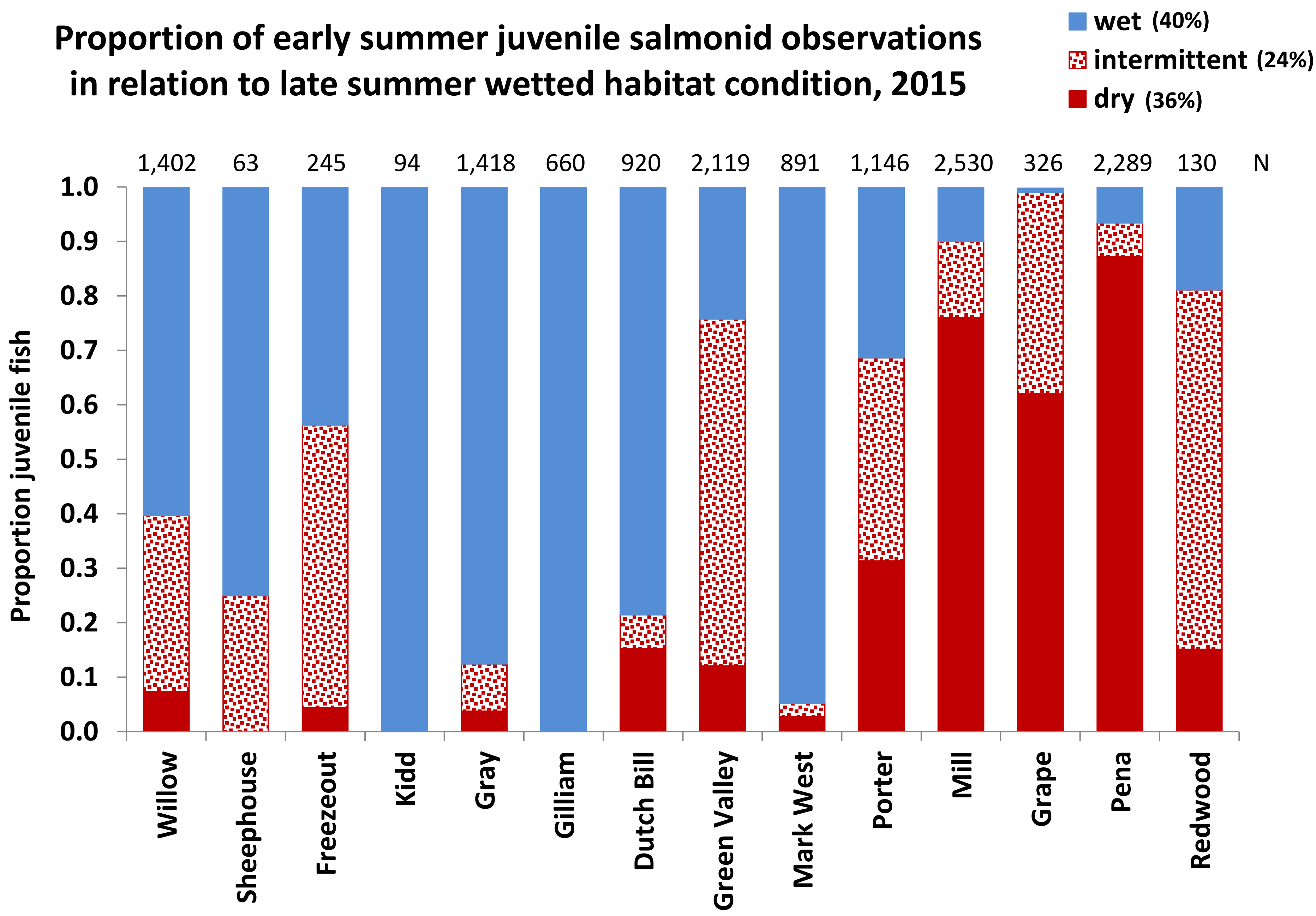
Habitat condition	Coho yoy	Coho parr	Steelhead yoy	Steelhead Parr	All juvenile salmonids
dry	71 (65%)	10 (29%)	1,743 (76%)	75 (75%)	1,899 (75%)
inter	20 (18%)	13 (37%)	306 (13%)	18 (18%)	357 (14%)
wet	19 (17%)	12 (34%)	236 (10%)	7 (7%)	274 (11%)

2015 Monitoring Streams



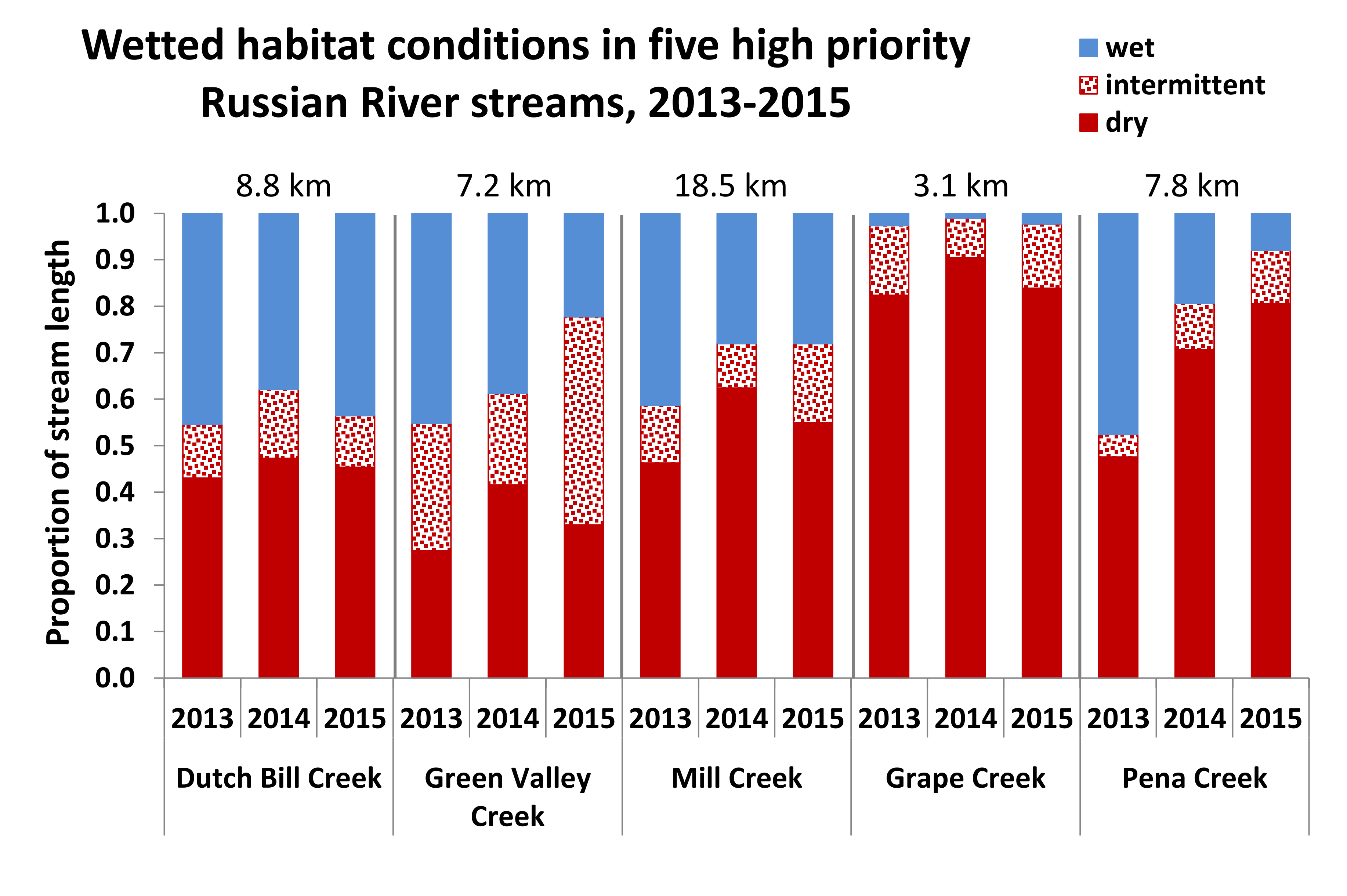


Proportion of wet, intermittent and dry stream habitat in late summer, 2015
wet (42%)
intermittent (19%)
dry (39%)
5.7
3.1
1.4
2.2
2.3
3.3
10.1
9.7
14.1
7.4
21.6
3.1
14.7
4.6
km
Proportion of habitat
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Willow
Sheephouse
Freezeout
Kidd
Gray
Gilliam
Dutch Bill
Green Valley
Mark West
Porter
Mill
Grape
Pena
Redwood
Estuary
upstream in Russian

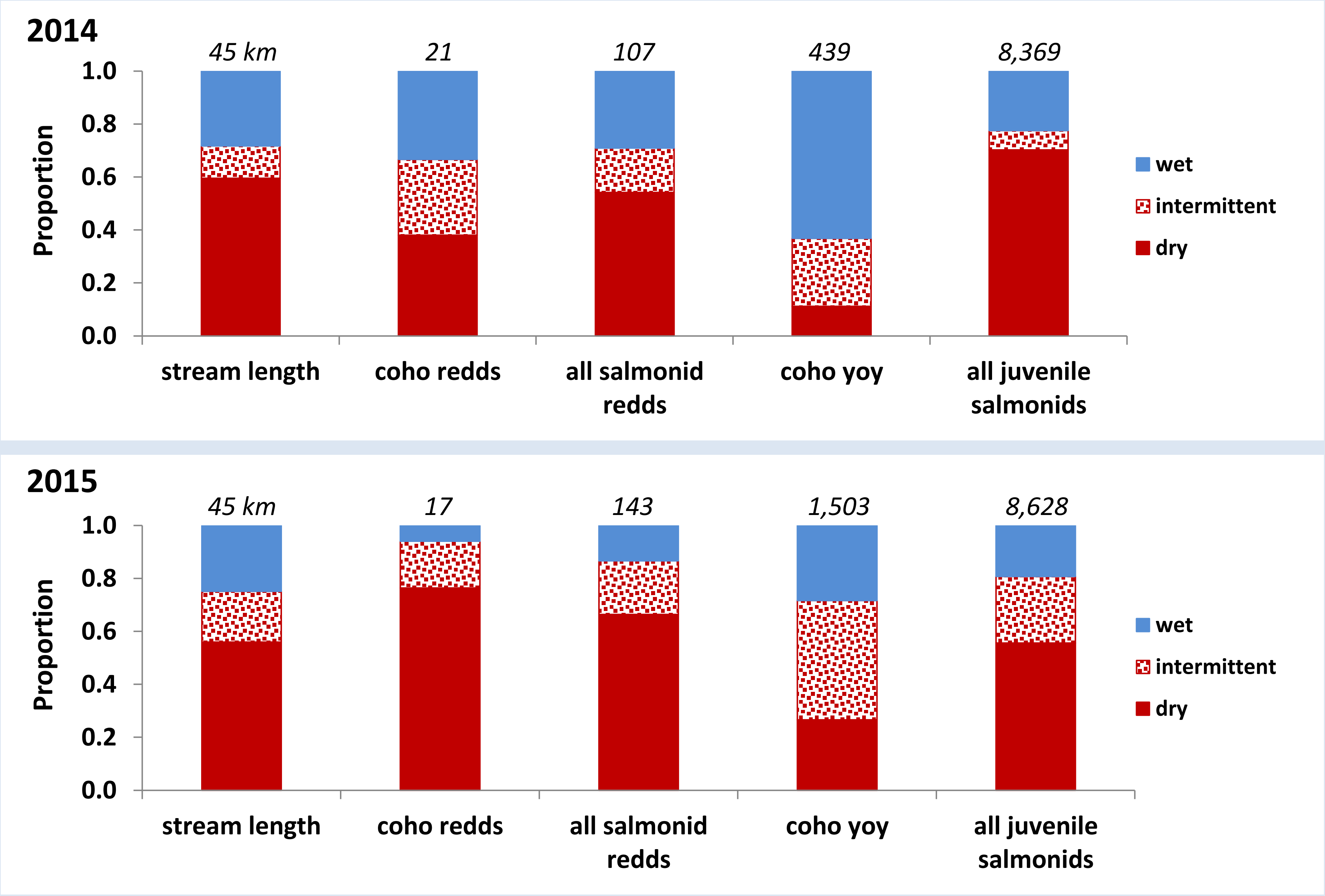


Proportion of early summer juvenile salmonid observations
in relation to late summer wetted habitat condition, 2015
wet (40%)
intermittent (24%)
dry (36%)
Proportion juvenile fish
1,402
63
245
94
1,418
660
920
2,119
891
1,146
2,530
326
2,289
130
N
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Willow
Sheephouse
Freezeout
Kidd
Gray
Gilliam
Dutch Bill
Green Valley
Mark West
Porter
Mill
Grape
Pena
Redwood
Estuary
upstream in Russian

Wetted habitat survey results

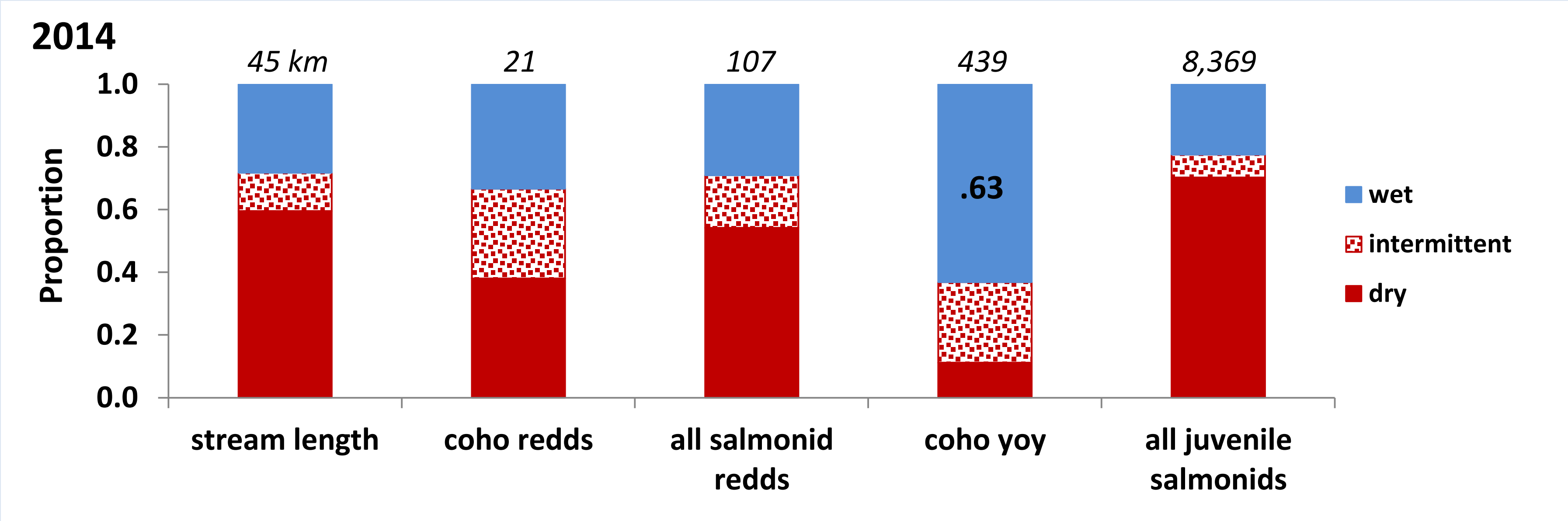


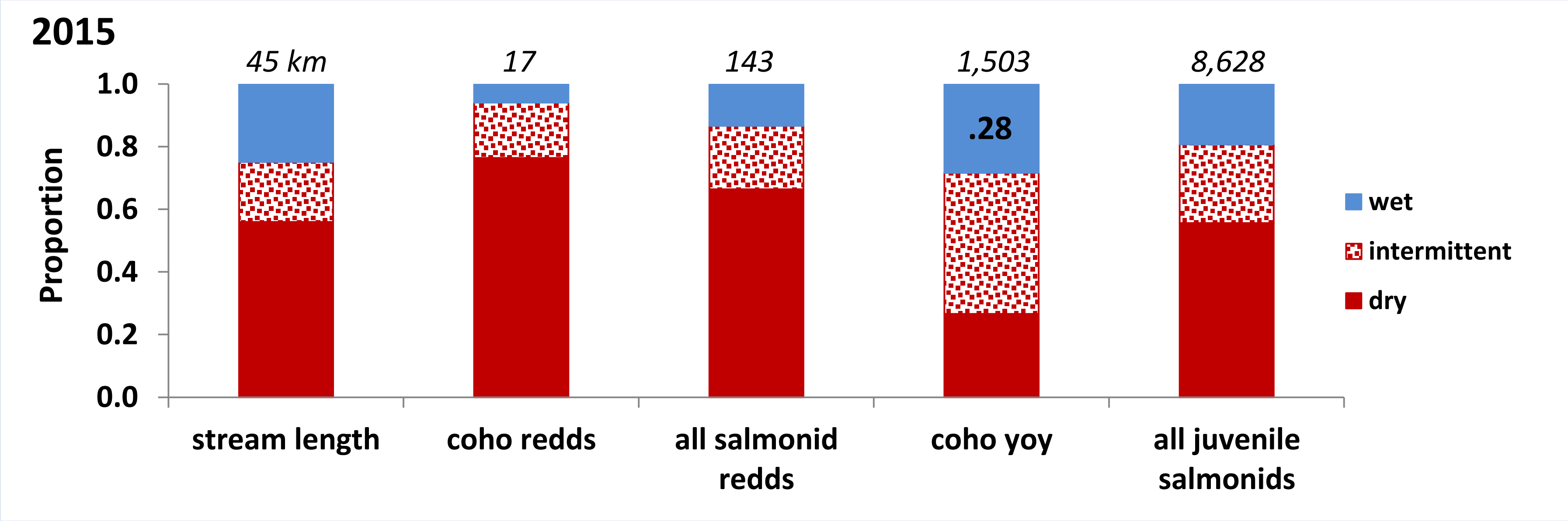
Results for five streams systems surveyed 2014-2015



Stream systems: Dutch Bill, Green Valley, Mill, Grape and Pena. Only includes results from stream lengths surveyed in both years.

Results for five streams surveyed 2014-2015





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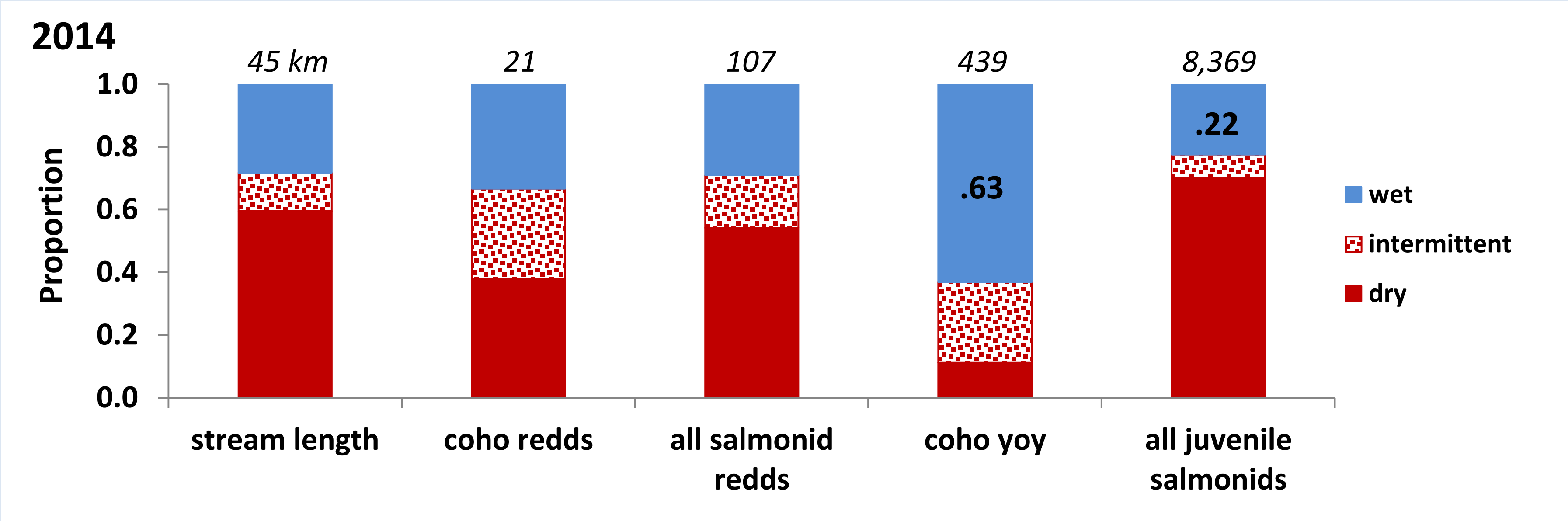
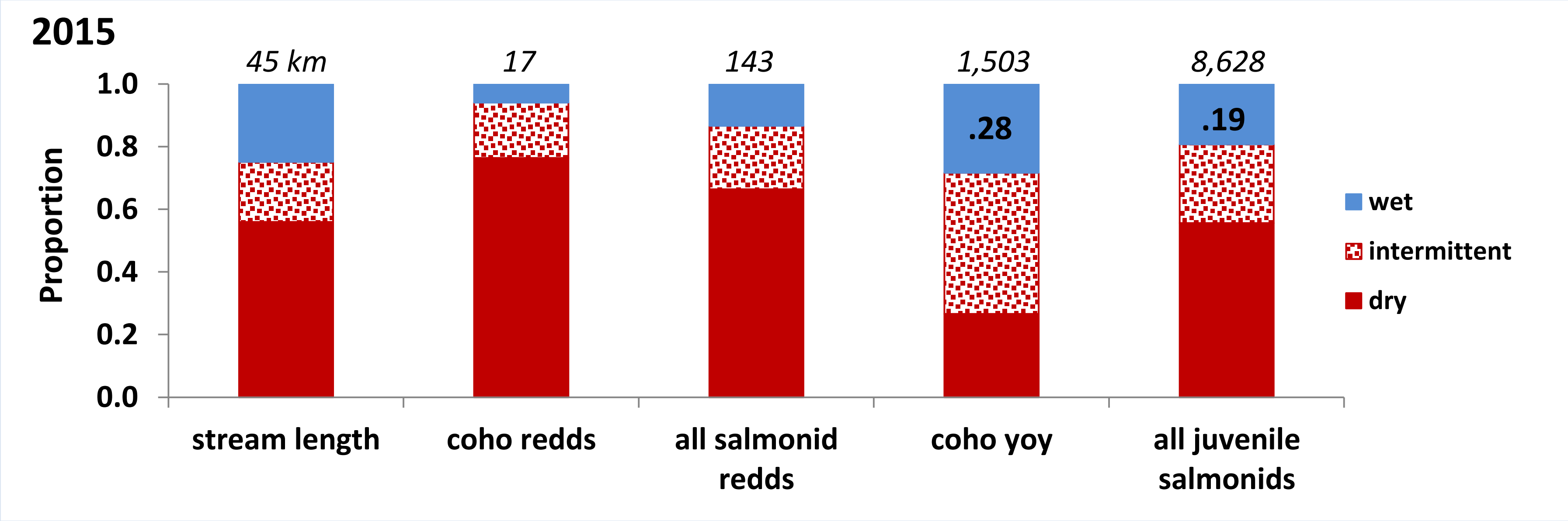




Stream systems: Dutch Bill, Green Valley, Mill, Grape and Pena. Only includes results from stream lengths surveyed in both years.

Results

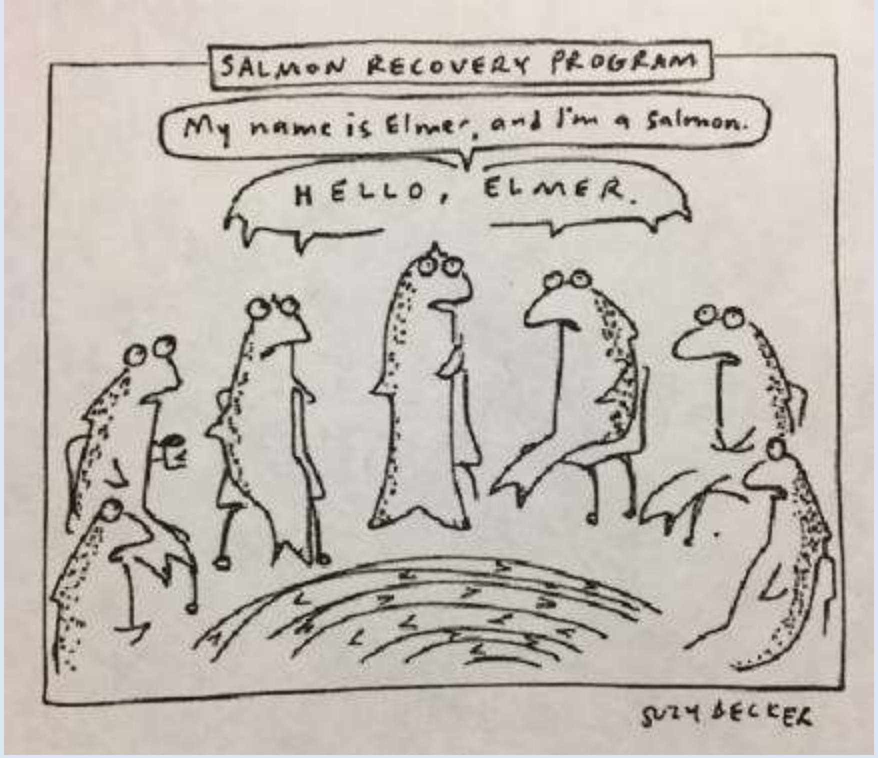
- **2012-2015: On average, only 41% length of all streams surveyed remained wet through summer (N=30, range 29-59%)**
- **2014: In 15 streams w/ snorkel & wetted hab data, ~45% of rearing juveniles had no chance of surviving the summer, ~10% had low chance (intermittent)**
- **2015: In 14 streams w/ snorkel & wetted hab data, 60% of rearing juveniles had no chance of surviving the summer**

Conclusions

- **Limited summer streamflow is a significant bottleneck to recovery of salmonid populations in the Russian**
- **Multiple years show similar results, impact varies based on annual spawning distribution**
- **To achieve long-term recovery of these populations, we have to increase summer streamflow**

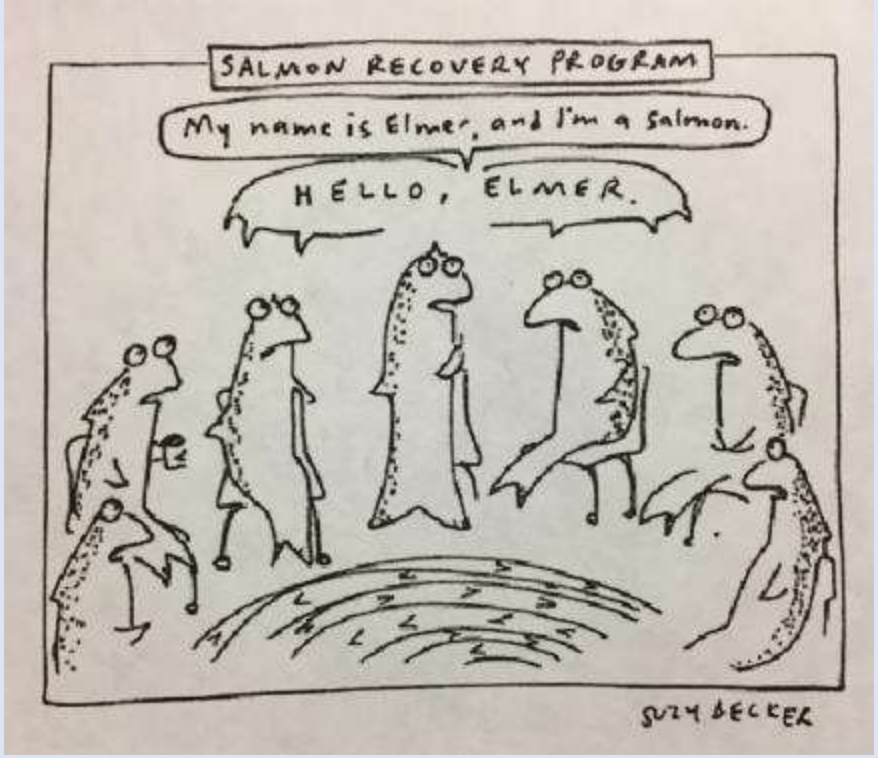
How did this effort support recovery actions?

- Identified flow-impaired, fish-rearing reaches and prioritized for flow enhancement projects (e.g., rain water catchment, frost control fans, etc)



How did this effort support recovery actions?

- Identified flow-impaired, fish-rearing reaches and prioritized for flow enhancement projects (e.g., rain water catchment, frost control fans, etc)
- Wetted habitat maps serve as spatial planning tools for practitioners for entire suite of projects (e.g., location of LWD sites)



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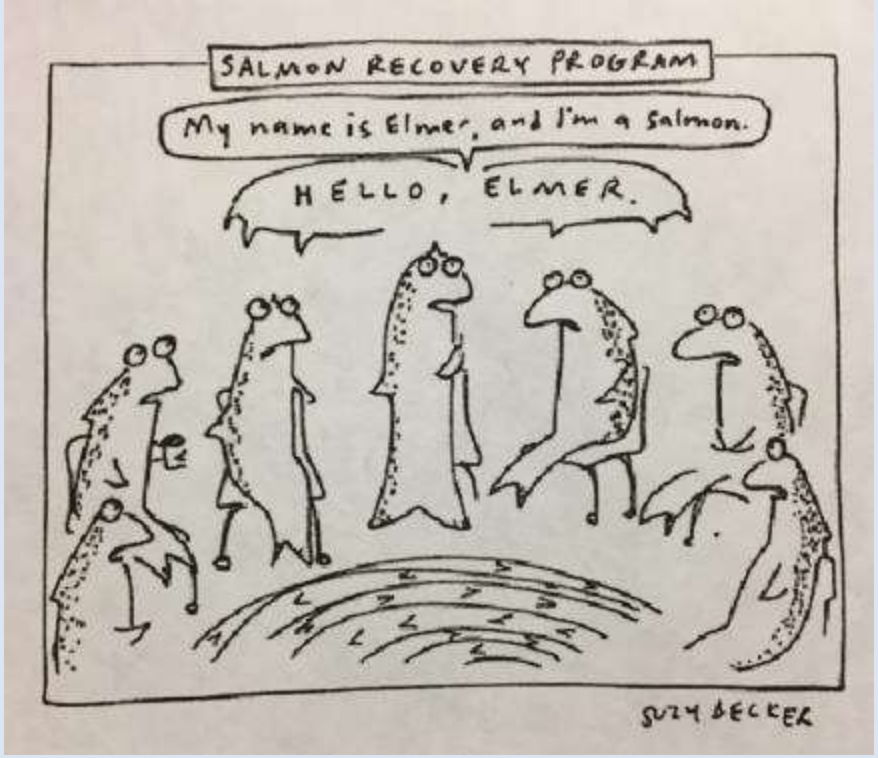
- Identified best reaches/streams for Coho Conservation Program stocking



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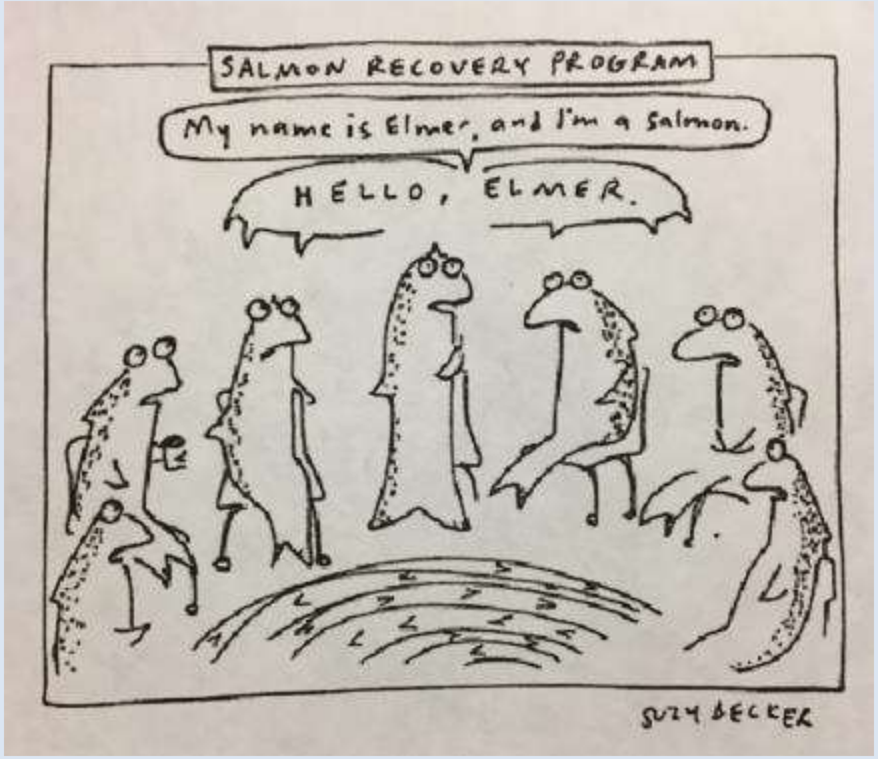
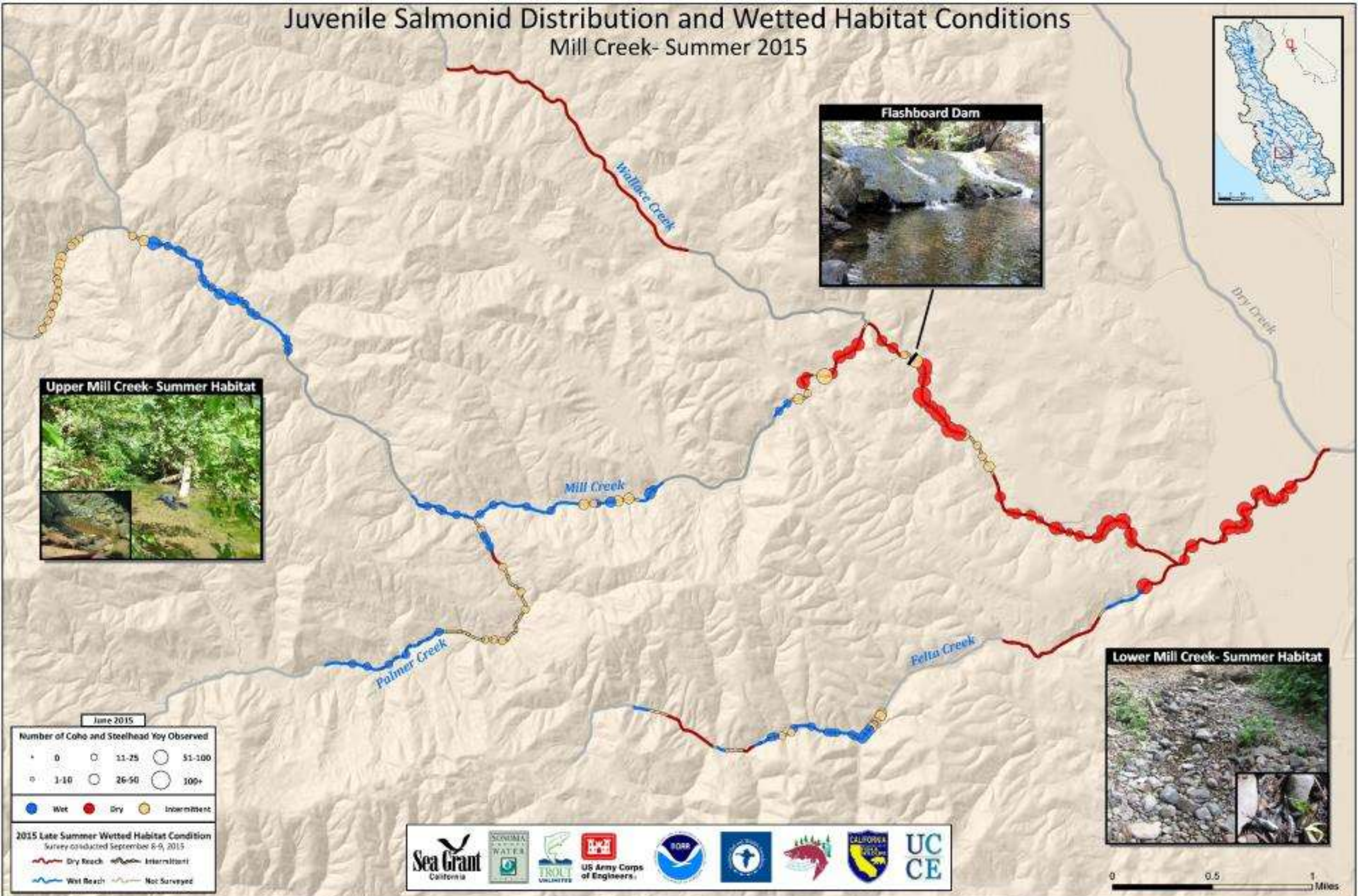
- Identified best reaches/streams for Coho Conservation Program stocking
- Helped to provide funding justification for barrier remediation



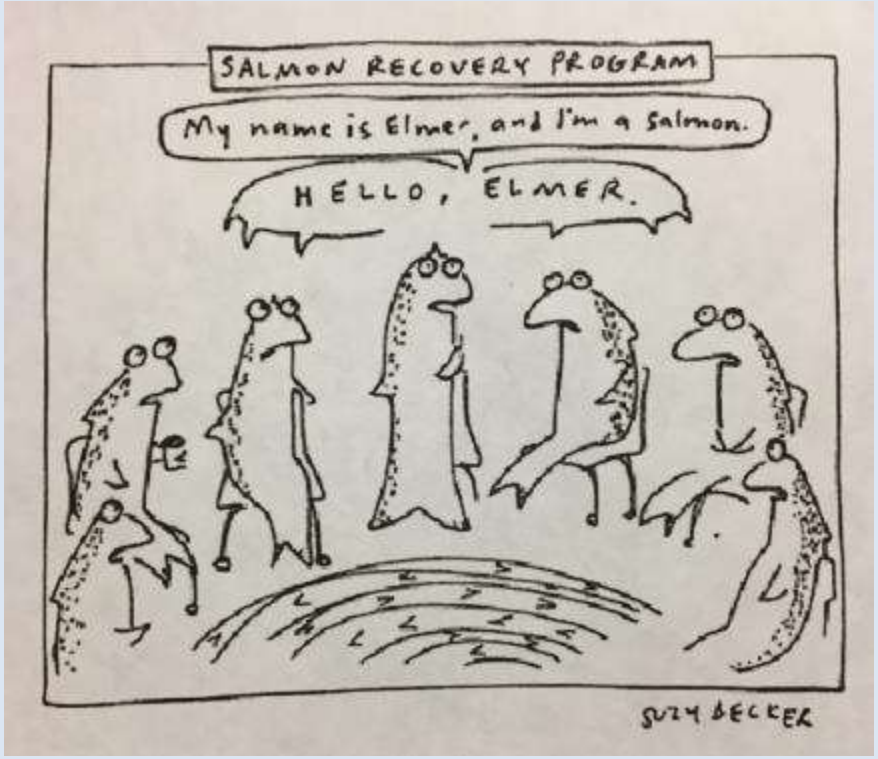


Juvenile Salmonid Distribution and Wetted Habitat Conditions
Mill Creek- Summer 2015
Flashboard Dam
Wallace Creek
Dry Creek
Upper Mill Creek- Summer Habitat
Mill Creek
Palmer Creek
Felta Creek
Lower Mill Creek- Summer Habitat
June 2015
Number of Coho and Steelhead Yoy Observed
0
1-10
11-25
26-50
51-100
100+
Wet
Dry
Intermittent
2015 Late Summer Wetted Habitat Condition
Survey conducted September 8-9, 2015
Dry Reach
Intermittent
Wet Reach
Not Surveyed
Sea Grant California
US Army Corps of Engineers
UC CE
0
0.5
1
Miles


Mill Creek Coho Salmon Redd Observations
Winters: 2011/12 through 2016/17
Fish passage over remediated dam site, March 2017
Flashboard Dam
Wallace Creek
Dry Creek
Mill Creek
Palmer Creek
Felta Creek
Observed coho salmon redd: 2016/17
Observed coho salmon redd: 2011/12 through 2015/16
Surveyed coho salmon spawning habitat
Sea Grant
California
TROUT
US Army Corps of Engineers
UC CE
0
0.5
1
Miles

How did this effort support recovery actions?

- Identified flow-impaired, fish-rearing reaches and prioritized for flow enhancement projects (e.g., rain water catchment, frost control fans, etc)
- Wetted habitat maps serve as spatial planning tools for practitioners for entire suite of projects (e.g., location of LWD sites)
- Identified best reaches/streams for Coho Conservation Program stocking
- Provided funding justification for barrier remediation
- Supported permitting of recurring flow release on flow-impaired stream



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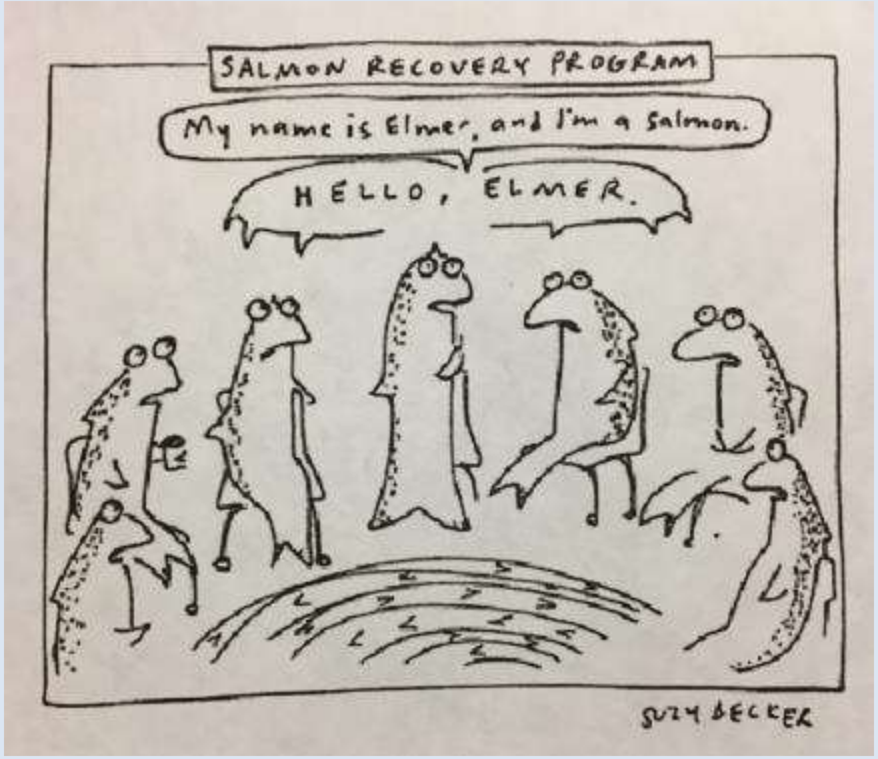
- Method used to monitor effectiveness of multiple flow releases



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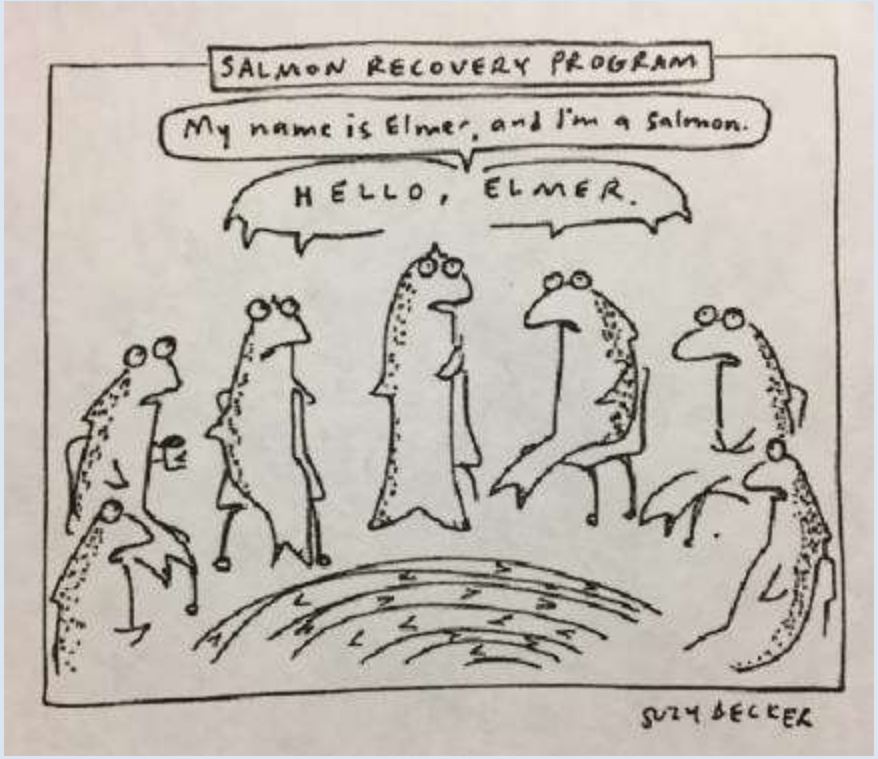
- Supported permitting of recurring flow release on flow-impaired stream
- Method used to monitor effectiveness of multiple flow releases
- *Working with UC Berkeley to develop model to predict drying using wetted habitat & climate data – tool for resource/water managers*



Thoughts…

- Think outside the box to maximize benefits of biological data collection
- What limiting factors are you facing in your watershed(s) and how can you develop empirical evidence?
- Relatively low cost methods tailored to answering specific questions may yield exponentially more from existing data
- Relating biological data to environmental data can reveal patterns
- Same exercise may validate effectiveness of remediation projects

Acknowledgements

- **Funding Sources:**
  U.S. Army Corps of Engineers
  CA Department of Fish and Wildlife
  National Fish and Wildlife Foundation
  NOAA Restoration Center
  Sonoma County Water Agency
  County of Sonoma

- **Field and Hatchery Crews**
- **Cooperating Landowners**
- **Watershed Stewards Project**

https://caseagrant.ucsd.edu/project/coho-salmon-monitoring

Telemetric Measurement Network for Instream Flow Monitoring and Diversion Control

Brad Job, P.E., Sr. Civil Engineer
Pacific Watershed Associates

Clean Water Act (CWA) Pollution Is"

- "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water."

CWA Pollutants Are:

“dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.”

150+ Years of Flashy Pollution

- Erosion and soil degradation
- Surface soil compaction from grazing and tractor logging
- Logging and resulting overstocked forests
- Water diversions
- Road cuts and gullies
- Stream linearization & entrenchment
- Draining wetlands
- Construction of impervious surfaces
- Removal of natural fire processes from the landscape
- Changes to forest species composition
- Conversion of grass lands
- Climate change

Water Quantity/Water Quality

- Newish California laws and policy provides the first opportunity for CA to link water quality and quantity.
- Required water diversion monitoring can be a vehicle for vastly better ambient water quality monitoring.

Both EPA and CalEPA Recognize the Problem

- LID requirements for new construction.
- Funding and support of watershed restoration projects.
- Stepped up enforcement for illicit diverters.
- Climate change realism.
- Persistent public comments about 303(d) listings for “flow”.
- USGS gauging efforts have primarily focused on peak flows.

The absence of pollutants is meaningless if pollution is killing fish

- Drought has highlighted low-flow problems.
- Most basins are probably over-allocated, if only seasonally.
- SWRCB addresses water quality/quantity nexus in “Policy for Maintaining In-Stream Flows in Northern CA Coastal Streams” (PMISF).
- AB2121
- SB88

Instream Flow Policy

- Policy for Maintaining Instream Flow in Northern California Coastal Streams
  - Adopted in October 2013.
  - Applies to Marin, Sonoma, and portions of Napa, Mendocino, and Humboldt Counties.
  - Requires season of diversion, minimum bypass flow, and maximum cumulative diversion.
  - Generally only applicable to recent water right holders.

Minimum Bypass Flow Equations

Drainage Area at POD or POI	Minimum Bypass Flow Formula
DA < 1 square mile:	$Q_{MBF} = 9.0\ Q_m$
1 < DA < 321 square miles	$Q_{MBF} = 8.8\ Q_m\ (DA)^{-0.47}$
321 square miles or larger	$Q_{MBF} = 0.6\ Q_m$

Where:
Q_{MBF} = minimum bypass flow in cubic feet per second
Q_m = mean annual unimpaired flow in cubic feet per second
DA = the watershed drainage area in square miles

Our Solution

Develop an open-source real-time water diversion control/flow gauging network that will:

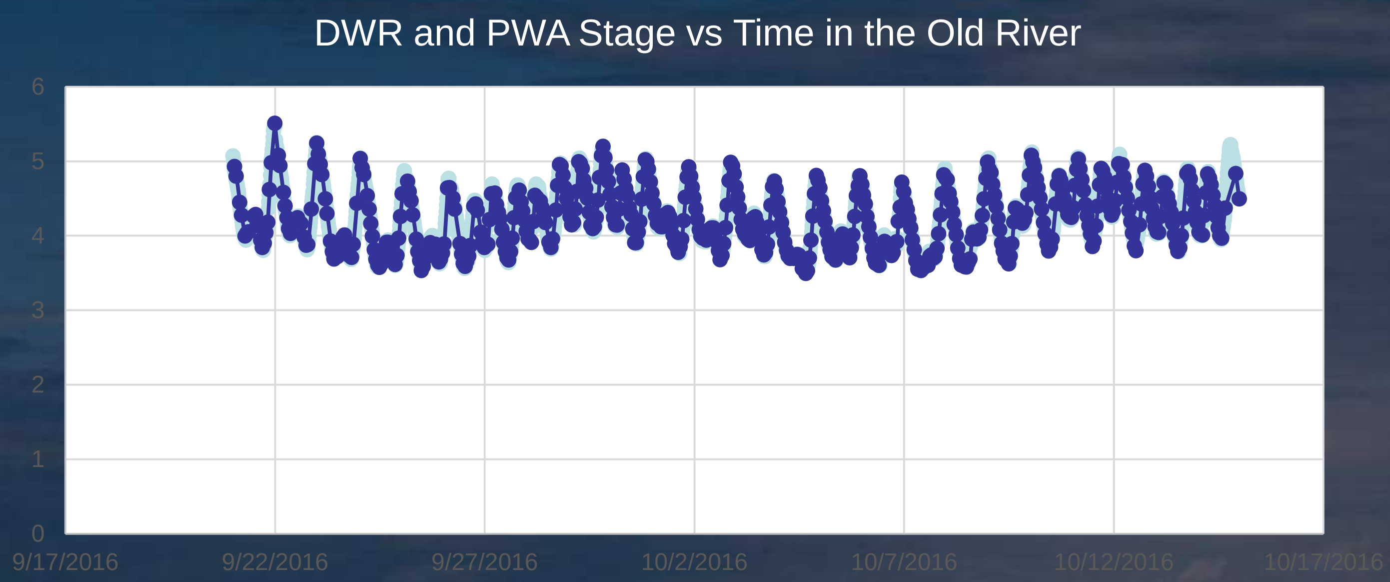
1. Assure compliance with PMISF.
2. Sequence diversions to minimize impacts of simultaneous water diversions.
3. Facilitate reduced pumping during lower flows.
4. Cease diverting when required by PMISF.
5. Simplify reporting of water diversion and use.
6. Create the telemetric network backbone that can eventually become a real-time water quality monitoring network.

PWA Mark I Telemeter

Backbone Hardware / Software

- C++ (mbed.org) running on inexpensive cell-connected microprocessor.
- Establish reliable and repeatable flow gauging method that is tamper-resistant, including siphon diversions.
- Relies on existing cellular networks or low-power radio (LoRa) modems.
- Web-based portal for managing data.

PWA Mark I Telemeter



What Can Be Monitored Remotely?

- In-stream flow / rate of diversion.
- Temperature.
- Conductivity, pH, dissolved oxygen.
- Turbidity (OBS).
- Cyanobacteria presence.
- PIT tag array readings.
- Pollutants whose presence can be reported via digital or analog signals.

Multiple Benefits

- Diverters can withdraw as much water as is their right without adversely affecting water quality and habitat quantity.
- Strategic placement at low-flow barriers could fine tune diversion systems to maximize accessible summer habitat.
- Compliance monitoring and reporting become vastly easier and more accurate.
- Low-flow monitoring with very fine temporal and spatial resolution.

More Benefits

- Alert downstream diverters of adverse water quality conditions.
- Uniform curtailment for similar water right holders in a drought emergency.
- Initial capital expense of backbone supported by water diverters.
- Instrumentation can reveal linkage between water quality and salmonid rearing success.

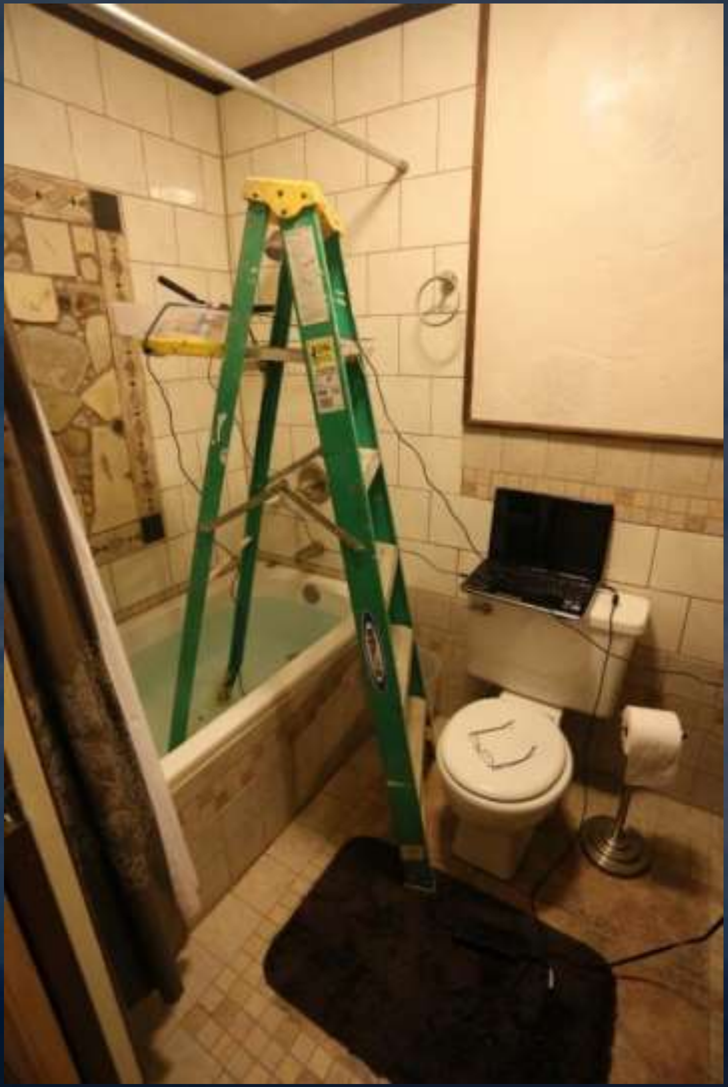
More Benefits

- Graphically display trends and conditions on website.
- Searchable by watershed, parameters, dates.
- Gather data to demonstrate TMDL progress or lack thereof.
- Rapid detection of impaired water quality.
- Data can link restoration actions, water quality results, and ecosystem health.

Microprocessor Software Development Schedule

- Deployed at DWR sites in the Delta June 2016
  - Validated data with DWR data.
  - Tested reliability and durability.
- Firmware
  - Interoperable diversion control
- Software
  - Web host and archiving processes.
- Water security application for storage and forebearance users.

Test Facilities



Ultrasonic Distance Measurer

- Used extensively in:
  - Water treatment
  - Industrial processes
  - Polaroid SX70 camera
- Sources of measurement errors
  - Floating debris
  - Waves
- Non-contact means less damage or loss.

Accuracy & Precision

- UDM Manufacturer reports accuracy of ± 1mm.
- Comparison to DWR pressure transducer showed R^2 = .994 with n = 5___
- SWRCB requires < 10% error.
- Primary source of inaccuracy lies within the stage-discharge relationship

Call Us

- Pacific Watershed Associates, McKinleyville Office (707)-839-5130, bradj@pacificwatershed.com
- Pacific Watershed Associates, Petaluma Office (707) 773-1385,
- WQ Consultants, (707)-624-6679, rpincus@wqconsultants.com

Factors Influencing Chinook Egg Survival in the Regulated Cle Elum (WA) River

Mark D. Bowen, Ph.D., Environmental Science Associates
Scott T. Kline,
WA Dept. of Fish and Wildlife
S. Mark Nelson,
Retired, US Bureau of Reclamation
Jeanette C. Haegele,
Retired, US Geological Survey
Joseph P. Kubitschek,
US Bureau of Reclamation

ESA

Introduction

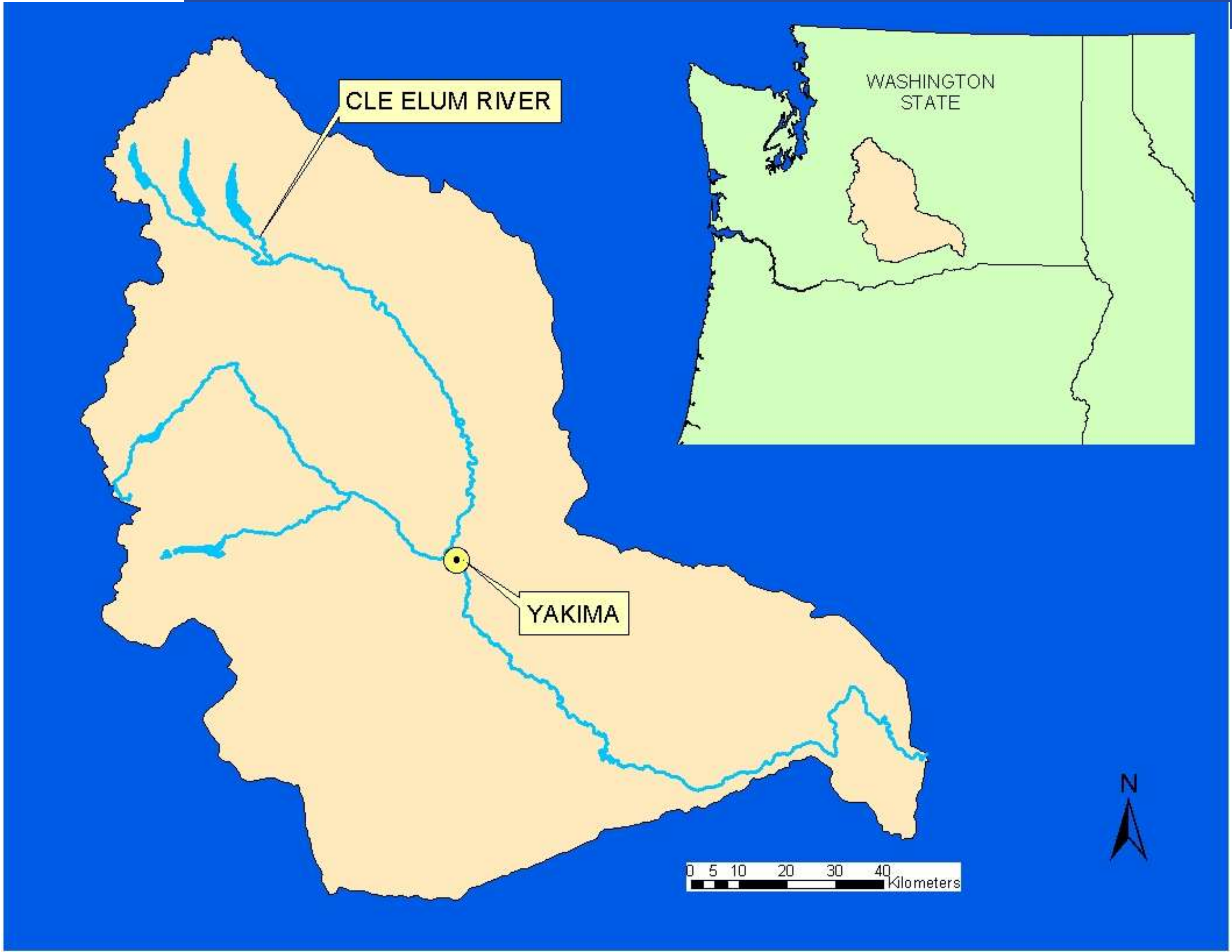
- From 2001-03, US Bureau of Reclamation (USBR) reduced Cle Elem (WA) autumnal Dam releases (Q) to reduce the chance of winter dewatering of spring chinook redds.

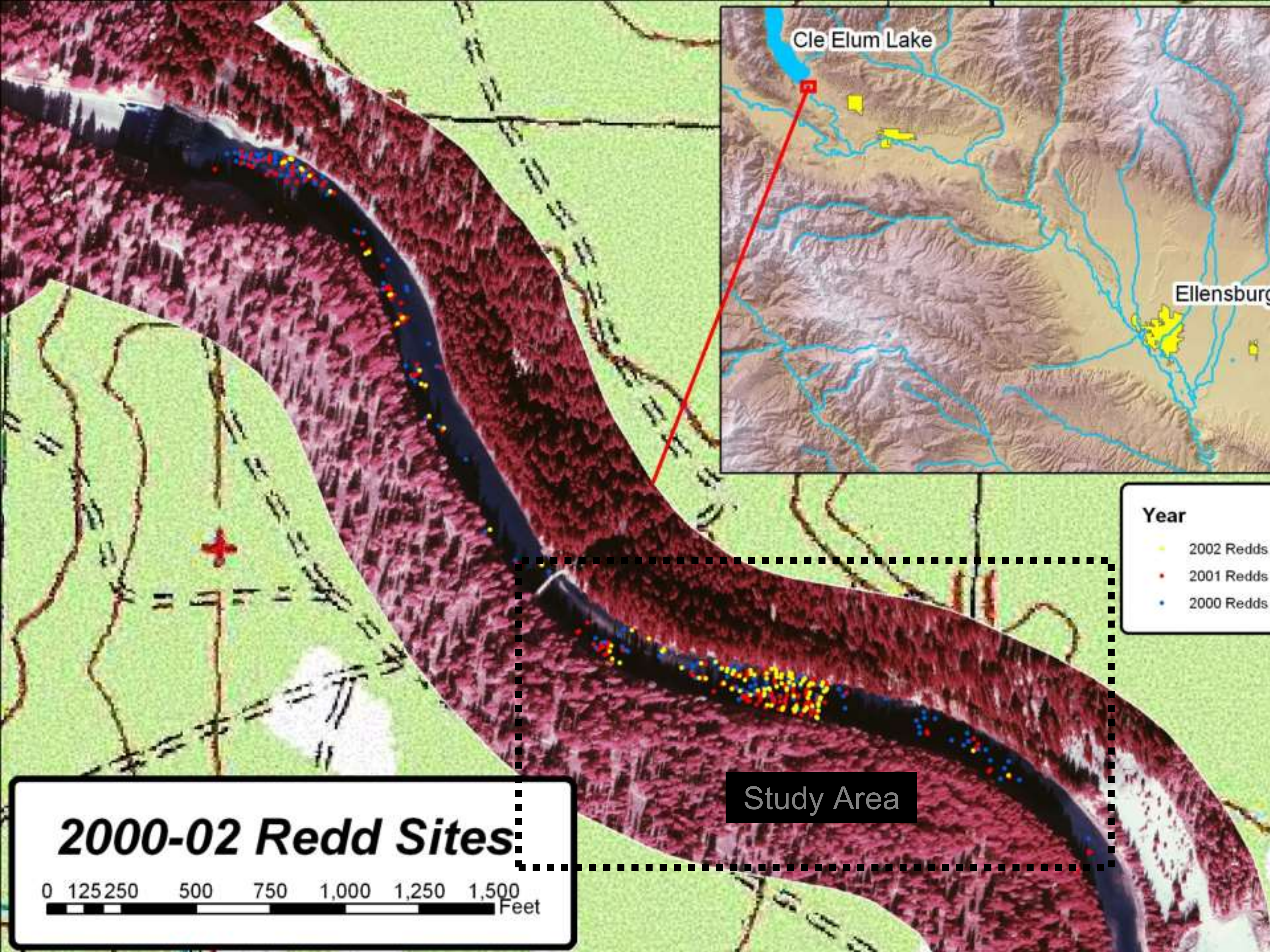
- We investigated the influence of dam-released Q on spring chinook habitat and:
  - 1. Egg survival
  - 3. Embryo fitness as measured by
    - weight with yolk sac, and
    - weight without yolk sac
  - 4. Physical and chemical habitat in surface waters and redds
    - Including hyporheic flow
  - 5. Invertebrate communities that colonize redds

We hypothesized that more upwelling sites might be less susceptible to egg mortality because fine sediment is less likely to be deposited on the redds

ESA

Study Site




Cle Elum Lake
Ellensburg
Year
2002 Redds
2001 Redds
2000 Redds
Study Area
2000-02 Redd Sites
0 125 250 500 750 1,000 1,250 1,500
Feet

Primary Research Objectives

1. Determine if Fall Q reductions increased spring Chinook egg mortality
2. Compare hydraulic characteristics and H2O quality between redds and other available habitat
3. Describe the redd-hyporheic environment
4. Evaluate the relationship between groundwater, hyporheic flow, and egg survival

Methods

1) Obtain data.
   a) Periodic groundwater elevations at the nearest gauge (Well 77-3); no continuous data
   b) Q records at calibrated gauges just upstream of study site
2) Measure temperature, DO, depth, velocity, and substrate adjacent to spring chinook redds and in other “non-redd” habitats
3) Measure hyporheic flow by piezometer
4) Estimate egg survival and embryo fitness

Methods

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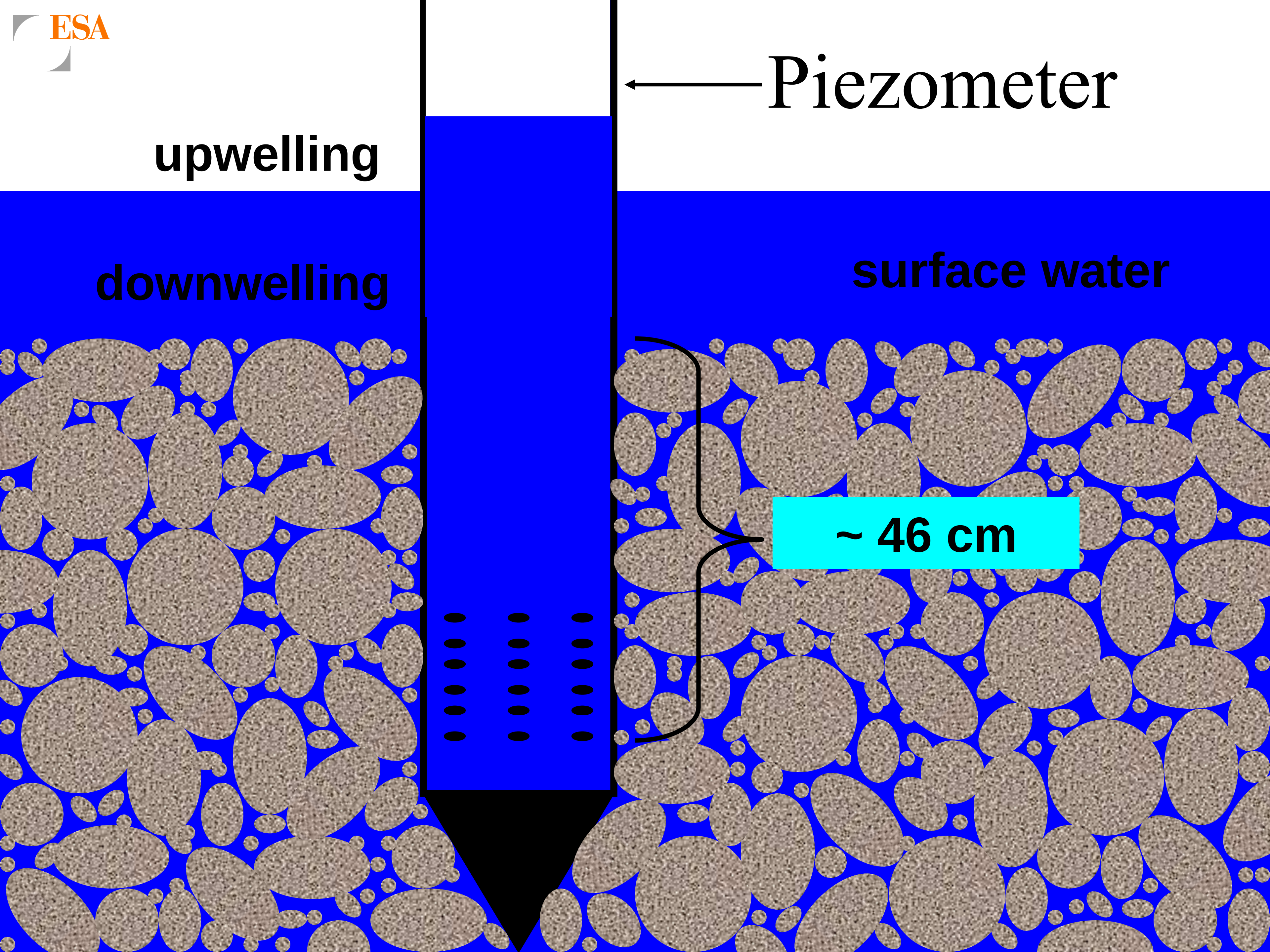
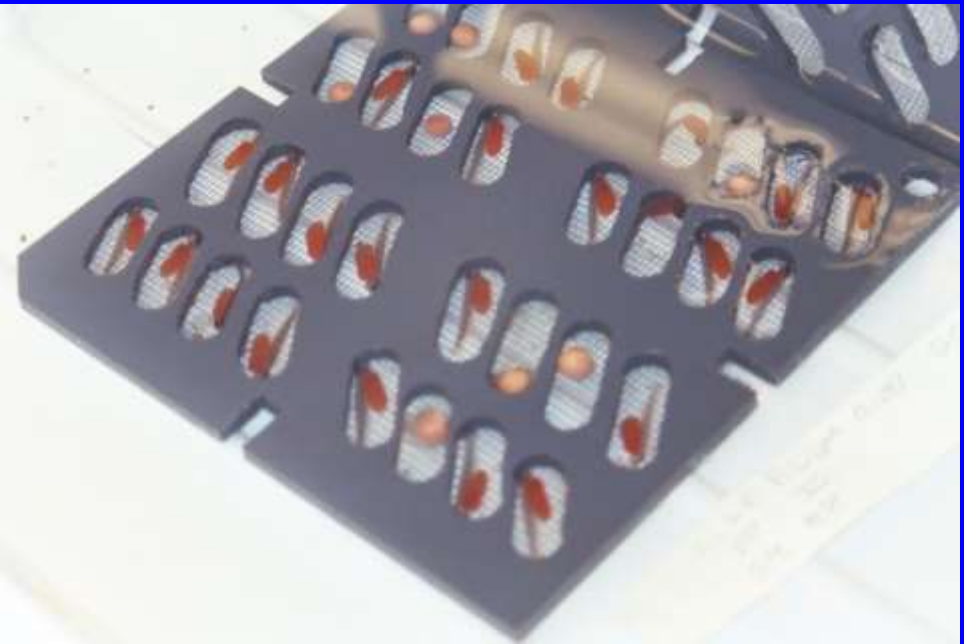
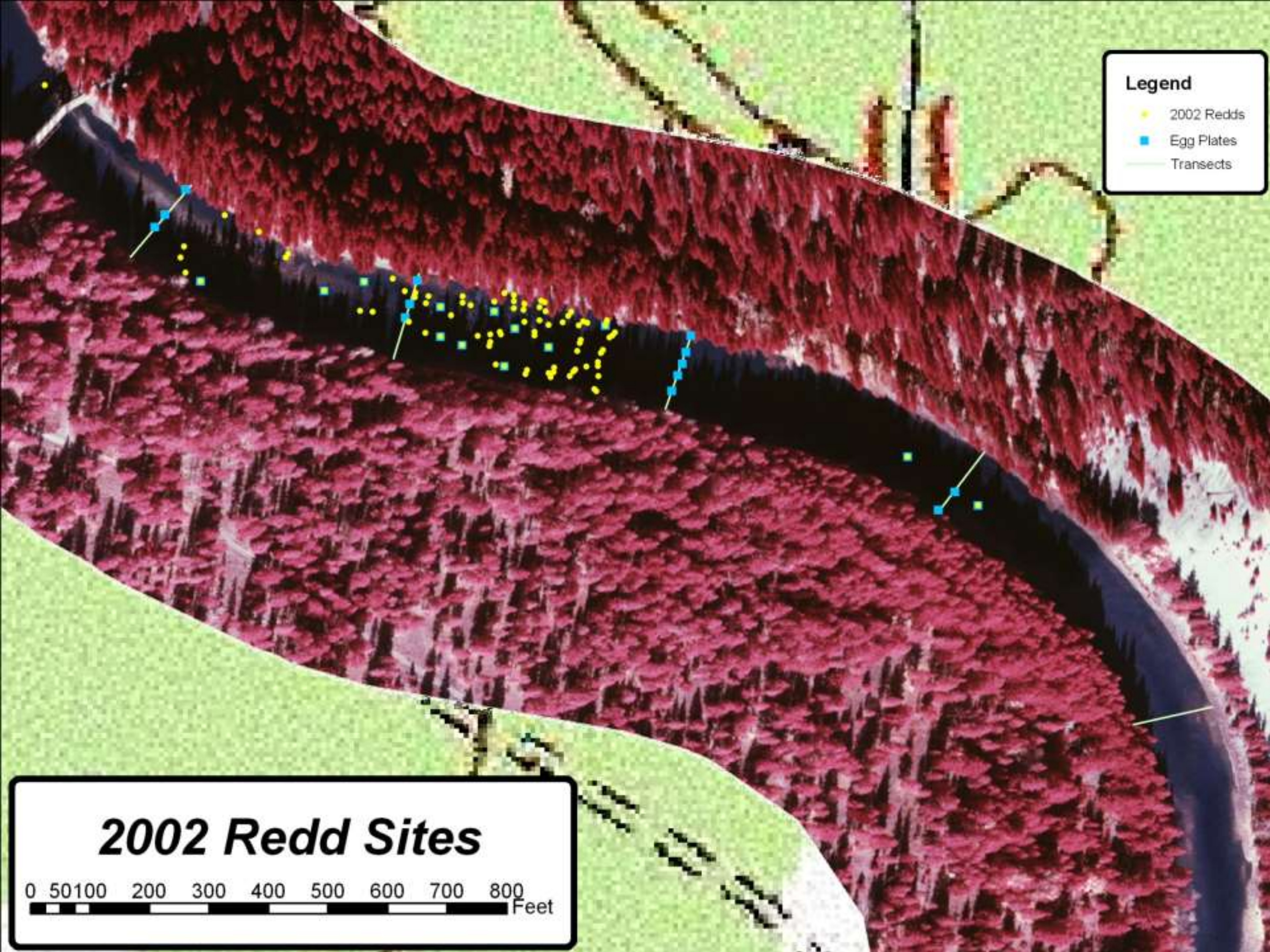

ESA
Piezometer
upwelling
downwelling
surface water
~ 46 cm

Embryo Survival/Fitness Methods

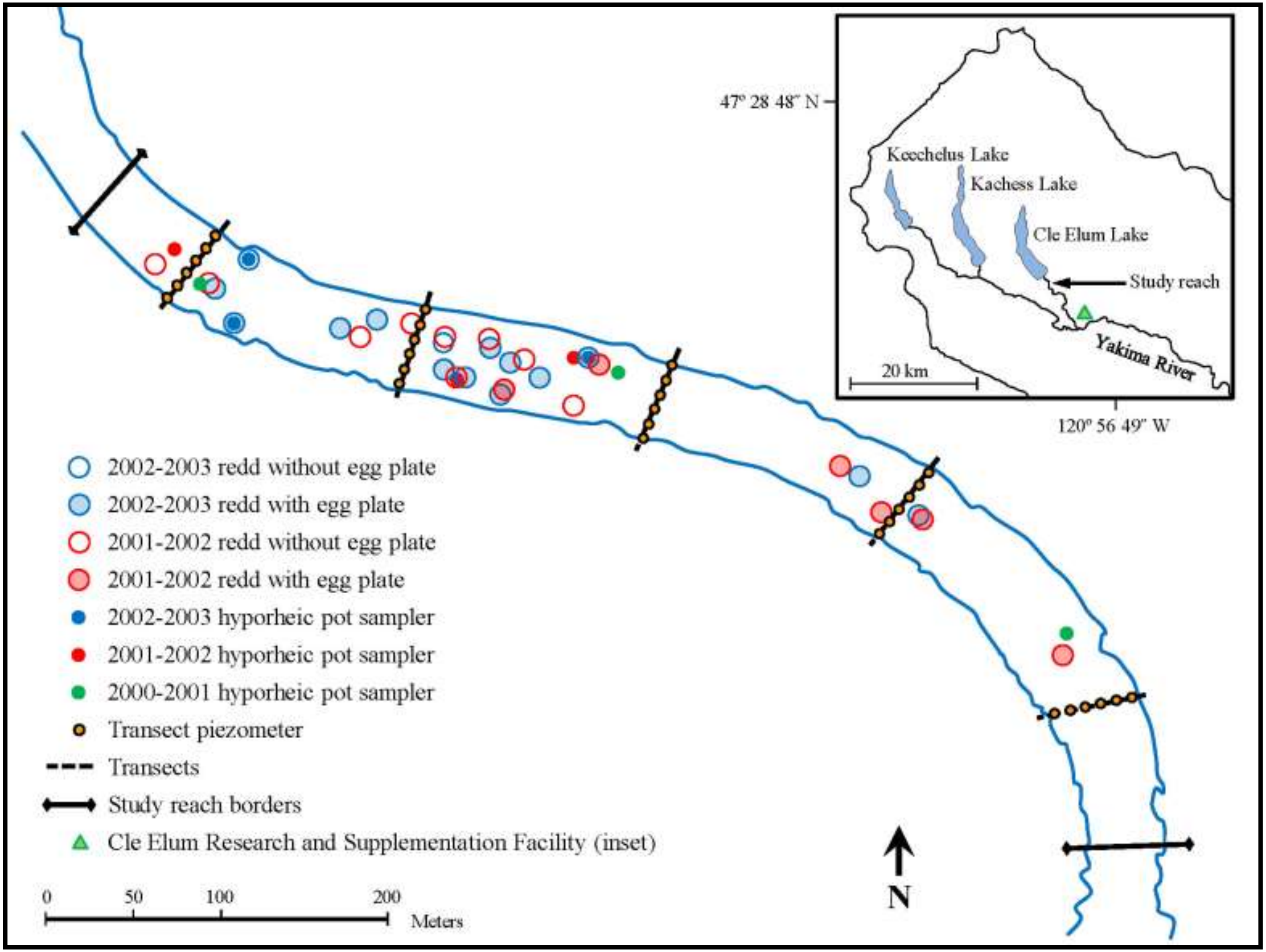


- Excavate holes to a depth of 33 cm depth
  - 13 adjacent to redds
  - 13 away from redds

- Obtain gametes at a nearby hatchery
- Fertilize eggs at field site
- Load egg plates (16 X 16 cm)
- Bury and allow to incubate
- After hatching remove egg plates
  - Count survivors
  - Measure length
  - Weigh alevins w/ and w/out yolk sac

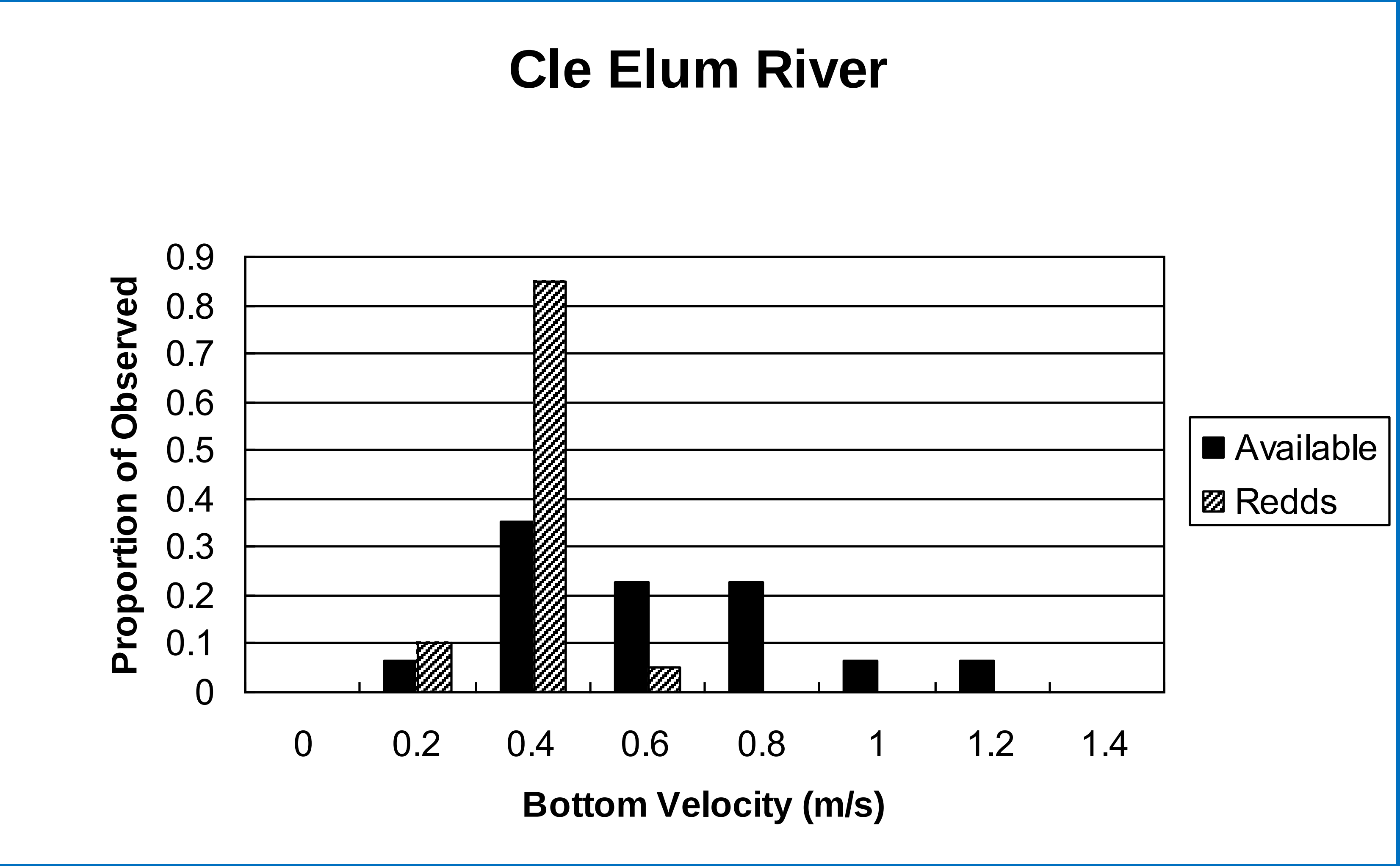

Legend
2002 Redds
Egg Plates
Transects
2002 Redd Sites
0 50100 200 300 400 500 600 700 800
Feet

Methods (2)

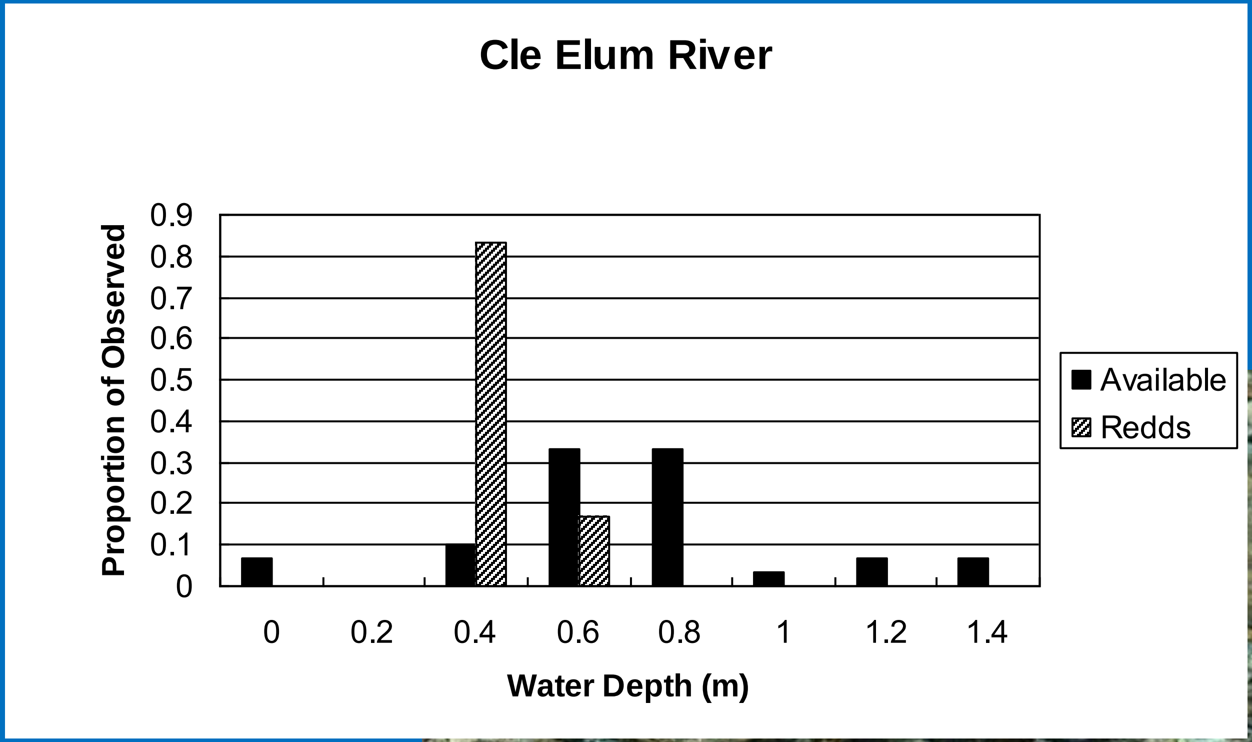


47° 28 48" N
Keechelus Lake
Kachess Lake
Cle Elum Lake
Study reach
Yakima River
20 km
120° 56 49" W
2002-2003 redd without egg plate
2002-2003 redd with egg plate
2001-2002 redd without egg plate
2001-2002 redd with egg plate
2002-2003 hyporheic pot sampler
2001-2002 hyporheic pot sampler
2000-2001 hyporheic pot sampler
Transect piezometer
Transects
Study reach borders
Cle Elum Research and Supplementation Facility (inset)
0
50
100
200
Meters
N

Results


Cle Elum River
Proportion of Observed
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Bottom Velocity (m/s)
Available
Redds

Water Depth



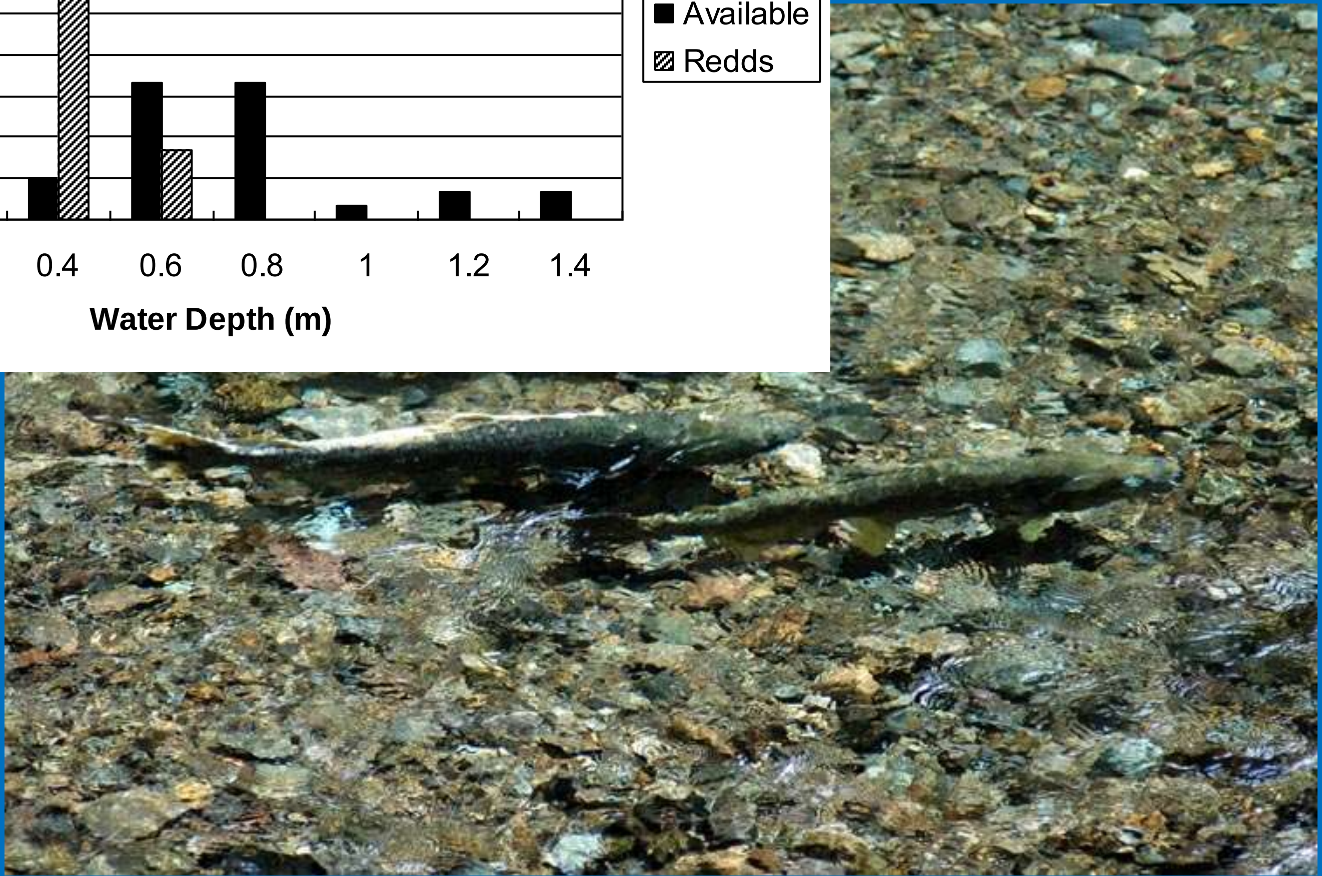
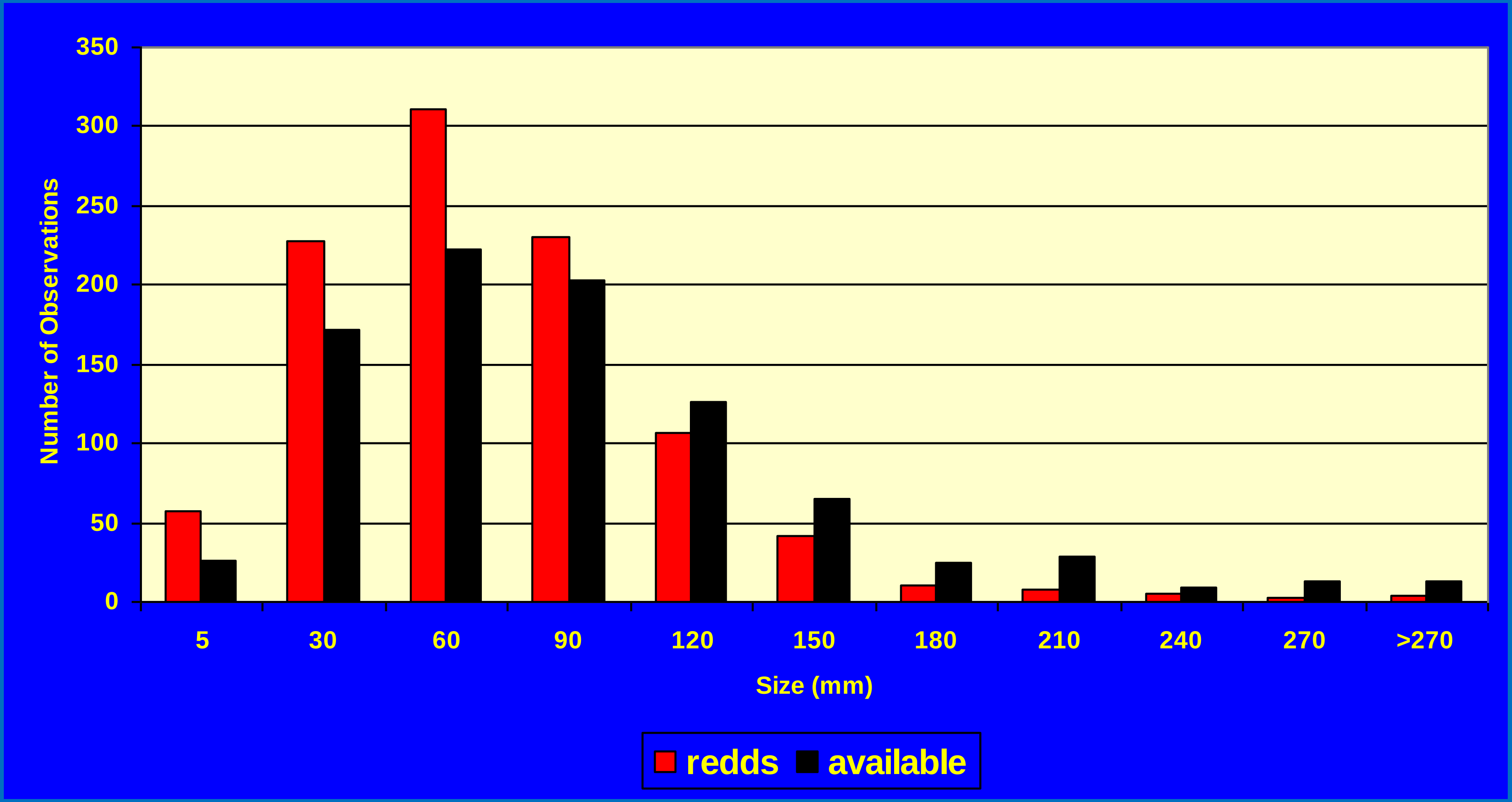


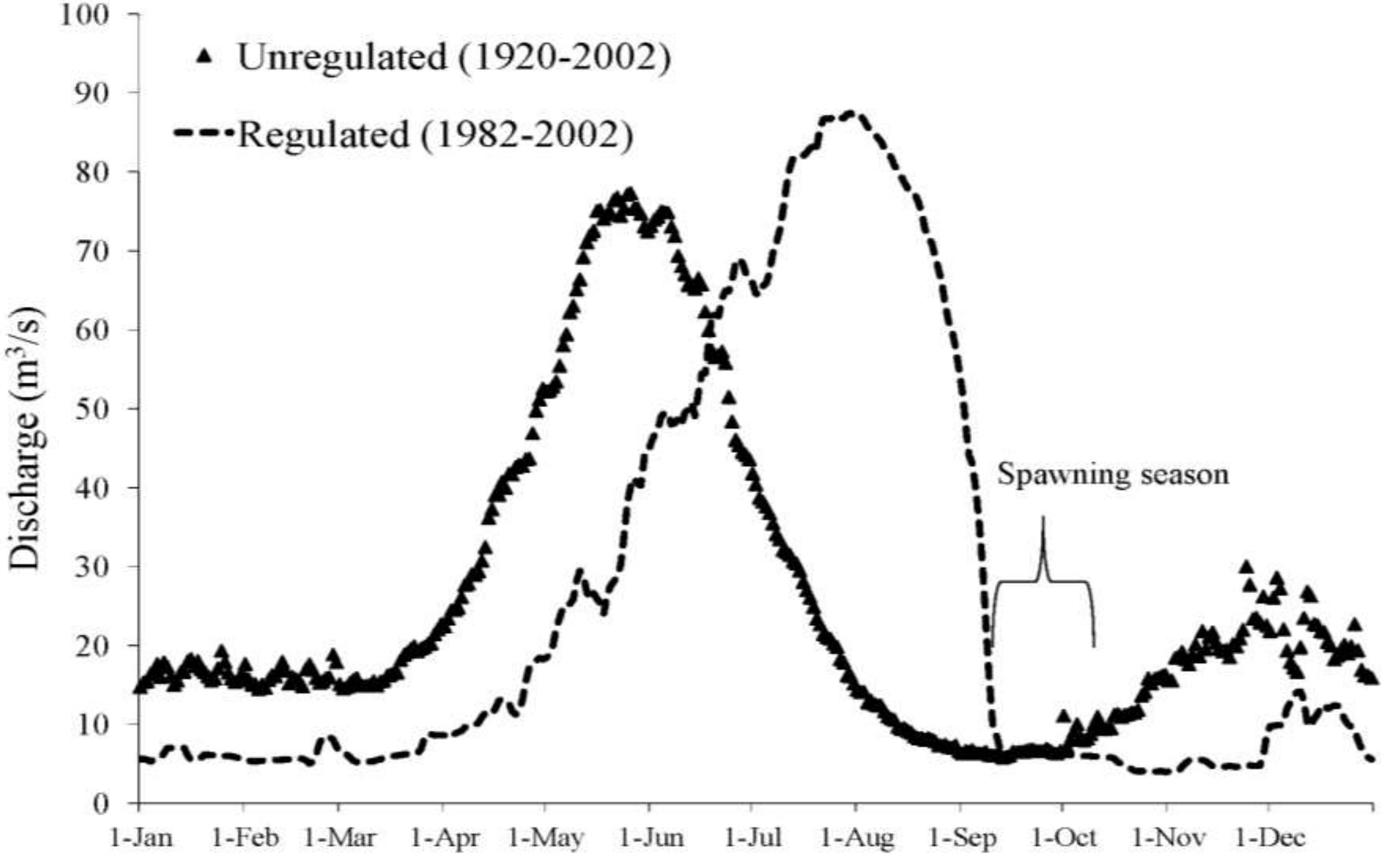
Photo Credit: Yakima Basin Environmental Education Program

Substrate

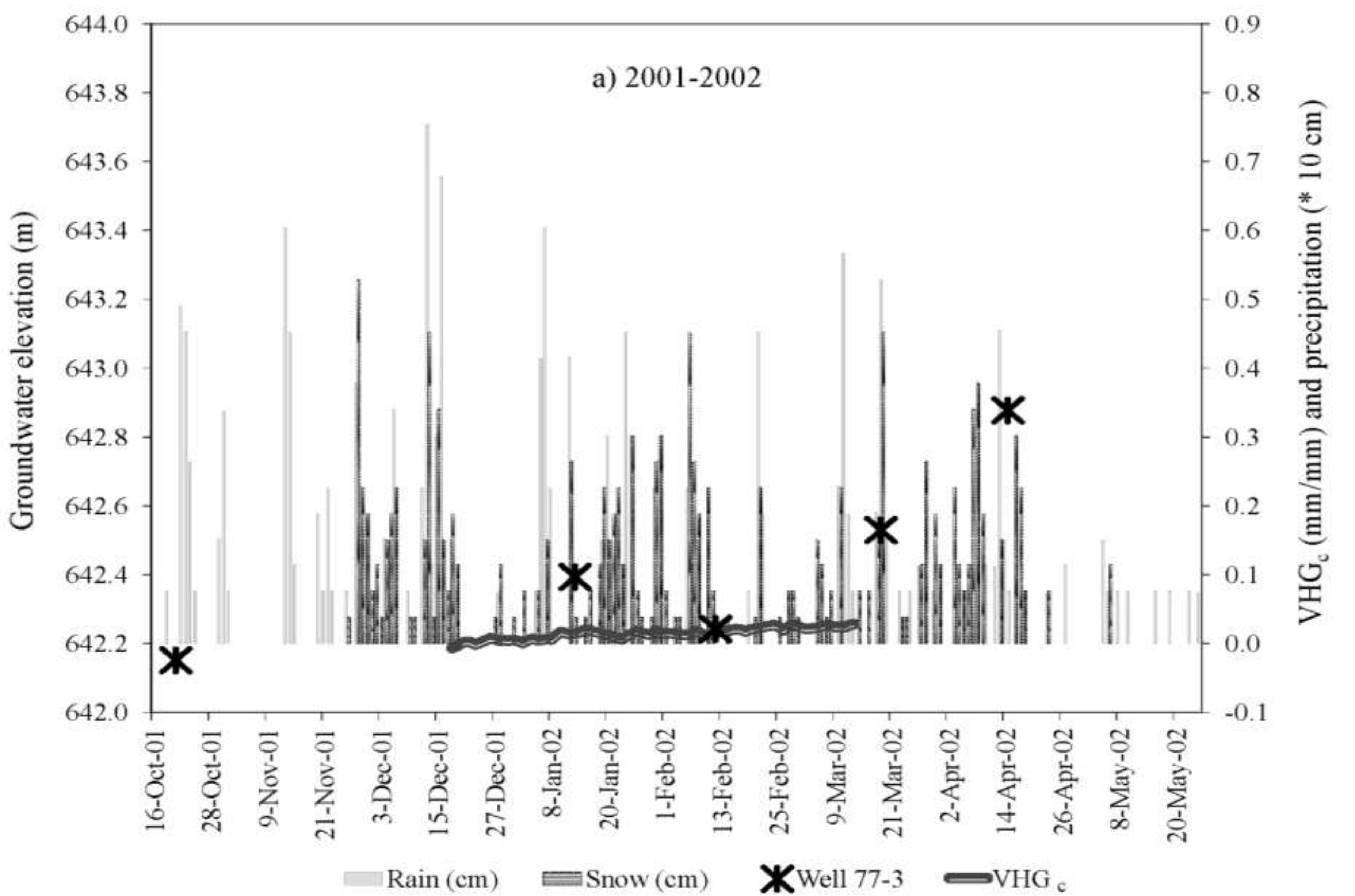


350
300
250
200
150
100
50
0
Number of Observations
5
30
60
90
120
150
180
210
240
270
>270
Size (mm)
redds
available

Surface Discharge (Q)

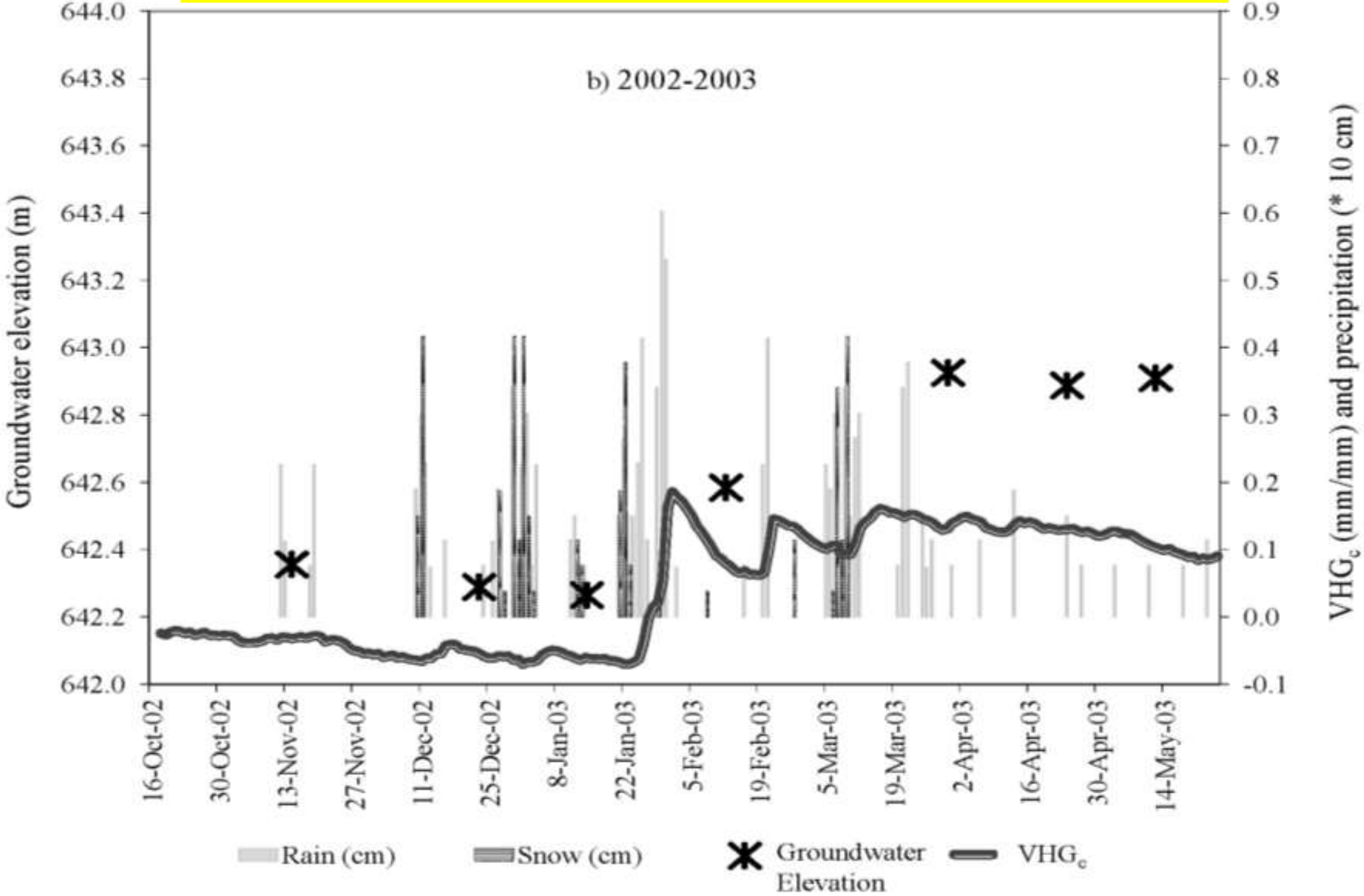


Slow Snow-Melt Year



Rain-on-Snow Event Year

But we never observed a correlation between Q and VHG



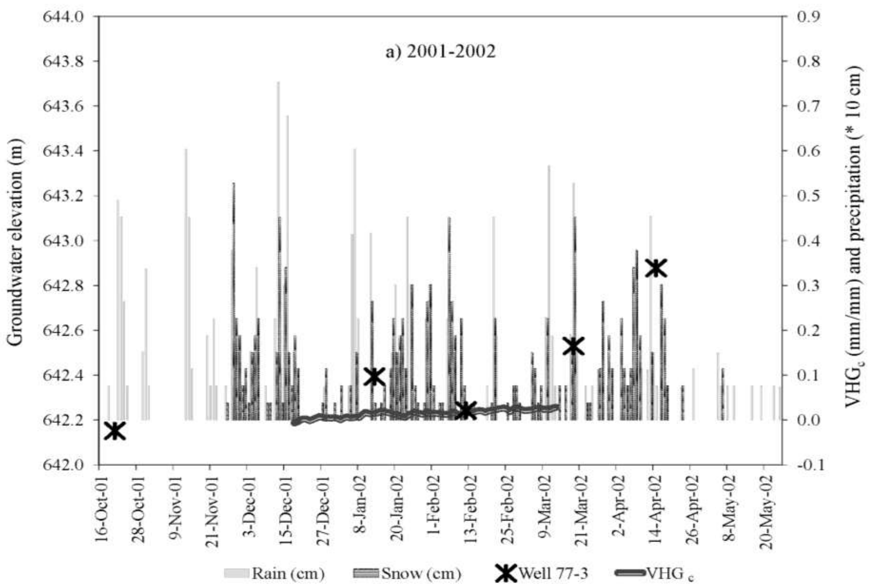
Comparing Years

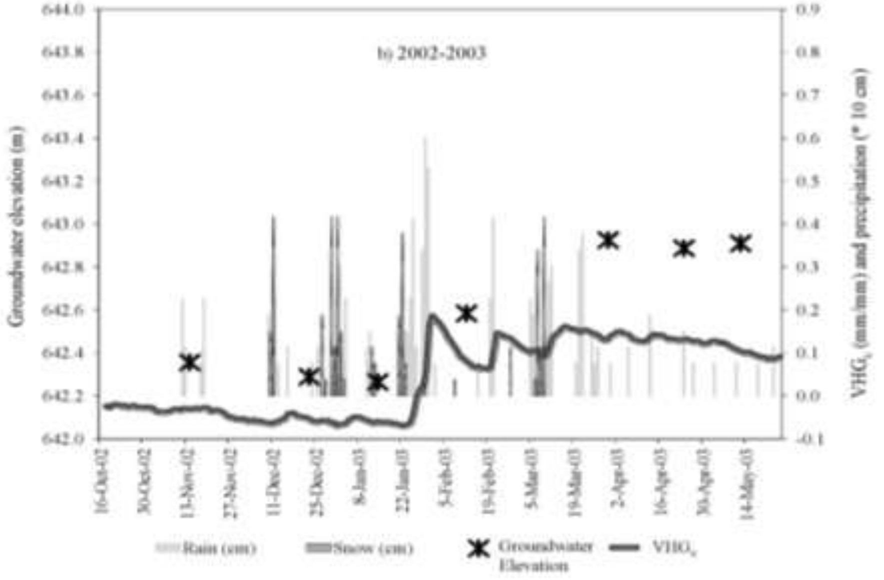
2001-02: Far more precipitation in this wet year; no substantial rain on snow event

Results: Groundwater elevation noticeably increasing by Mar. 21, 2002; VHGc rises slowly and consistently

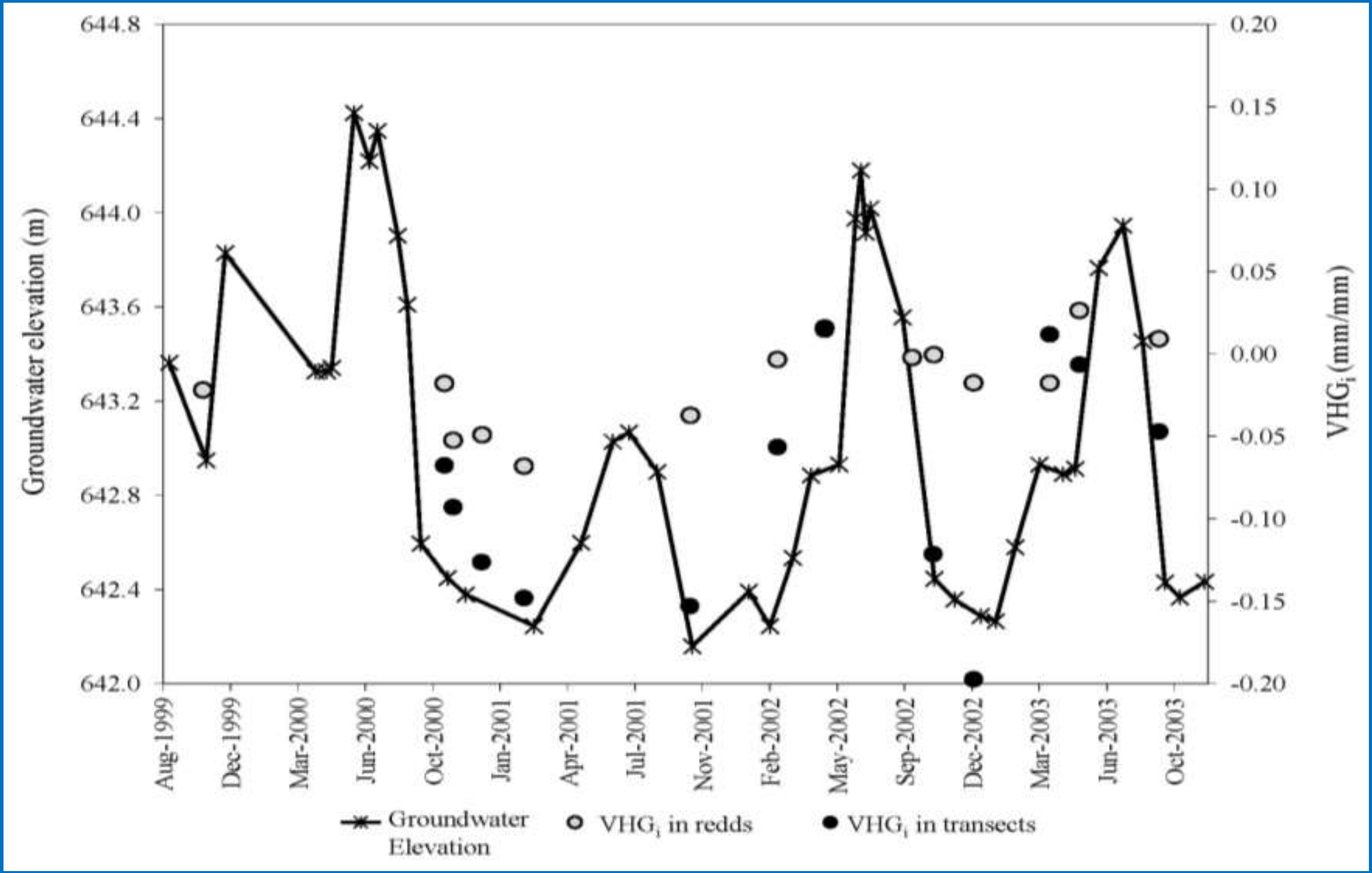
2002-03: Far less precipitation in this below average year; major rain on snow event in late January

Results: Groundwater elevation noticeably increasing by Feb. 12, 2003; VHGc rises substantially and immediately after the rain on snow event



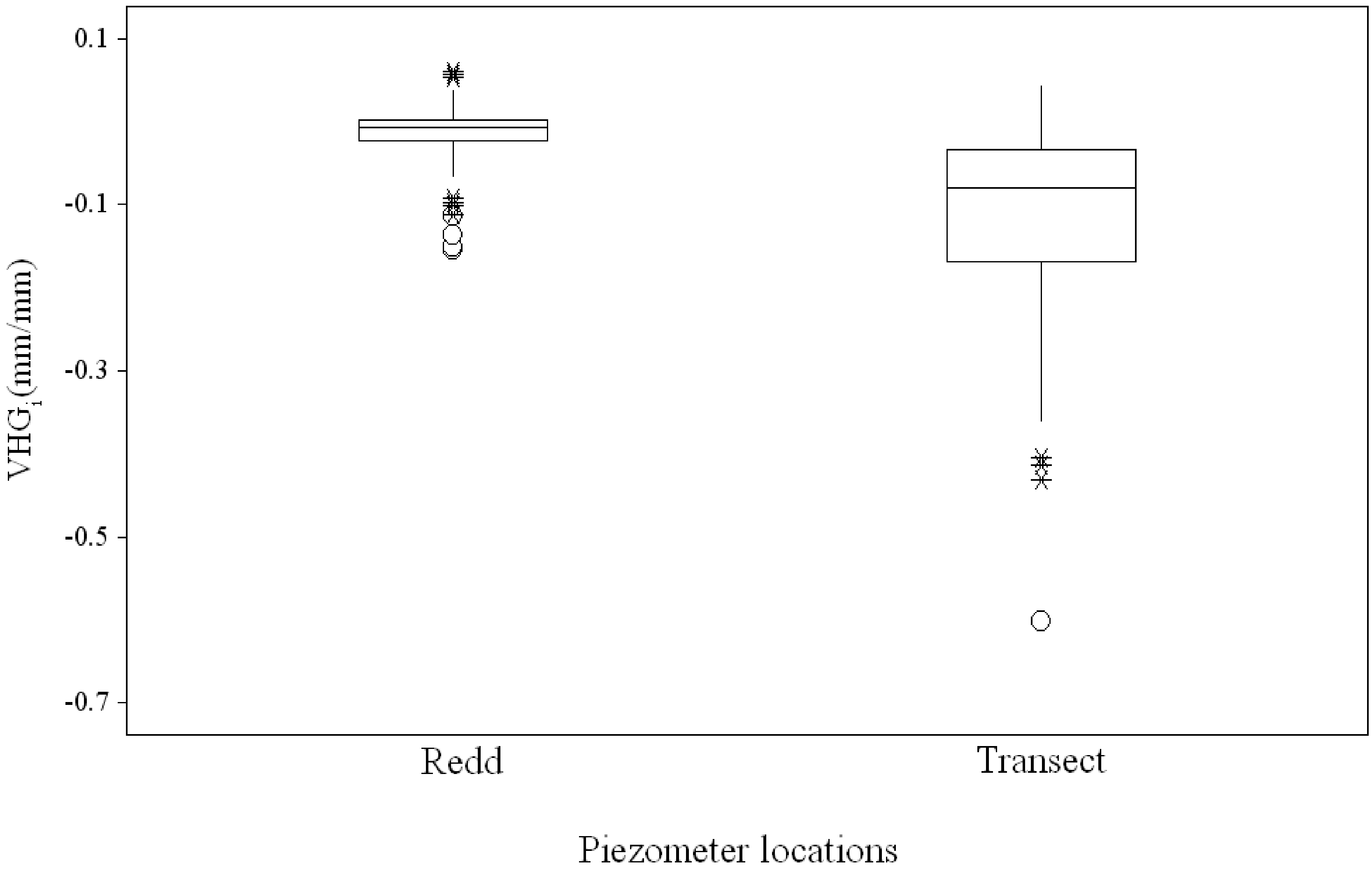


Groundwater-VHG Relationship

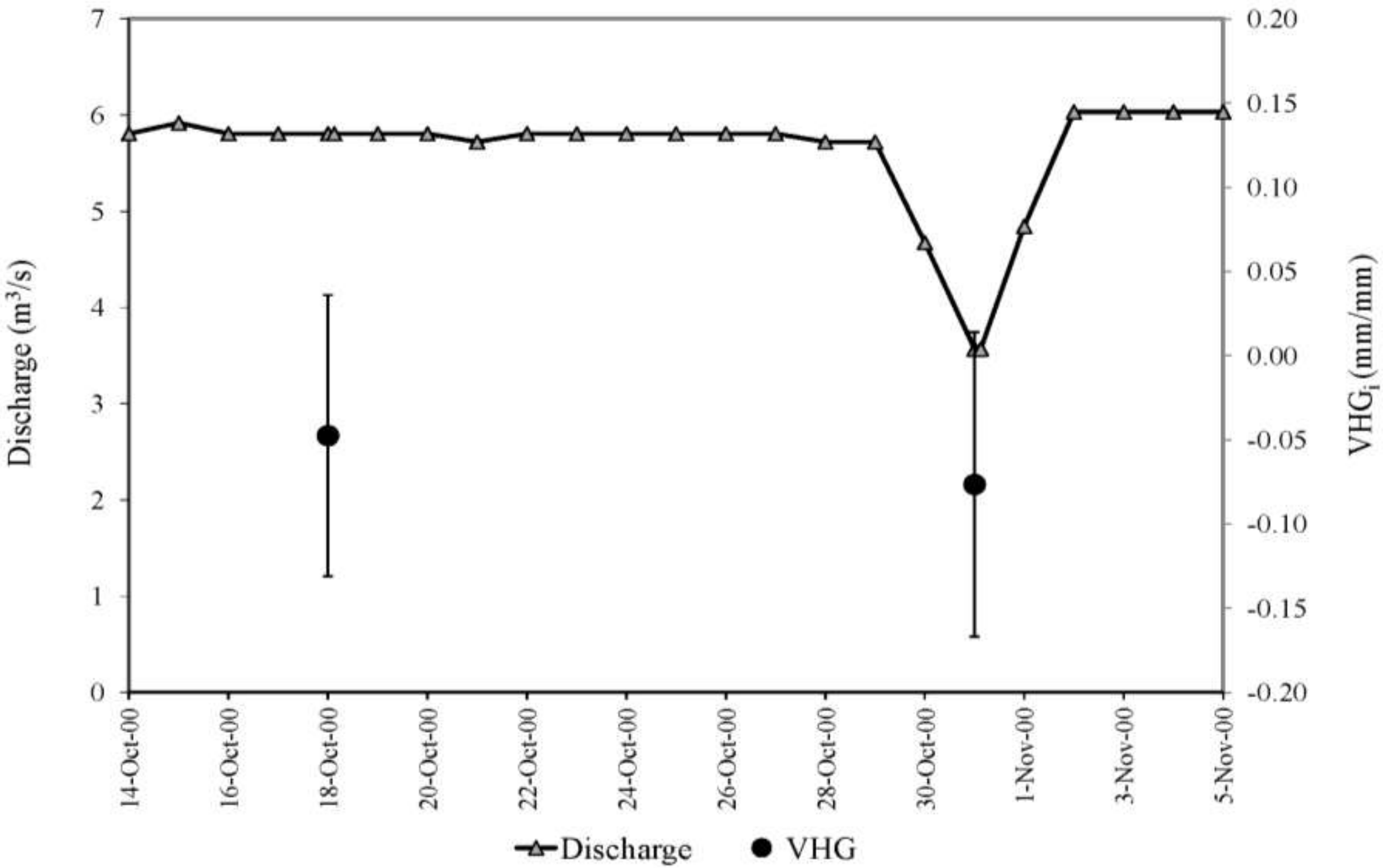


Note: No correlation between Q and VHGi

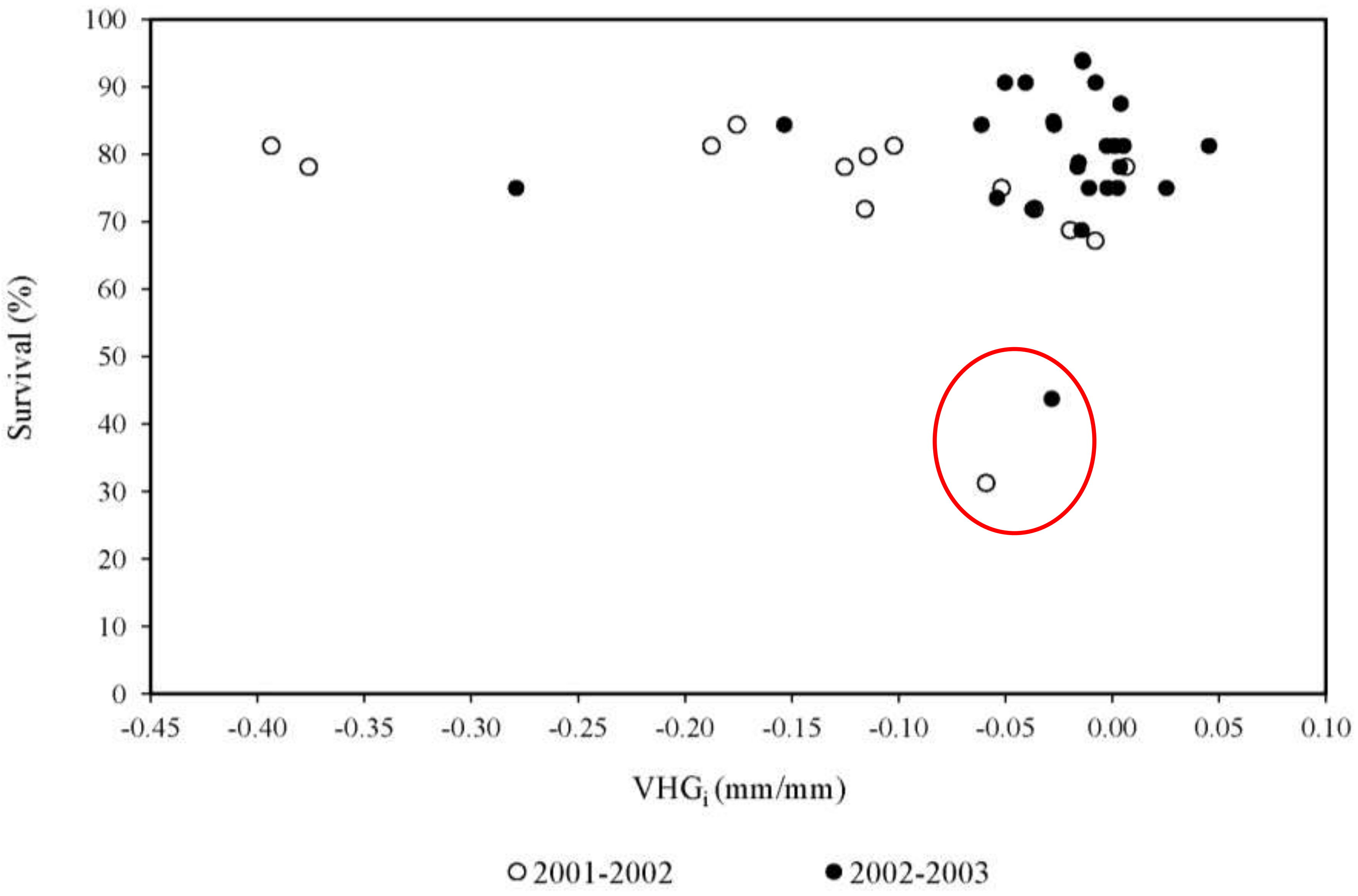
VHG: Redd vs Transect



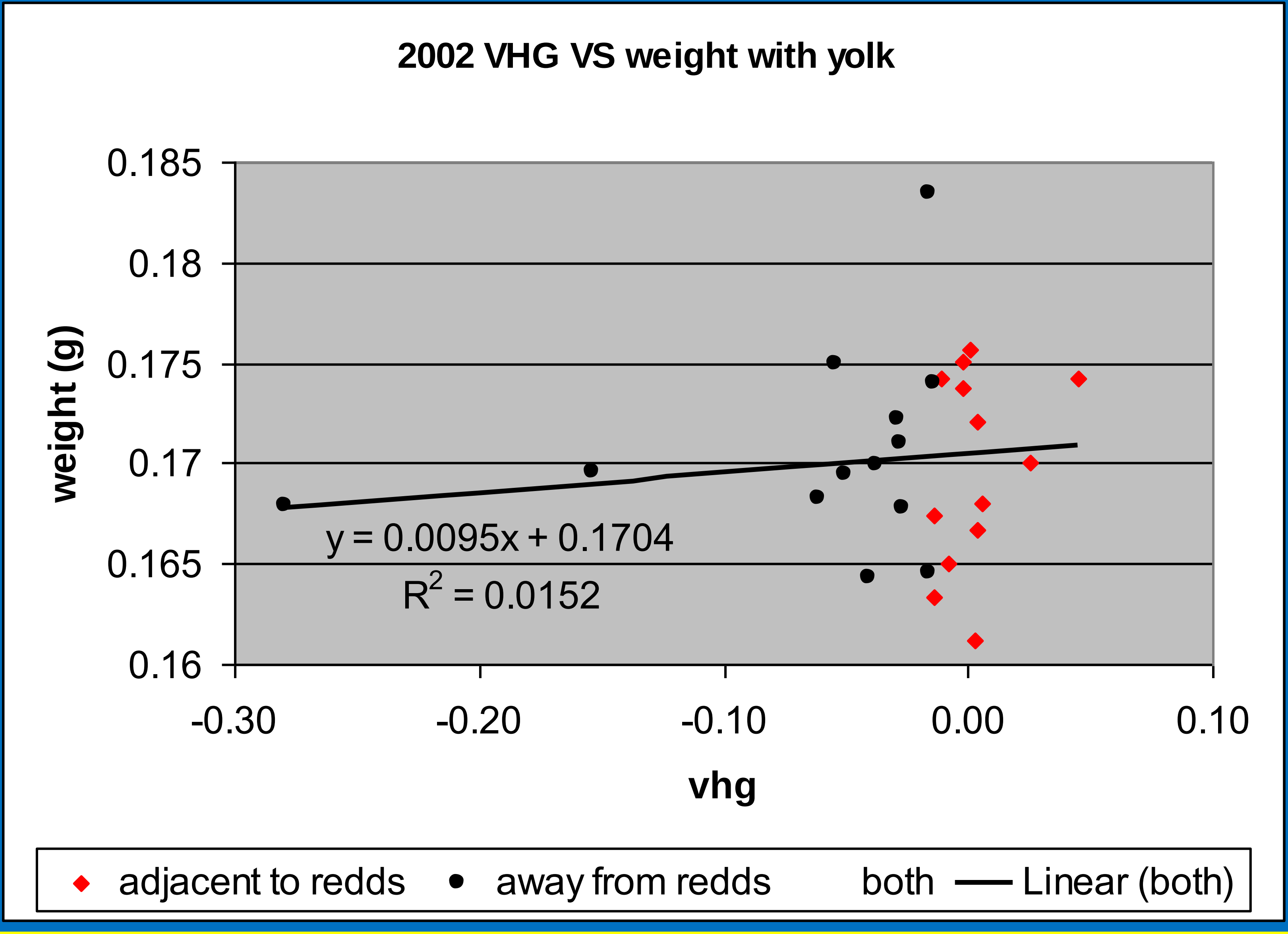
Q Reduction Experiment



VHG and Egg Survival

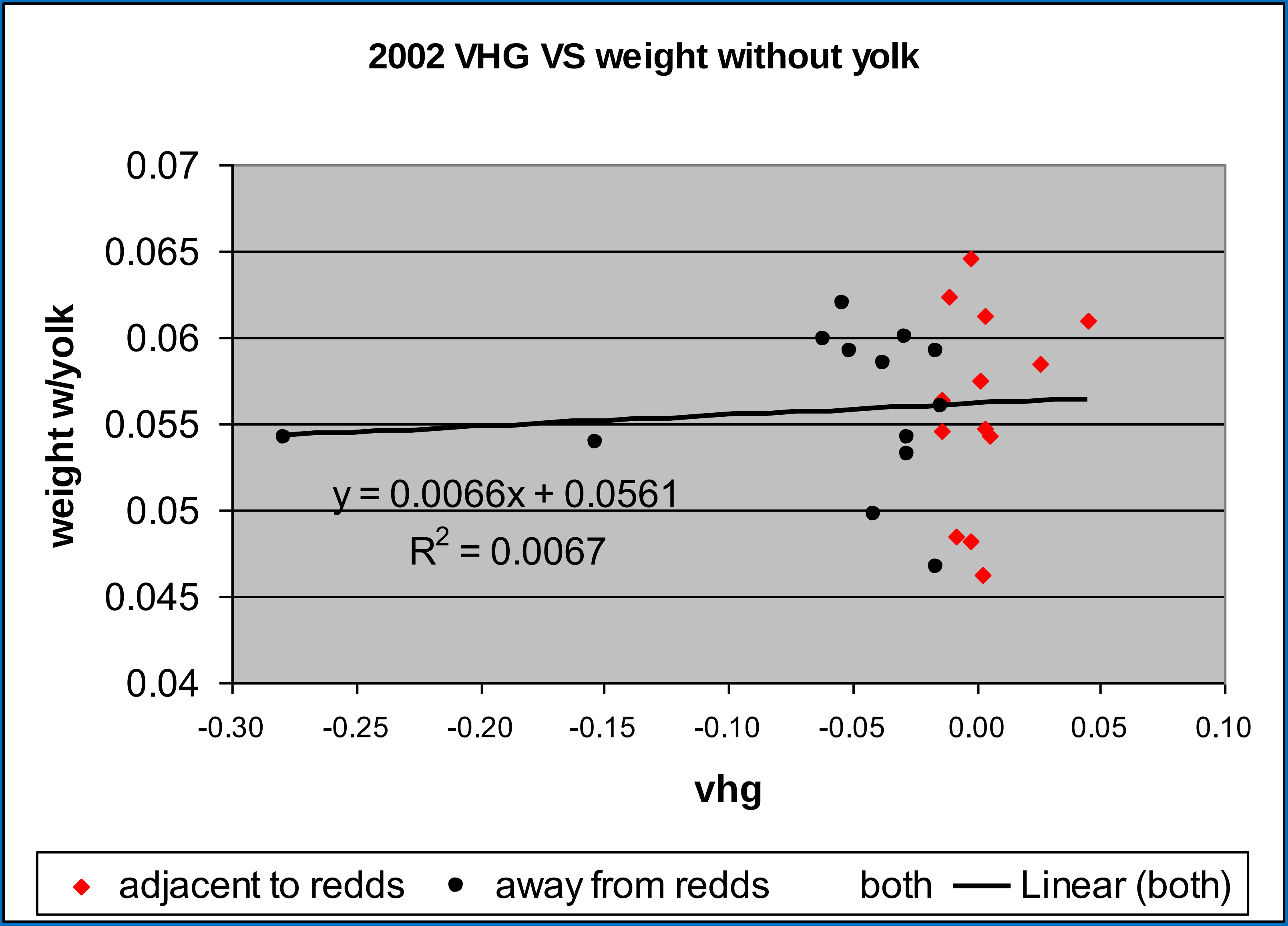


VHG and Egg Survival

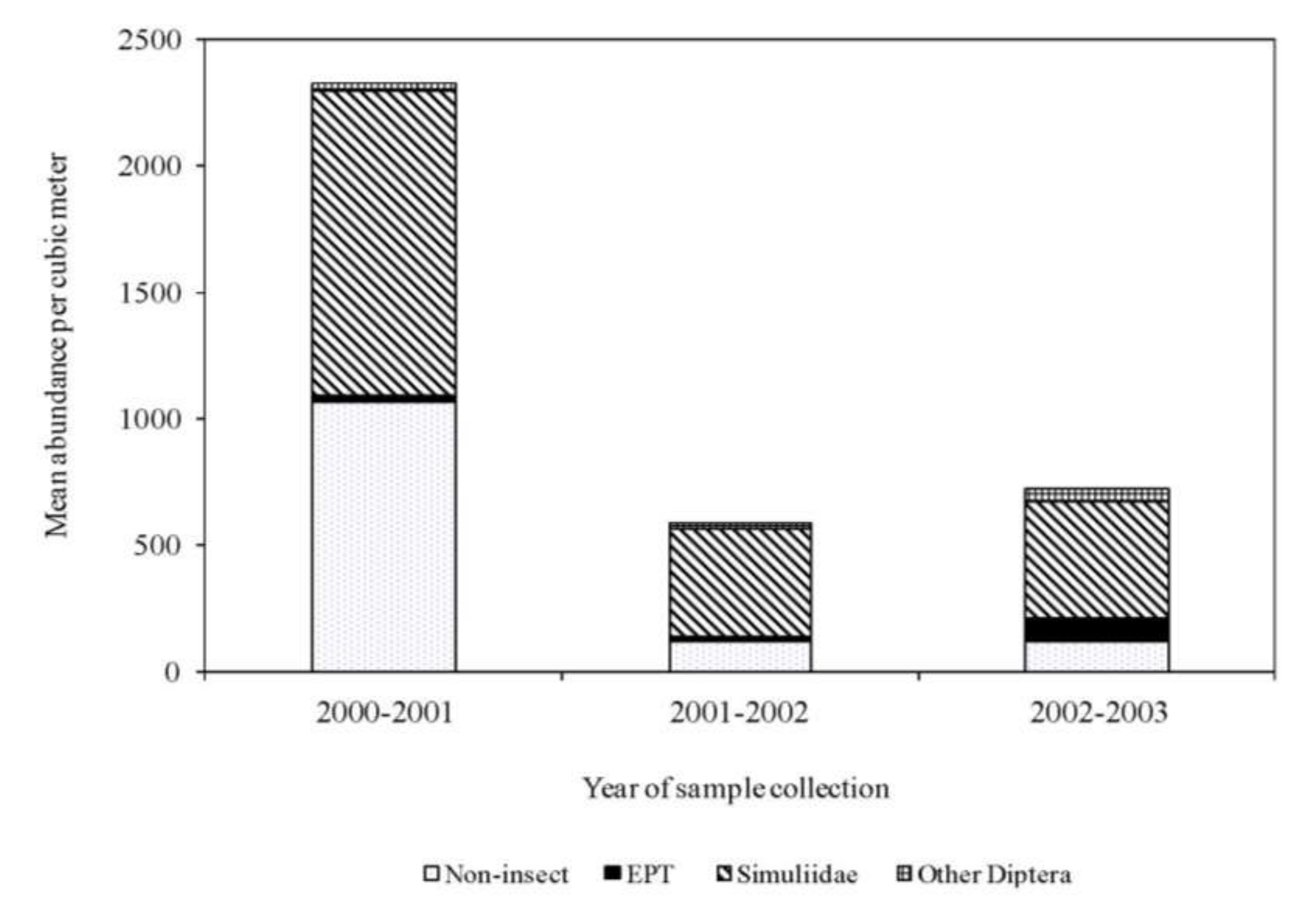


But consider new work by Malcolm et al. 2008

VHG and Egg Survival



Invertebrate Community



Conclusions (1)

1. Redds are placed in the same area and in similar proportions year after year.
2. Redd sites differ from other available habitat:
   a) Cle Elum R. Spring Chinook select redd sites where the post-construction velocity is 0.2-0.5 m/s; smaller than other available microhabitat sites
   b) Cle Elum R. Spring Chinook select redd sites where the post-construction depth is 0.3-0.5 m; in an intermediate range compared to other available microhabitat sites
   c) Cle Elum R. Spring Chinook use redd sites where the post-construction substrate ranges from 3-100 mm; in an intermediate range compared to other available microhabitat sites

Conclusions (2)

3. Redd sites differ from other available habitat:
   a) Cle Elum R. Spring Chinook select redd sites where the VHG is less downwelling than other available microhabitat sites
   b) Cle Elum R. Spring Chinook select redd sites where survival is not affected by changes in discharge – within the range studied
   c) Cle Elum R. Spring Chinook redd sites were never observed to produce survival lower than 65%; but egg survival in other microhabitat sites (non-redds) was on occasion 29-41%

Conclusions (3)

4. Dam effects
   a) Caused a shift in the peak Q from late May-early June to July-August
   b) Provided a substantial reduction in flow immediately before the spring Chinook spawning season commenced
5. Groundwater-Hyporheic Flow Relationship
   a) Precipitation type (rain or snow), amount, and timing drives the timing of groundwater recharge and elevation
   b) Groundwater recharge and elevation drive vertical head gradient in the spawning reach

Conclusions (4)

6. Discharge – VHG Relationship
   a) We observed no regular pattern between surface discharge and VHGi
   b) We found that in Autumn experiment, a 37% reduction in discharge did result in a significant reduction in VHGi
   c) We hypothesize that when groundwater is depleted (as it was in October, 2000), a substantial discharge reduction can significantly influence hyporheic flow.
7. VHG – Egg Survival Relationship
   a) Egg survival and alevin fitness were not significantly influenced by VHG under the conditions studied
   b) We hypothesize that consistent good habitat quality, DO, and temperature along with spring Chinook redd site selection and redd-building produces routinely high egg survival in this spawning reach.

Implications for Restoration on Rivers with Substantial Sediment Load

1. Site selection for restoration
   a) Census VHG throughout the river
   b) Choose sites that are slightly downwelling or upwelling for restoration of spawning habitat
2. If you have a particular stream segment designated for restoration
   a) Census VHG throughout the river including the site
   b) If the designated site is strongly downwelling consider restoration for rearing habitat and not spawning habitat

ESA

Acknowledgements

Many thanks to the dozens of individuals that contributed to the study mentioned in this presentation. All of their contributions are appreciated and continue to advance our understanding of salmonid habitat requirements and how to restore those habitats.

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

USGS
science for a changing world

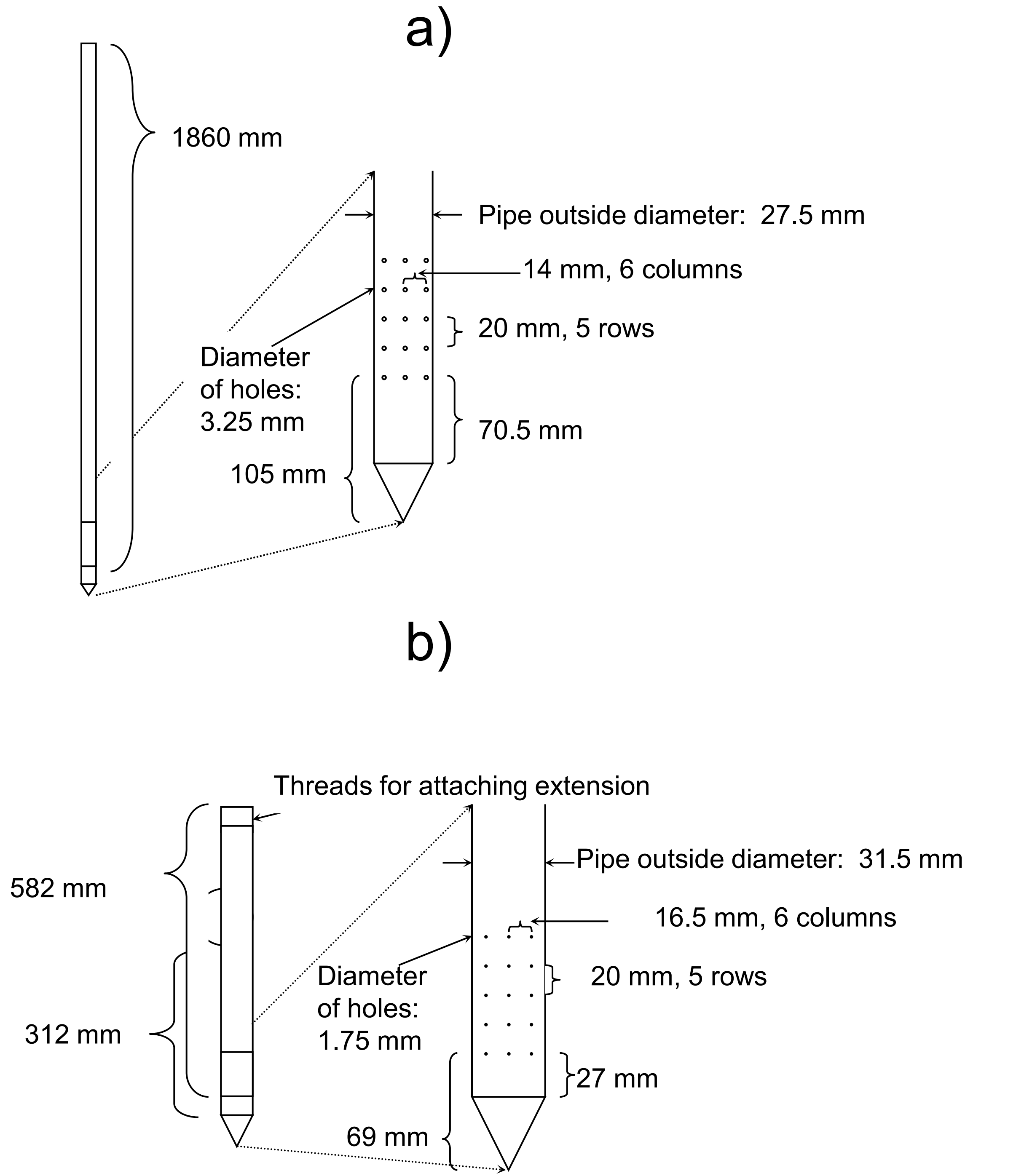
The End

Questions on piezometer design or other topics:

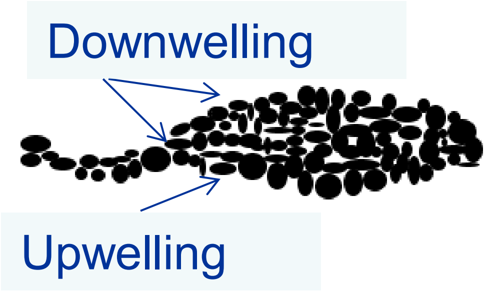
Mbowen@ESAssoc.com

Photo Credit: Aaron Dufault, WA Dept. of Fish and Wildlife

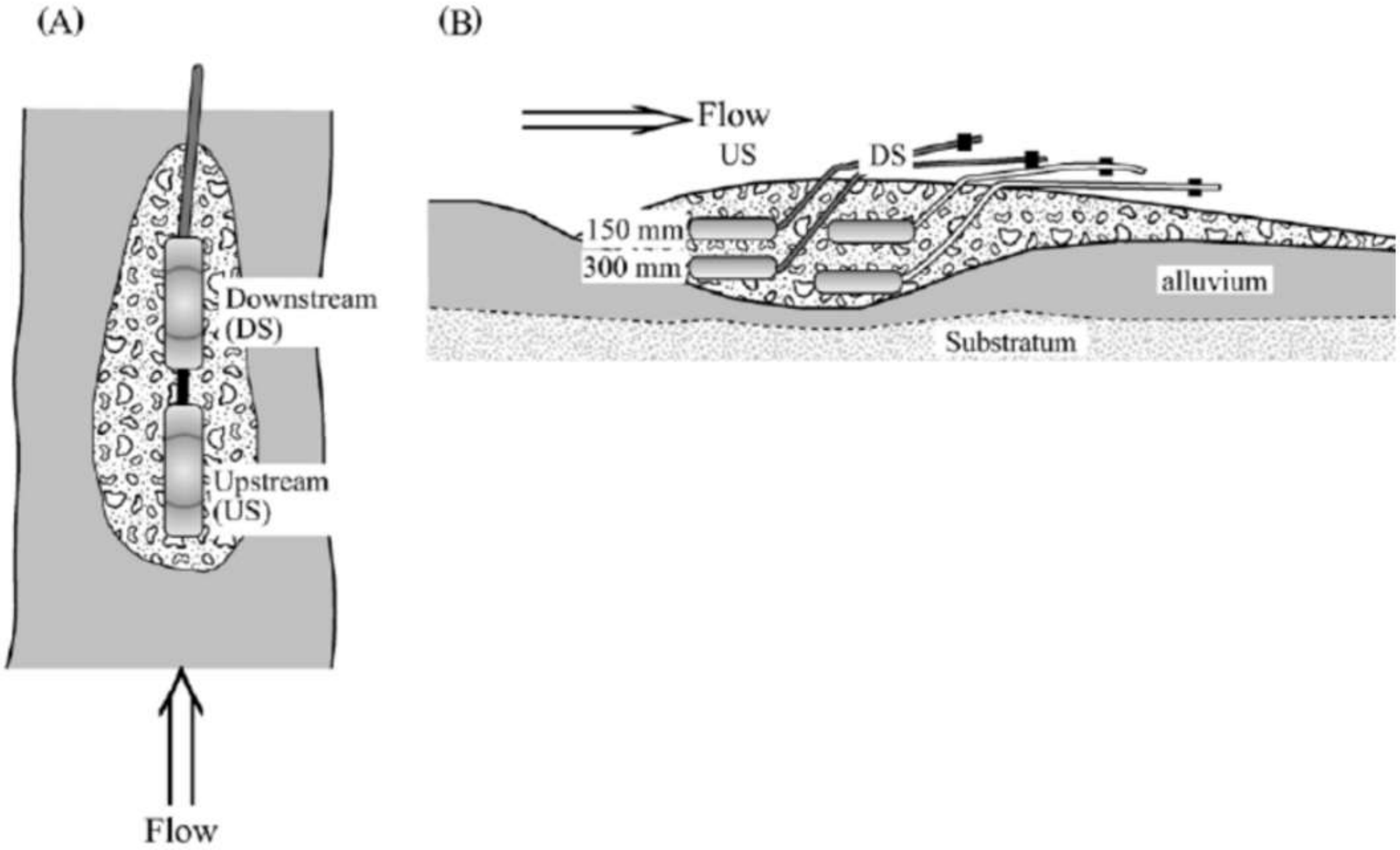
Piezometer Design



Schematic of a Redd



Sampling the Redd Environment



Planning and Implementing Watershed Scale Road Improvement Projects

Thomas H. Leroy and Danny Hagans

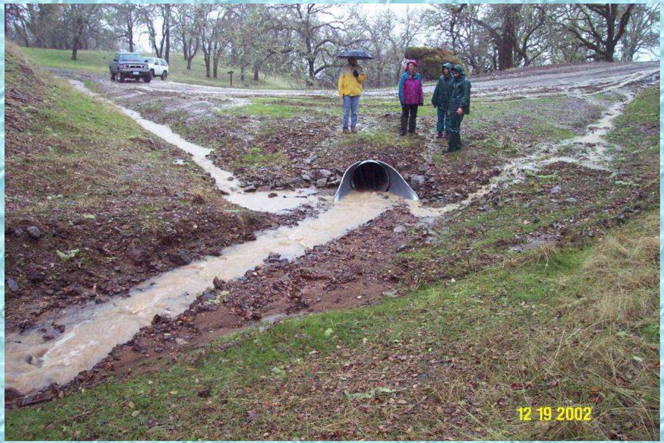
Pacific Watershed Associates

8 Take home points from this presentation

1. Understand the concept of cumulative impacts
2. Understand roads are key limiting threats to salmonids in many watersheds
3. Recognize when your road system requires improvements
4. Learn to distinguish between erosion and sediment delivery
5. Understand the concept of stealth sediment
6. Consider the impacts roads have on hillside hydrology
7. Recognize the most successful projects have broad "buy in" from all interested parties
8. Know the resources that are available to you and your watershed organization

Do the following photos look familiar?

If so, then you have a problem and need to take action



Road Surface Rilling and gullying

Shallow, Short Culvert

Muddy water running off your road and into streams (Stealth Sediment)

Ditch Erosion

Stream Crossing Erosion:
Gullying and Fillslope Landslides

Deranged Hillside Hydrology

Primary Impacts From Decades of Road and Skid Trail Construction-

(1) Caused unprecedented accelerated sediment delivery to the watersheds observed as both channel stored sediment and imbedded channel substrates.
(2) Significantly disrupts hillside hydrology and alters the stream hydrograph.
(3) Can inhibit fish access to historical habitat.

What is wrong with this conversation?

Tom: How would you rate the conditions of your road system on your ranch?

Landowner: Our roads are in great shape, we grade them every year……

Tom: Don't you think the gully in this road is an environmental problem?

Landowner: Its just one little gully, how bad can that be for the environment….

Cumulative impacts…AKA (The tragedy of the commons) (Death by a thousand cuts) (Mauled by a pack of chiwawas)

- Individuals acting independently and quasi-rationally according to each's self-interest behave contrary to the best interests of the whole group by depleting some common resource such as water volume, water quality, and fisheries resources


1:20,000
22-65
6-FF-20


Sediment Delivery

41. South Fork Eel River Population

Interior Eel River Diversity Stratum

Core, Functionally Independent Population

Moderate Extinction Risk

Population likely above depensation threshold

9,300 Spawners Required for ESU Viability

689 mi^2 watershed (8% Federal ownership)

464 IP-km (288 IP-mi) (29% High)

Dominant Land Uses are Timber Production and Agriculture

Key Limiting Stresses are 'Lack of Floodplain and Channel Structure' and 'Altered Hydrologic Function'

Key Limiting Threats are 'Roads' and 'Dams/Diversions'

Highest Priority Recovery Actions

• Increase instream flows by reducing diversions • Determine effects of marijuana cultivation and minimize if necessary • Increase large woody debris (LWD), boulders, or other instream structure	• Restore natural channel form and function by addressing confinement and channelization • Reduce abundance of Sacramento pikeminnow • Reduce sediment barriers formed by alluvial deposits at the confluence of tributaries

SONCC, 2015

	Stresses	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	Very High	Very High[1]	Very High	Very High	Very High
2	Altered Sediment Supply	Very High	Very High	Very High	High	Very High	Very High
3	Altered Hydrologic Function[1]	Medium	High	Very High[1]	High	Medium	High
4	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
5	Impaired Water Quality	Medium	High	High	High	Medium	High
6	Barriers	-	High	High	Medium	High	High
7	Increased Disease/Predation/Competition	Low	High	High	High	Low	High
8	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	High
9	Adverse Fishery- and Collection-Related Effects	-	-	Low	Low	Medium	Low
10	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting stresses and limited life stage

SONCC, 2015

Threats		Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Threat Rank
1	Roads[1]	Very High	Very High	Very High[1]	Very High	Medium	Very High
2	Dams/Diversions [1]	Low	High	Very High[1]	Medium	High	High
3	Timber Harvest	High	High	High	High	Medium	High
4	High Severity Fire	High	High	High	Medium	High	High
5	Road-Stream Crossing Barriers	-	High	High	High	High	High
6	Urban/Residential/Industrial Dev.	Medium	High	High	High	Medium	High
7	Invasive Non-Native/Alien Species	Low	Medium	High	High	Low	High
8	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
9	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
10	Climate Change	Medium	Medium	Medium	Medium	Medium	Medium
11	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
12	Fishing and Collecting	-	-	Low	Low	Medium	Low
13	Hatcheries	Low	Low	Low	Low	Low	Low

[1] Key limiting threats and limited life stage

SONCC, 2015

		2007-08		2008-09		2009-2010		2010-11		2012-13		2013-14		2014-15		2015-16	
Comparision of FRGP Funded Grants 2008 - 2016 (does not include contingency projects)																	
		#	Funded	#	Funded	#	Funded	#	Funded	#	Funded	#	Funded	#	Funded	#	Funded
AC	Americorps	1	$393,001	1	$399,387	1	$430,450	1	$481,959	0	$0	1	$452,846	1	$552,745	1	$450,000
ED	Education	5	$131,424	7	$153,645	6	$182,373	0	$0	0	$0	0	$0	0	$0	0	$0
EF	Enforcement	0	$0	0	$0	0	$0	0	$0	0	$0	1	$33,990	0	$0	0	$0
FP	Fish Passage at crossings	8	$837,510	5	$1,766,084	4	$1,338,289	1	$138,395	4	$4,105,121	3	$1,479,966	4	$1,924,937	3	$2,589,116
HA	Habitat Acquisition	0	$0	0	$0	1	$870,000	0	$0	0	$0	0	$0	0	$0	0	$0
HB	Barrier Modification	5	$1,496,385	1	$10,294	4	$952,004	2	$198,534	1	$522,471	8	$2,329,920	2	$391,586	2	$1,383,517
HI	**Instream Habitat Restoration**	8	$351,678	8	$449,178	13	$852,464	13	$1,519,048	16	$2,285,590	19	$2,958,092	22	$4,016,997	16	$4,803,876
HR	Riparian Restoration	5	$594,537	2	$85,218	6	$427,056	3	$358,826	4	$884,808	1	$432,066	2	$235,696	3	$252,941
HS	Instream Bank Stabilization	1	$13,439	2	$157,676	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0
HU	**Upslope Restoration**	10	$2,254,078	12	$4,133,114	20	$4,733,278	10	$3,993,296	1	$408,137	11	$3,259,953	8	$1,743,487	4	$1,025,804
MD	Monitoring FRGP Status & Trends	8	$903,021	8	$1,430,597	8	$2,312,044	1	$589,475	11	$3,696,369	8	$1,814,460	6	$2,777,600	8	$2,301,137
MO	Monitoring Watershed Restoration	1	$146,252	2	$321,798	2	$858,182	0	$0	0	$0	2	$417,705	1	$34,539	0	$0
OR	Organizational Support	2	$378,287	2	$322,148	1	$8,483	2	$529,788	0	$0	2	$410,819	0	$0	0	$0
PI	Public Involvement	2	$567,253	3	$296,991	2	$481,498	1	$20,997	0	$0	1	$301,521	2	$470,173	0	$0
PD	**Project Design**	0	$0	0	$0	0	$0	9	$1,207,781	6	$1,252,721	7	$616,179	10	$1,239,694	11	$911,885
PL	**Evaluation, Assessment, Planning**	9	$1,239,276	9	$1,811,838	12	$2,935,048	8	$1,020,587	0	$0	3	$796,300	7	$964,911	6	$851,336
RE	Cooperative Rearing	0	$0	1	$99,467	0	$0	2	$483,517	1	$450,722	2	$718,758	0	$0	0	$0
SC	Fish Screens	1	$67,697	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0
TE	Training and Education	3	$60,603	0	$0	1	$34,166	2	$48,212	0	$0	2	$148,600	0	$0	0	$0
WC	Water Conservation Measures	0	$0	0	$0	1	$192,591	2	$2,707,695	1	$160,117	1	$416,794	2	$635,013	1	$323,029
WD	Water Measuring Devices	0	$0	0	$0	1	$158,300	0	$0	0	$0	0	$0	0	$0	0	$0
WP	Water Purchase	0	$0	0	$0	0	$0	$0	$0	0	$0	0	$0	0	$0	0	$0
			$9,434,441		$11,419,433		$16,167,206		$13,297,914		$13,546,056		$16,587,969		$14,989,378		$14,692,423

* 1 @ 650,000 in SB * PL 662,177 for CEQA * 3 yr CEQA 1.99M * 1 @ 2.49M
** PL 403,000 for CEQA SB passage design 500,000

Pre-Project Planning

Options:
Develop a Watershed Group to:
-procure, compile, and disseminate pertinent information to your neighbors regarding all potential watershed related activities
-Pool resources for shared use road evaluation and upgrading
- Create a shared understanding of the environmental impacts of your road system

Get to know the Regulatory Authorities that are experts and knowledgeable of your watershed. They can help you understand the fisheries resources in your watershed and help procure funding for your planning or implementation project

Get to know the nice people at your local Resource Conservation District (RCD),
these folks are a huge underutilized resource for all things restoration…..

Understand how your watershed community uses the watershed resources and make sure your overall plan is consistent with as many as possible-This can be used to create a long-term transportation plan for the whole watershed and allow for the most extensive "buy in" from your neighbors.

Seven Step Process of Inventorying and Treating Road Erosion

1) Problem identification – through inventory and assessment
2) Problem quantification – determining future sediment delivery
3) Prescription development – heavy equipment and labor intensive treatments
4) Treatment prioritization
5) Implementation (upgrading & decommissioning)
6) Implementation & effectiveness monitoring
7) Maintenance

Identification of road-related erosion

- **Stream crossing** erosion (gullying)
- **Road-related landslides** (mass wasting)
- **Road surface runoff and related erosion** (surface erosion and gullying)

- **A road location with erosion but no future sediment delivery is not an "erosion site" that needs to be inventoried or treated to protect water quality or fish habitat**

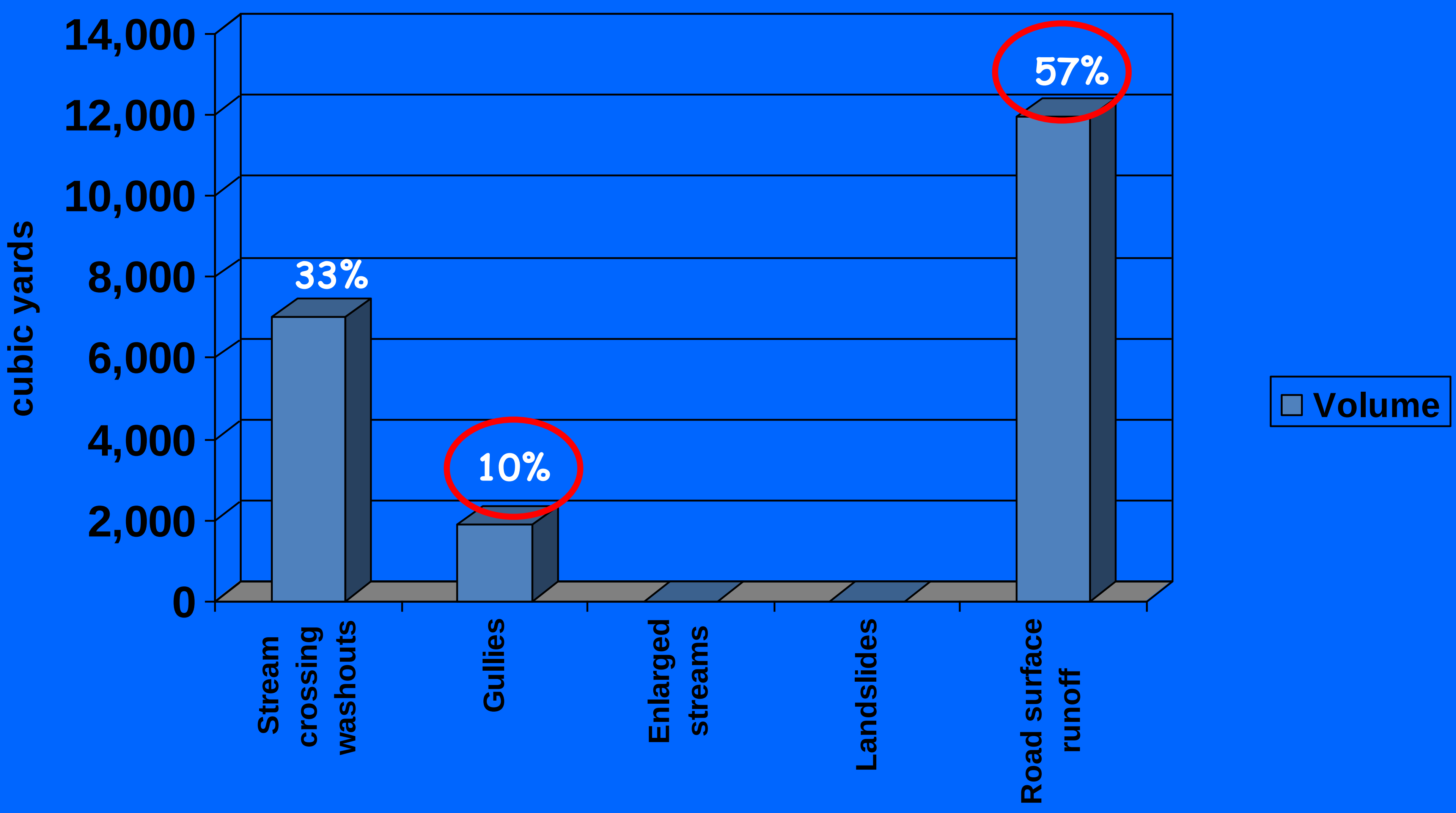
Four Road Upgrading Treatment Mantras

1) **Treat sites of sediment delivery**
2) Treat the cause, not the symptom
3) If you don't change anything, it's just going to happen again
4) Prevent erosion before you have to try to control it

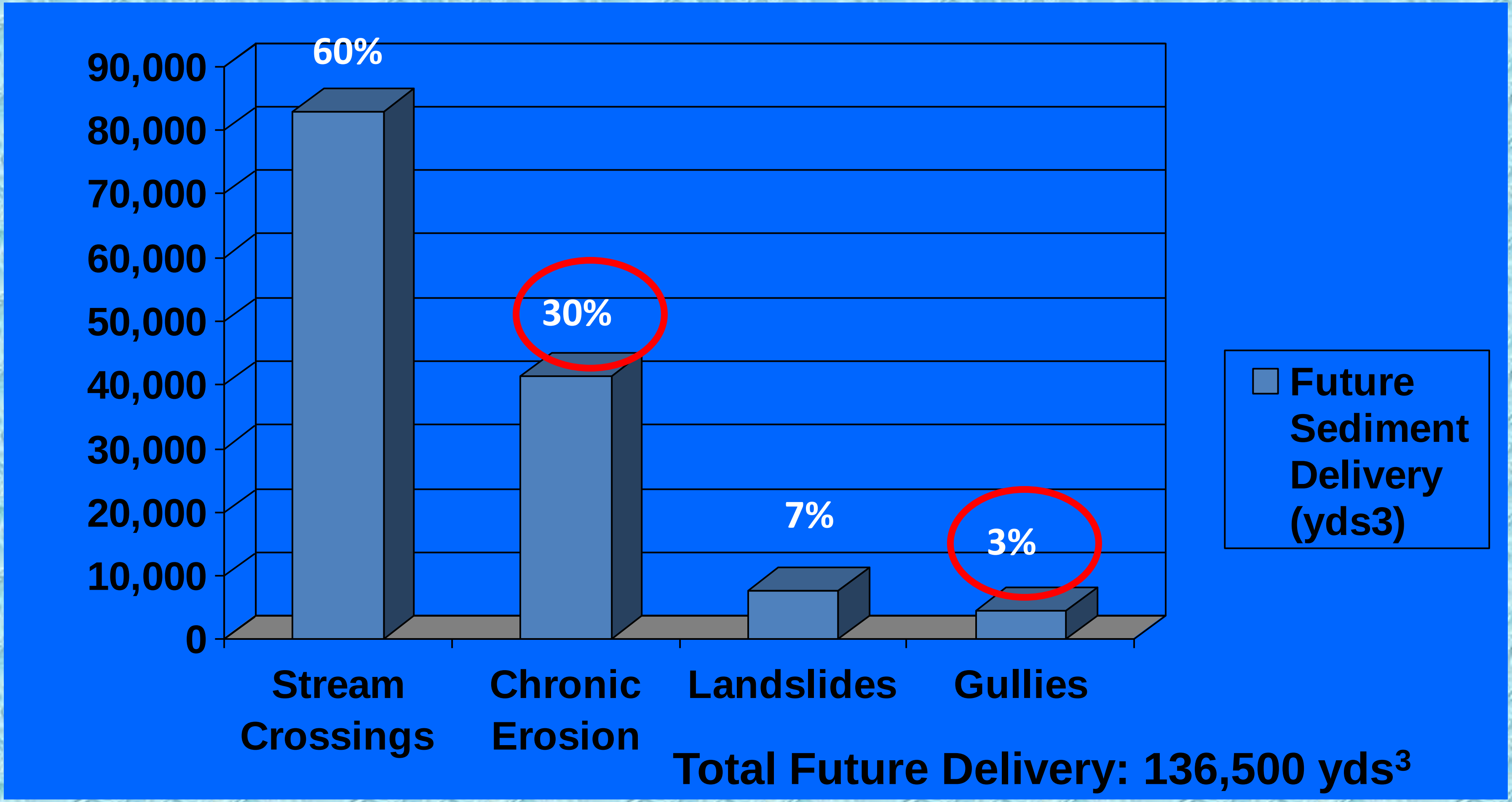
Erosion versus sediment delivery:

1) Treat sites of sediment delivery

Sources and amounts of sediment produced from 9.1 miles of road in the Coast Road Watershed Erosion and Restoration Planning Project, Monterey County, CA



Hollow Tree Creek (20.8mi^2), Future Sediment Delivery by Site Type



Four Road Upgrading Treatment Mantras

1) Treat sites of sediment delivery
2) **Treat the cause, not the symptom**
3) If you don't change anything, it's just going to happen again
4) Prevent erosion before you have to try to control it

Treat the cause, not the symptom

...Symptomatic treatment

An excellent example of treating the symptom and not the cause

remember……every complex problem has a simple solution that doesn’t work

Gullies from road surface runoff

Another gully…

Treating the cause by dispersing road runoff

Treatment Prioritization

There are many things to consider when prioritizing roads and road features for treatment including but not limited to:

- Where are the fish barriers
- Potential future sediment delivery from road surfaces, stream crossings, and landslides
- Risk of failure (culvert plugging, landslide activation, stream diversion, ect.)
- Long term transportation plan
- Short and long term management plans

Implementation

Road shape conversion

Insloped with ditch, wheel ruts & berm – Gullied with 100% connectivity

Outsloped with rolling dips – No connectivity

Road shape conversion

Insloped
with ditch –
100% connectivity

Outsloped with
rolling dips –
No connectivity

Treated Road - Clean Connectivity

Four Road Upgrading Treatment Mantras

1) Treat sites of sediment delivery
2) Treat the cause, not the symptom
3) **If you don't change anything, it's just going to happen again**
4) Prevent erosion before you have to try to control it

3) If you don't change anything, it's just going to happen again…

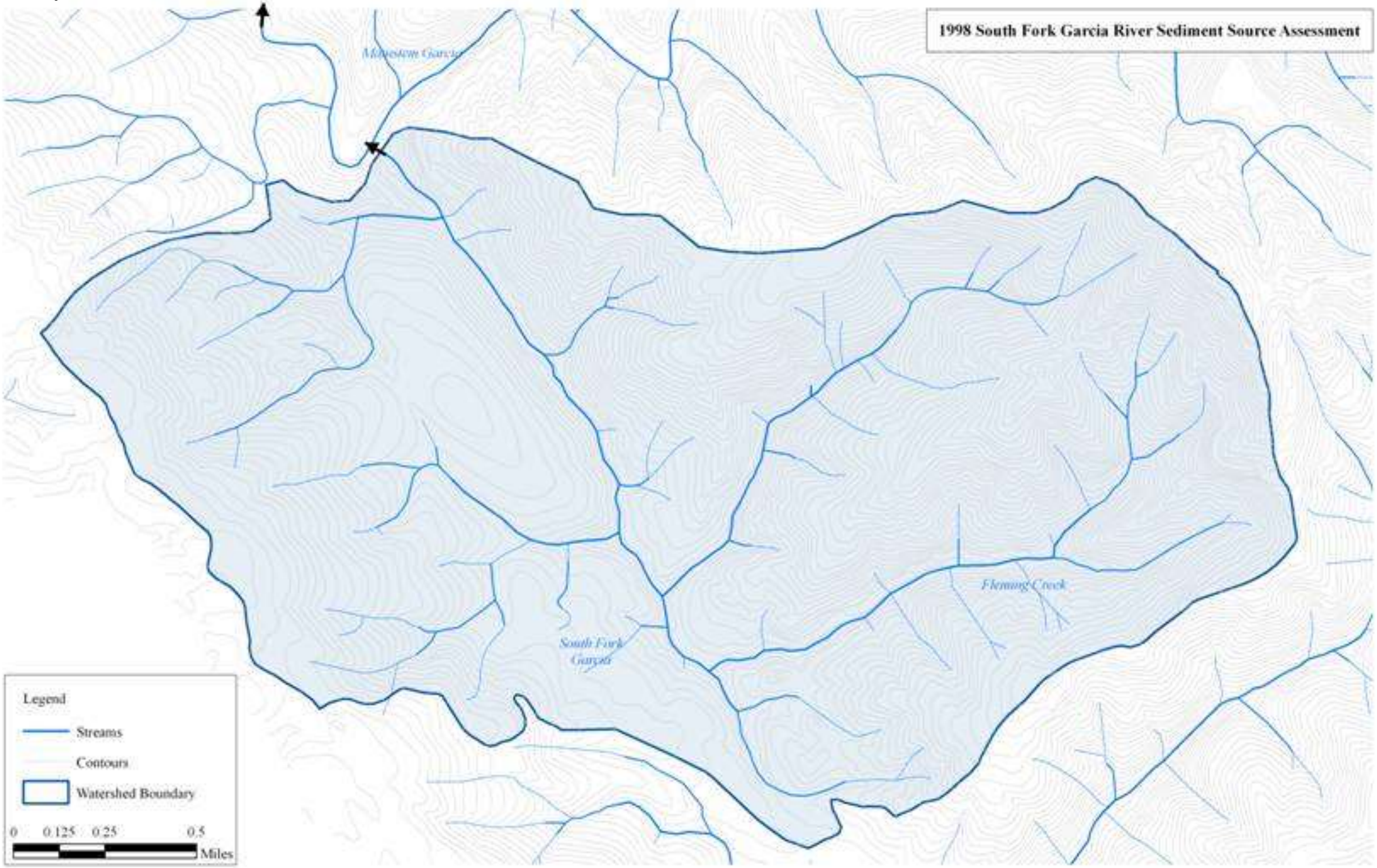
Four Road Upgrading Treatment Mantras

1) Treat sites of sediment delivery
2) Treat the cause, not the symptom
3) If you don't change anything, it's just going to happen again
4) **Prevent erosion before you have to try to control it**

4) Prevent things from happening in the first place!

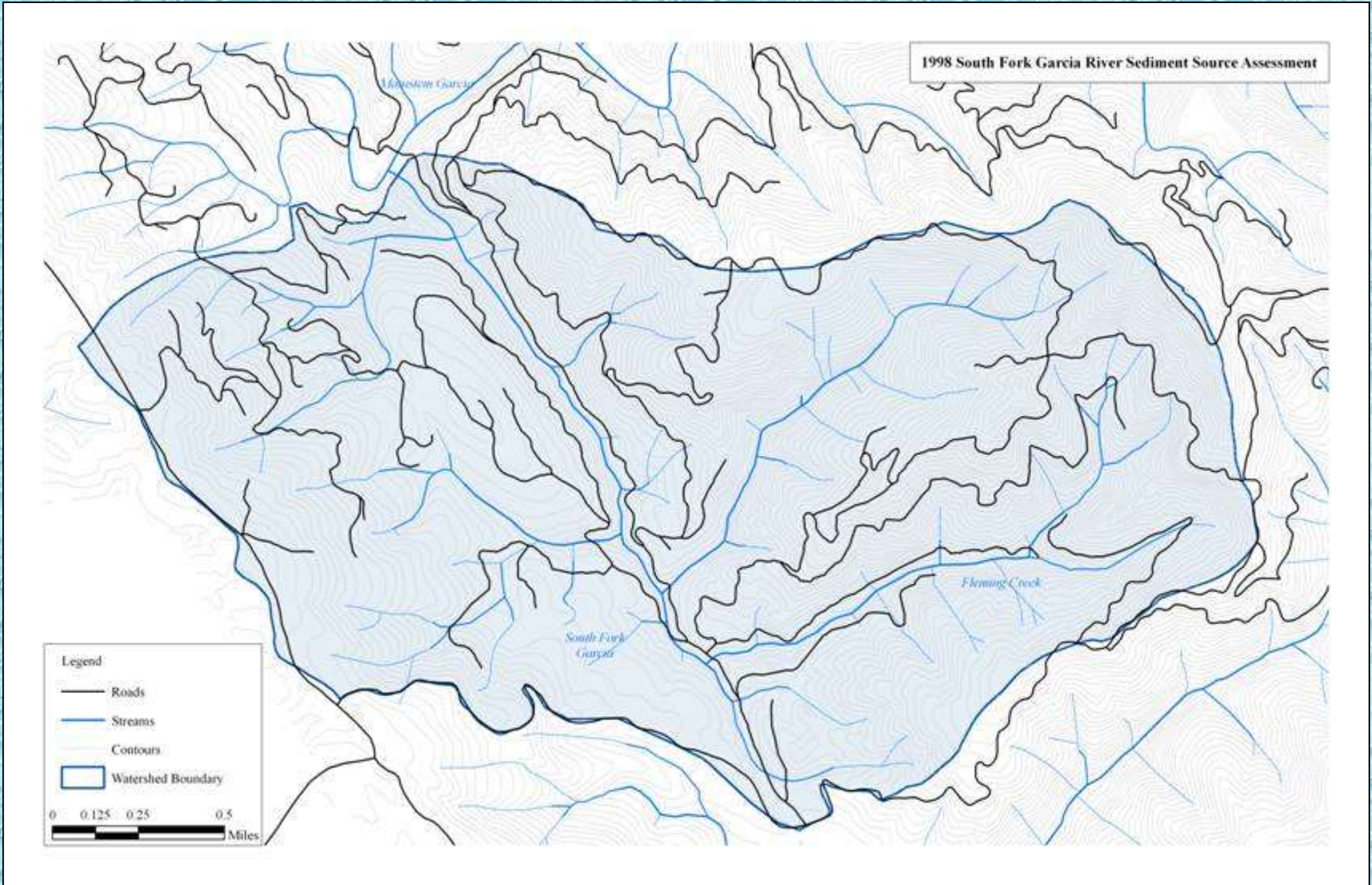
So here's an example… results of the 1998 South Fork Garcia River sediment source assessment

4.3 square mile watershed



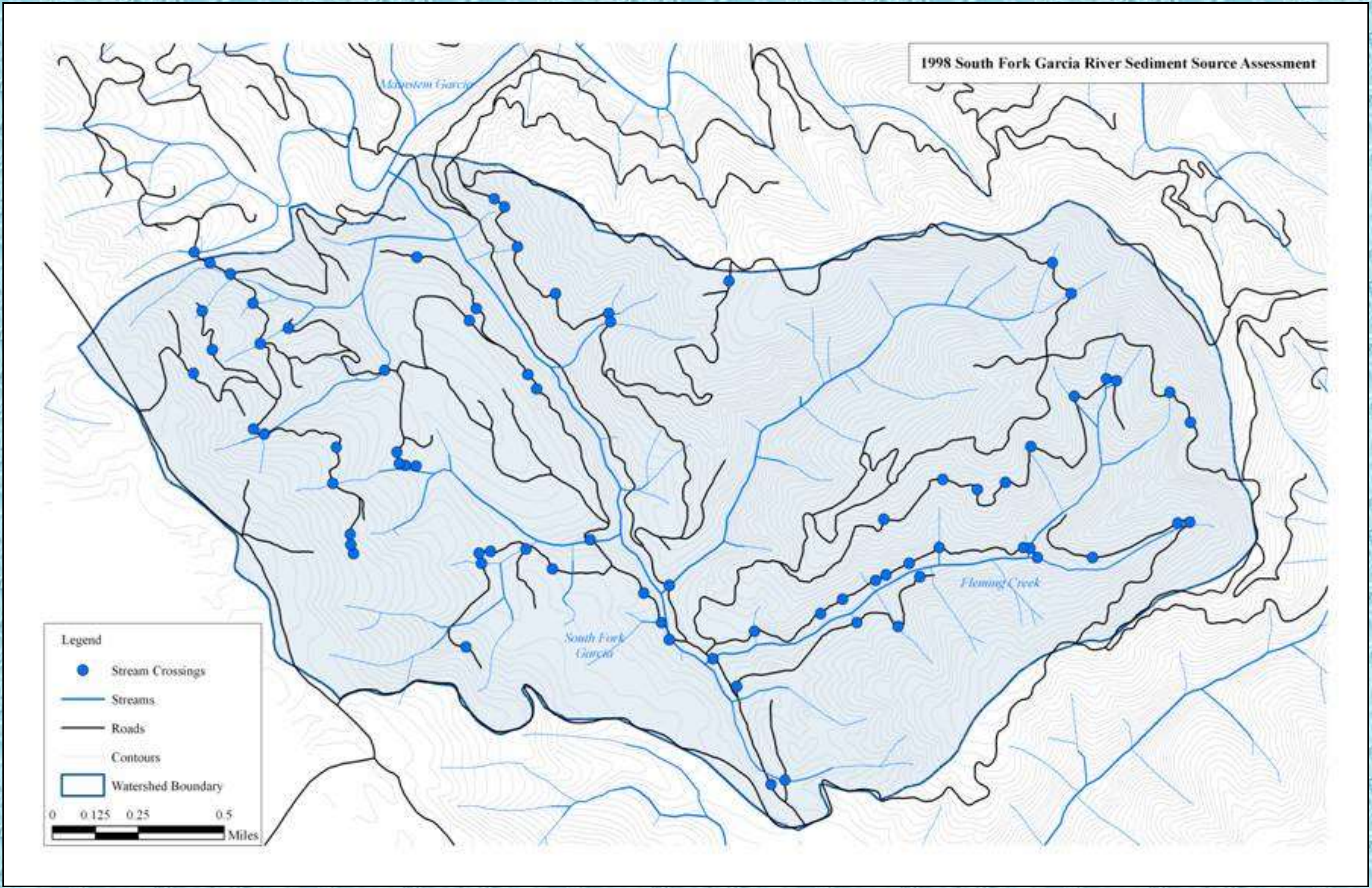
Identify road network

30.6 miles of road
7.1 miles of road/square mile



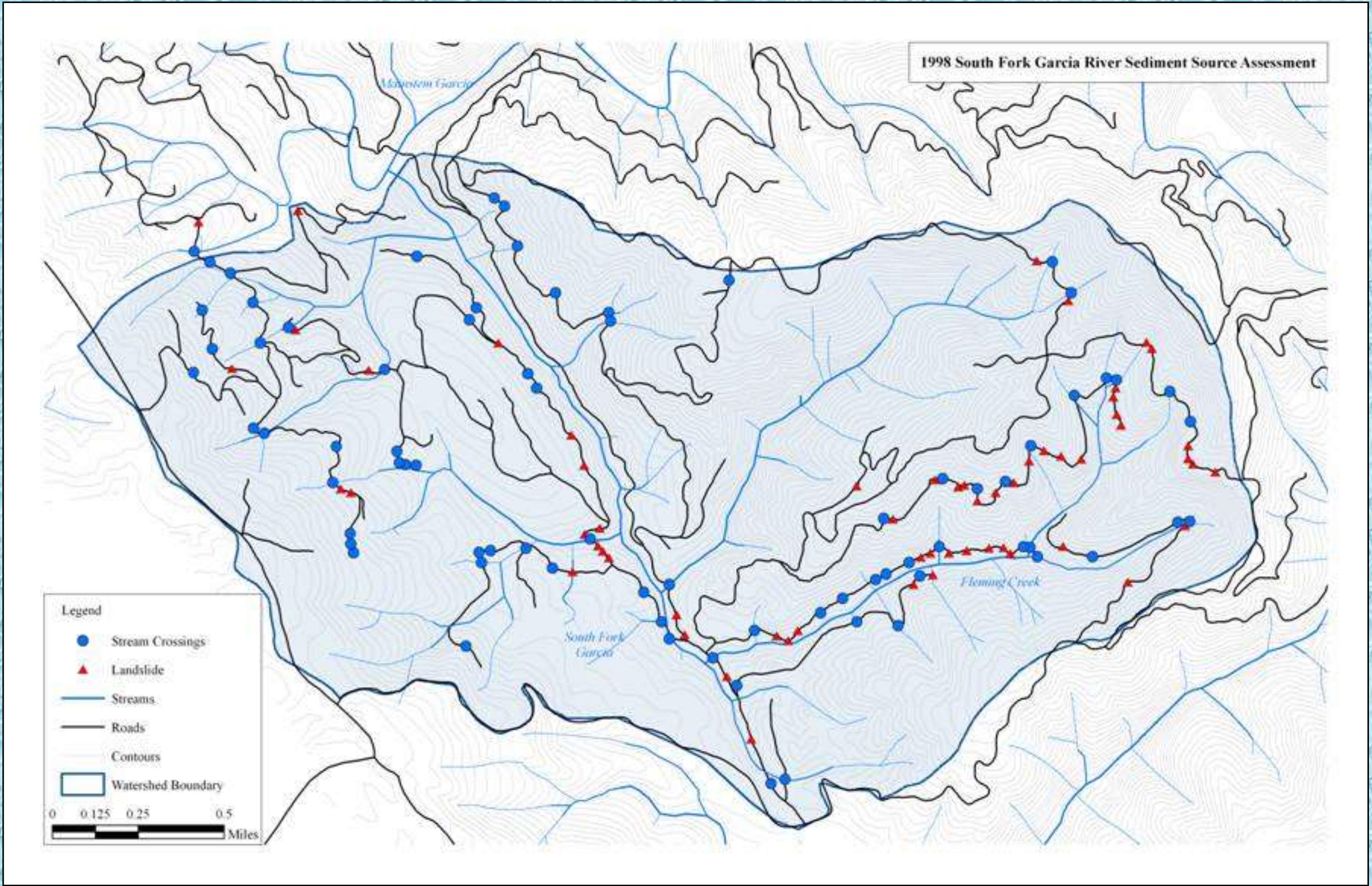
Identify Stream Crossings

76 stream crossings



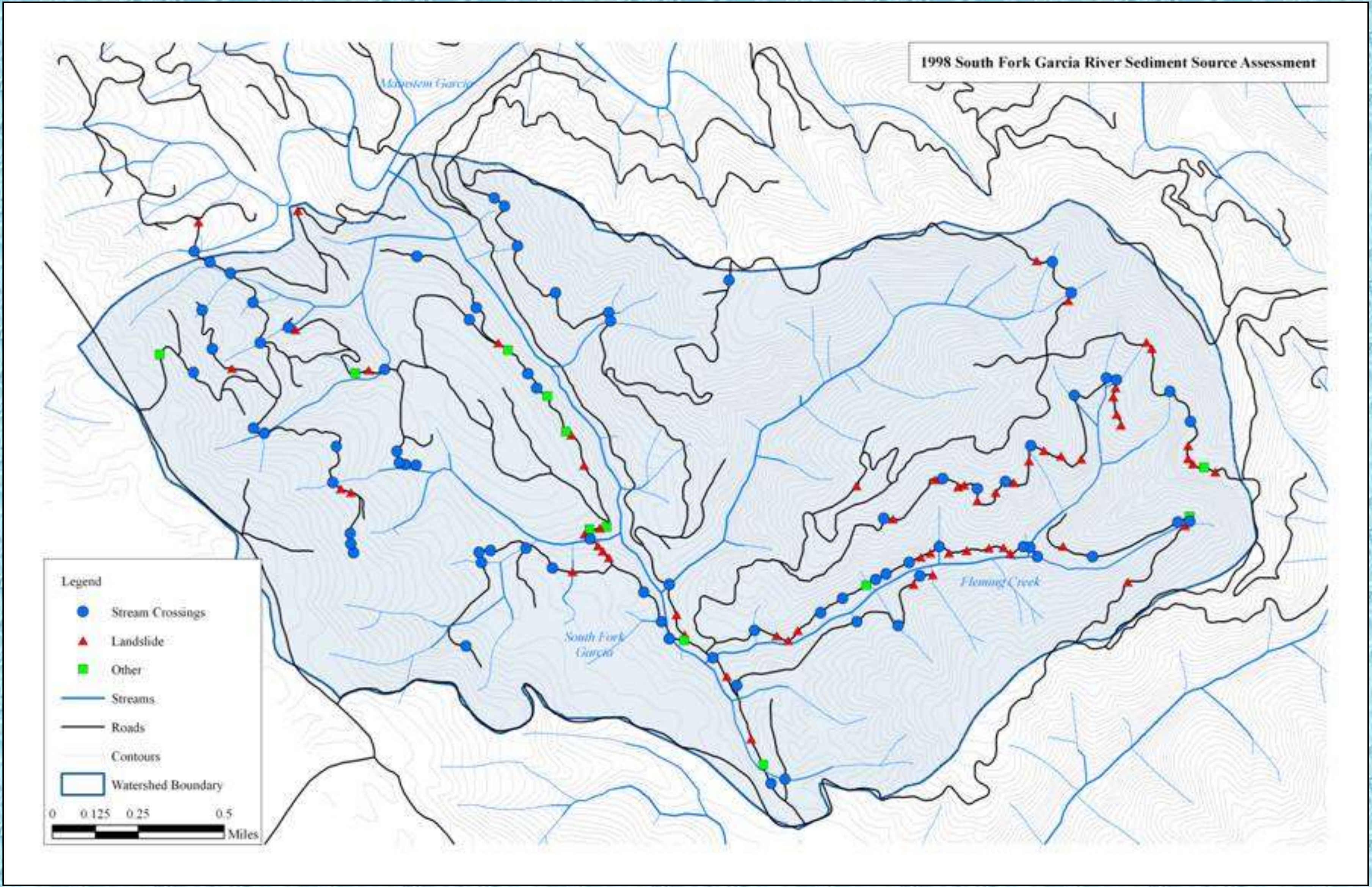
Identify Landslides

76 stream crossings, 59 potential landslides



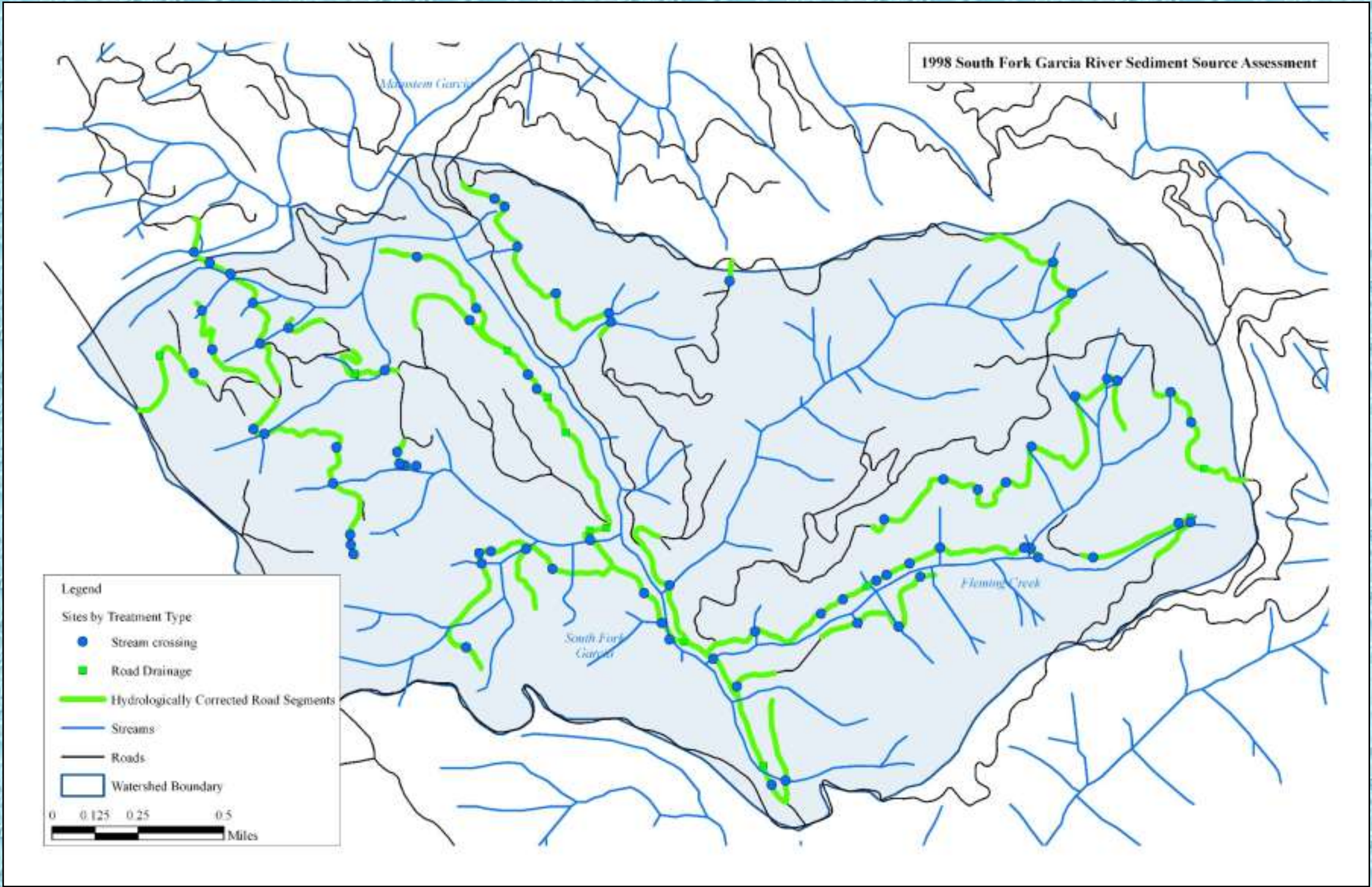
Other Problems

76 stream crossings, 59 potential landslides, 12 other gully problems



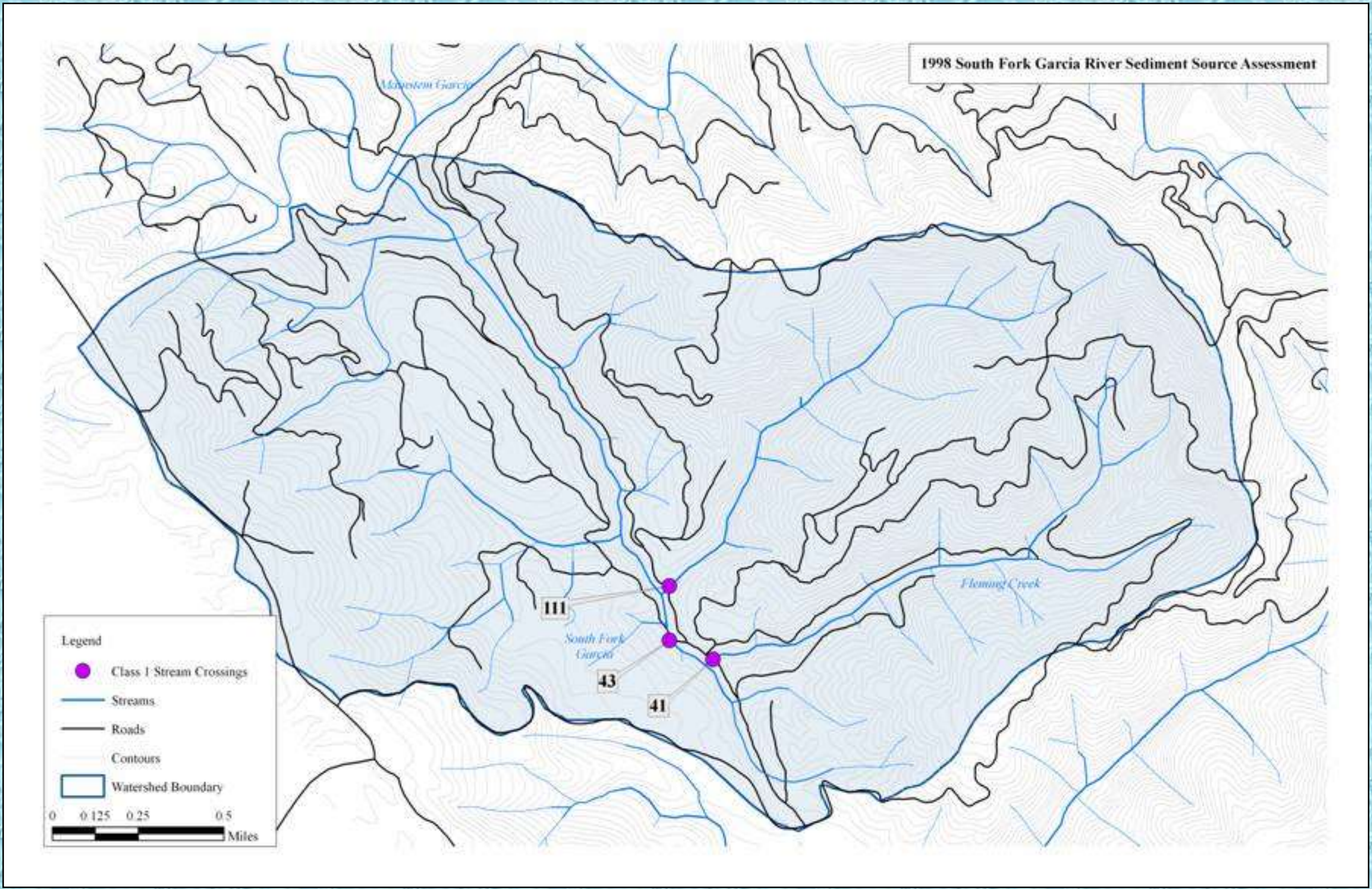
Hydrologically Connected Road Surfaces

12.9 miles of hydrologic connectivity



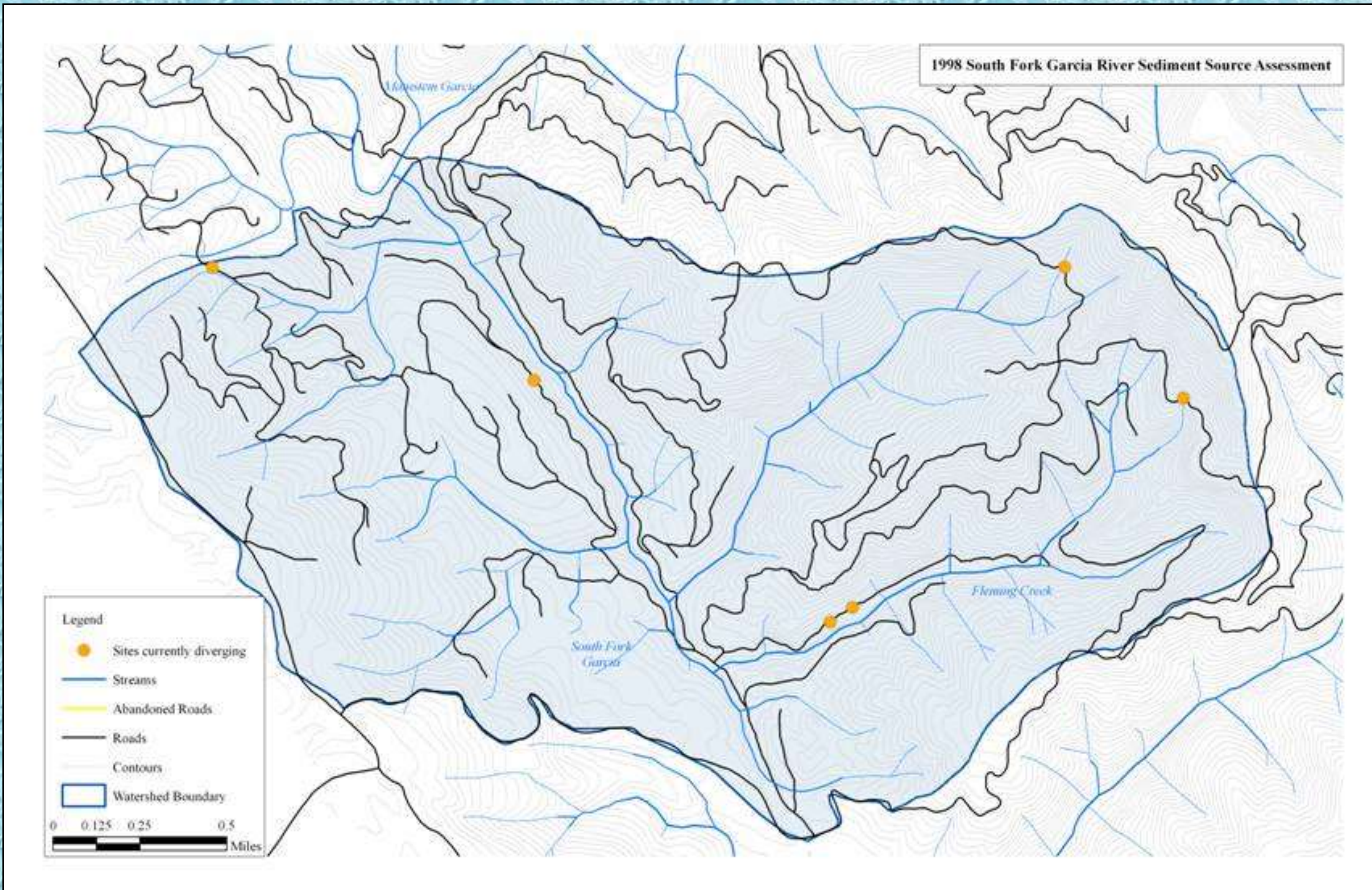
Fish Barriers

3 Class 1 stream crossings with fish passage problems



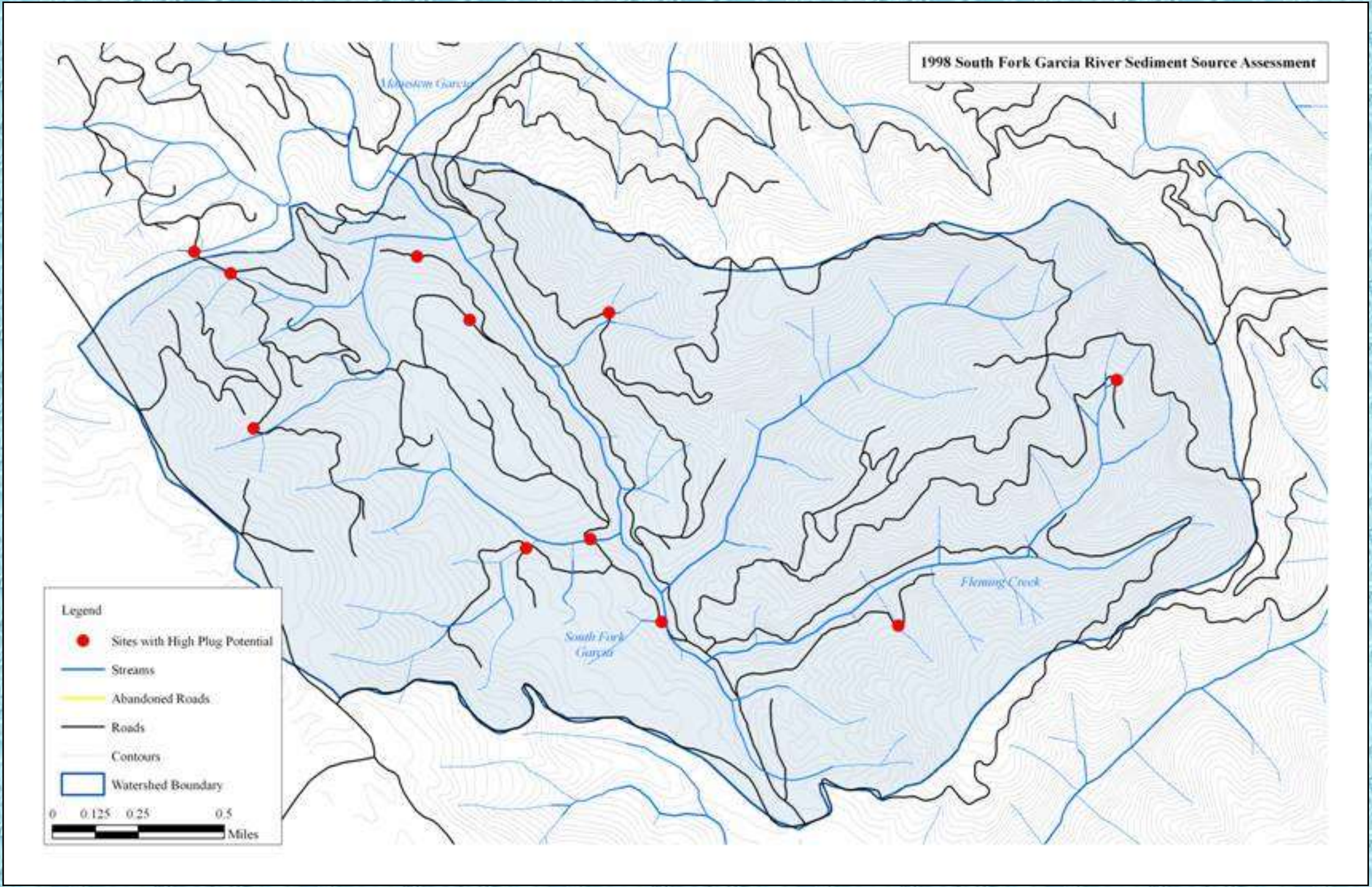
Diverted Streams

6 streams currently diverted



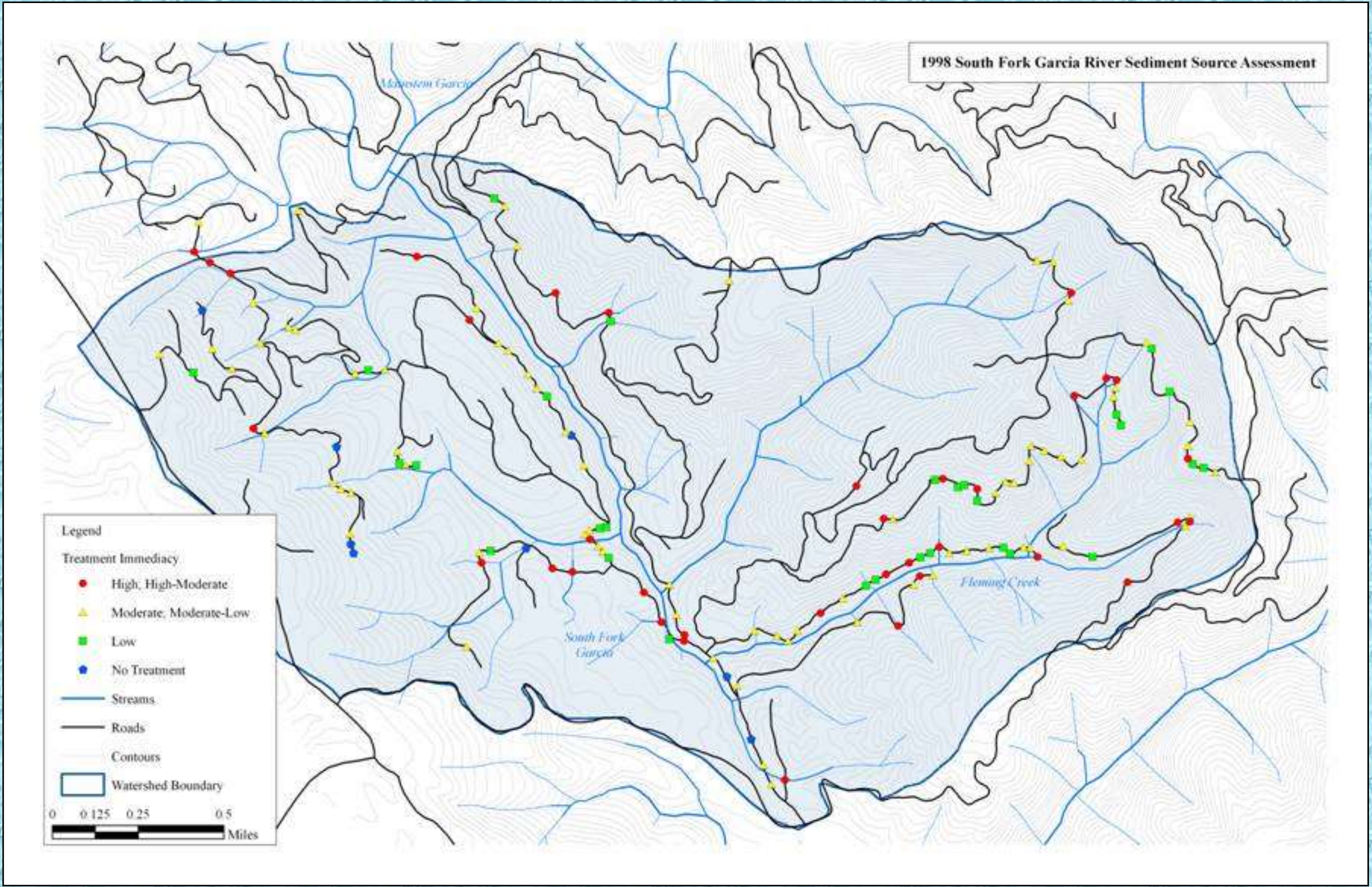
Culverts with High Plug Potential

11 culverts with a high plug potential

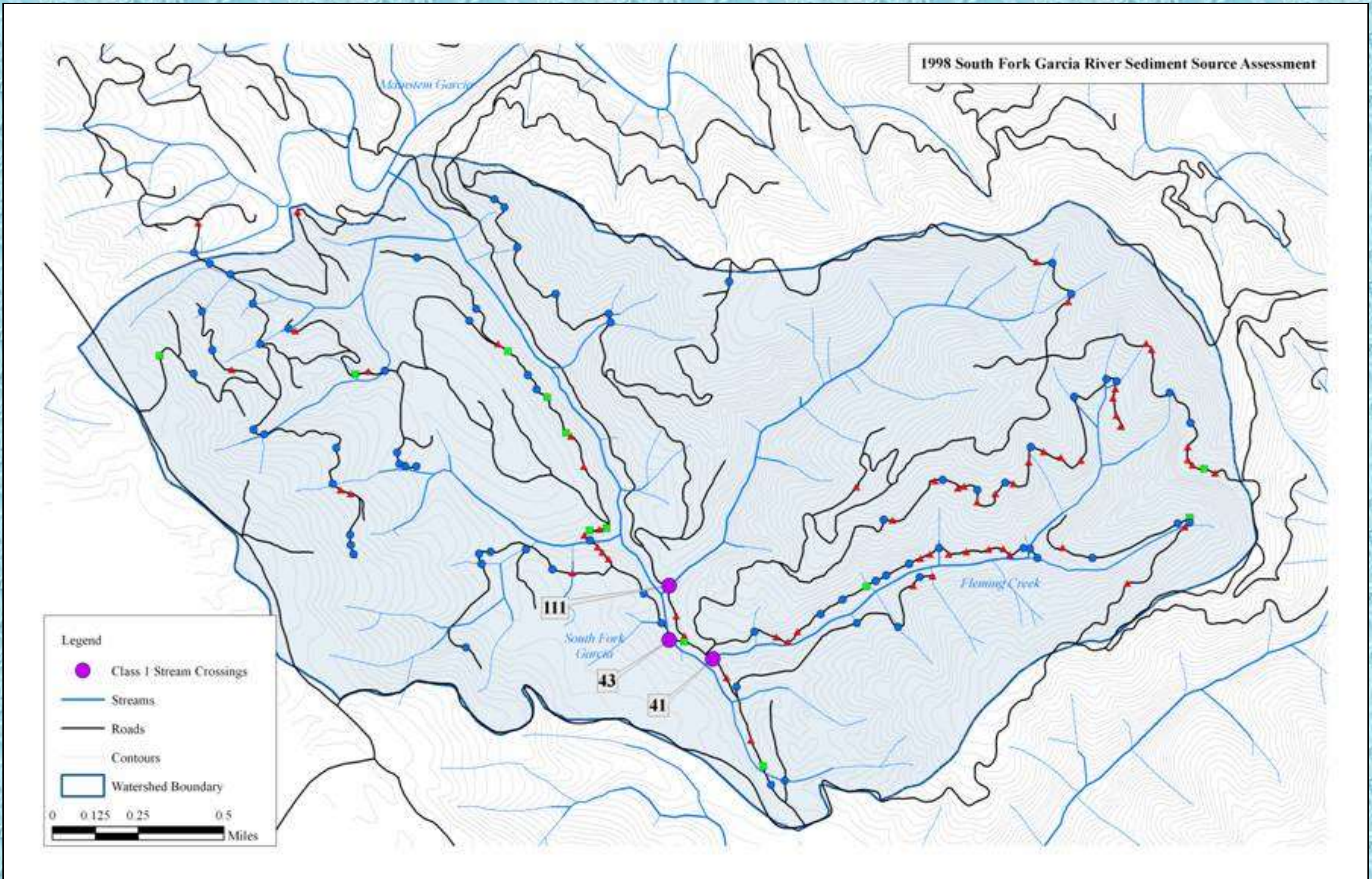


Assign Treatment Priorities

Summary of treatment priority for all sites



Total estimated cost for "Complete" sediment control: $890,000



Measures of success

- **Road upgrading – *resiliency & threat reduction***
  - Decreased culvert plugging
  - No unexpected stream diversions
  - Lower frequency of stream crossing washout
  - Lower sediment delivery from crossing failure
  - Lower frequency and delivery from road fill failures
  - Hydrologic connectivity reduced to 10% to 20%, or less

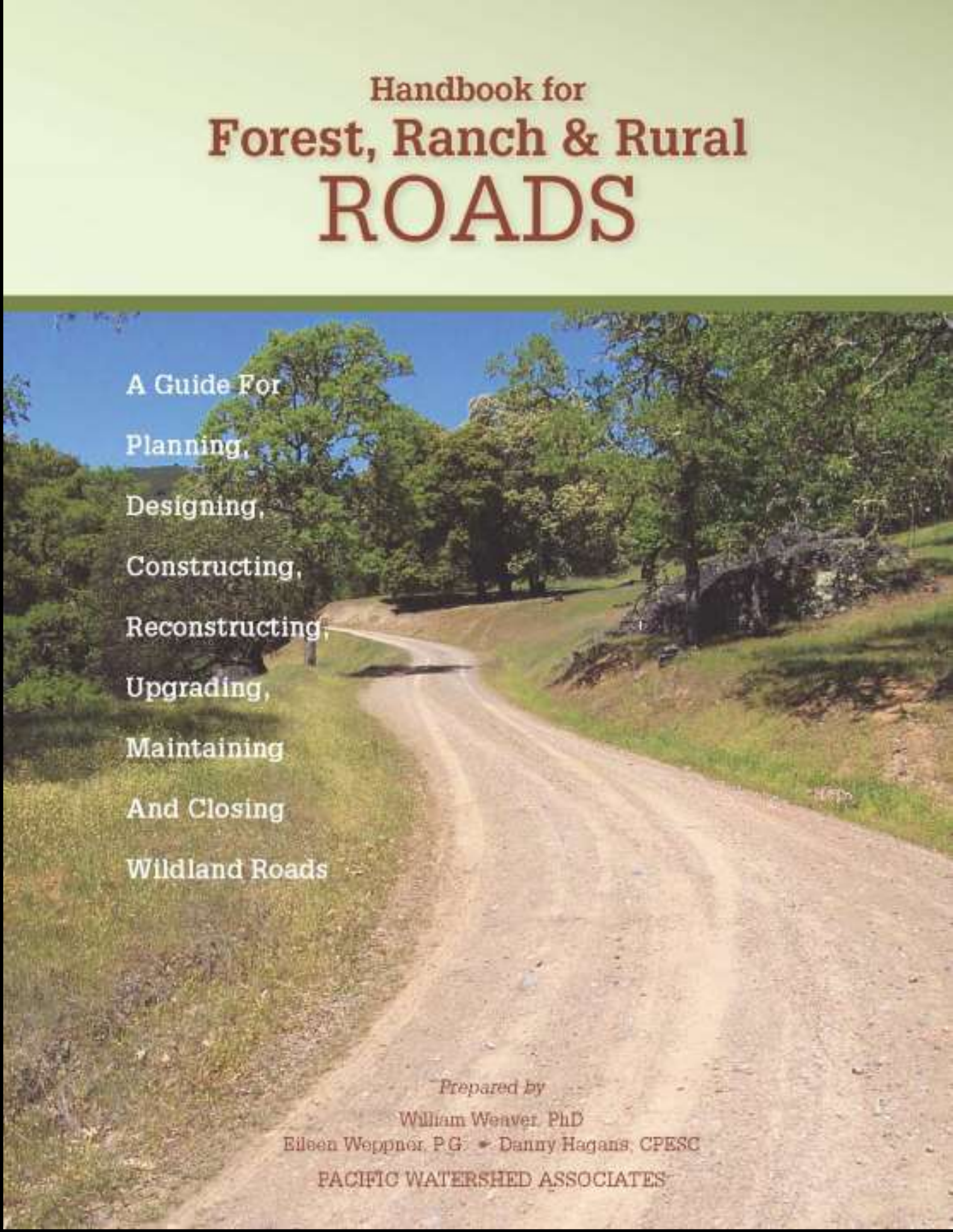
- **Road decommissioning – *eliminate threats***
  - Excavated stream crossings exhibit less than 5%, preferably less than 2%, loss of erodible fill volume
  - Lower frequency & delivery from road fill failures
  - Hydrologic connectivity reduced to less than 5% (Tara)

Protect and Restore Water Quality and Aquatic Habitat Through Protective Land and Road Management

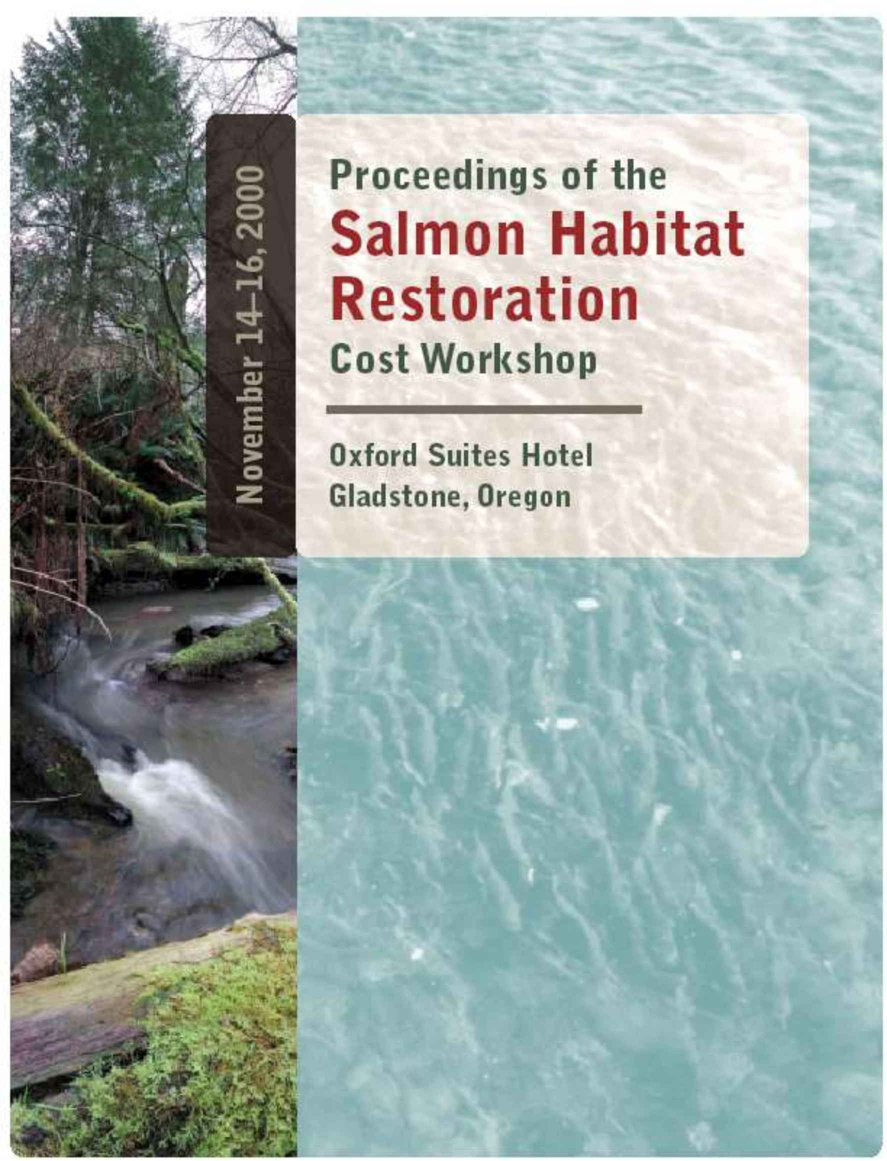
8 Take home points from this presentation

1. Understand the concept of cumulative impacts
2. Understand roads are key limiting threats to salmonids in many watersheds
3. Recognize when your road system requires improvements
4. Learn to distinguish between erosion and sediment delivery
5. Understand the concept of stealth sediment
6. Consider the impacts roads have on hillside hydrology
7. Recognize the most successful projects have broad "buy in" from all interested parties
8. Know the resources that are available to you and your watershed organization

Useful References



Useful References *(cont)*



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March 2004

graphic design: Jeff Bright, www.jeffbrightdesign.com

spawning coho salmon photos: Thomas Dunklin, www.thomasbdunklin.com

Useful References *(cont)*

State of California
The Resources Agency
Department of Forestry & Fire Protection

Designing Watercourse Crossings for Passage of 100-year Flood Flows, Wood, and Sediment

Peter Cafferata, Thomas Spittler, Michael Wopat, Greg Bundros, and Sam Flanagan

California Forestry Report No. 1

February 2004

http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/T0848E/t0848e-09.htm

Field measurement of soil erosion and runoff

by **N. W. Hudson**

Silsoe Associates

Ampthill, Bedford

United Kingdom

Food and Agriculture Organization of the United Nations

Rome, 1993

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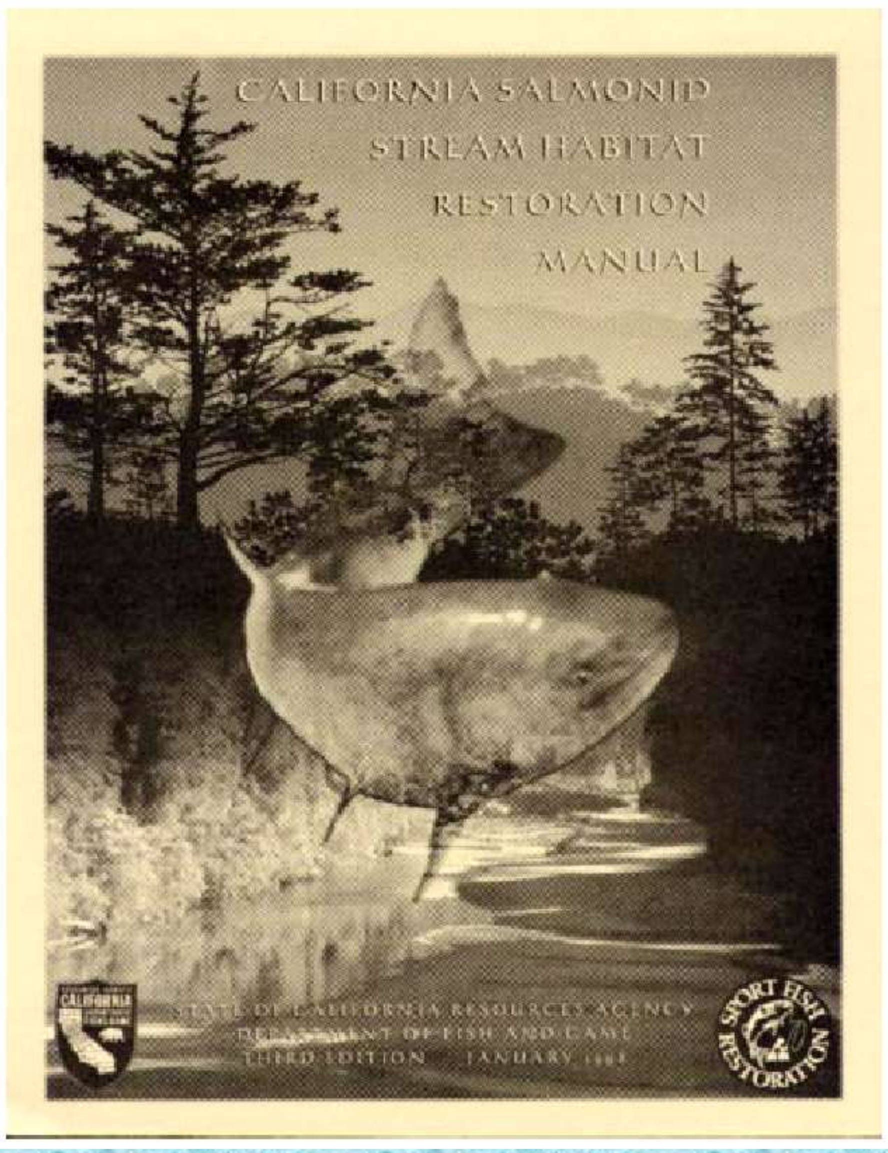
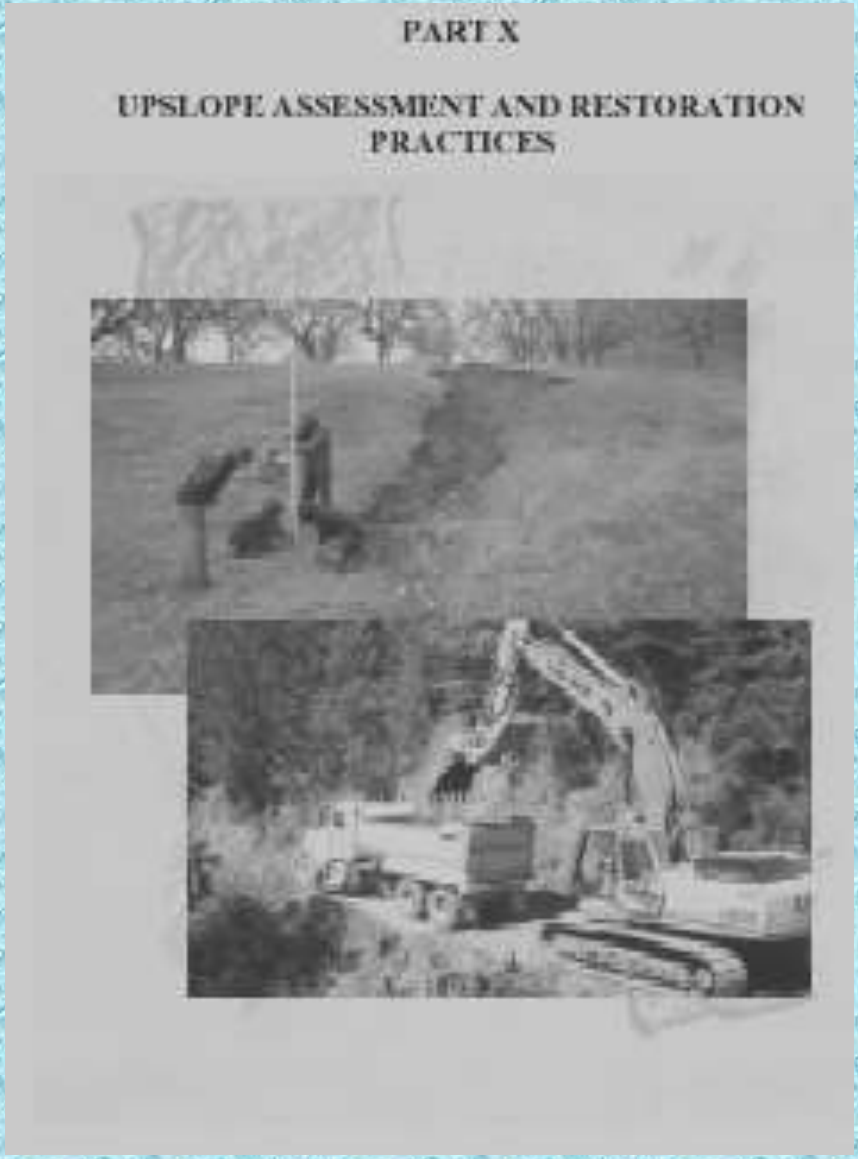
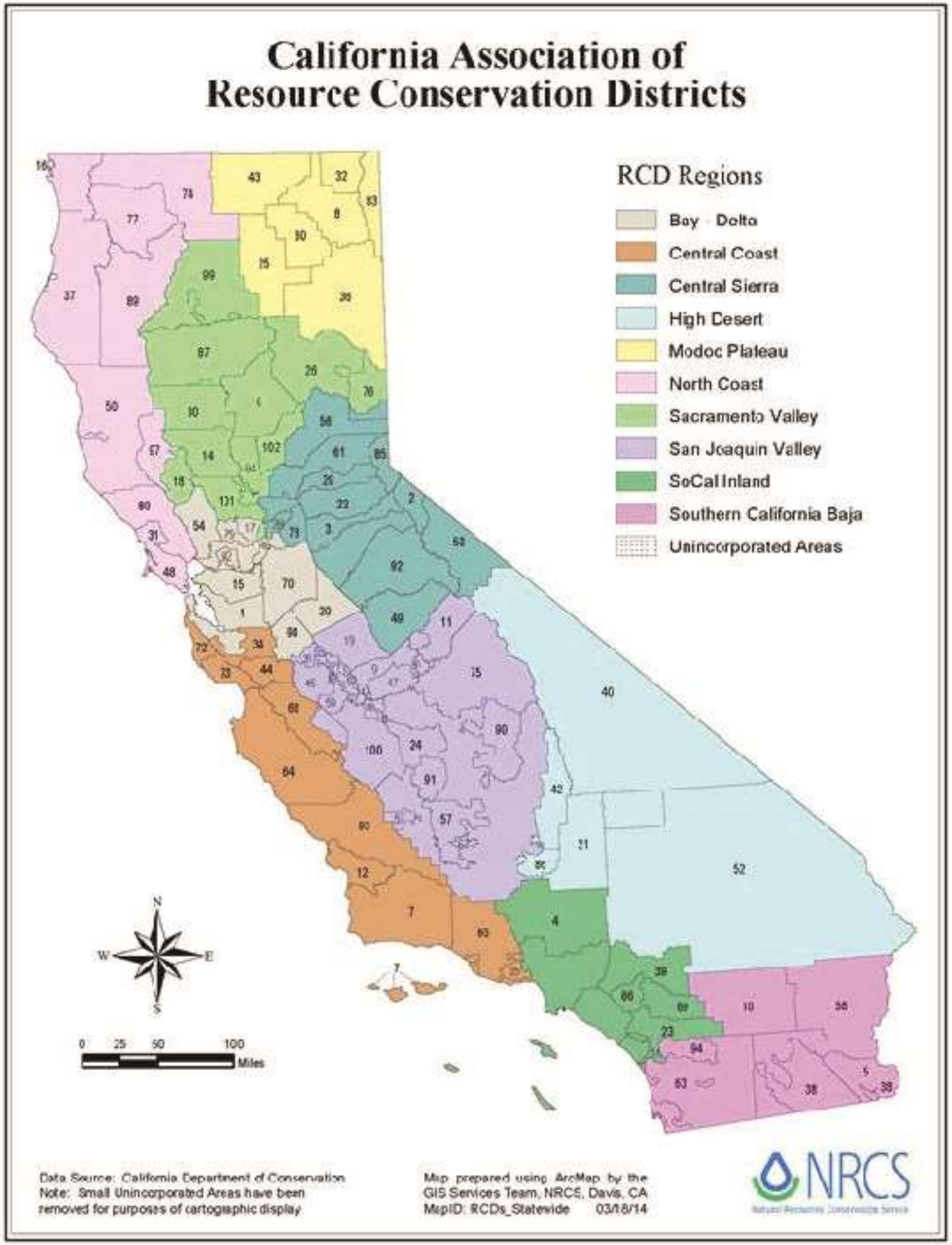
- PRACTICALITIES
- AVOID 'BEFORE AND AFTER' EXPERIMENTS
- STATISTICS

Useful References *(cont)*





California RCD Directory---- http://www.carcd.org/rcd_directory0.aspx



VALLEY BOTTOM GEOMORPHOLOGY, FLOW INUNDATION, AND FLOODPLAIN CONNECTIVITY

Salmonid Restoration Conference
29 March 2017 • Davis, CA

Stillwater Sciences
Jay Stallman
Senior Geologist
jay@stillwatersci.com

OFF-CHANNEL AND FLOODPLAIN HABITAT

- **Rearing habitat governs smolt production and carrying capacity**
  - Deep pools
  - Bank margins and side channels
  - Floodplain ponds, wetlands, and sloughs
- **Winter rearing habitats often most critical**
  - Refuge from high velocity
  - Improved feeding and growth
- **Winter rearing habitat often limiting**
  - Wood removal, reduced large wood input
  - Floodplain disconnection by channel incision, flood control, mining
  - Simplified flow paths

EVALUATING FLOODPLAIN INUNDATION AND CONNECTIVITY IN SUPPORT OF HABITAT RESTORATION

- Geologic controls on local base level, channel gradient, and confinement
- Floodplain and channel thalweg longitudinal profiles
- Elevation of valley landforms above floodplain surface
- Flow, sediment, and wood inputs
- Hydrodynamics and sediment transport
- Disturbance history

EVALUATING FLOODPLAIN INUNDATION AND CONNECTIVITY IN SUPPORT OF HABITAT RESTORATION

- Geologic controls on local base level, channel gradient, and confinement
- **Floodplain and channel thalweg longitudinal profiles**
- **Elevation of valley landforms above floodplain surface**
- Flow, sediment, and wood inputs
- **Hydrodynamics** and sediment transport
- Disturbance history

CASE STUDIES

Two case studies with different geomorphic settings and disturbance histories:

Elk River

- Largest tributary to Humboldt Bay
- Sediment-impaired channel conditions in coastal plain reaches

Salmon River

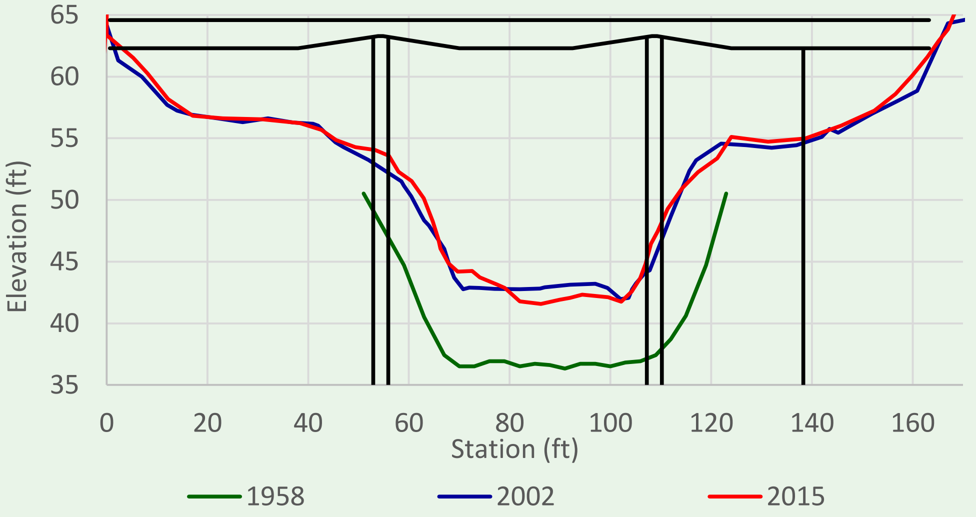
- Large tributary to the Klamath River in western Siskiyou County
- Mining altered floodplain morphology and reduced availability of floodplain habitats

ELK RIVER RECOVERY ASSESSMENT

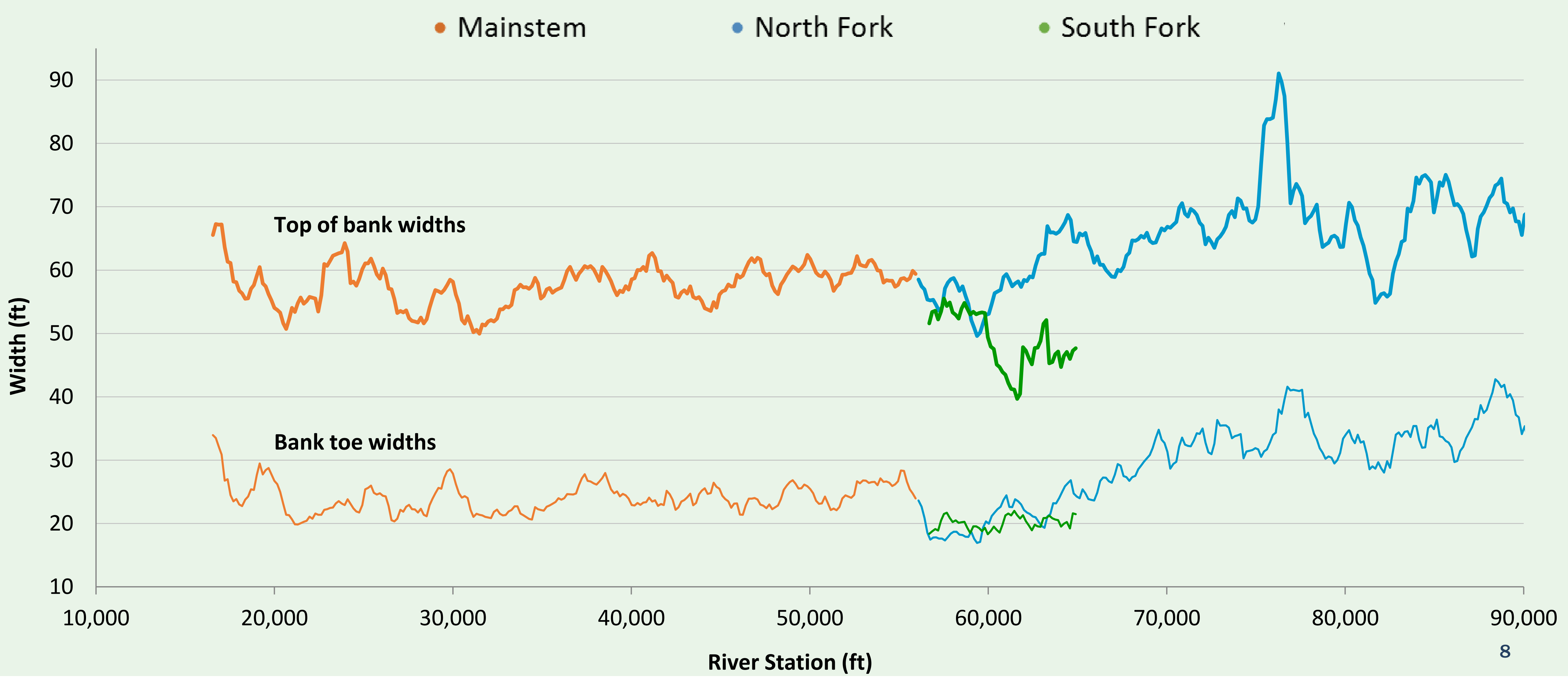
USDA NRCS
UC Cooperative Extension
US Fish and Wildlife Service
State Water Resources Control Board
US Bureau of Land Management
USFS Redwood Sciences Lab
County of Humboldt

Jack Lewis
Salmon Forever
Humboldt Redwood Co.
Green Diamond Resource Co.
Redwood Community Action Agency
California Coastal Conservancy
Elk River Landowners

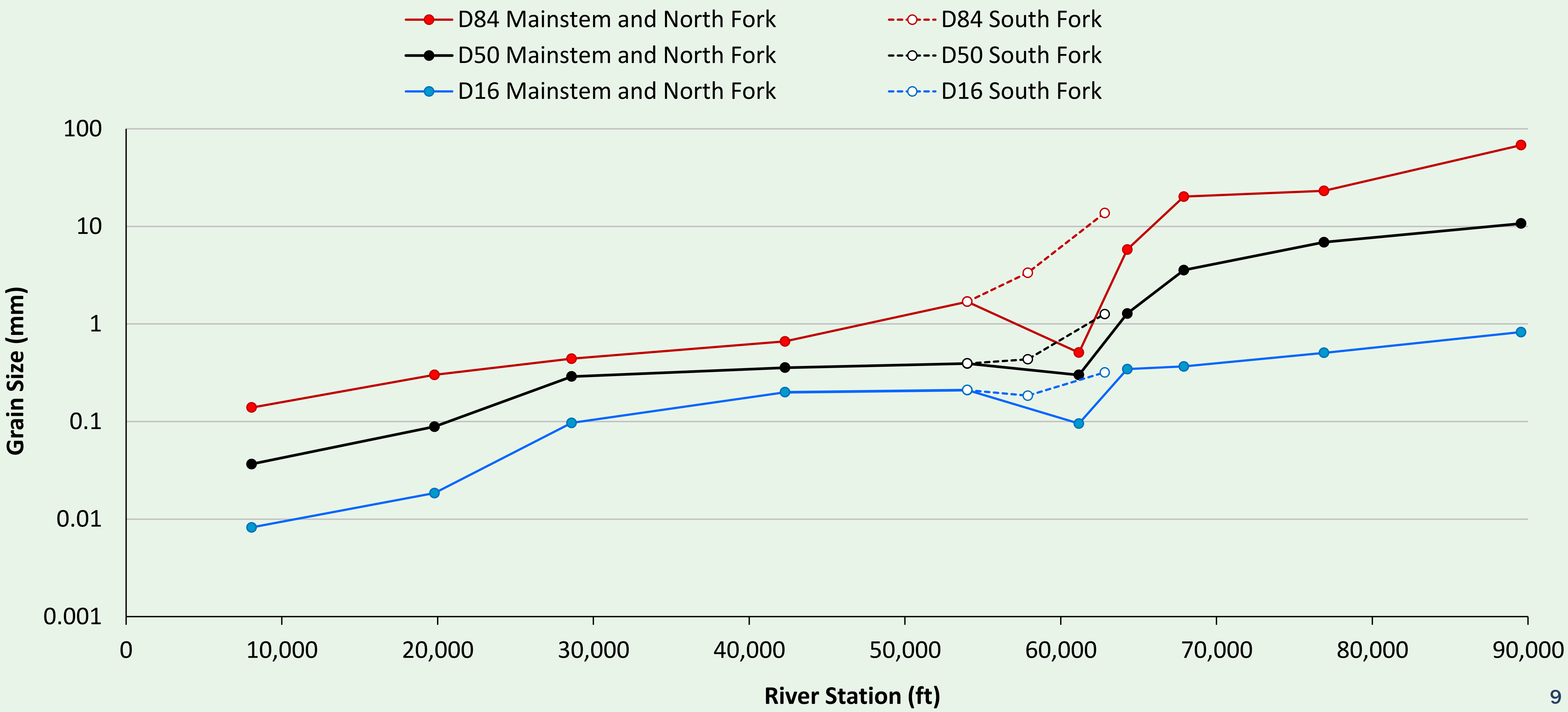
SEDIMENT IMPAIRED CHANNEL CONDITIONS



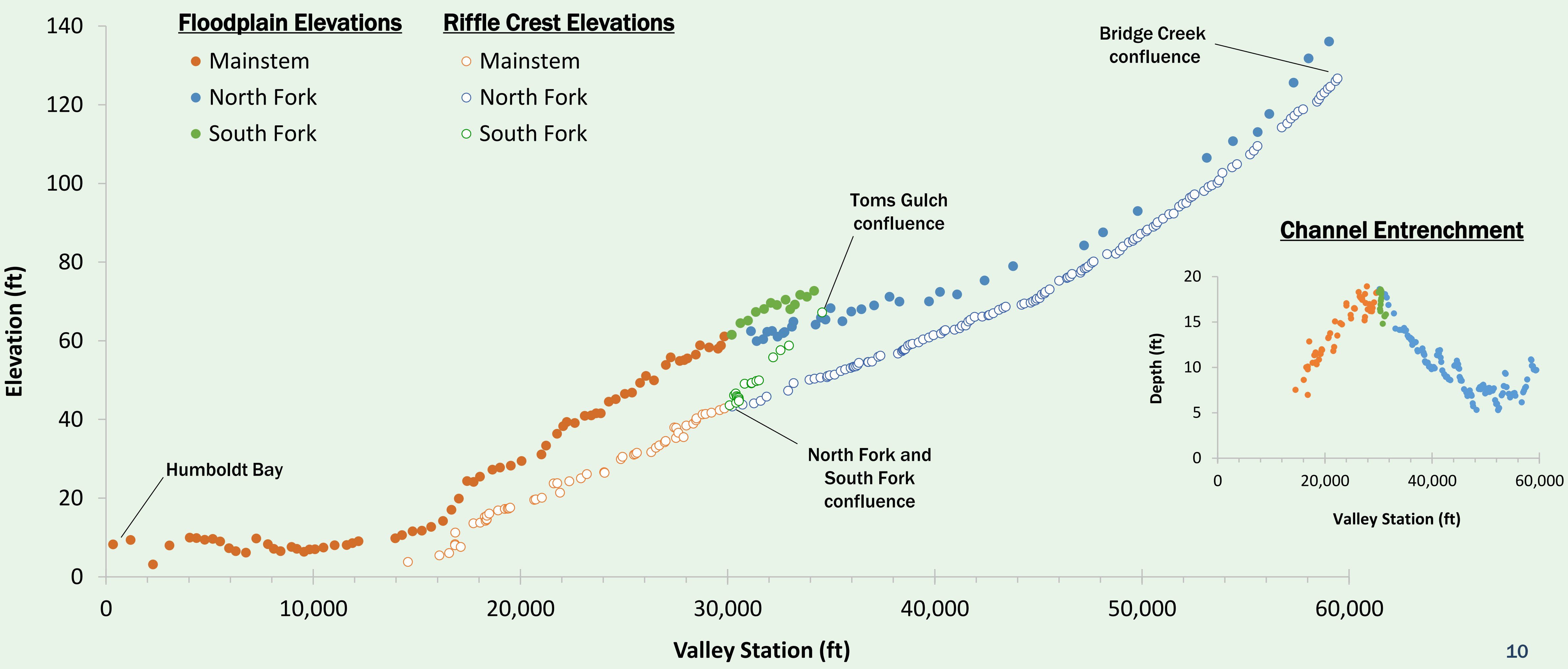
TOP OF BANK AND TOE WIDTHS

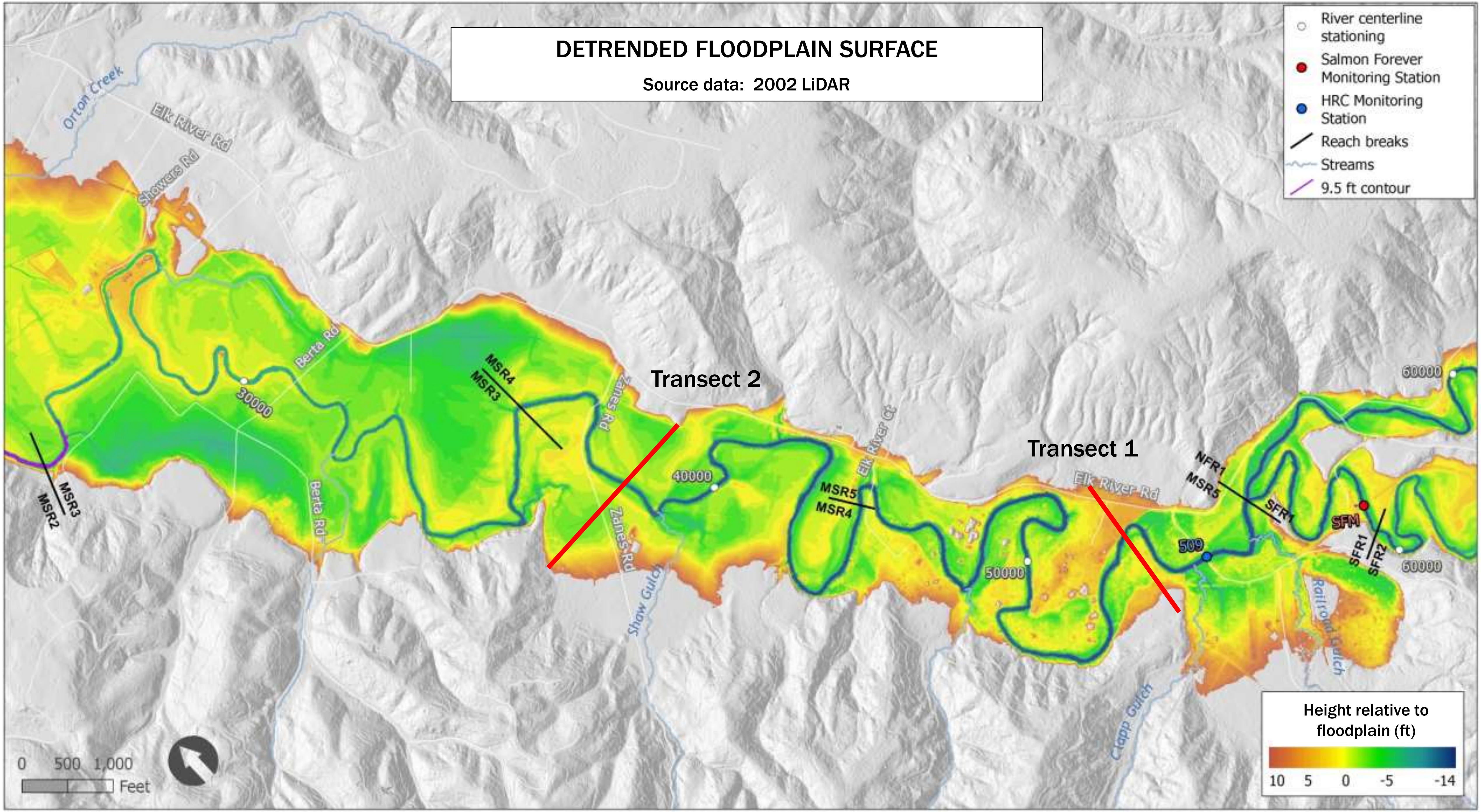


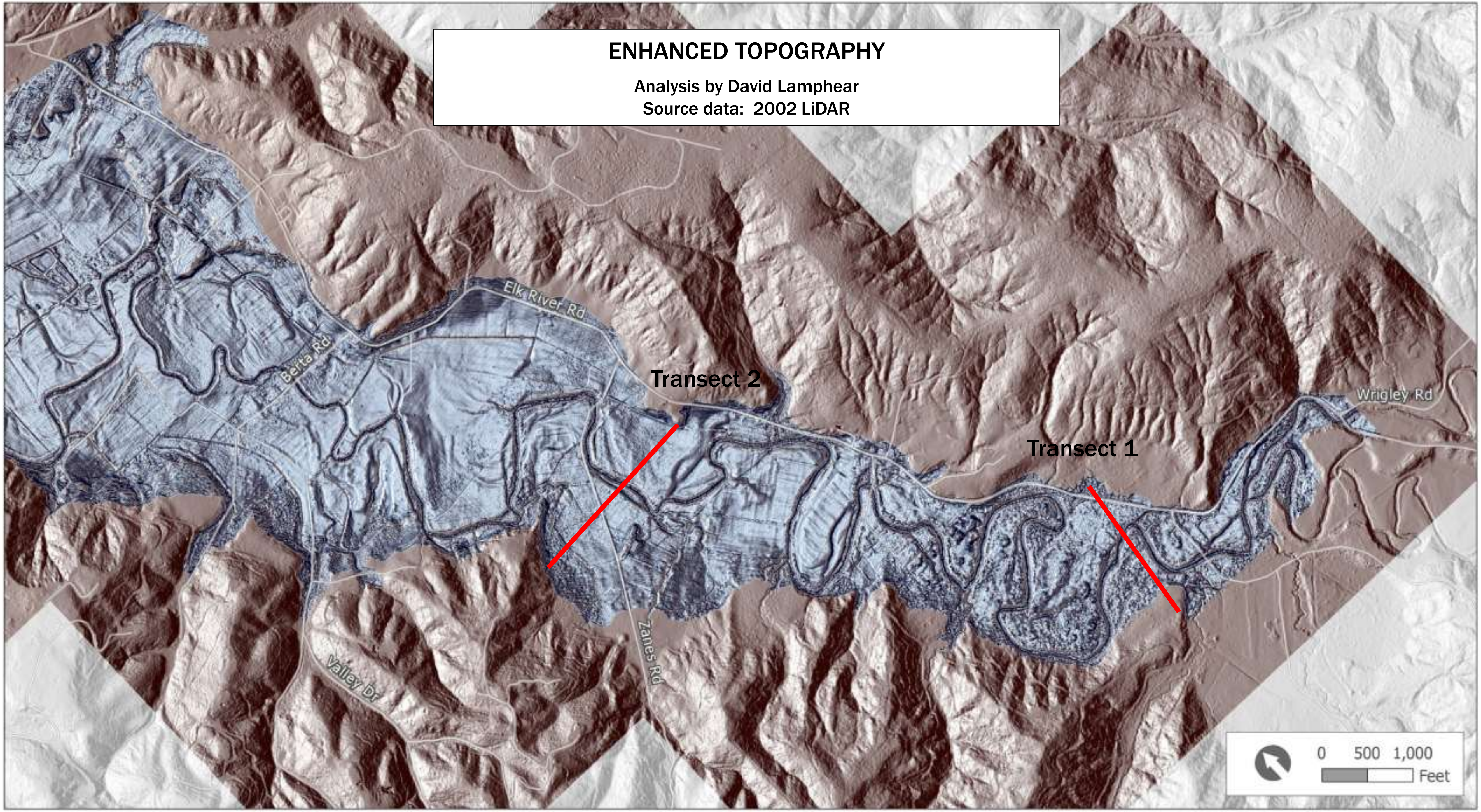
BED PARTICLE SIZE



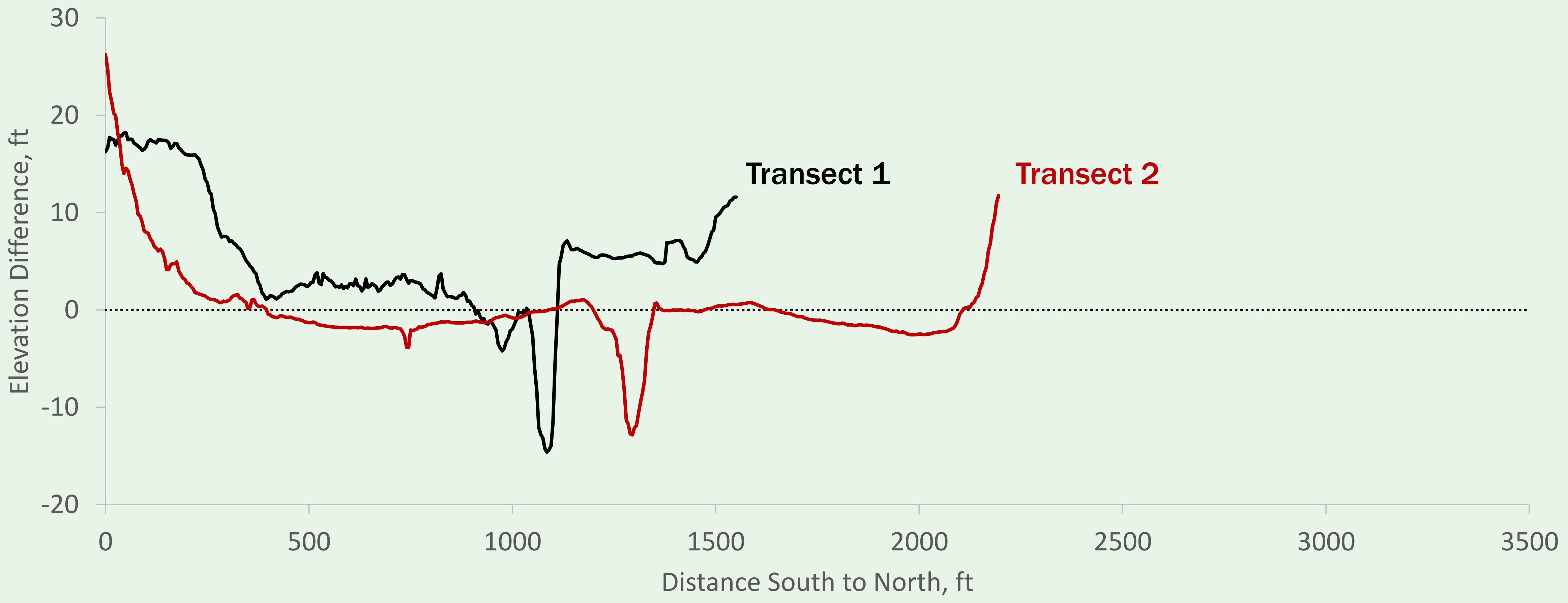
VALLEY AND CHANNEL LONGITUDINAL PROFILE

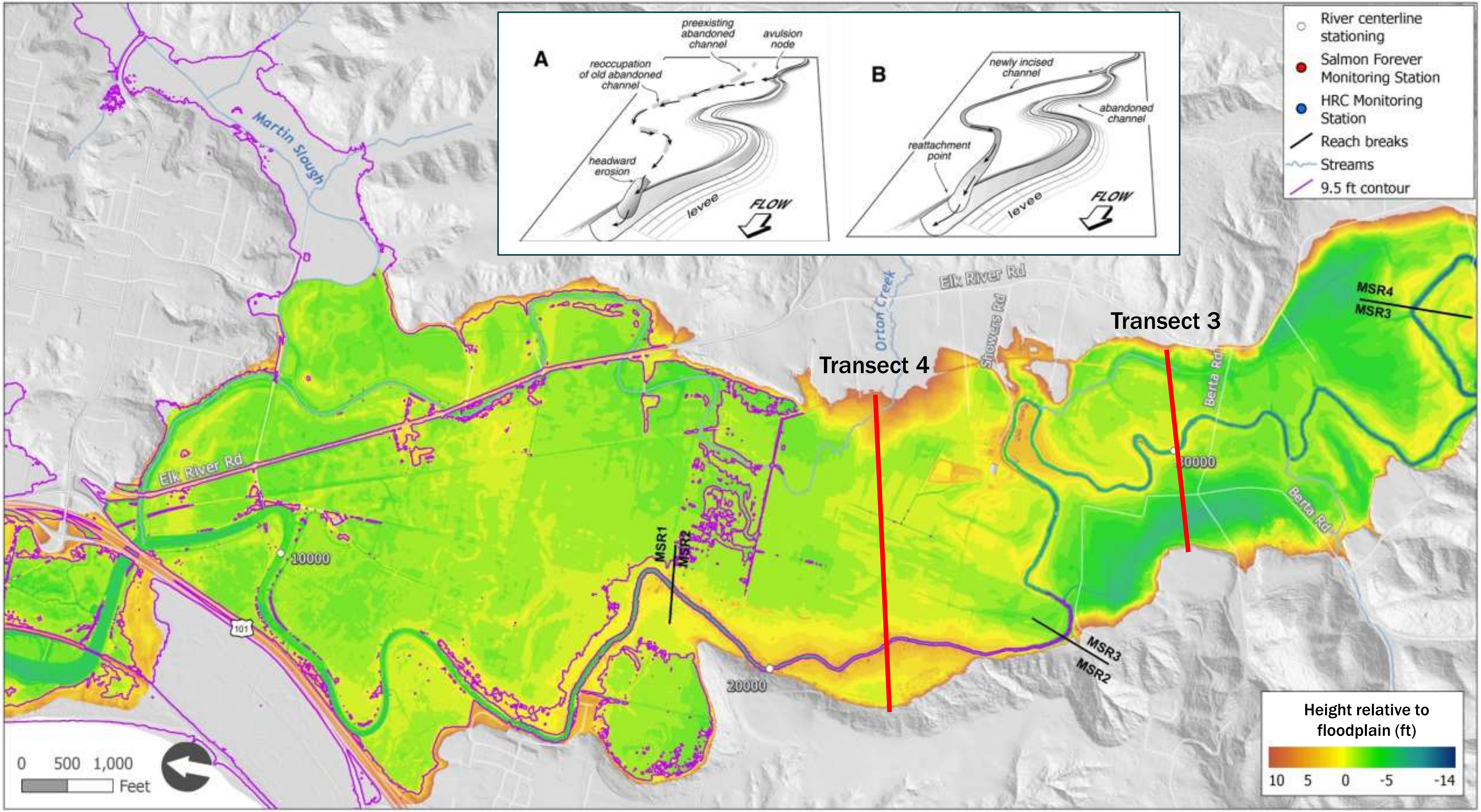



DETRENDED FLOODPLAIN SURFACE
Source data: 2002 LiDAR
River centerline stationing
Salmon Forever Monitoring Station
HRC Monitoring Station
Reach breaks
Streams
9.5 ft contour
Orton Creek
Elk River Rd
Showers Rd
Berta Rd
Zanes Rd
Elk River Ct
Shaw Gulch
Clapp Gulch
Railroad Gulch
Transect 2
Transect 1
MSR4
MSR3
MSR2
MSR5
NFR1
SFR1
SFR2
SFM
509
30000
40000
50000
60000
Height relative to floodplain (ft)
10 5 0 -5 -14
0 500 1,000
Feet

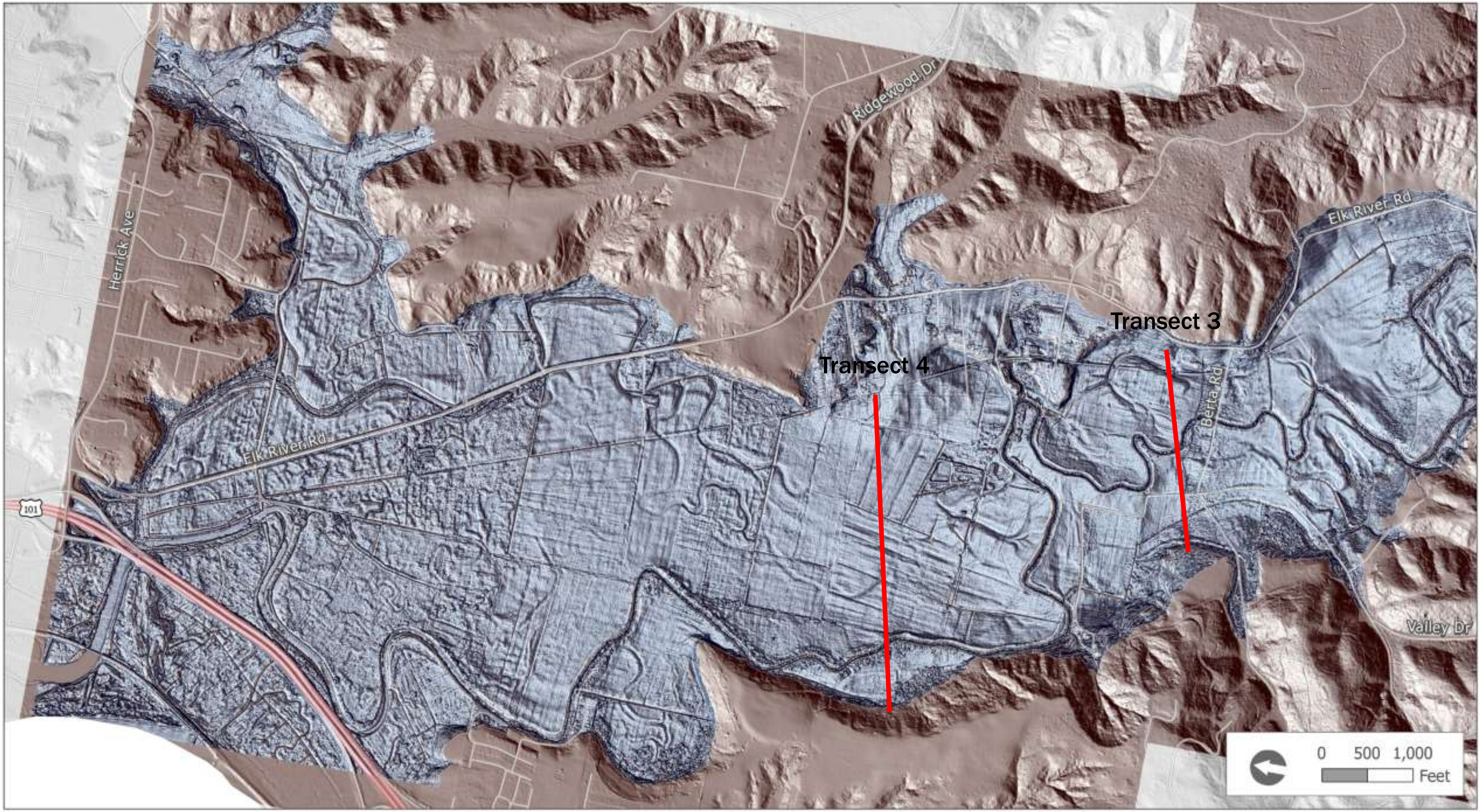

ENHANCED TOPOGRAPHY
Analysis by David Lamphear
Source data: 2002 LiDAR
Elk River Rd
Berta Rd
Transect 2
Transect 1
Wrigley Rd
Zanes Rd
Valley Dr
0 500 1,000
Feet

VALLEY TRANSECTS: UPPER VALLEY





A
preexisting abandoned channel
avulsion node
reoccupation of old abandoned channel
headward erosion
levee
FLOW
B
newly incised channel
abandoned channel
reattachment point
levee
FLOW
River centerline stationing
Salmon Forever Monitoring Station
HRC Monitoring Station
Reach breaks
Streams
9.5 ft contour
Martin Slough
Elk River Rd
Orton Creek
Showers Rd
Berta Rd
Transect 3
Transect 4
MSR1
MSR2
MSR3
MSR4
10000
20000
30000
101
0 500 1,000
Feet
Height relative to floodplain (ft)
10 5 0 -5 -14



Ridgewood Dr
Herrick Ave
Elk River Rd
Elk River Rd
Transect 3
Transect 4
Berta Rd
Valley Dr
101
0 500 1,000
Feet

VALLEY TRANSECTS: LOWER VALLEY

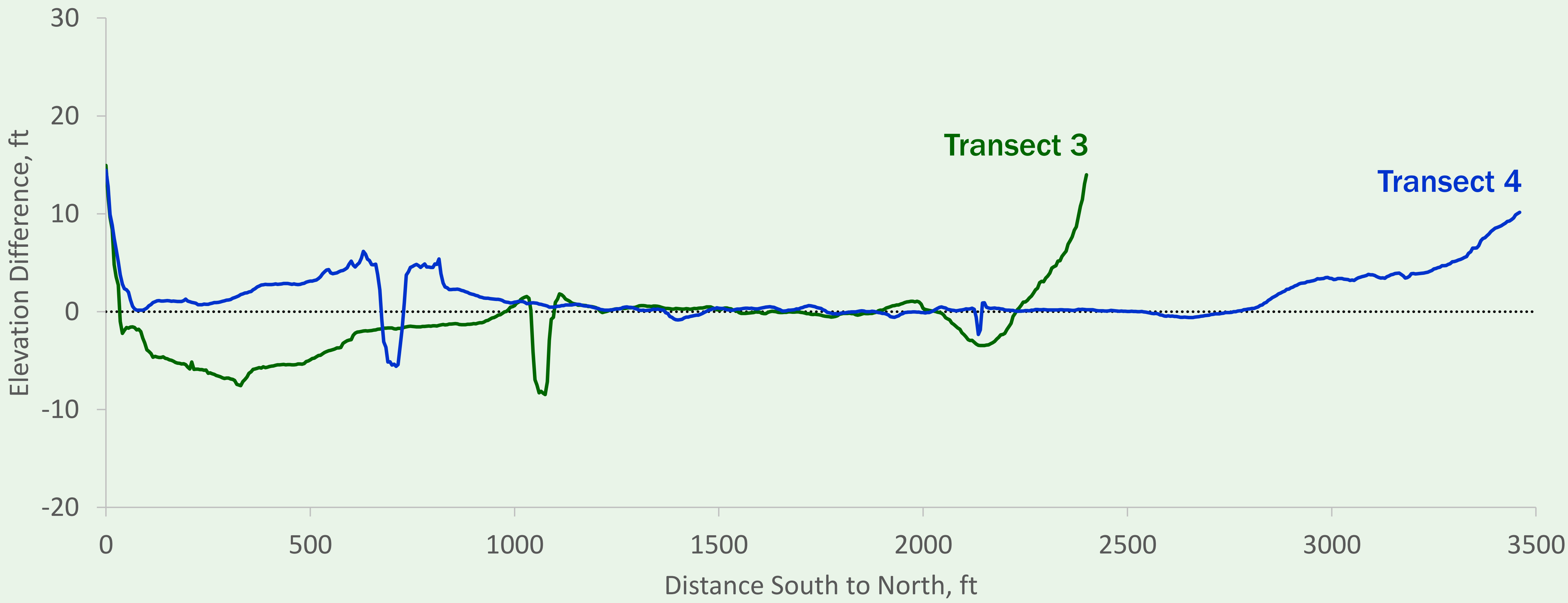
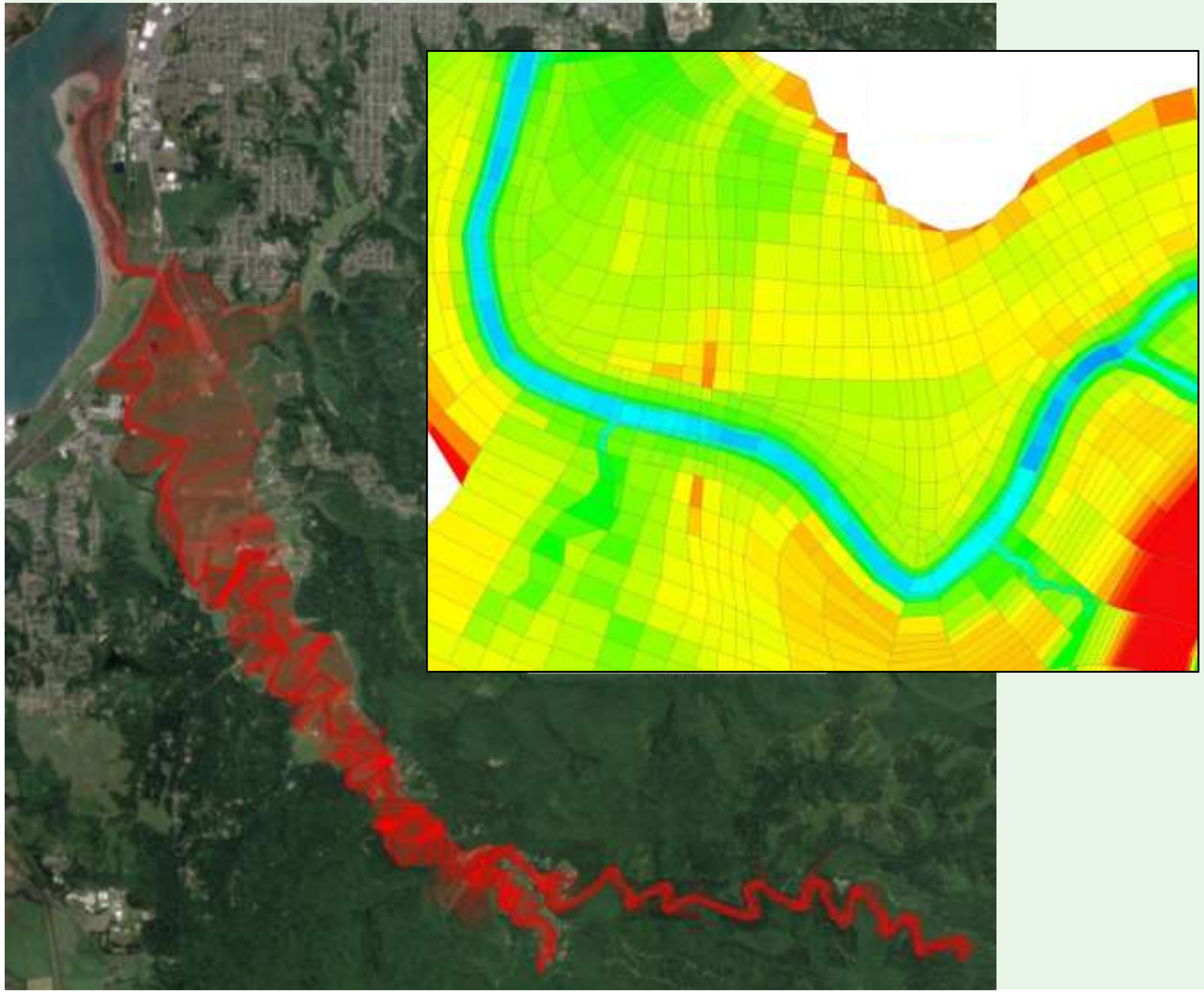
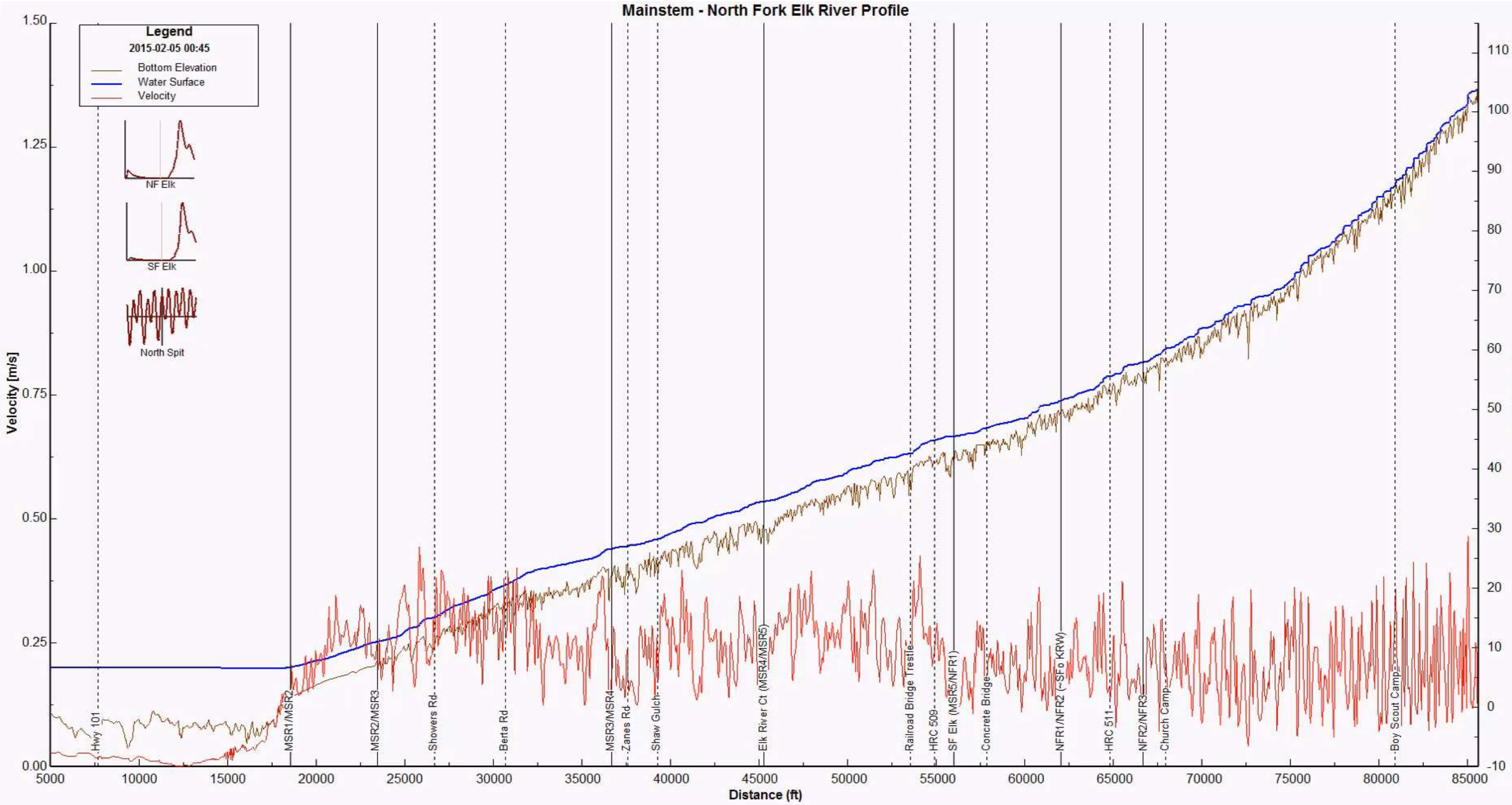



Photo by Brad Finney

HYDRODYNAMIC MODEL



- Environmental Fluid Dynamics Code (2D)
- 18 mi of river channel
- Topographic sources:
  - 1-m LiDAR DEM
  - Elk River long-profile survey
  - Recent cross-section surveys
- Grid Resolution
  - 1 cell for channel bed
  - 2 cells for each channel bank
  - Multiple floodplain cells
- Boundary Conditions
  - Flow for NF and SF Elk and tributaries
  - Tidal water surface elevations
  - Culvert/tide gate structures



Mainstem - North Fork Elk River Profile
Legend
2015-02-05 00:45
Bottom Elevation
Water Surface
Velocity
NF Elk
SF Elk
North Spit
Velocity [m/s]
Elevation (ft)
Distance (ft)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
110
100
90
80
70
60
50
40
30
20
10
0
-10
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
55000
60000
65000
70000
75000
80000
85000
Hwy 101
MSR1/MSR2
MSR2/MSR3
Showers Rd
Berta Rd
MSR3/MSR4
Zanes Rd
Shaw Gulch
Elk River Ct (MSR4/MSR5)
Railroad Bridge Trestle
HRC 509
SF Elk (MSR5/NFR1)
Concrete Bridge
NFR1/NFR2 (~SFo KRW)
HRC 511
NFR2/NFR3
Church Camp
Boy Scout Camp

BANKFULL AND PEAK DISCHARGES
FEBRUARY 2015

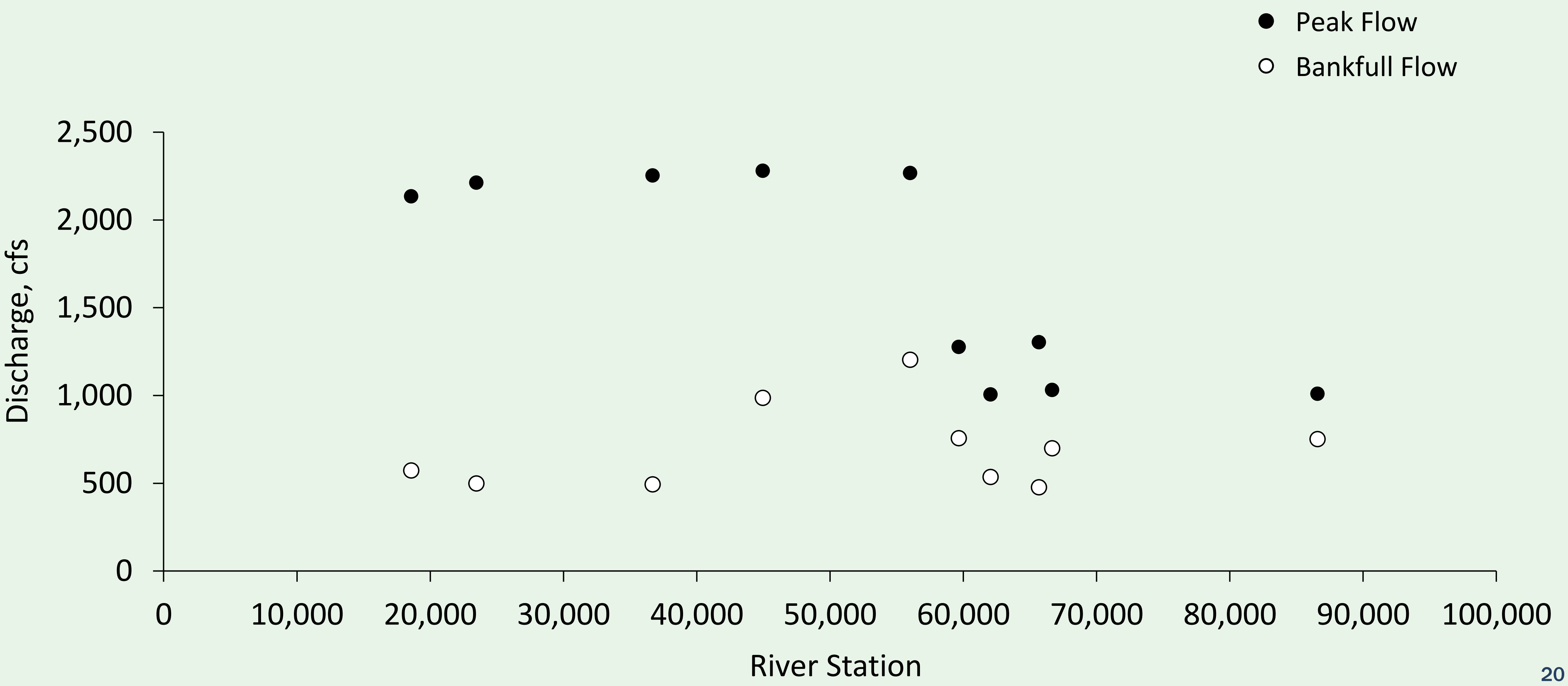
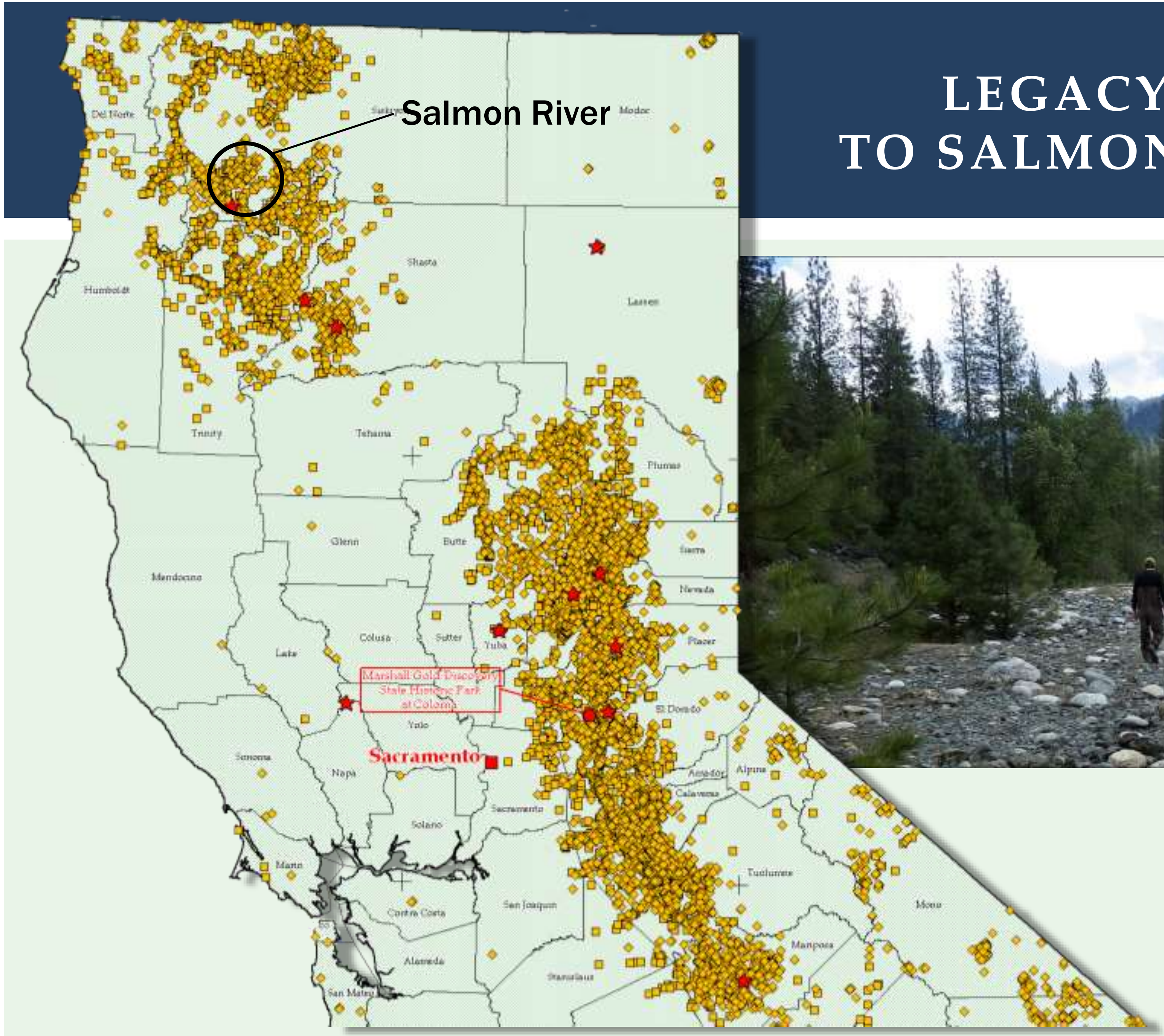


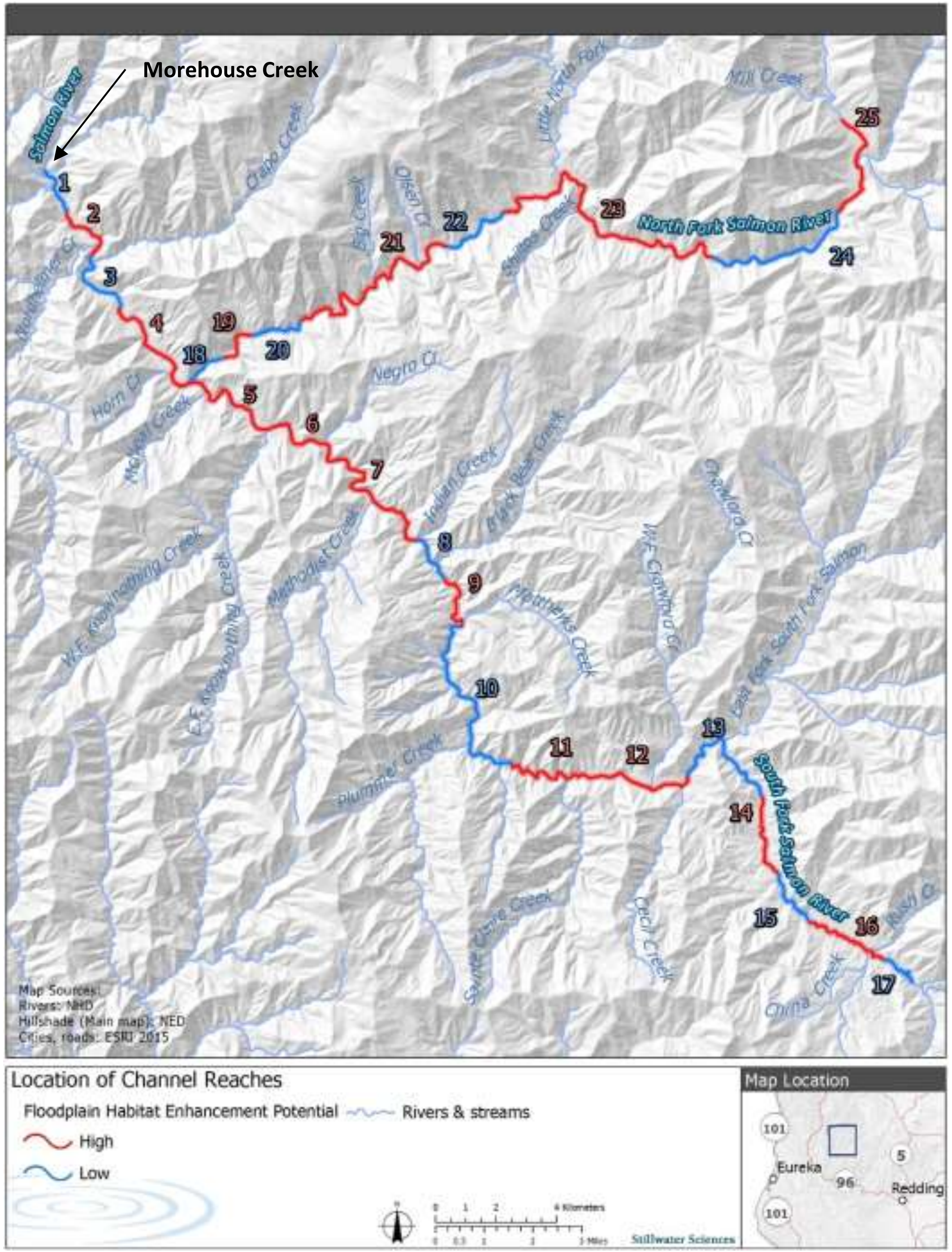

Photo by Brad Finney

SALMON RIVER OFF-CHANNEL AND FLOODPLAIN HABITAT RESTORATION

LEGACY MINING IMPACTS TO SALMON RIVER FISH HABITAT

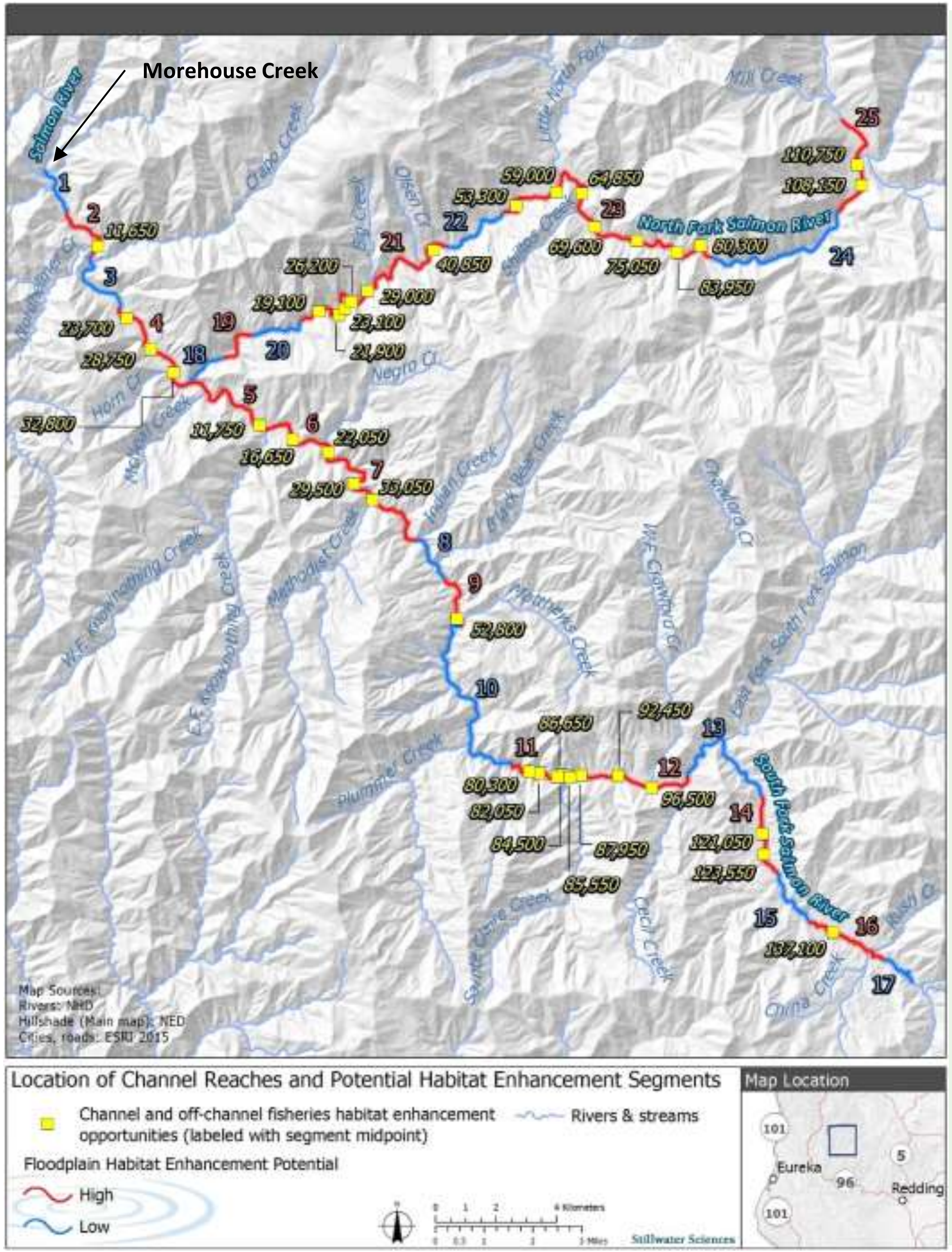


- Denudation and degraded riparian
- Channel and floodplain aggradation
- Coarsened bed with reduced mobility
- Reduced channel complexity
- Reduced floodplain inundation
- Elevated summer water temperatures



GEOMORPHIC REACHES

- Valley confinement
- Predominantly bedrock vs alluvial channel boundaries
- Extent of mining disturbance and existing infrastructure



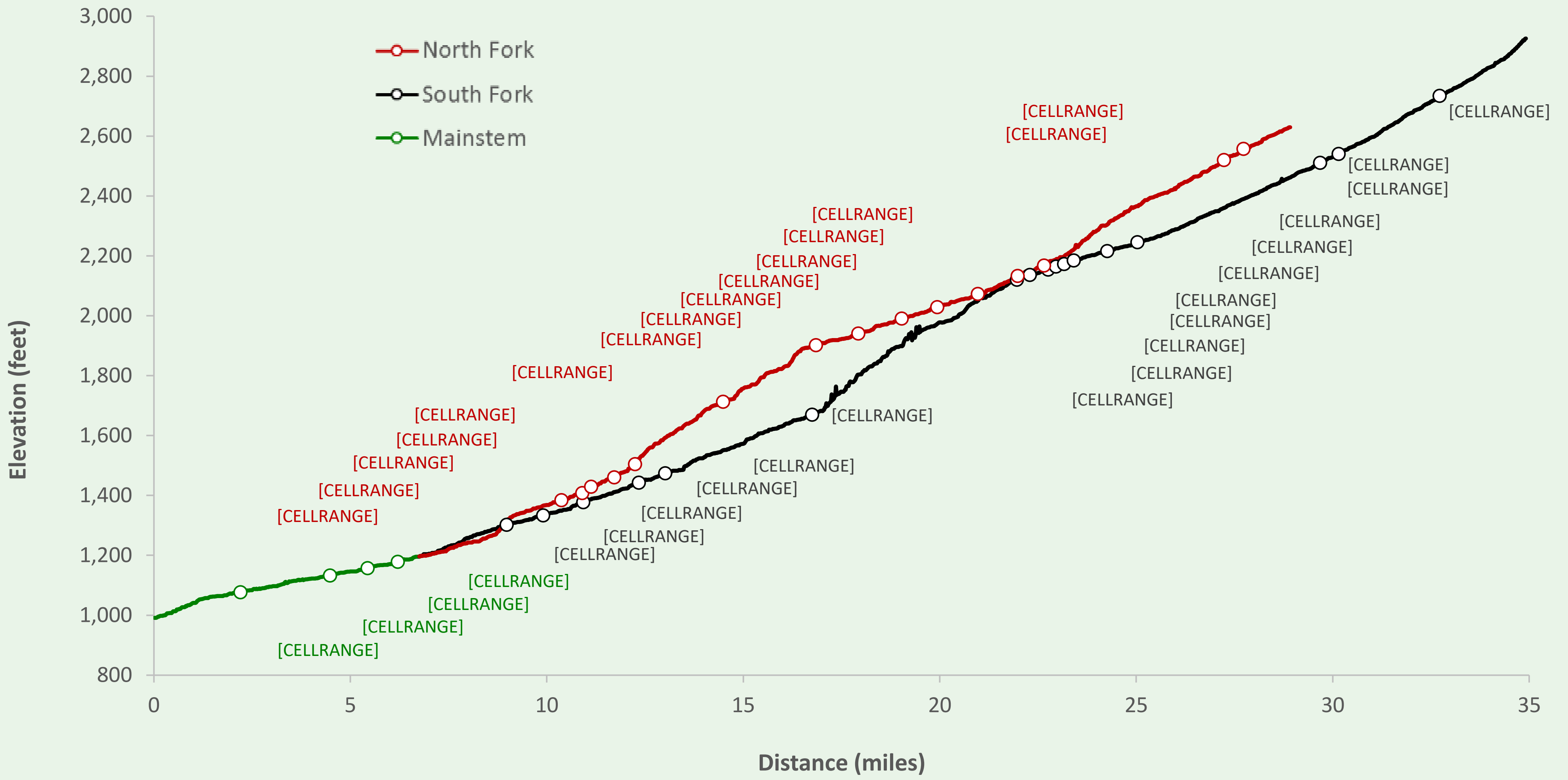
GEOMORPHIC REACHES

- Valley confinement
- Predominantly bedrock vs alluvial channel boundaries
- Extent of mining disturbance and existing infrastructure

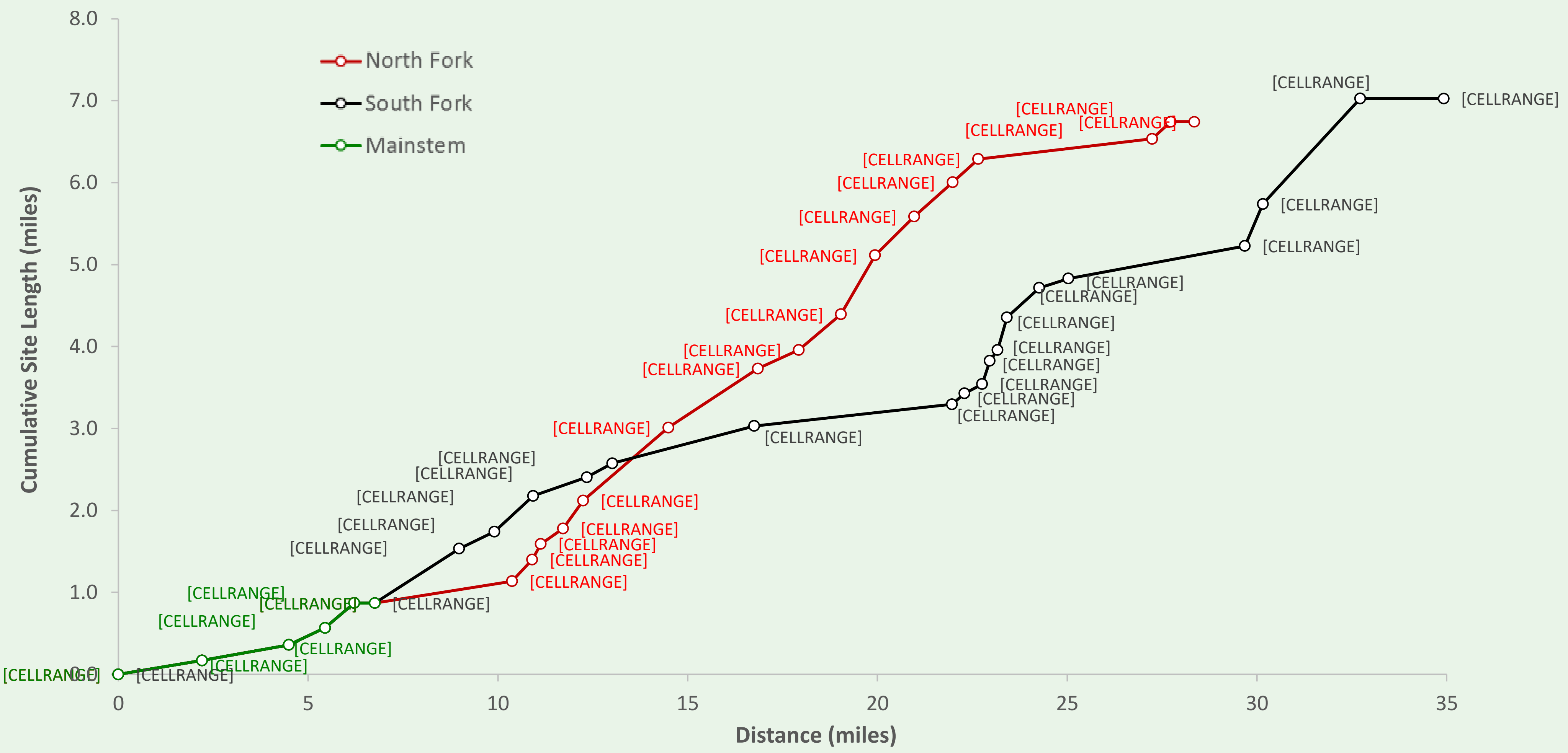
POTENTIAL ENHANCEMENT SEGMENTS

- Channel gradient and confinement
- Alluvial channel features
- Floodplain Inundation
- Existing riparian vegetation
- Summer mainstem thermal suitability
- Proximity to major tributaries and other cold water refugia
- Existing spawning and rearing habitat
- Priorities identified by Salmon River Collaborative In-stream Restoration Technical Advisory Committee

SEGMENT DISTRIBUTION

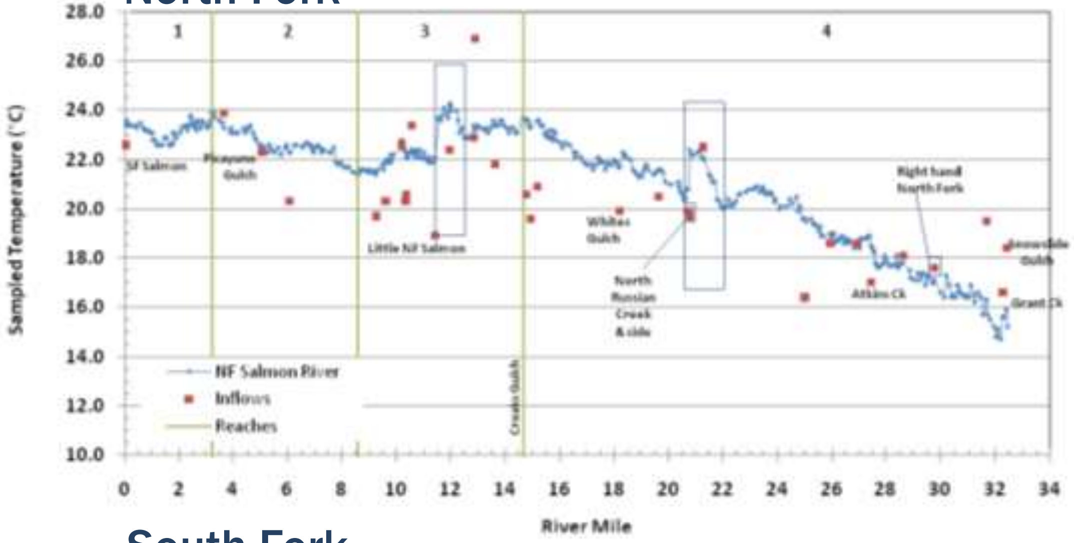


CUMULATIVE SEGMENT LENGTH

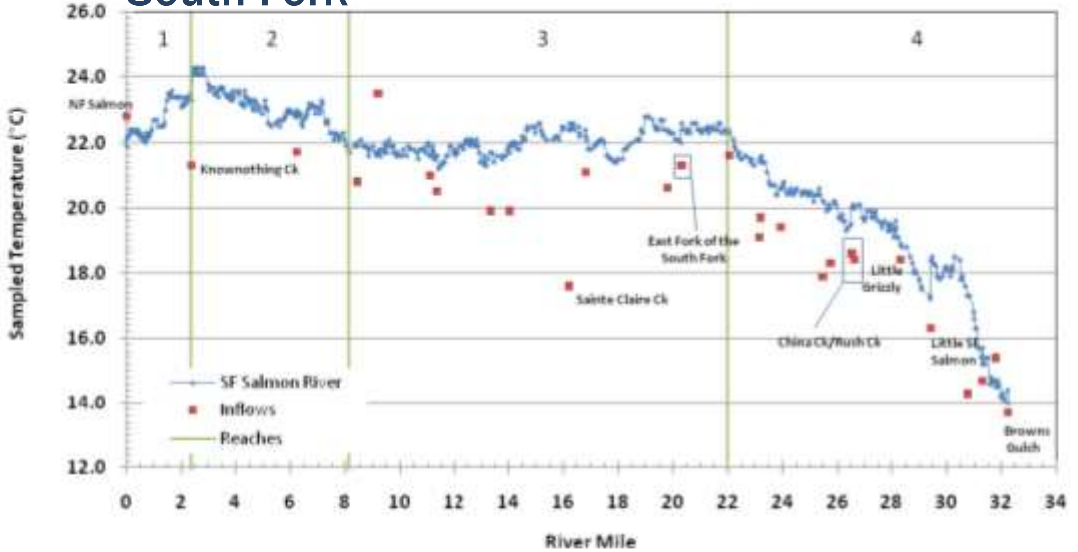


TEMPERATURE PROFILES
JULY 2009

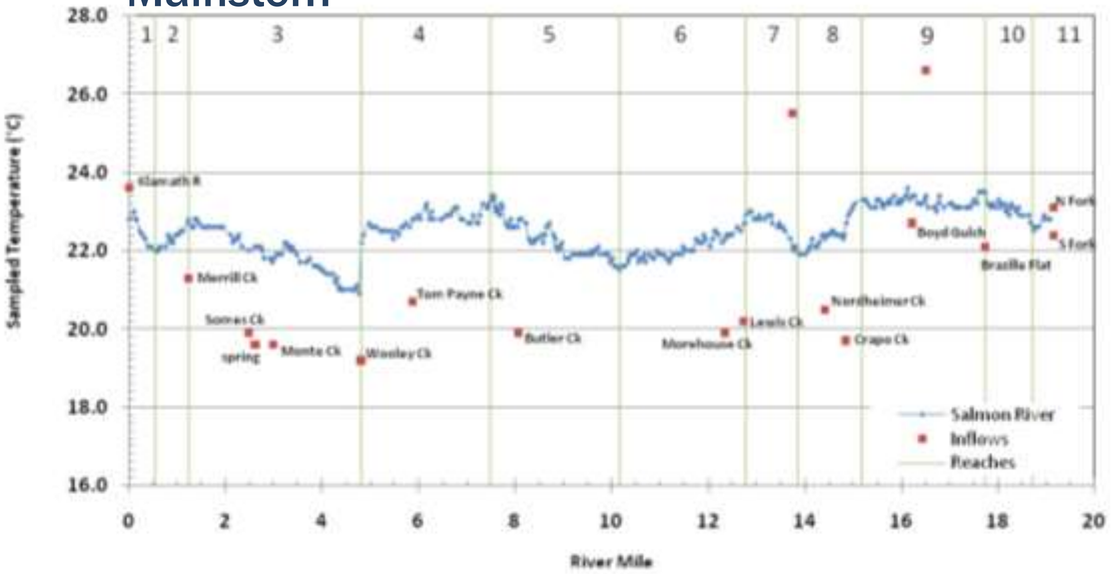
North Fork



South Fork

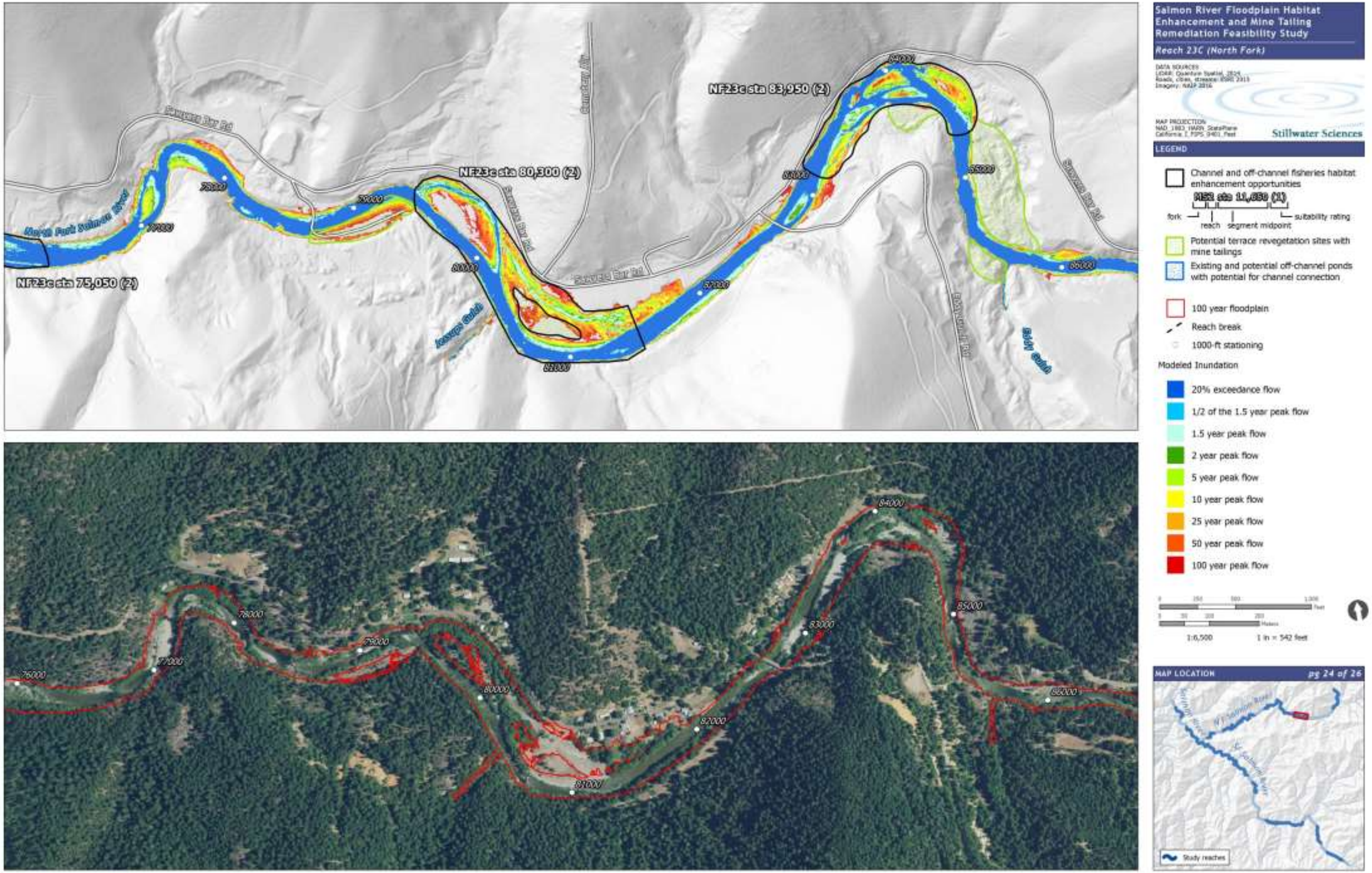


Mainstem

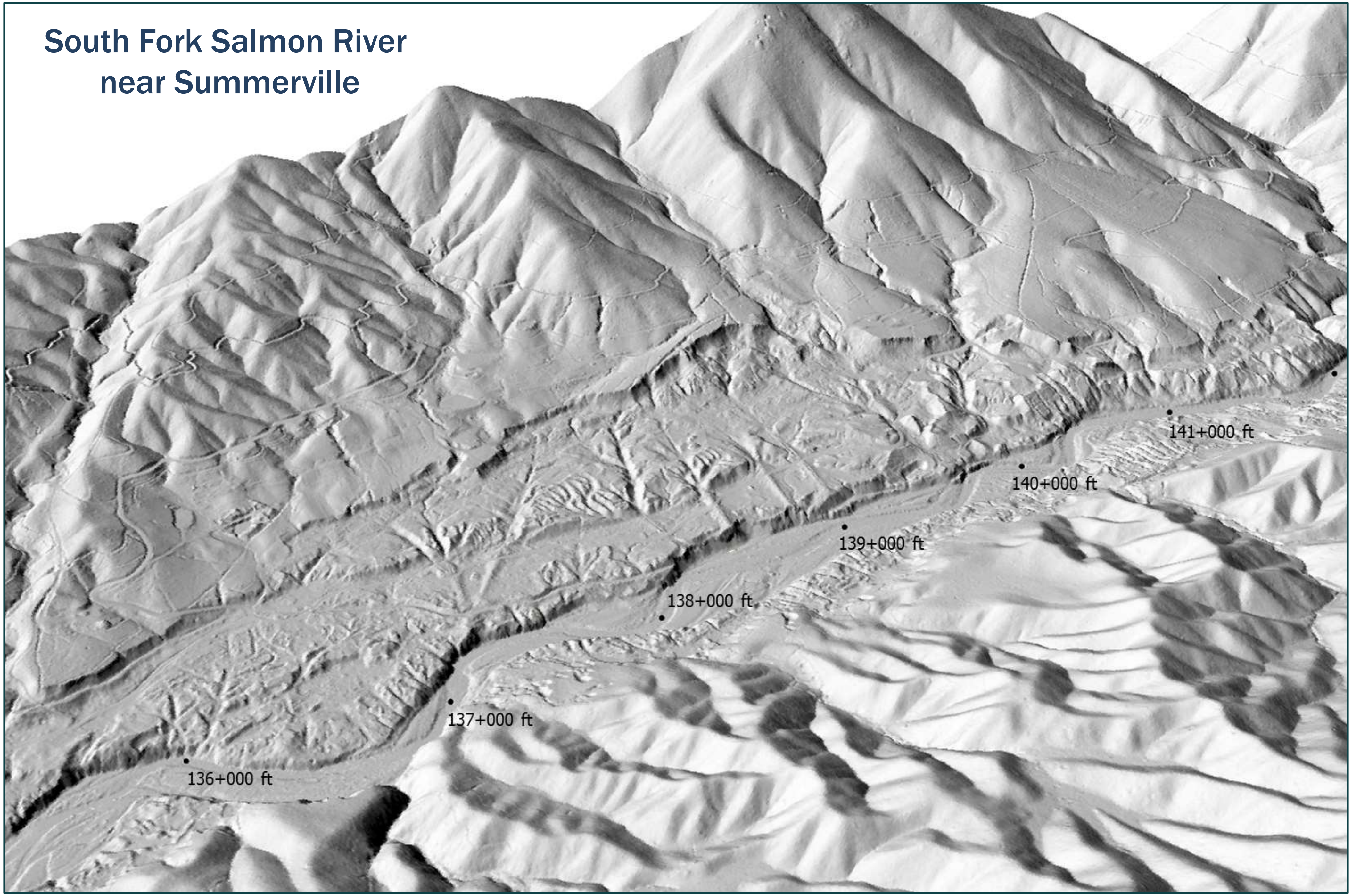


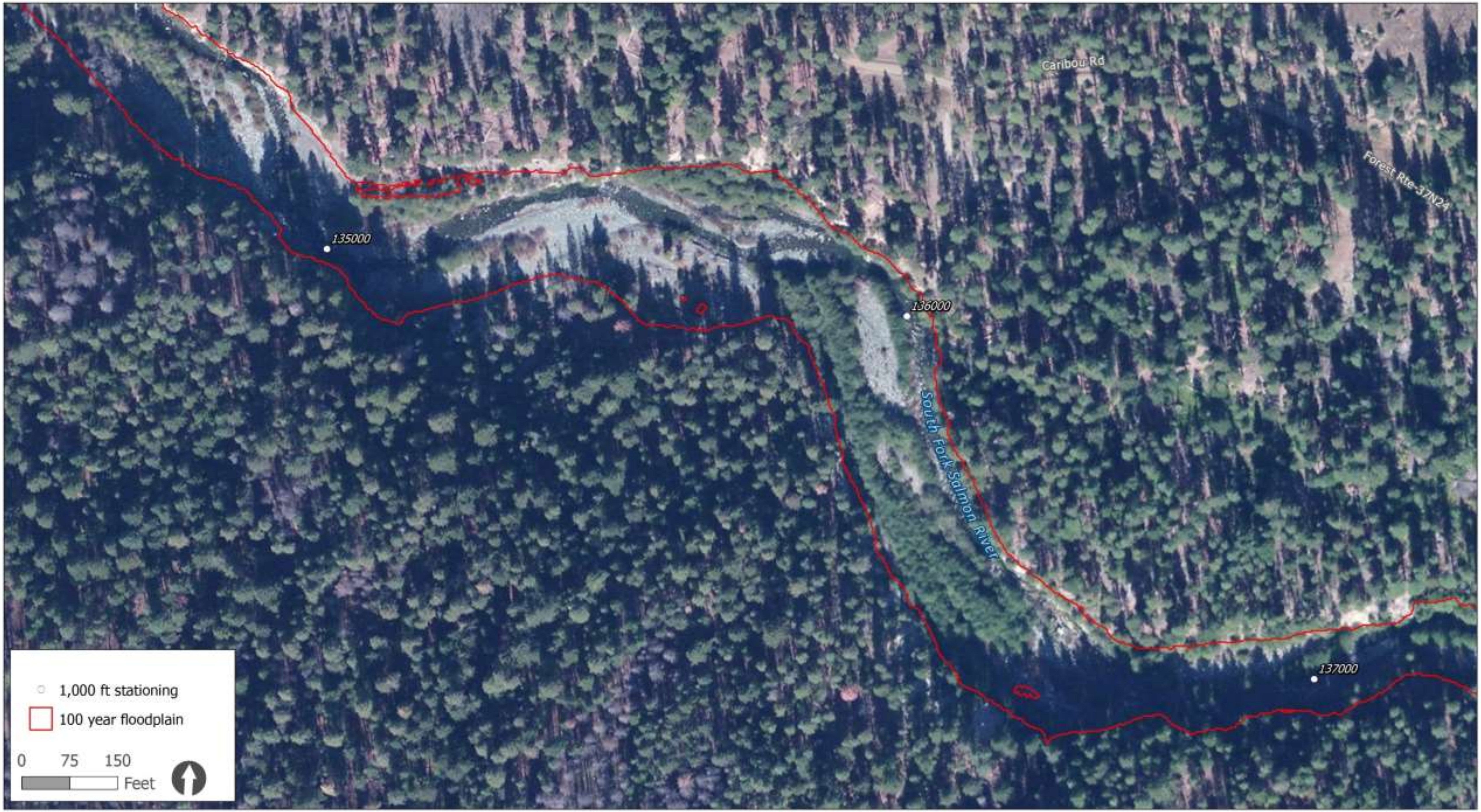
HYDRAULIC MODELING OF INUNDATION

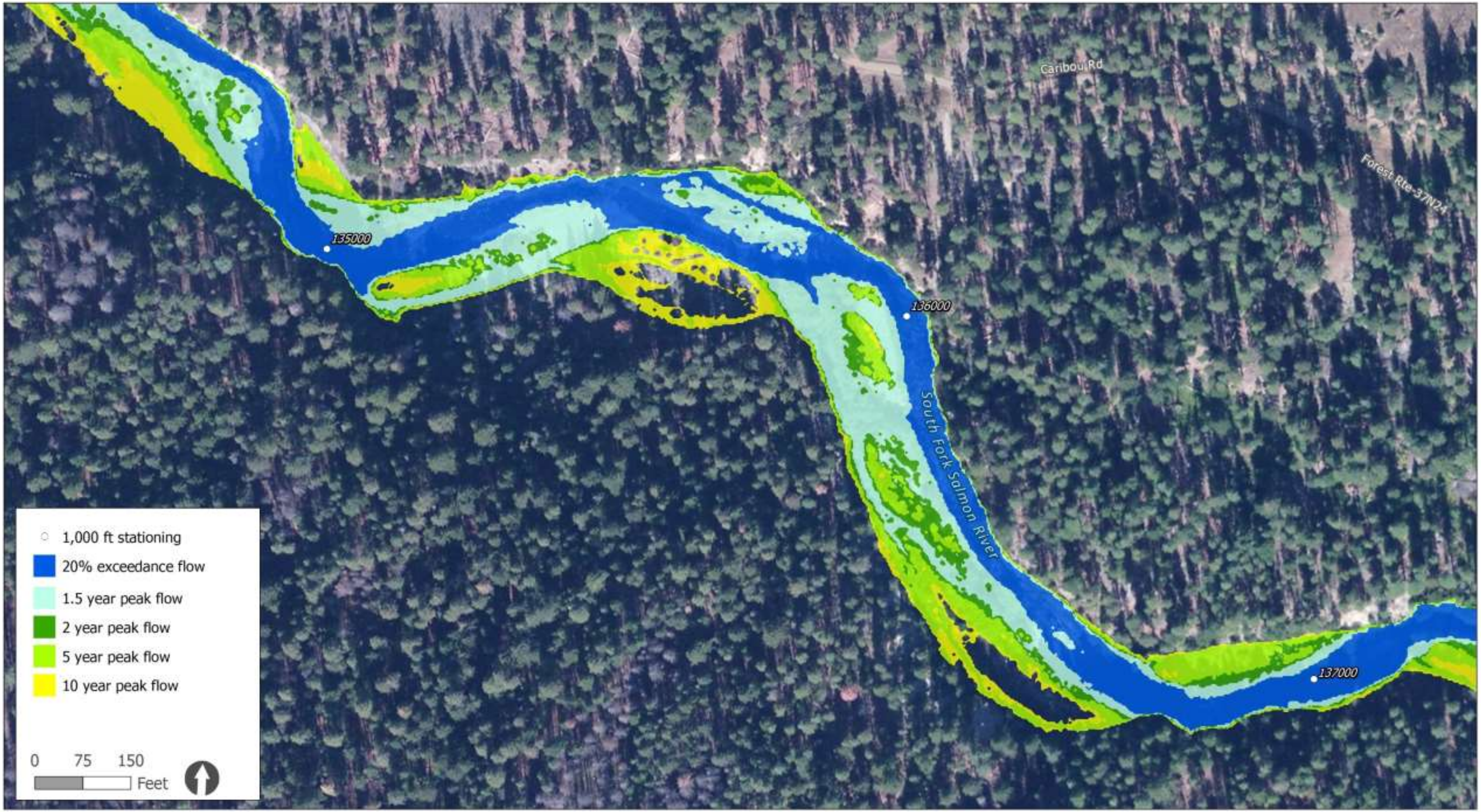
- Hydrologic Engineering Center's River Analysis System (HEC-RAS) 5.0 (2D)
- 35 mi of river channel
- Topographic source: 2014 LiDAR DEM
- Grid Resolution:
  - Center spacing 10 ft X 10 ft
  - Refined by adding resolution and strategic cell center orientation
- Simulated Flows:
  - 20% exceedance to 100-year peak flow
  - Daily flow duration and peak flow magnitudes (LPIII) scaled by drainage area using Salmon River at Sommes Bar gage (USGS Station No. 11522500; 751 mi^2)


Salmon River Floodplain Habitat Enhancement and Mine Tailing Remediation Feasibility Study
Reach 23C (North Fork)
Stillwater Sciences
LEGEND
Channel and off-channel fisheries habitat enhancement opportunities
fork
reach
segment midpoint
suitability rating
Potential terrace revegetation sites with mine tailings
Existing and potential off-channel ponds with potential for channel connection
100 year floodplain
Reach break
1000-ft stationing
Modeled Inundation
20% exceedance flow
1/2 of the 1.5 year peak flow
1.5 year peak flow
2 year peak flow
5 year peak flow
10 year peak flow
25 year peak flow
50 year peak flow
100 year peak flow
1:6,500
1 in = 542 feet
MAP LOCATION
pg 24 of 26
Study reaches
NF23c sta 75,050 (2)
NF23c sta 80,300 (2)
NF23c sta 83,950 (2)
North Fork Salmon River
Sawyers Bar Rd
76000
77000
78000
79000
80000
81000
82000
83000
84000
85000
86000

South Fork Salmon River near Summerville

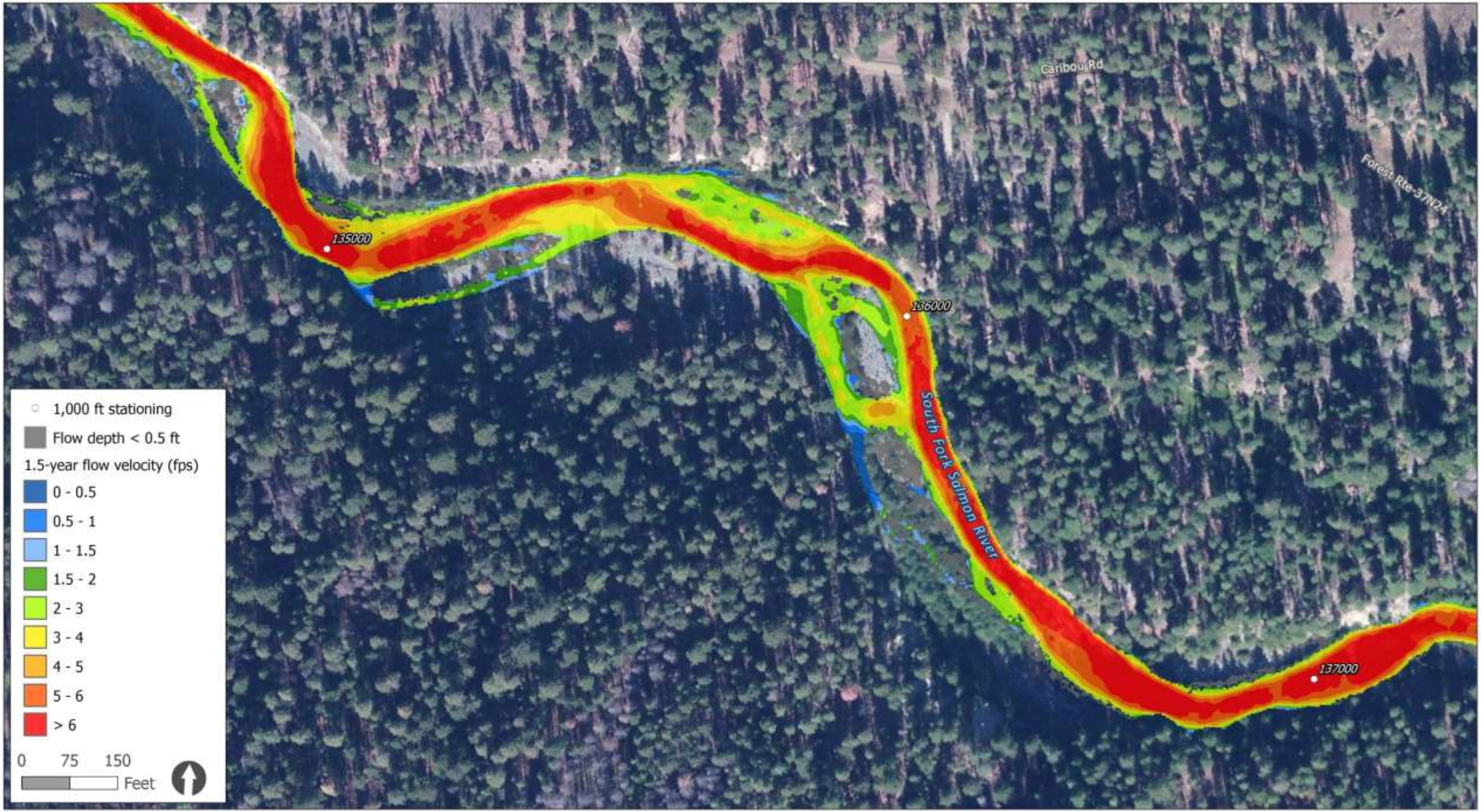



Caribou Rd
Forest Rte-37N24
135000
136000
137000
South Fork Salmon River
1,000 ft stationing
100 year floodplain
0 75 150
Feet



Caribou Rd
Forest Rte-37N24
135000
136000
137000
South Fork Salmon River
1,000 ft stationing
20% exceedance flow
1.5 year peak flow
2 year peak flow
5 year peak flow
10 year peak flow
0 75 150
Feet


Caribou Rd
Forest Rte-37N24
135000
136000
137000
South Fork Salmon River
1,000 ft stationing
Flow depth < 0.5 ft
20% exceedance flow velocity (fps)
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
5 - 6
> 6
0 75 150
Feet



Caribou Rd
Forest Rte-37N24
135000
136000
137000
South Fork Salmon River
1,000 ft stationing
Flow depth < 0.5 ft
1.5-year flow velocity (fps)
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
5 - 6
> 6
0 75 150
Feet

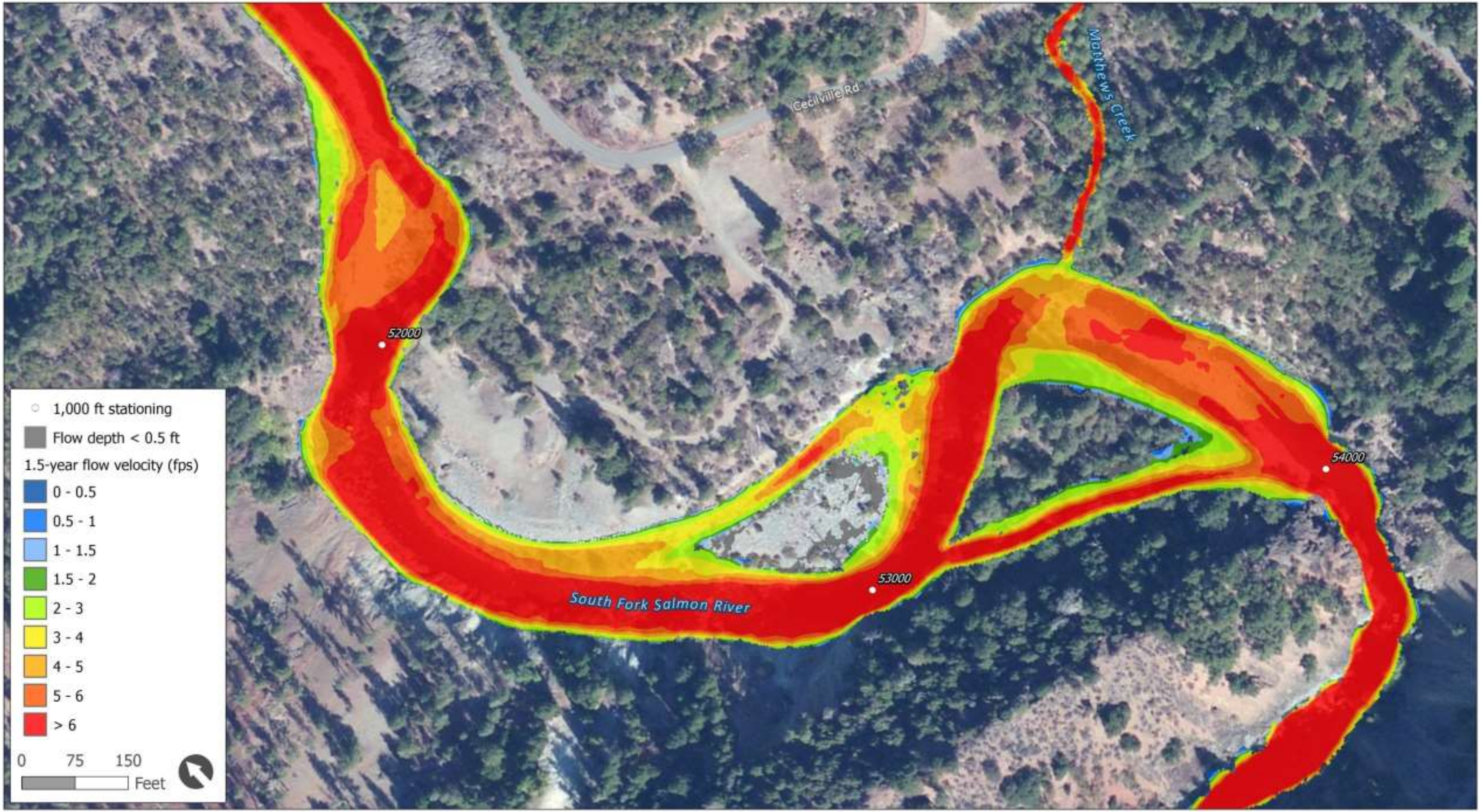
CONCLUSIONS

- Geologic controls on base level, channel gradient, and confinement
- Floodplain and channel thalweg longitudinal profiles
- Elevation of valley landforms above floodplain surface
- Flow, sediment, and wood inputs
- Hydrodynamics and sediment transport
- Disturbance history

Cecilville Rd
Matthews Creek
52000
53000
54000
South Fork Salmon River
1,000 ft stationing
100 year floodplain
0 75 150
Feet

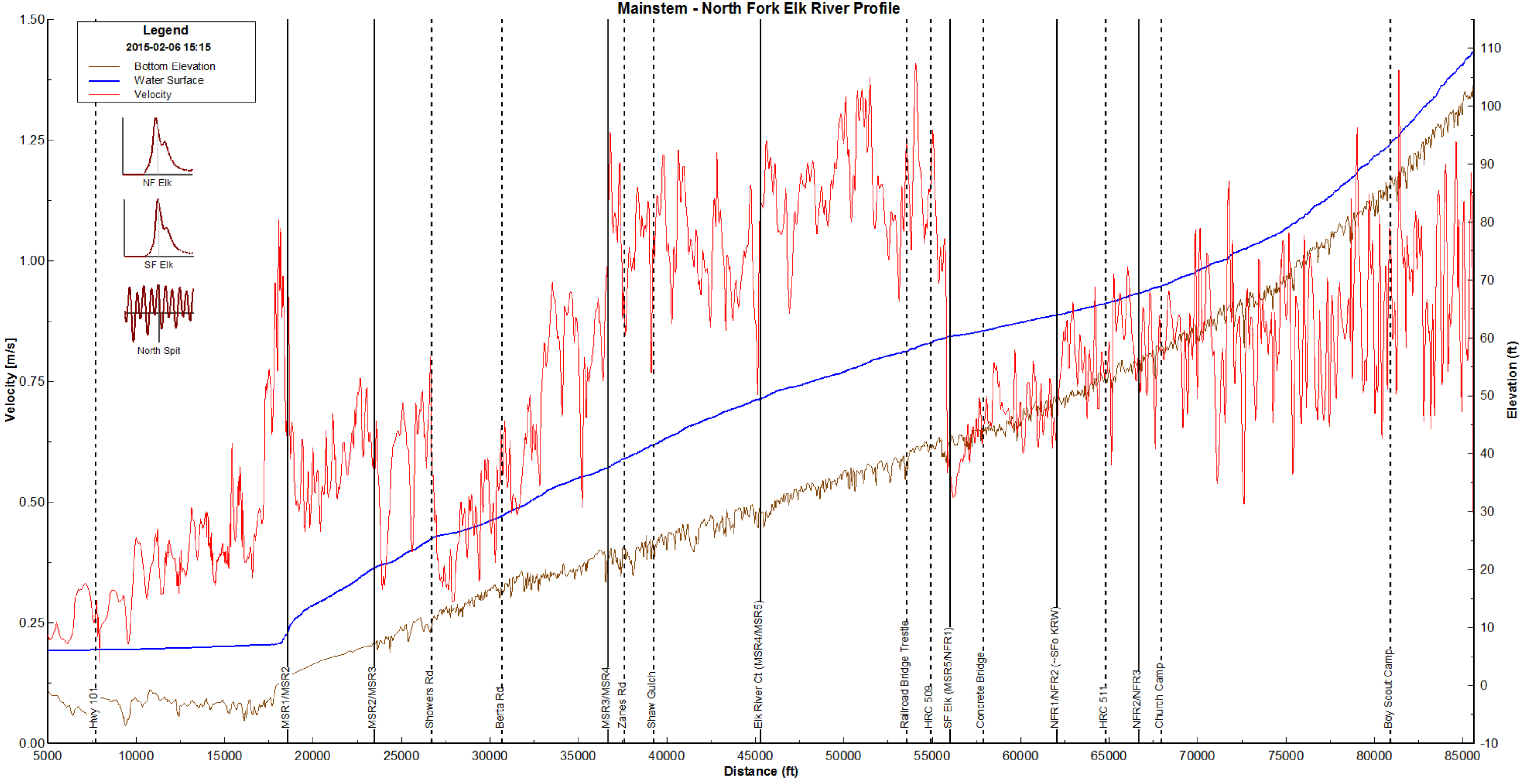
Cecilville Rd
Matthews Creek
52000
53000
54000
South Fork Salmon River
1,000 ft stationing
20% exceedance flow
1.5 year peak flow
2 year peak flow
5 year peak flow
10 year peak flow
0
75
150
Feet

Cecilville Rd
Matthews Creek
52000
53000
54000
South Fork Salmon River
1,000 ft stationing
Flow depth < 0.5 ft
20% exceedance flow velocity (fps)
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
5 - 6
> 6
0 75 150
Feet



Cecilville Rd
Matthews Creek
52000
53000
54000
South Fork Salmon River
1,000 ft stationing
Flow depth < 0.5 ft
1.5-year flow velocity (fps)
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
5 - 6
> 6
0
75
150
Feet

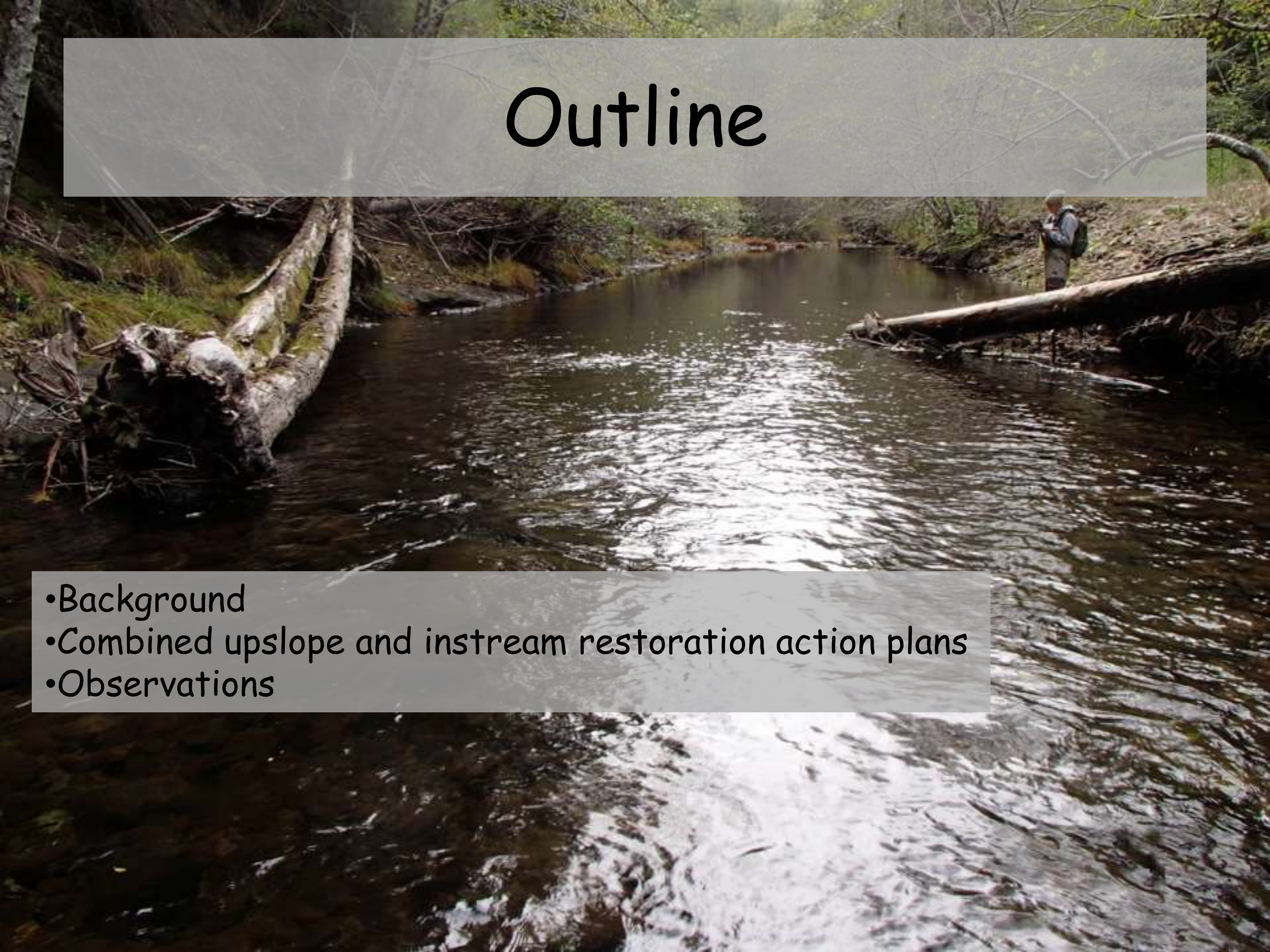
LONGITUDINAL PATTERNS IN REACH-SCALE HYDRODYNAMICS: FEBRUARY 2015




Evaluating Stream Channel Corridors for Habitat Improvement Projects
Tom Leroy and Chris Moore
With lots of help from
Eileen Weppner
Courtney Sundberg
Anna Hall
Pat Moorehouse
Joel Flynn
Pacific Watershed Associates

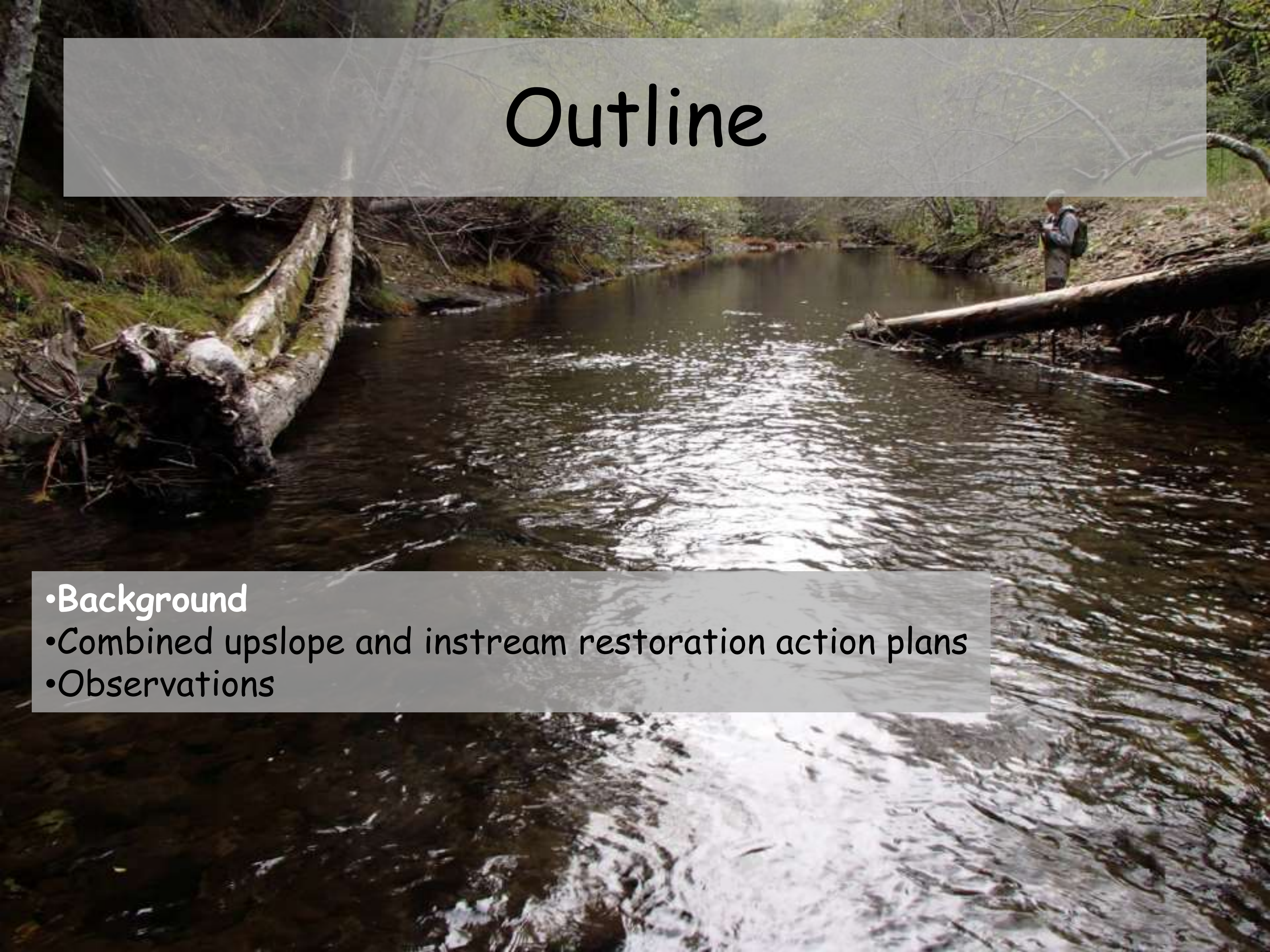
Collaborators

CDFW FRGP
Redwood Forest Foundation
Campbell Global
ERWIG
California Conservation Corps
Trout Unlimited



Outline

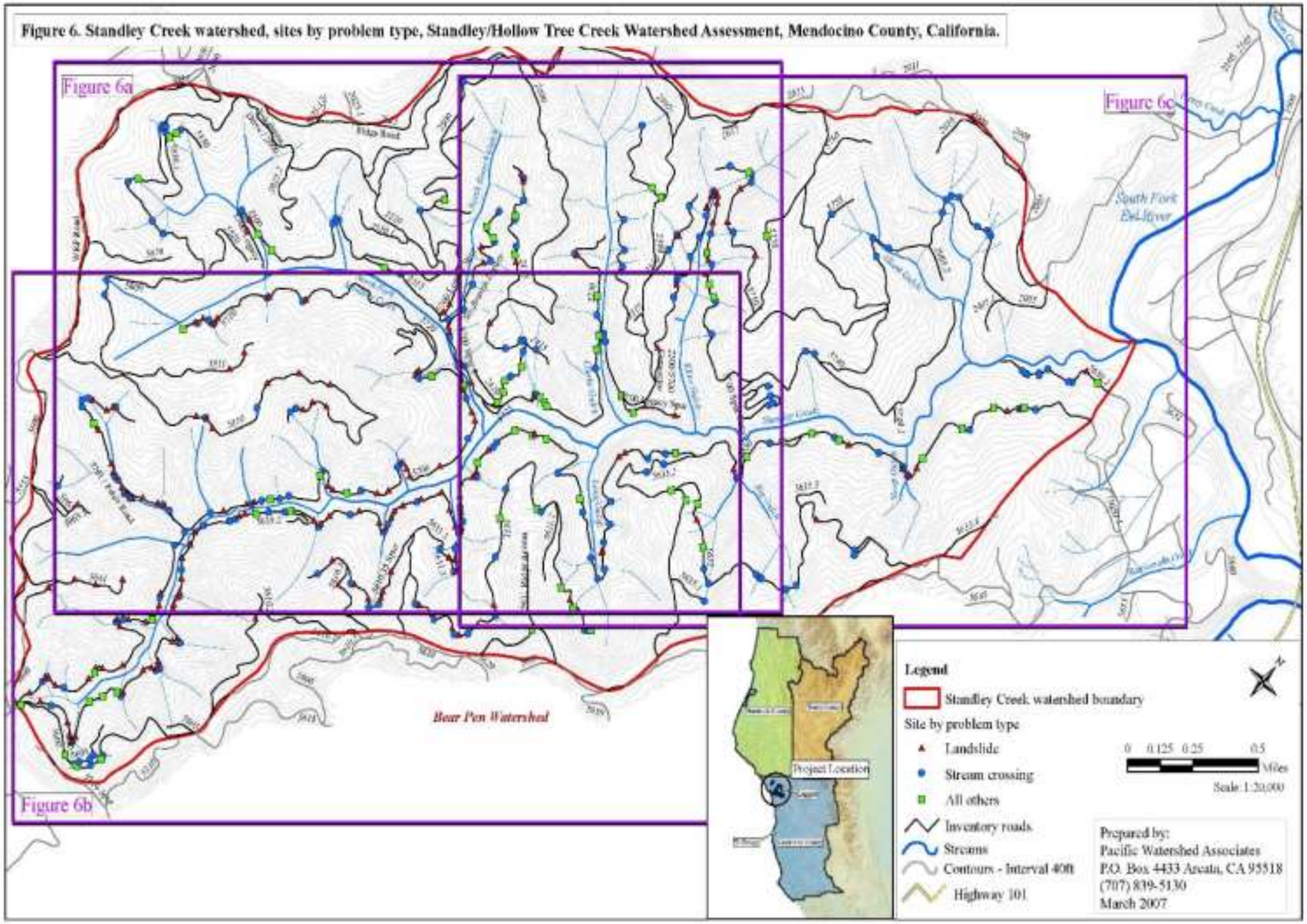
- Background
- Combined upslope and instream restoration action plans
- Observations



Outline

- **Background**
- Combined upslope and instream restoration action plans
- Observations

Standley Creek Road Assessment



Failing log spanner bridge
(nice big fat reusable logs)

General Conditions in the Watersheds Under Consideration

Ownership Status: Owned by RFFI, a non-profit organization dedicated to changing the paradigm of managed landscapes in Northern California.

General Watershed Conditions:

(1) All of the watersheds under consideration have been heavily logged by past land owners over the last 100 years. Mostly even aged management.

(2) The watersheds are severely overstocked with small conifers and tan oak.

(3) There is very little water drafting going on in the watersheds.

(4) The watersheds all have historic and current Salmon runs and flow to the South Fork Eel system, an important Salmon and Steelhead stream in Northern California.

General Conditions in the Watersheds Under Consideration

Primary disturbances to the watersheds and their impacts:

(1) Road and Skid Trail Construction-

-Has caused unprecedented accelerated sediment delivery to the watersheds observed as both channel stored sediment and imbedded channel substrates.

-Significantly disrupts hillside hydrology and alters the stream hydrograph.

-Can inhibit fish access to historical habitat.

(2) Unregulated Industrial Scale Logging-

-Significantly disrupts hillside hydrology and alters the stream hydrograph.

-Causes compaction of the hillside ground surface.

-Converted hillside tree composition from old growth conifer dominant to very small conifers with increased hardwoods.

-Converted riparian forests from old growth conifer to hardwood dominant. This in turn significantly disrupted the natural process of wood recruitment and retention in the stream system (more on that later).

(3) Stream clearing-

-Increased channel velocities.

-Reduced cover, velocity refuge, and overall channel complexity.

-Increased channel incision and plays a role in the reduced connectivity of channels to their floodplains.

General Conditions in the Watersheds Under Consideration

One last thought:

It is important to note that the disruption to the ecological services that these watersheds provide was not the result of any one of the disturbance events outlined earlier, but rather, the dilapidated conditions we currently observe are the result of the combined, nuanced, interaction of all of these disturbance events.

The take home point:

If one wants to recover the ecological functions of a watershed from anthropogenic disturbance you should plan to remediate all of the various disturbances and their impacts.

Sediment Delivery

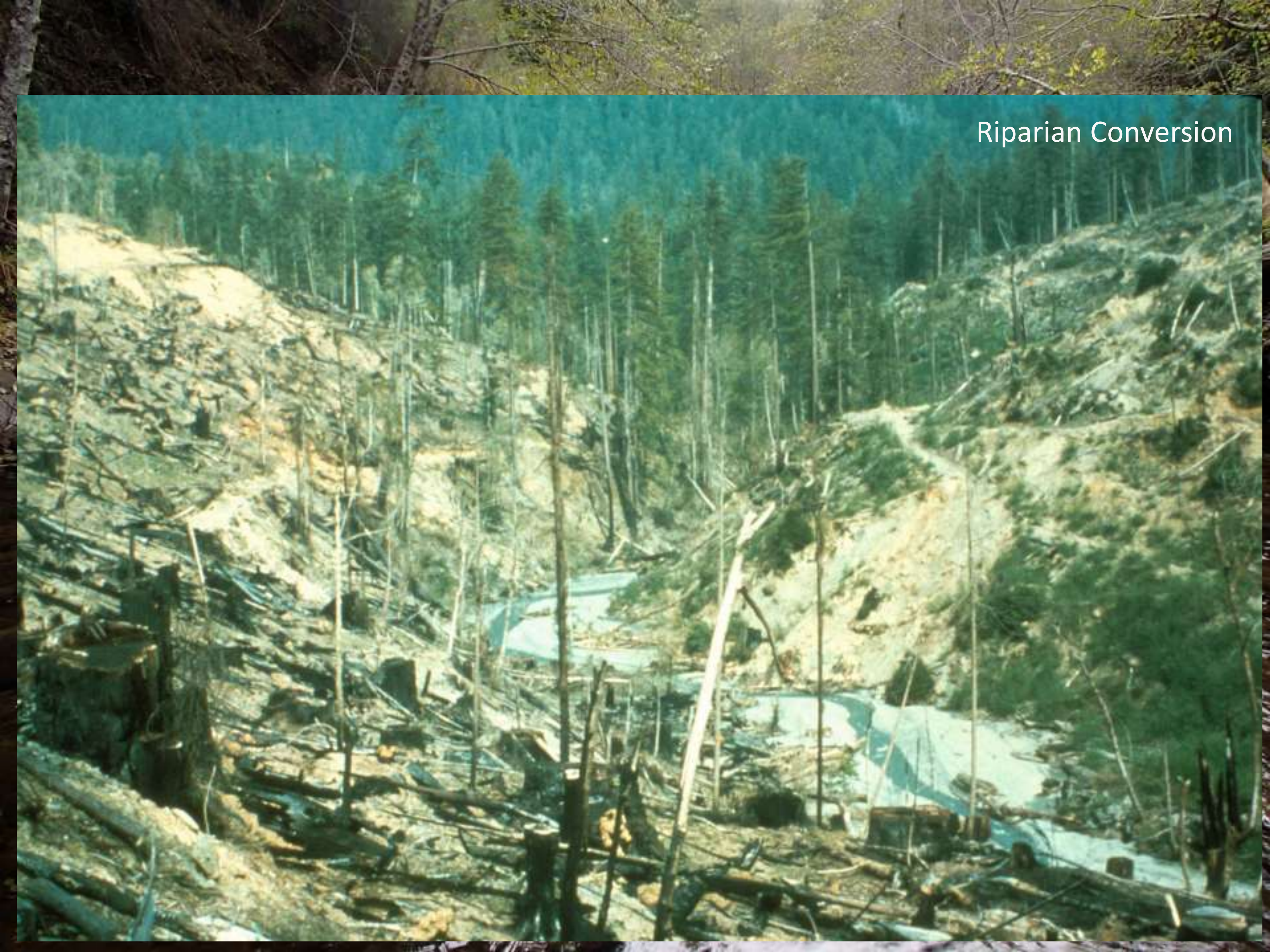
1:20,000

Sediment Delivery

Sediment Delivery

Stream Clearing

Stream Clearing


Riparian Conversion

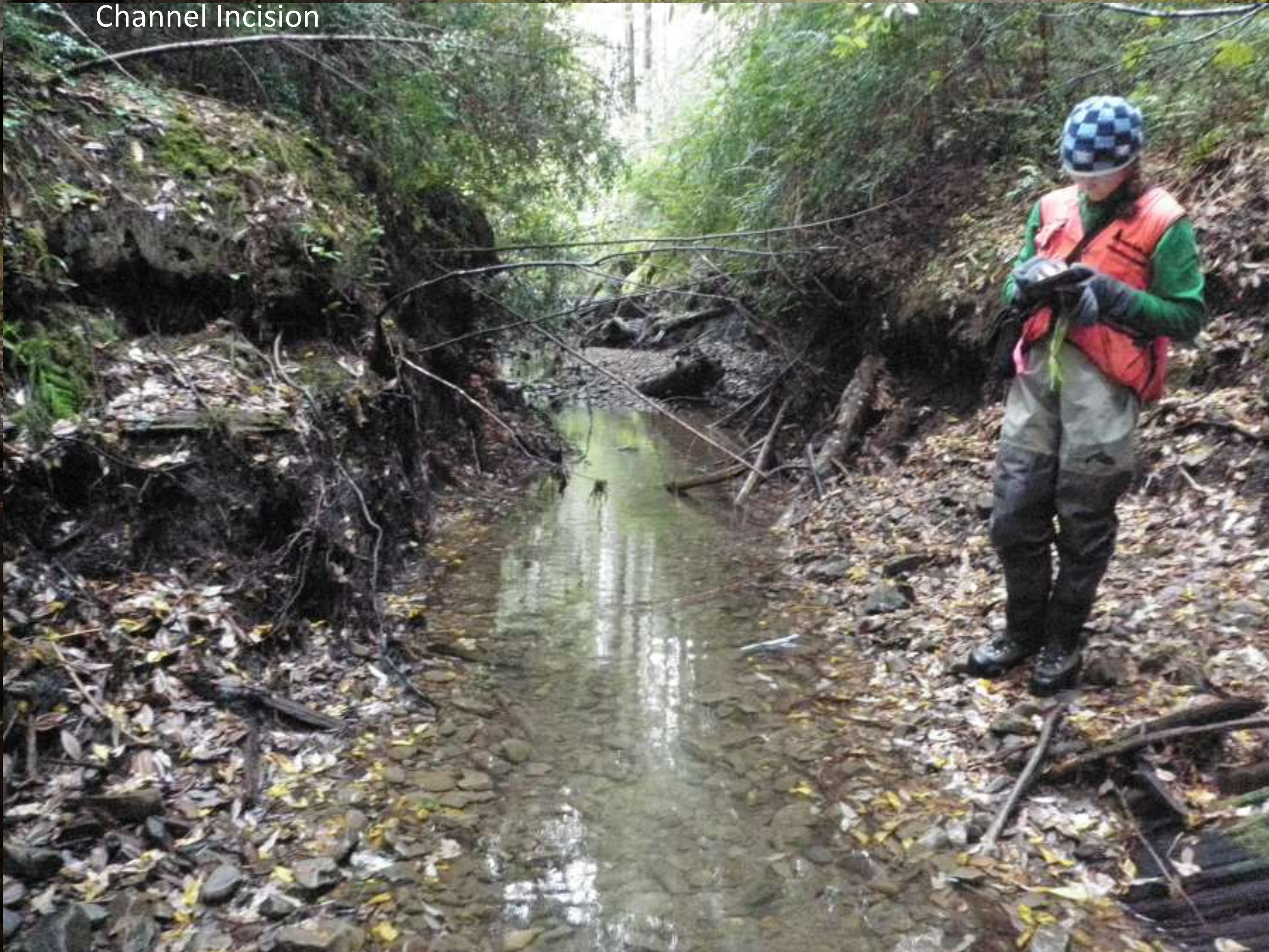

Riparian Conversion
Deciduous forest

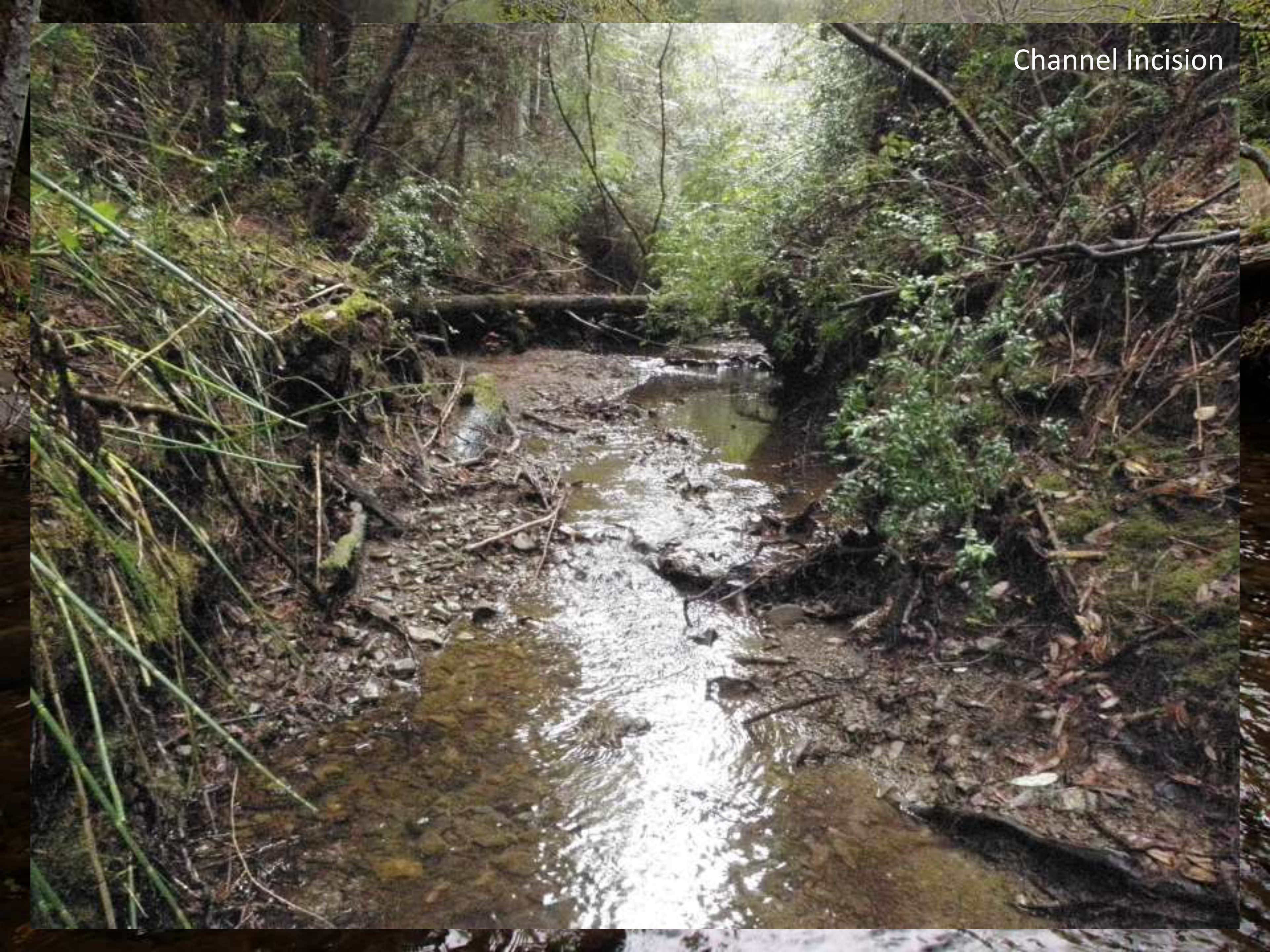
Riparian Conversion

What used to be a conifer dominated riparian forest is now dominated by deciduous forest


Riparian Conversion

Channel Incision




Channel Incision

The over all strategy for improving fisheries conditions on a sub watershed scale

(1) Identify Priority Watersheds/Subwatersheds-For our project we decided to work on the least disturbed watersheds first, leaving the “train wrecks” for last. The idea being that we can most cost-effectively treat the best streams first which will hopefully reach their carrying capacity and then be a hub of fish distribution throughout the rest of the watershed.

(2) The johnsian steps to engineering geology: Identify, Characterize, analyze, mitigate…..

(3) General approach for any given sub watershed or stream reach

   (1) Conduct road and stream assessments to characterize existing conditions, identify limitations and constraints, and develop multiphase implementation plans.

   (2) Starting at the lower portions of the watershed, implement plans that concurrently remove or significantly improve the inner gorge and streamside road systems and create robust “key” wood features within the stream reach. Do not cut off stream access by road removal at this point. Its all about thoughtful planning and logistics…….

   (3) After the wood jams have adjusted for a season or two, plan a riparian project that accelerates the successional process of converting the hardwood forest back to a conifer dominated forest. This will add LWM and biomass to the stream system and accelerate the return of a natural process wood recruitment and retention in the stream reach.

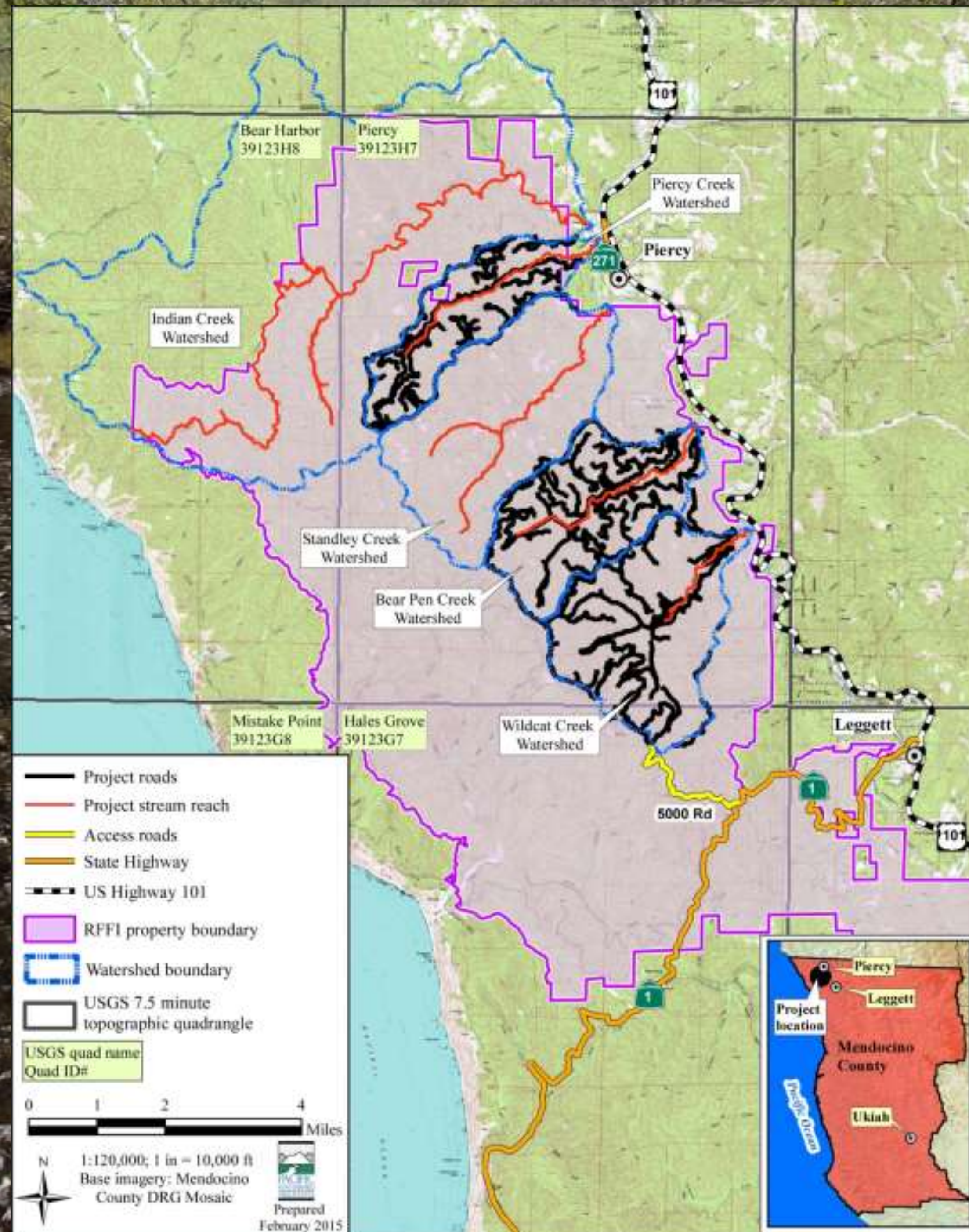
Usal Forest Coho Recovery Plan

Goal: Co-develop upslope sediment reduction and stream corridor improvement prioritized action plans on 5 watersheds over a 50,000 acre area.

Location: South Fork Eel River, Leggett CA.

Watersheds: Wildcat, Bear Pen, Standley, Piercy, Indian

The assessment area



URFC Desired Future Road Conditions

Anderson Creek Roads

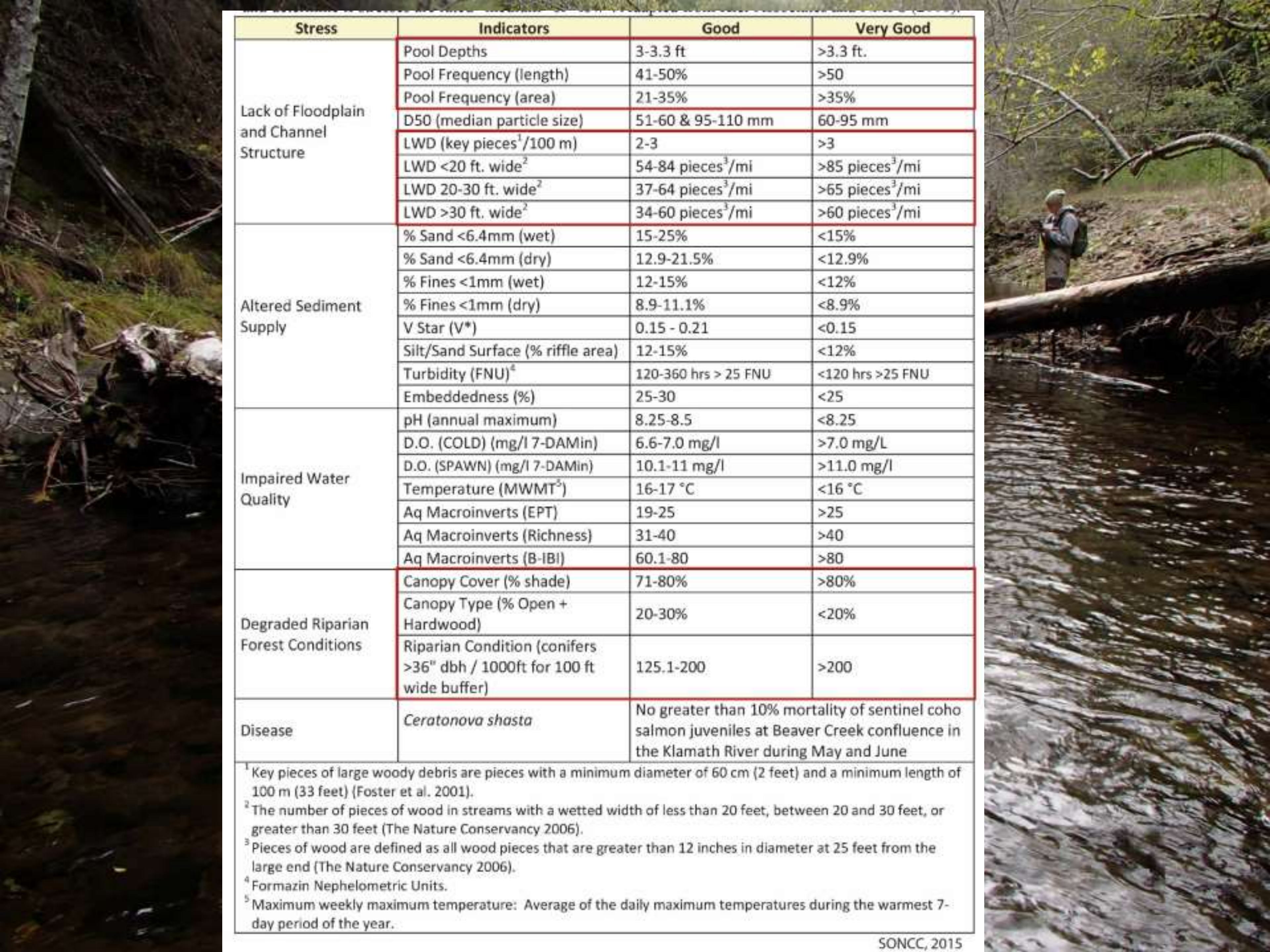
Primary data categories for the stream survey

data collected every 500′

- General information
- Location data
- Bankfull width and depth estimates
- Channel and valley characteristics
- Channel and bank sedimentary characteristics
- Reach accessibility
- Material availability
- Riparian size and composition
- Riparian anchoring conditions
- Existing in channel wood densities
- Frequency and depth of all pools

Data collected at existing LWD features

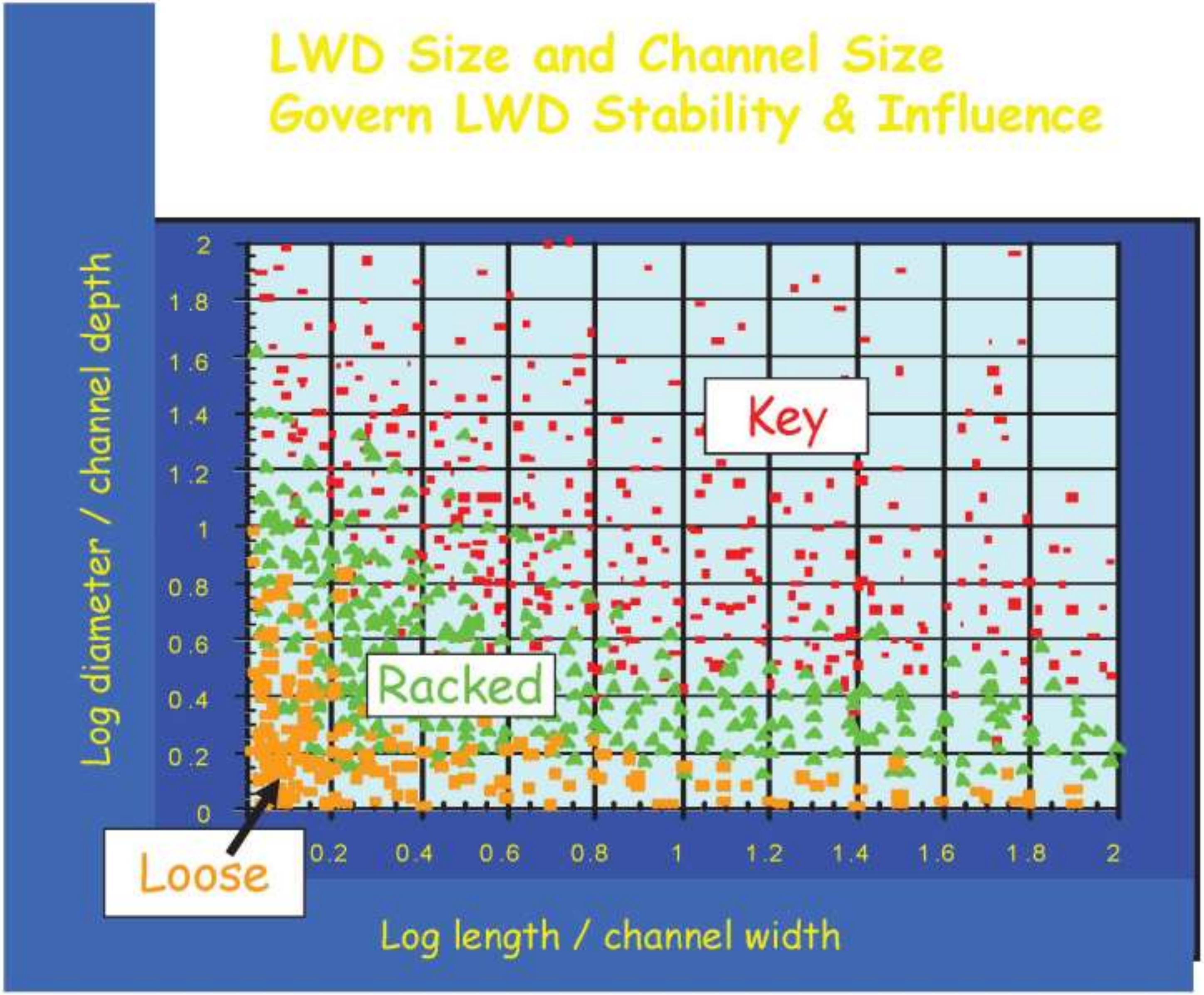
- Feature ID #
- Key log attributes
- Racked material %
- Associated residual pool depth
- % pool cover
- Origination (constructed/natural)
- Notes on jam characteristics



Stress	Indicators	Good	Very Good
Lack of Floodplain and Channel Structure	Pool Depths	3-3.3 ft	>3.3 ft.
	Pool Frequency (length)	41-50%	>50
	Pool Frequency (area)	21-35%	>35%
	D50 (median particle size)	51-60 & 95-110 mm	60-95 mm
	LWD (key pieces[1]/100 m)	2-3	>3
	LWD <20 ft. wide[2]	54-84 pieces[3]/mi	>85 pieces[3]/mi
	LWD 20-30 ft. wide[2]	37-64 pieces[3]/mi	>65 pieces[3]/mi
	LWD >30 ft. wide[2]	34-60 pieces[3]/mi	>60 pieces[3]/mi
Altered Sediment Supply	% Sand <6.4mm (wet)	15-25%	<15%
	% Sand <6.4mm (dry)	12.9-21.5%	<12.9%
	% Fines <1mm (wet)	12-15%	<12%
	% Fines <1mm (dry)	8.9-11.1%	<8.9%
	V Star (V*)	0.15 - 0.21	<0.15
	Silt/Sand Surface (% riffle area)	12-15%	<12%
	Turbidity (FNU)[4]	120-360 hrs > 25 FNU	<120 hrs >25 FNU
	Embeddedness (%)	25-30	<25
Impaired Water Quality	pH (annual maximum)	8.25-8.5	<8.25
	D.O. (COLD) (mg/l 7-DAMin)	6.6-7.0 mg/l	>7.0 mg/L
	D.O. (SPAWN) (mg/l 7-DAMin)	10.1-11 mg/l	>11.0 mg/l
	Temperature (MWMT[5])	16-17 °C	<16 °C
	Aq Macroinverts (EPT)	19-25	>25
	Aq Macroinverts (Richness)	31-40	>40
	Aq Macroinverts (B-IBI)	60.1-80	>80
Degraded Riparian Forest Conditions	Canopy Cover (% shade)	71-80%	>80%
	Canopy Type (% Open + Hardwood)	20-30%	<20%
	Riparian Condition (conifers >36" dbh / 1000ft for 100 ft wide buffer)	125.1-200	>200
Disease	*Ceratonova shasta*	No greater than 10% mortality of sentinel coho salmon juveniles at Beaver Creek confluence in the Klamath River during May and June	

[1] Key pieces of large woody debris are pieces with a minimum diameter of 60 cm (2 feet) and a minimum length of 100 m (33 feet) (Foster et al. 2001).
[2] The number of pieces of wood in streams with a wetted width of less than 20 feet, between 20 and 30 feet, or greater than 30 feet (The Nature Conservancy 2006).
[3] Pieces of wood are defined as all wood pieces that are greater than 12 inches in diameter at 25 feet from the large end (The Nature Conservancy 2006).
[4] Formazin Nephelometric Units.
[5] Maximum weekly maximum temperature: Average of the daily maximum temperatures during the warmest 7-day period of the year.

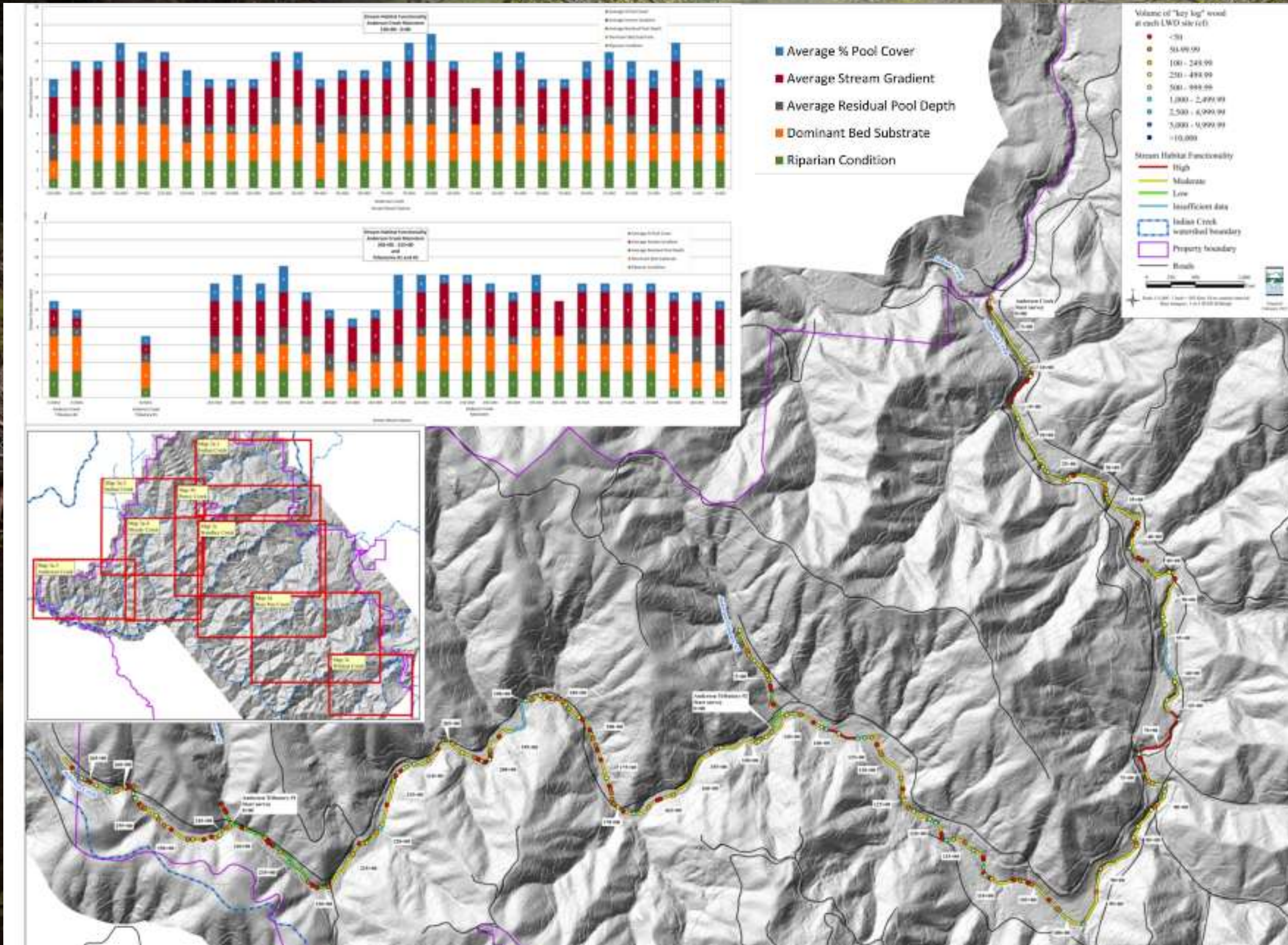
SONCC, 2015



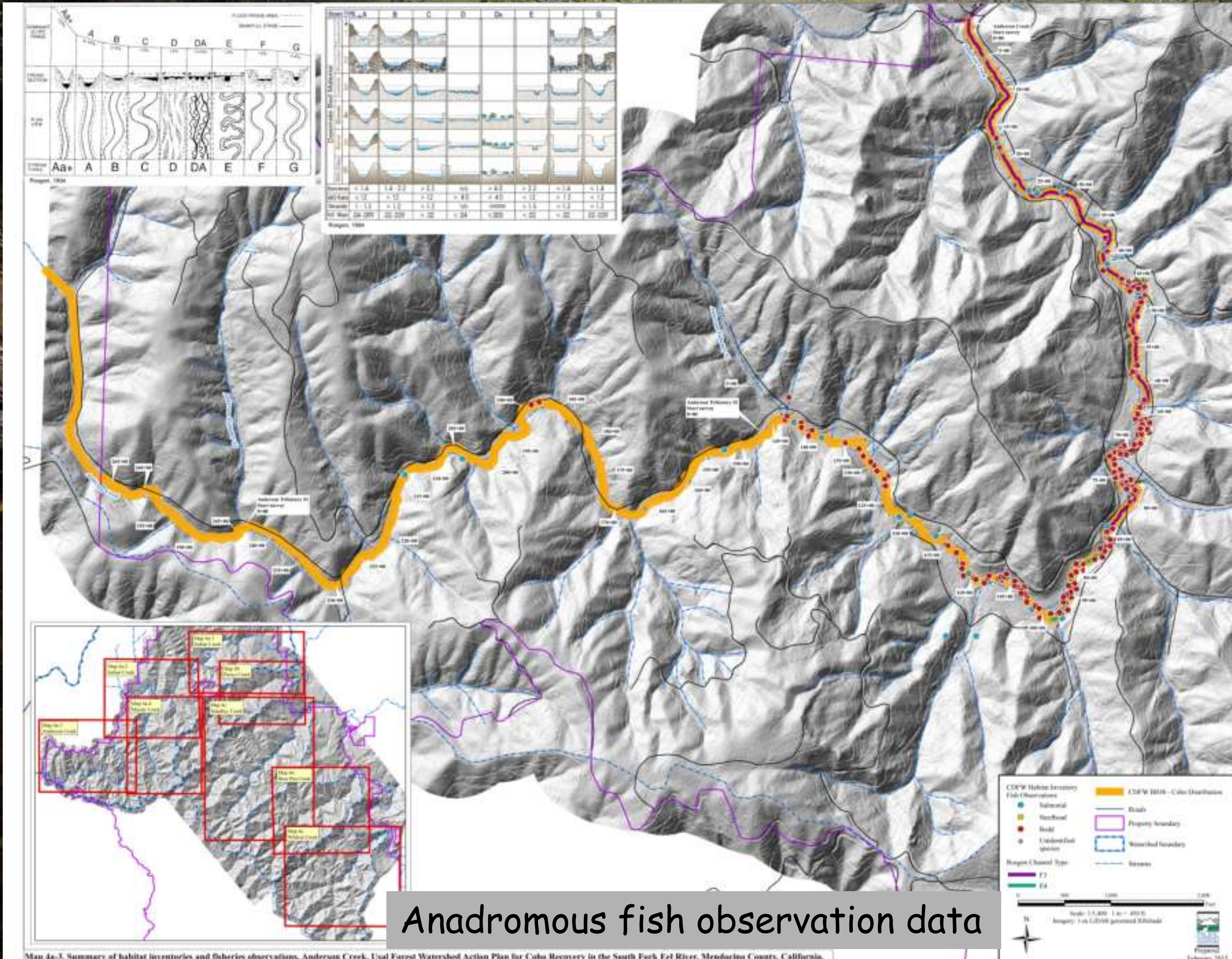
Abbe and Montgomery, 2003

Table 8. Scoring parameters for selected riparian corridor attributes, Usal Forest Watershed Action Plan for Coho Recovery in the South Fork Eel River, Mendocino County, California

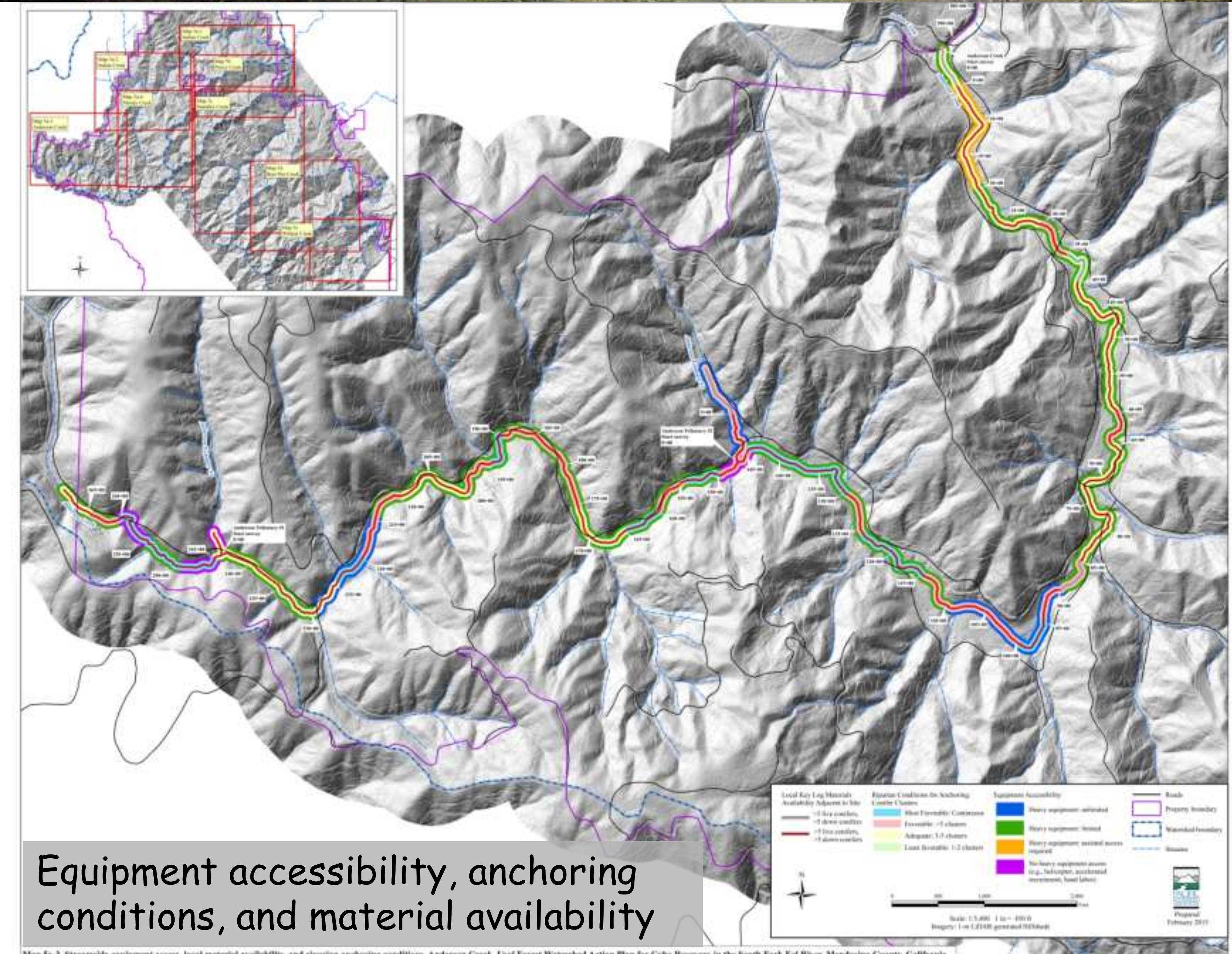
Increasing functionality →				
Condition →	Minimal	Low	Moderate	High
Score →	1	2	3	4
Riparian Corridor attribute				
Riparian Conditions	small dia. 0"-12"; <50 % conifer	Small dia. 0"-12"; >50% conifer	Large dia. >12"; <50 % conifer	Large dia.>12"; >50% conifer
Avg residual pool depth	0-0.99	1-1.99	2-2.99	3+
% Cover	0-24.99	25-49.99	50-74.99	>75
Dominant bed substrate	bedrock/boulder/Fine-grained	>50% Sand; <25% Cobble/Gravel	>50% Sands; 25% - 50% cobble/gravel	<50% sands; >50% cobble and gravel dominated
Channel grade	5+	4-4.99	3 to 3.99	1 to 2.99 (<3)



Stream habitat functionality and LWD distribution observations



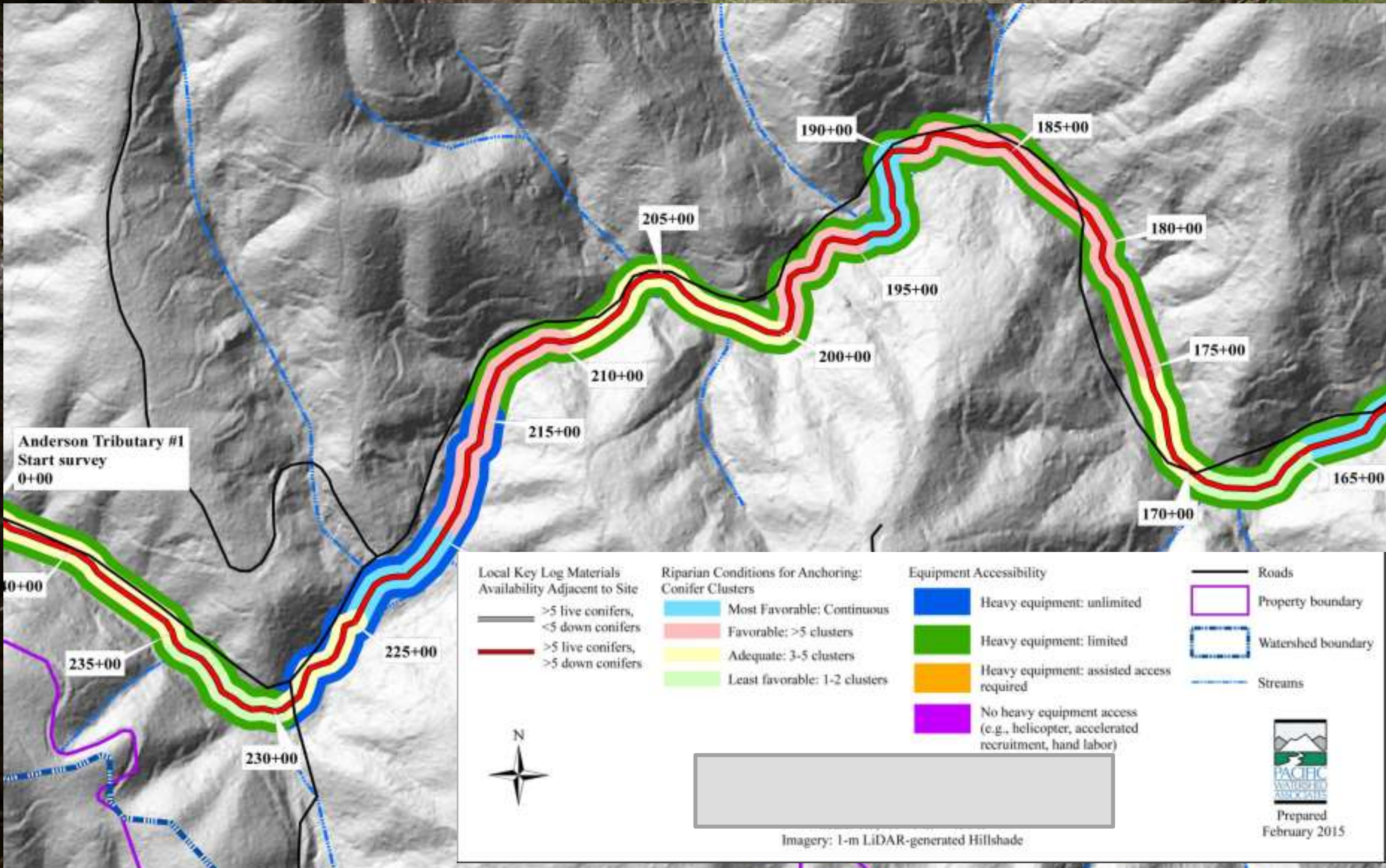
Anadromous fish observation data



Equipment accessibility, anchoring conditions, and material availability

Map 5a-3. Streamside equipment access, local material availability, and riparian anchoring conditions, Anderson Creek, Usal Forest Watershed Action Plan for Coho Recovery in the South Fork Eel River, Mendocino County, California.

Equipment accessibility, anchoring conditions, and material availability



Anderson and Moody Creek Prioritized Action Plan