Causal Assessment in the Garcia River Watershed

Participants:

North Coast Regional Water Quality Control Board

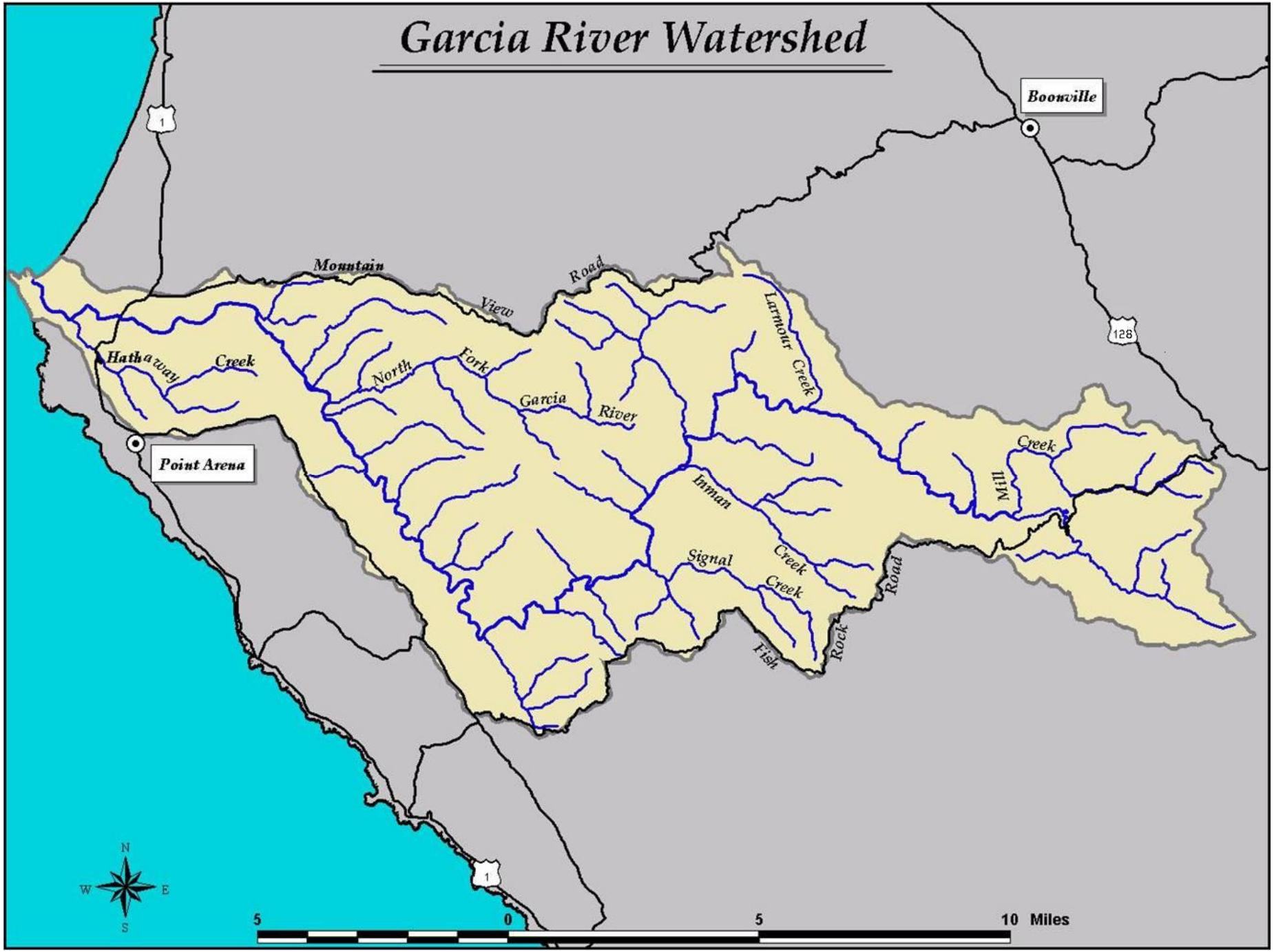
The Nature Conservancy

California Fish & Game

U.S. EPA

SCCWRP


Garcia River


Garcia River Watershed
Boonville
Mountain
View
Road
Larmour Creek
128
Hathaway
Creek
North
Fork
Garcia
River
Point Arena
Inman
Creek
Mill
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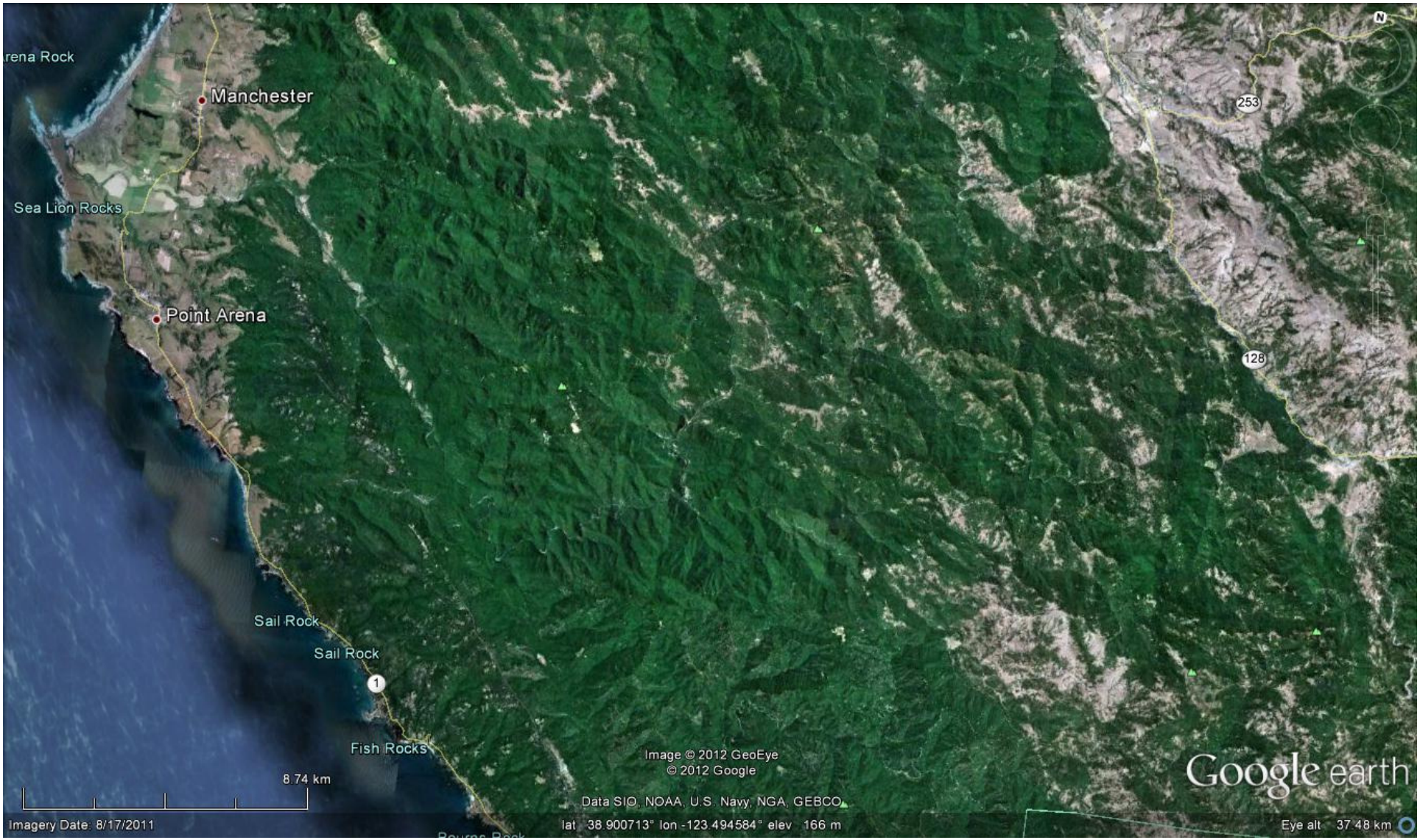
rena Rock
Manchester
Sea Lion Rocks
Point Arena
Sail Rock
Sail Rock
Fish Rocks
8.74 km
253
128
1
Image © 2012 GeoEye
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
Imagery Date: 8/17/2011
lat 38.900713° lon -123.494584° elev 166 m
Eye alt 37.48 km

Early Logging (1860s-1915)

The Garcia Mill (1867-1915)

- Located seven miles up river from mouth
- 40k board feet per day
- Dammed river 8 months of the year
- Impounded river for over one mile upstream
- Flume transported lumber downstream

From *The Early Days of Point Arena,* Oliff and Carlstedt

The Interior

- Generally inaccessible to early logging
- Dominated by late seral forests
- Largely untouched until 1950s

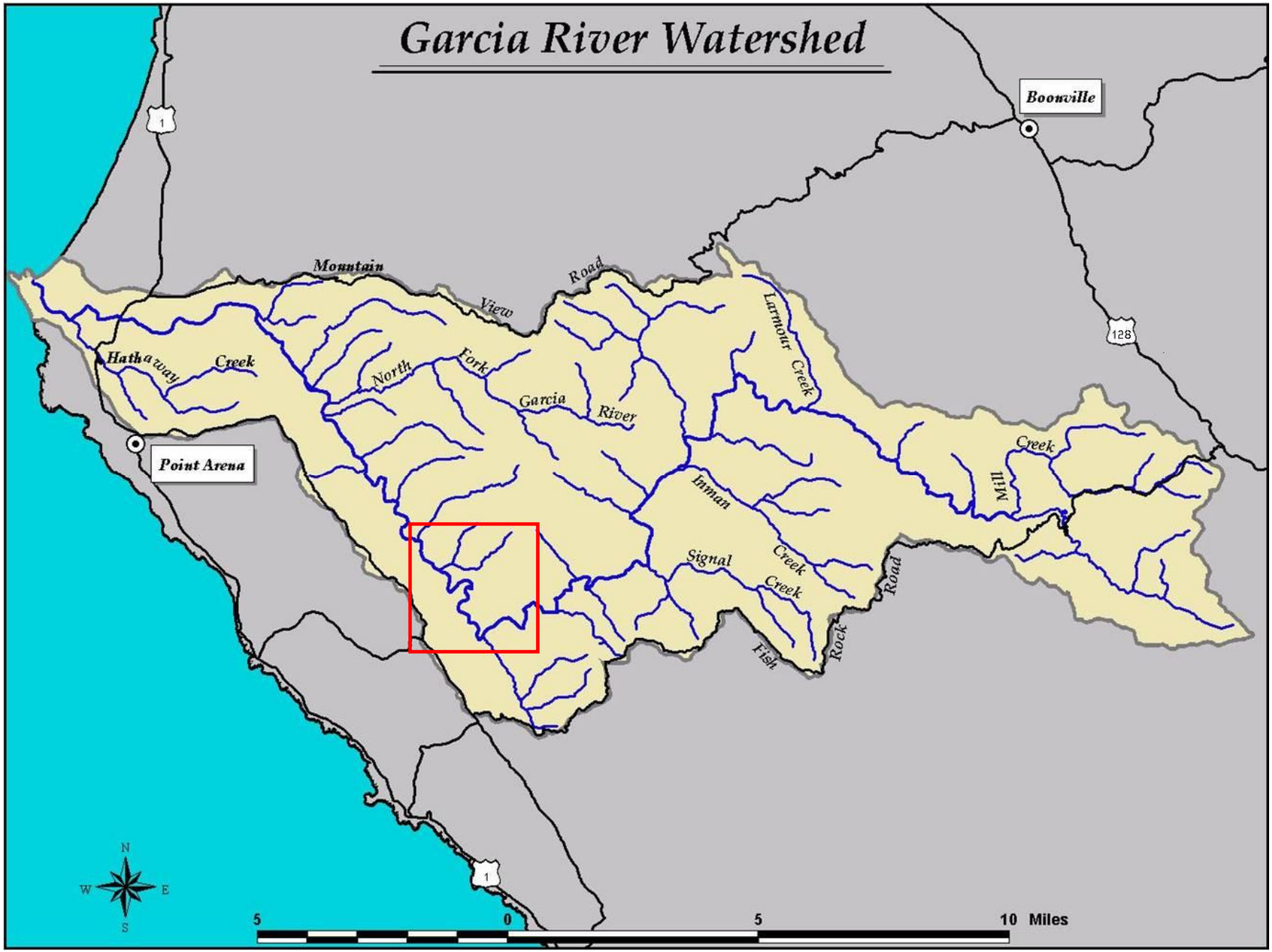
Mailliard Ranch Cathedral Grove

Post WWII Logging
1950s-1960s

- Housing boom demands wood products
- Improved heavy equipment
- Construction of roads/skid trail network
- River no longer used for transport
- No environmental regulations

Garcia River Watershed History:

Post World War II Logging (1950-70s)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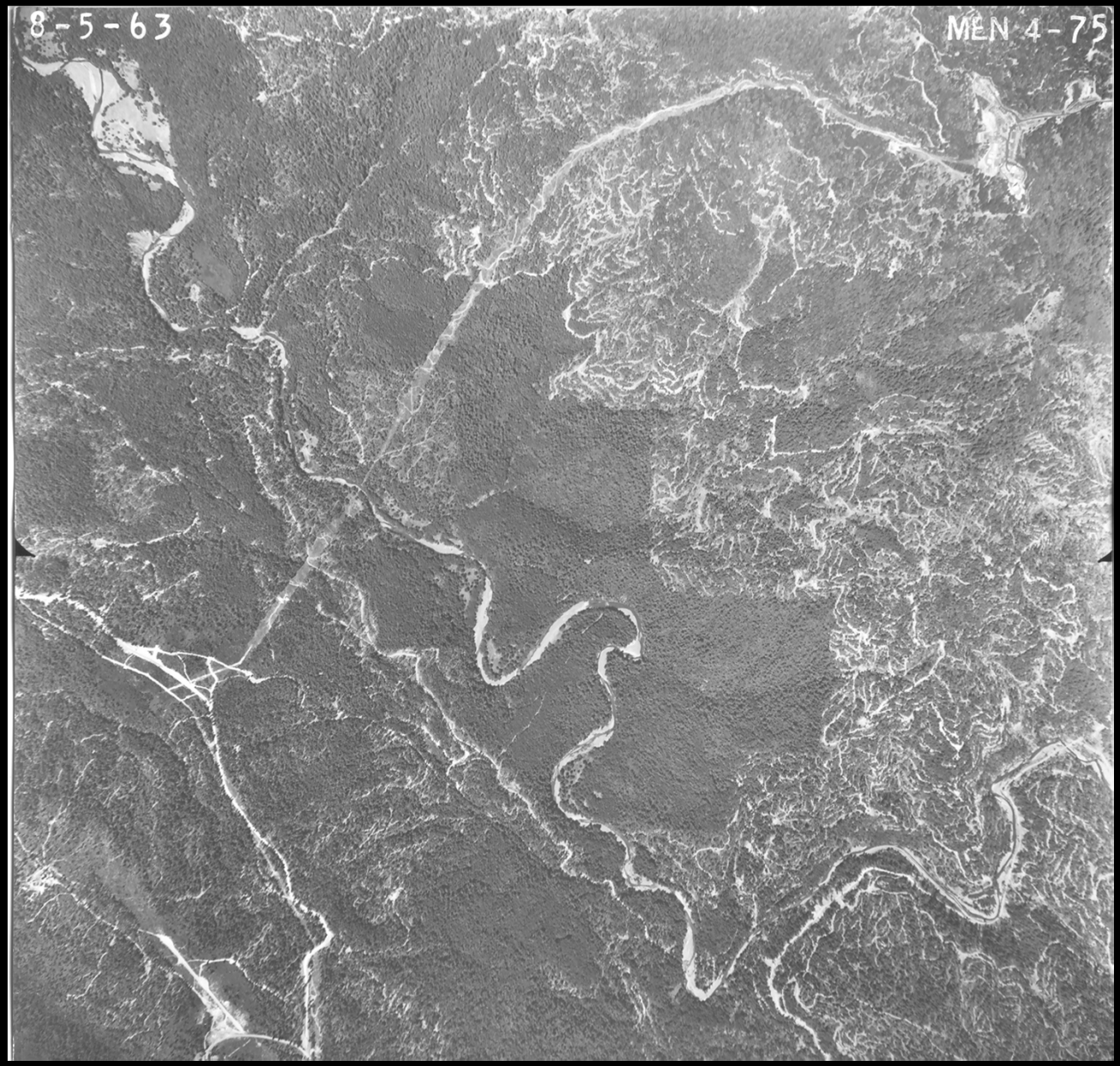
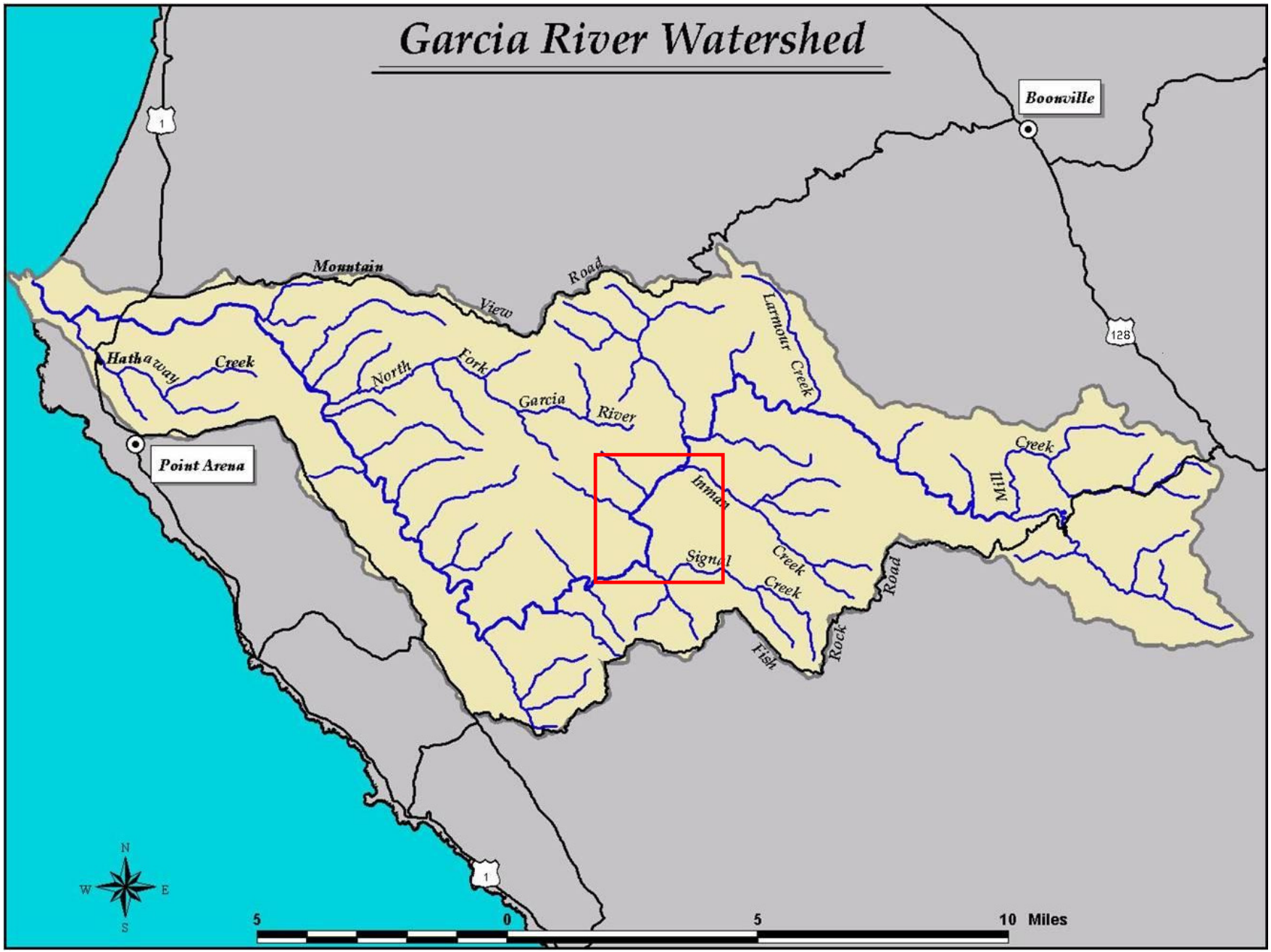
Garcia to South Fork 1952

Garcia to South Fork 1963

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Garcia to Inman 1952

Garcia to Inman 1963

Signal Creek - 1955

CDFG, 1955

Renewed Logging 1980s-1990s

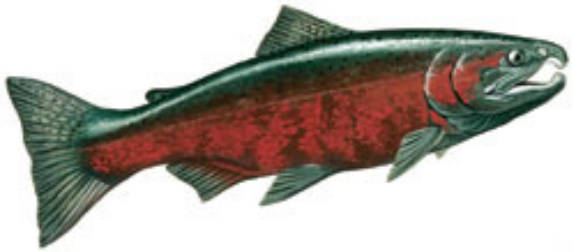
1985

Approximately 43% of watershed experienced new logging and road reconstruction between mid-1980s and mid-1990s (EPA, TMDL)

Also in-channel gravel mining 1960s -1990s

Garcia River Salmonids

Chinook Salmon
ENDANGERED



Coho Salmon
ENDANGERED

Steelhead Trout
THREATENED

Pink Salmon
ENDANGERED

1993 - 303d Listing for Sediment and Temperature

2002 - Garcia River Watershed Sediment TMDL Action Plan adopted into basin plan.

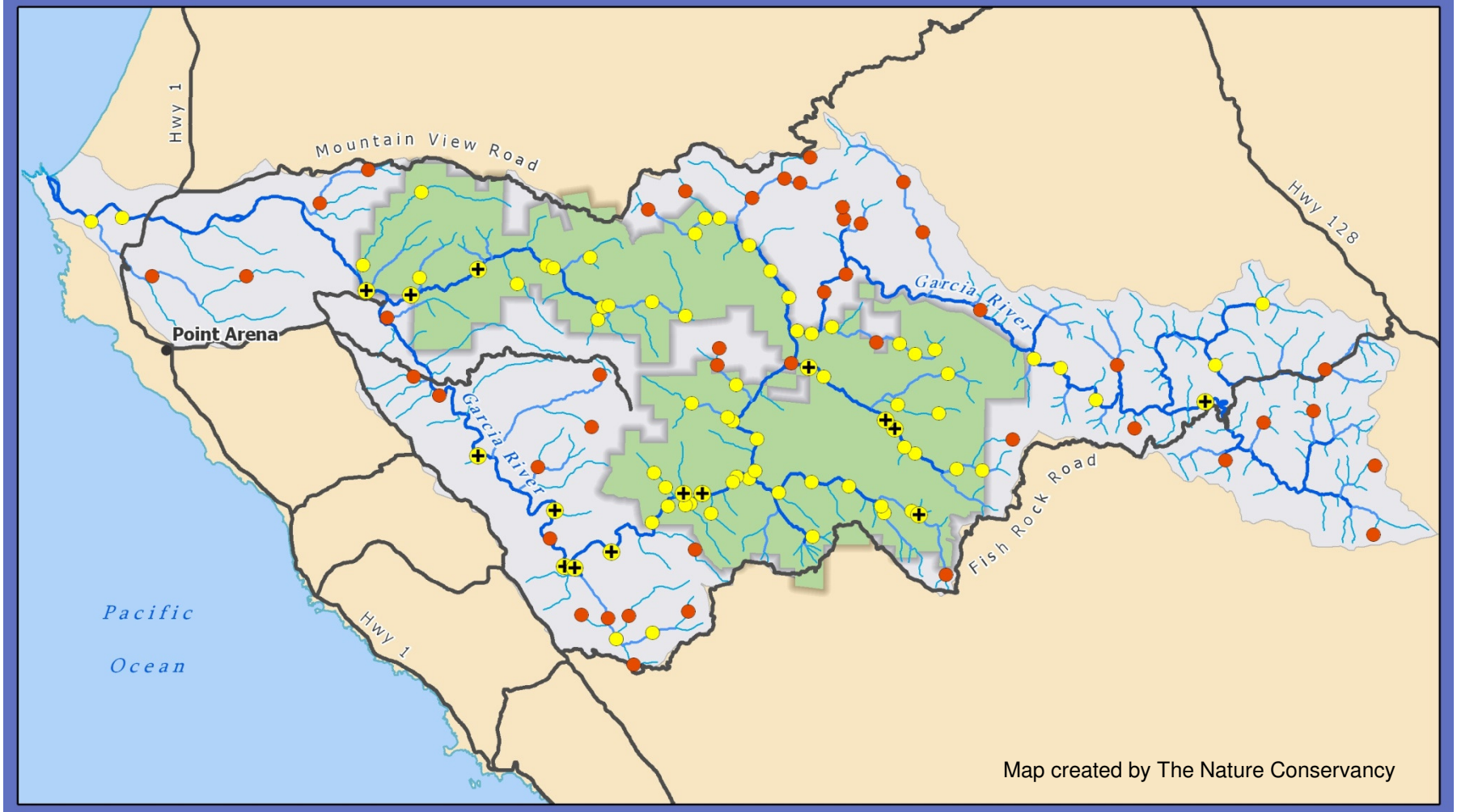
GOAL: To reduce controllable human-caused sediment delivery to the watershed in order to meet water quality objectives.

Accomplished through changing land management:

- modernization of timber methods
- better ag/grazing standards
- no more gravel mining
- extensive restoration projects on lower Garcia

Today, 2/3 of watershed participating in TMDL compliance efforts

Garcia River EMAP X-Sites

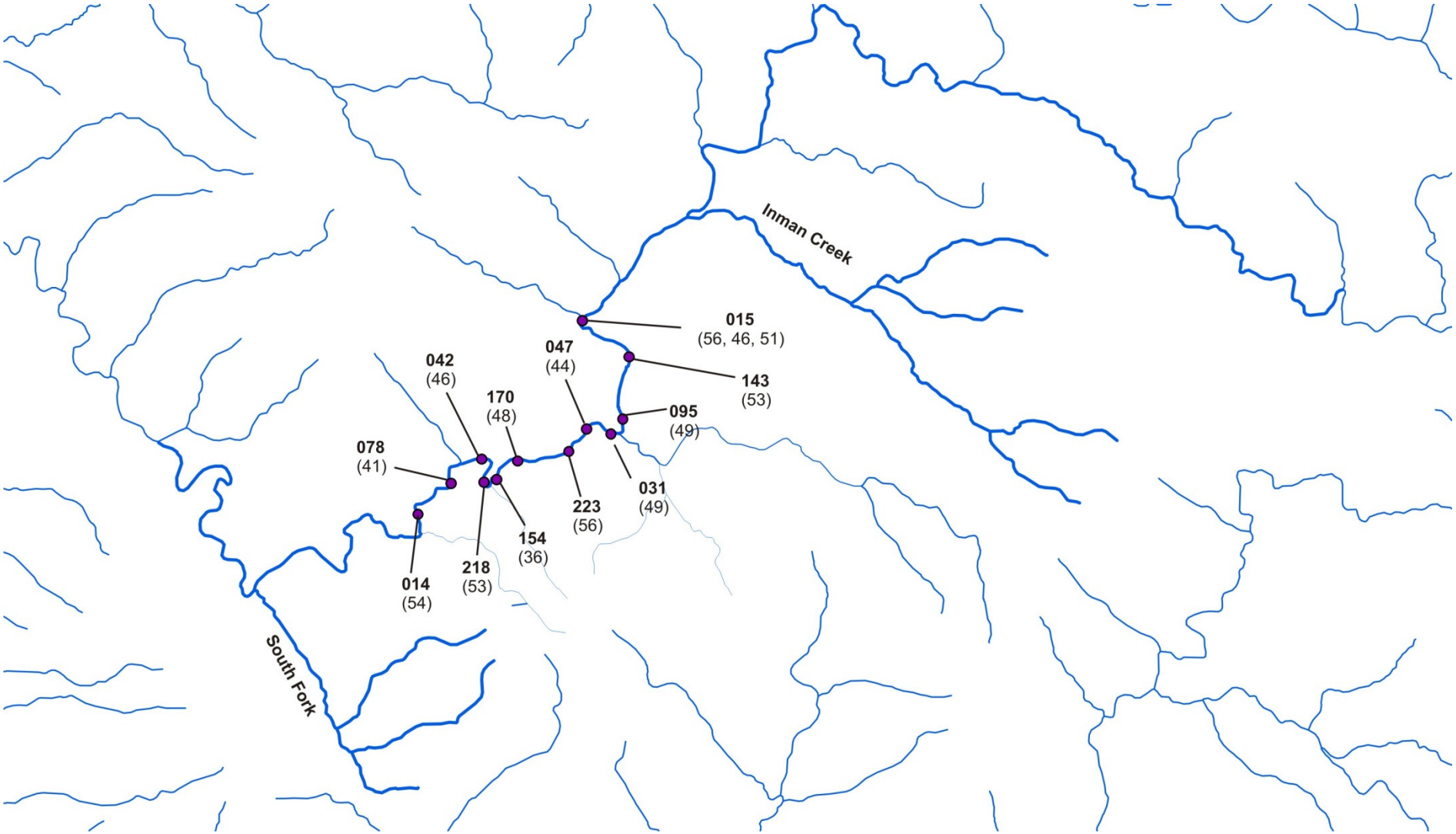


Panel 1
Panel 1 Unsampled
Public Roads
Garcia River Forest
Garcia River Watershed

0 1 2 4 Miles

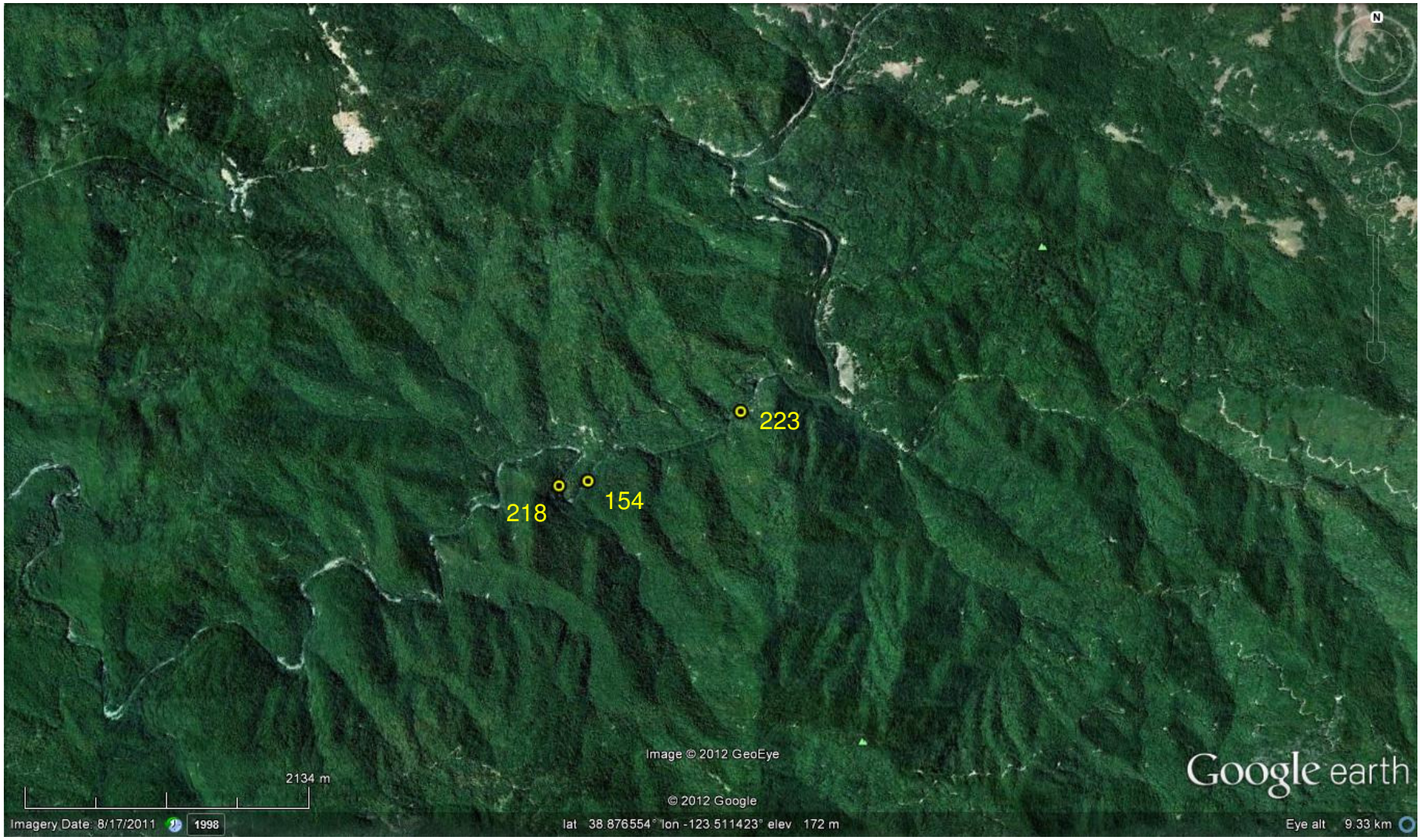
N

Case Definition: 2008 Inner Gorge Sites



Case Definition:

- Case = site 154
- Downstream comparator = site 218 (~200m downstream)
- Upstream comparator = site 223 (~1200m upstream)



Inner Gorge Top 5 Dominant Taxa

SITE	014	078	042	**218**	**154**	170	**223**	047	031
Chironomidae	56%	66%	41%	44%	**56%**	54%	42%	58%	50%
Gumaga	6%	2%	14%	8%	**10%**		7%	3%	
Optioservus	3%		8%	5%	**7%**	8%	12%	3%	5%
Tricorythodes								4%	7%
Paraleptophlebia	7%	4%				2%			
Rhithrogena									4%
Torrenticola		3%	4%	6%	**4%**	2%	12%		
Oligochaeta	11%	12%	16%	19%	**15%**	20%	8%	16%	11%
chiros + worms	**67%**	**78%**	**57%**	**63%**	**71%**	**74%**	**50%**	**74%**	**61%**
Total Count (# of specimens)	536	525	501	501	**503**	514	513	525	501

Candidate Causes

Sedimentation:

- increased embeddedness; increased SFGF; increased turbidity

Increased Temperature:

- related to channel alteration and riparian removal

Altered Flow Regime:

- increased peakflow; decreased baseflow; Δ surficial flow

Physical Habitat:

- decreased woody debris, decreased in-stream habitat; Δ pool/riffle frequency

Pesticides, Nutrients and Petroleum:

- all related to marijuana gardens in upper watershed

Decreased Dissolved Oxygen:

- related to warming, lower turbulence, increased glide, increased W/D ratio

Δ pH

Spatial-Temporal Co-Occurrence:
select examples of supporting signal (at least for 154 against 223)

Candidate Cause	154	218	%Diff	SOE Score	223	%Diff	SOE Score
Instream habitat diversity	0.29	0.28	2%	---	0.54	-46%	+
% Glide	51	17	200%	+	26	96%	+
Glide count (# transects)	8	4	100%	+	2	300%	+
% fastwater habitat	14	11	27%	---	23	-39%	+
Standard deviation depth	25	81	-69%	+	49	-49%	+
% Sand+fines+ fine gravel	25	30	-17%	---	9	178%	+
% Embedded	59	59	0%	---	36	64%	+
Epifaunal substrate	11	12	-8%	0	16	-31%	+

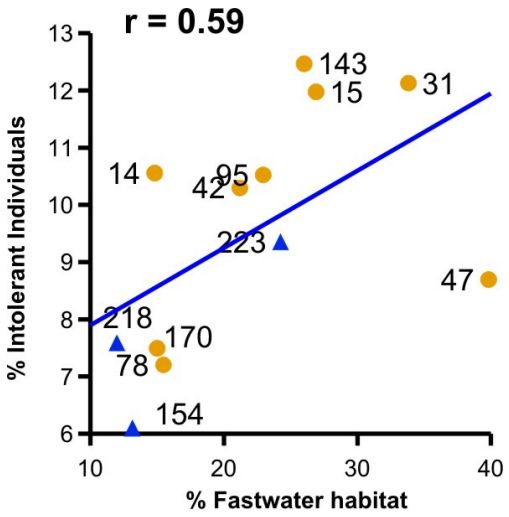
Spatial-Temporal Co-Occurrence:
select examples of non-supporting signal

Candidate Cause	154	218	%Diff	SOE Score	223	%Diff	SOE Score
Woody debris volume in wetted channel	0.48	0		---	0		---
% Dry channel	0	0		---	0		---
Discharge (cfs)	15	5	200%	---	7	114%	---
Temperature (°C)	17.2	19.3	-11%	---	18.3	-6%	---

Stressor response within the case:

- extended “case” to include all 12 inner gorge sites
- most relationships very weak (r < 0.5)
- when stronger relationships were seen, they were a mixed bag of ~ interpretable, non interpretable, or against expectations

makes sense



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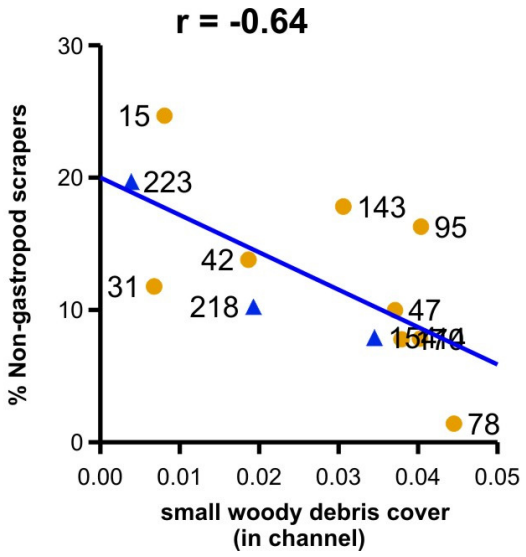
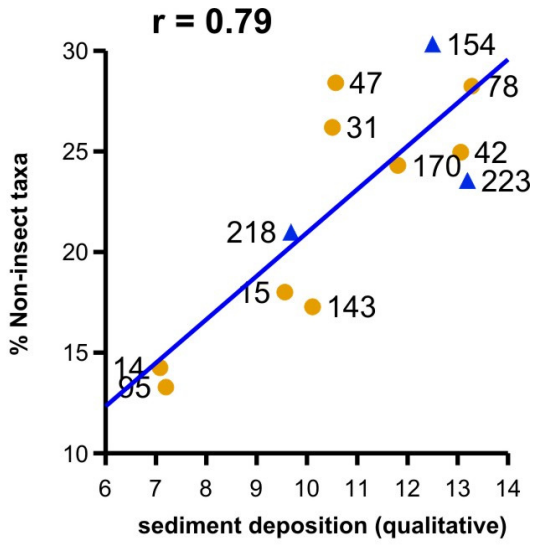


non-expected pattern

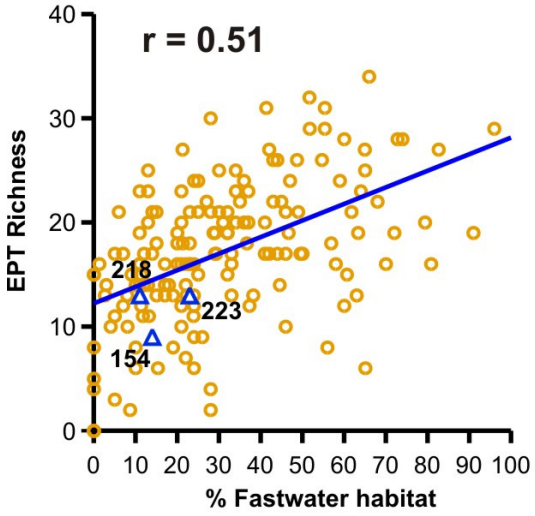


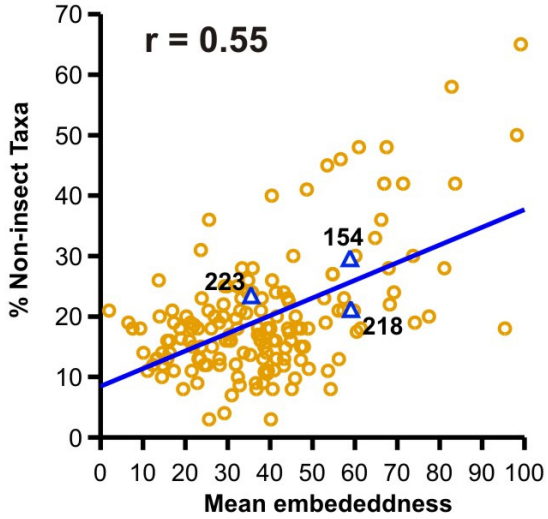
Stressor response from outside the case:

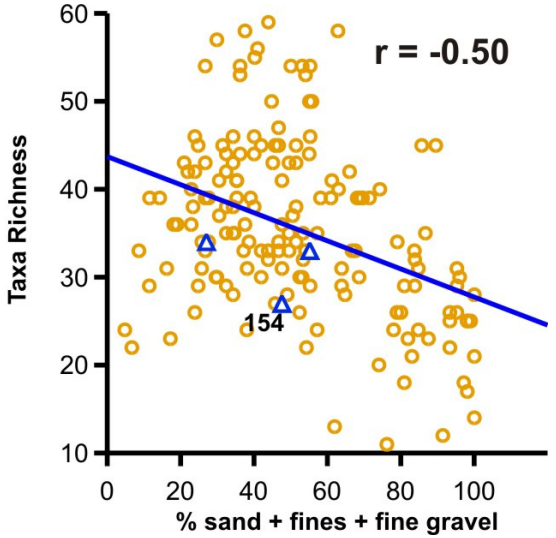
- 153 North Coast probability sites sampled 2000-2008

- included 30 from the Garcia watershed

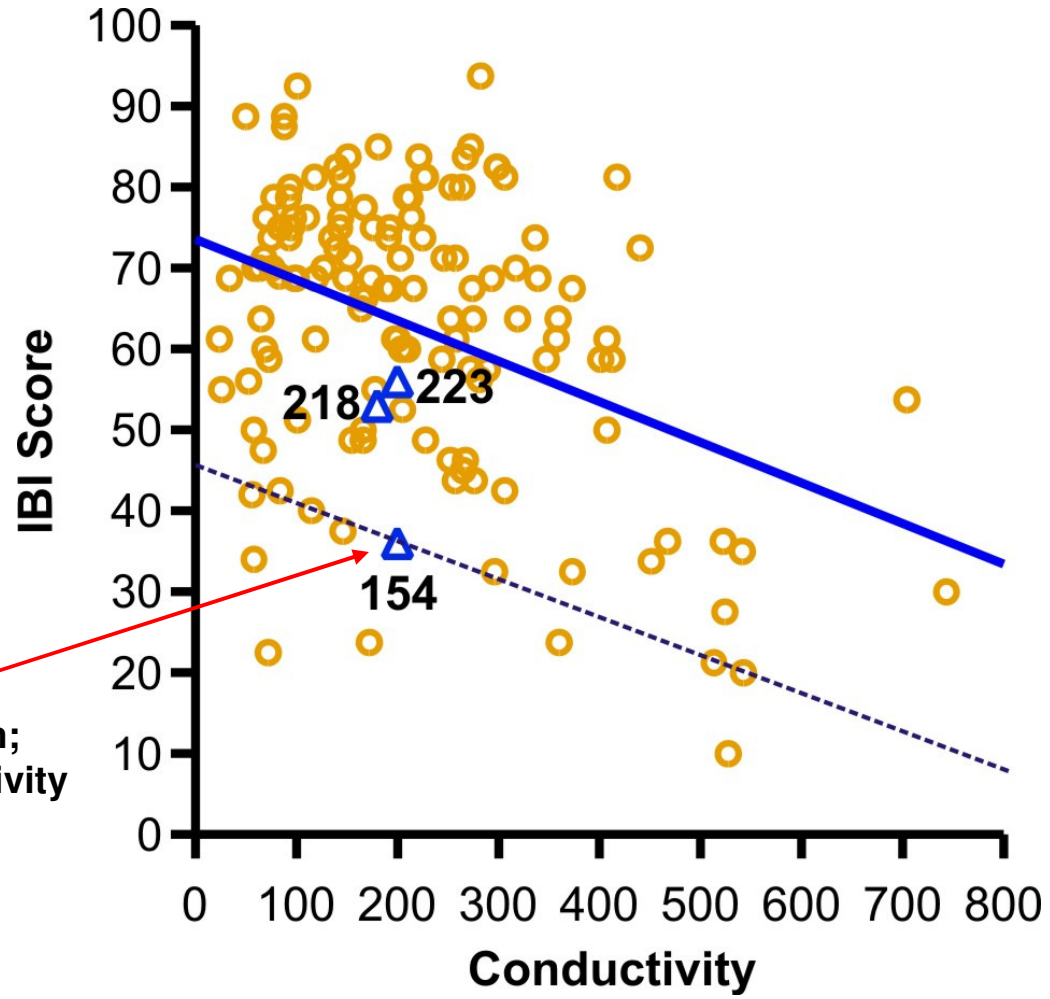
- again, most relationships very weak (r < 0.5), but when stronger relationships were seen, they made sense







Quantile regression used to refute some candidate causes:



case site falls below 5th percentile regression; argues against conductivity as cause

Scoring summary for site 154 against 218/223

	Low DO	pH	Temp	Cond-uctivity	PHAB	Sediment (bed)	Flow	Increased Pesticides	Increased Nutrients	Increased Petroleum
Types of Evidence That Use Data From the Case										
Spatial/Temporal Co-Occurrence	+	0	0	+/--- overall: ---	+	---/+ overall: +	---	NE	NE	NE
Causal Pathway	0	-	0	-	+	+	+	0	0	0
Stressor Response From the Field	-	-	-	-	+ (weak!)	-	-	NE	NE	NE
Types of Evidence That Use Data From the Elsewhere										
Stressor Response From Other Field Studies	-	-	-	-	+ (weak!)	+	-	NE	NE	NE
Evaluating Multiple Types of Evidence										
Consistency of Evidence	-	-	-	-	+	+	-	0	0	0

Final Conclusions: Likely contributors

Candidate Cause	Evidence and comments
Physical habitat	Greater habitat diversity observed at comparator sites (especially site 223) than at case site, including more instream cover, more fastwater (riffle) habitat, less glide habitat, greater variation in depth, etc.
Sedimentation	Comparator sites (especially 223) less embedded and with less sand + fines + fine gravel. Differences consistent with legacy effects from historical timber harvest, and site 223 being a higher gradient, more constrained reach that transports sediment downstream

Final Conclusions: Unlikely contributors

Candidate Cause	Evidence and comments
Conductivity	Differences in conductivity values between case and comparators neither large nor ecologically significant; no pathway apparent for effect at one site, but not another, given their close proximity
pH	Differences in pH values between case and comparators neither large nor ecologically significant; no pathway apparent for effect at one site, but not another, given their close proximity
Flow (= discharge, % dry channel)	Case site had higher discharge than comparators when measured; causal pathways for water diversions or withdrawals that might affect case but not comparators seem absent

Final Conclusions: Significant questions remain

Candidate Cause	Evidence and comments
DO, Temperature	Longer term DO and temp measures are needed for evaluation, although certain channel alterations related to historical timber harvest and gravel mining contribute necessary links in causal pathways
Nutrients, pesticides, petroleum	No data available

Lessons Learned:

1. Stakeholder involvement is critical for success

2. Comparator site selection is critical for success

3. Stressor-response data from within the case should be interpreted with caution

- "response" assumes a gradient exists, but if all sites are on the impaired end of that gradient, relationships may be spurious

4. CADDIS is a great communication tool but is REALLY time consuming; we should be mindful of that as we incorporate into statewide bio-objectives.