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

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North Coast Water Board

and

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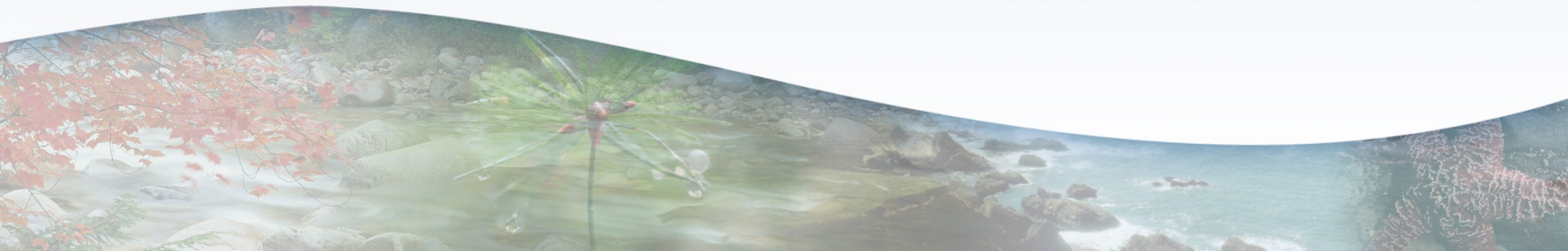
Presentation Topics

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



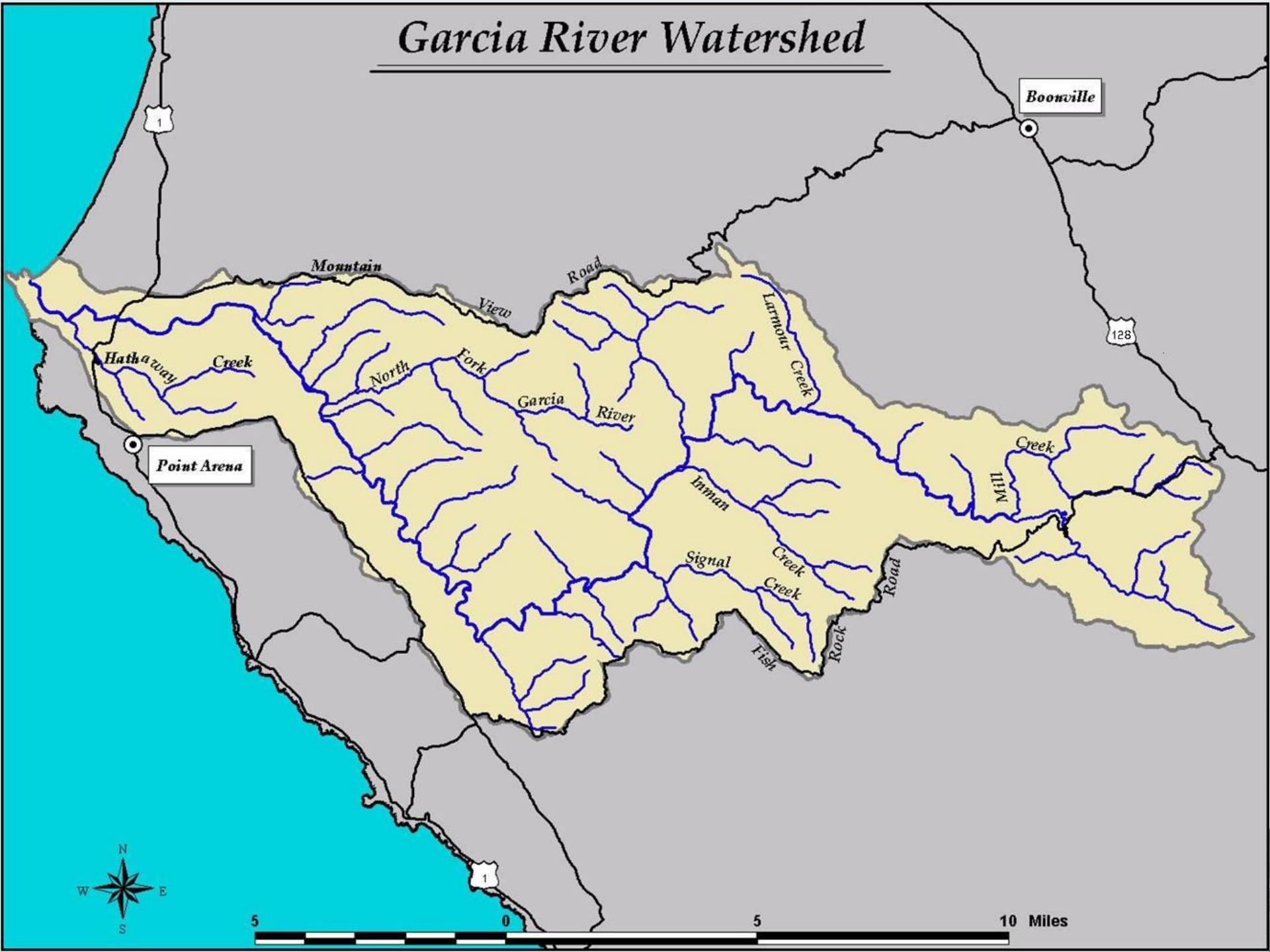

Garcia River Watershed
Boonville
Point Arena
1
128
Mountain View Road
Hathaway Creek
North Fork Garcia River
Larmour Creek
Mill Creek
Inman Creek
Signal Creek
Rock Road
Fish
N
W
E
S
5
0
5
10 Miles


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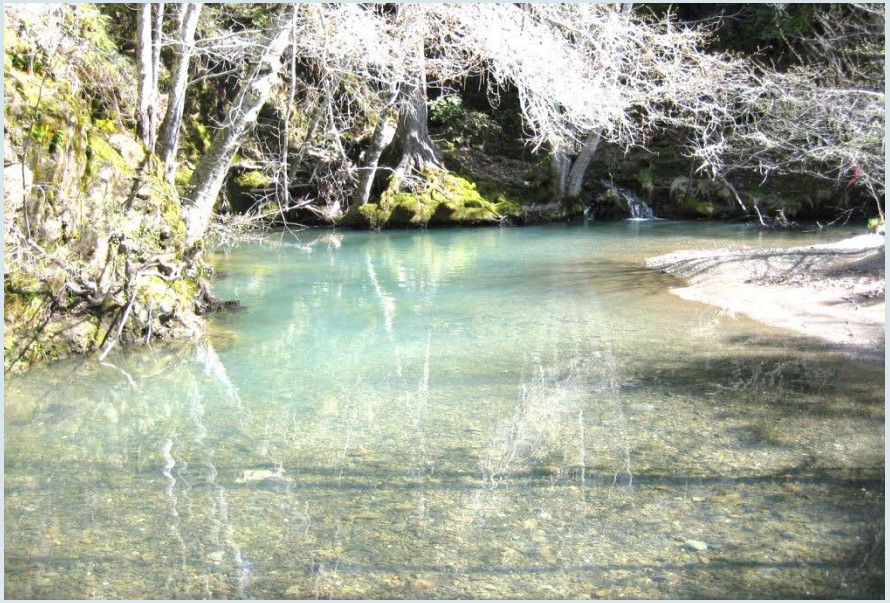
Photo credits: Larry Serpa, TNC and Stephen Bargsten, NCRWQCB



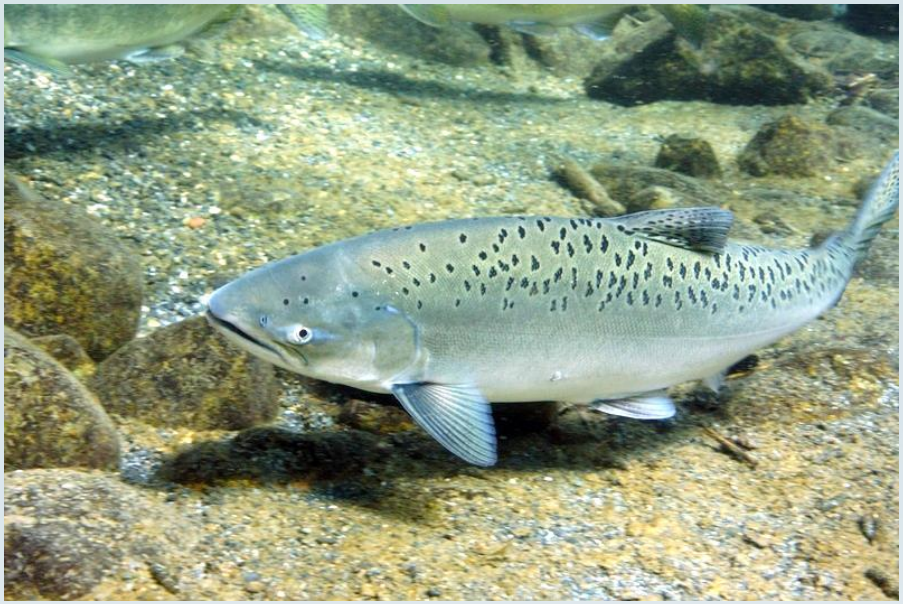
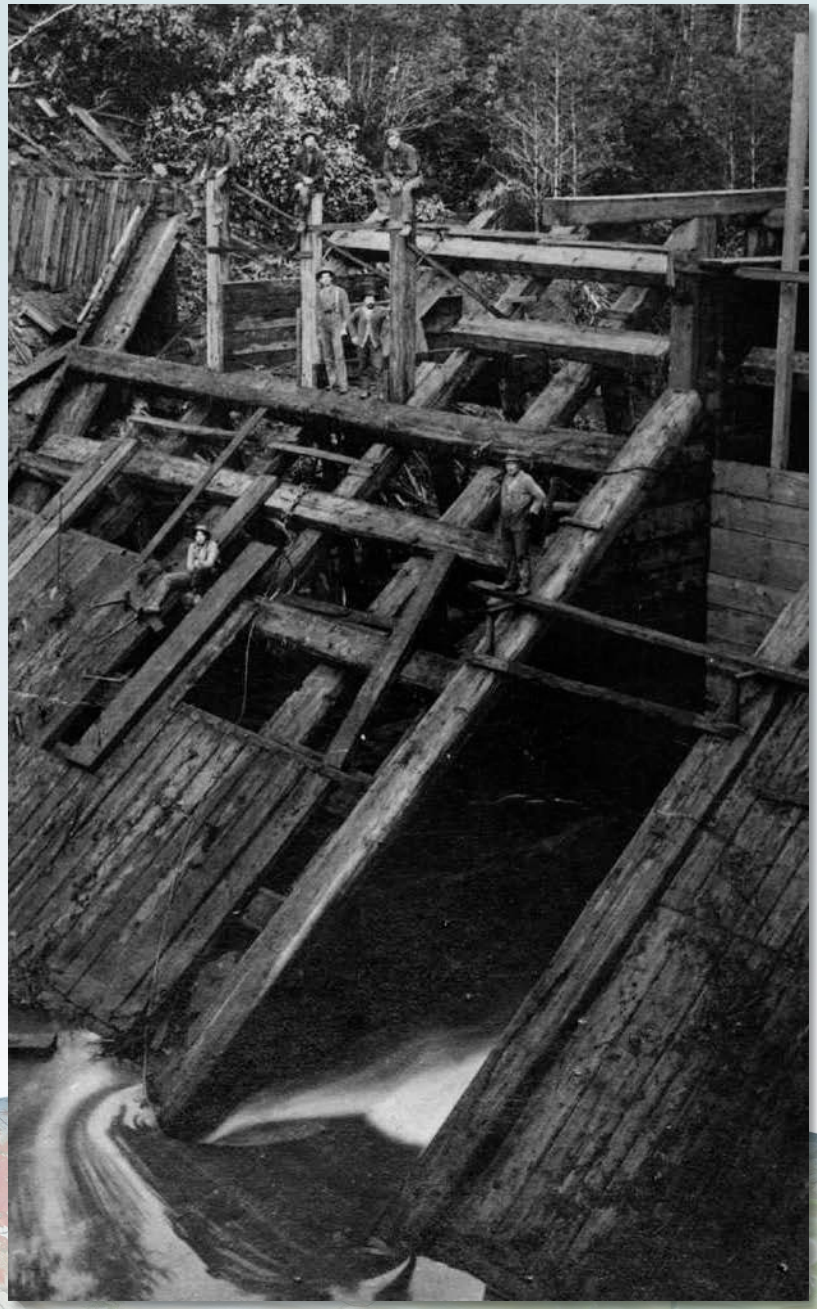
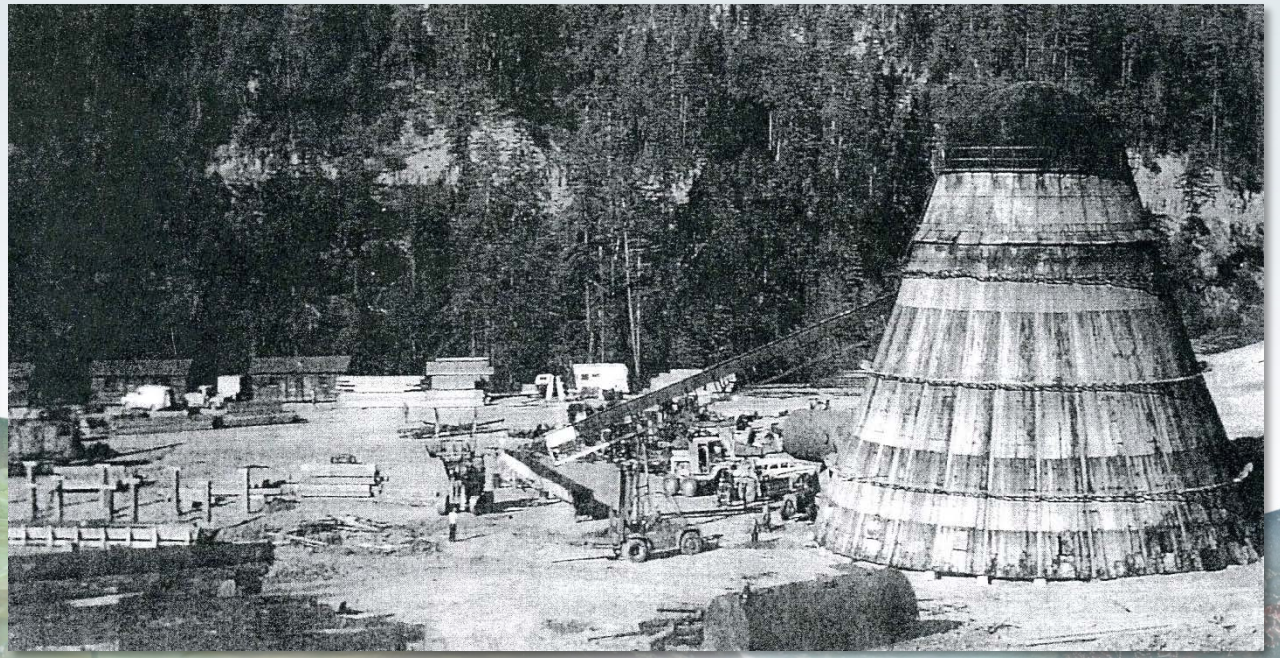


Photo credits: ©Thomas Dunklin (Spotty Chinook) and ©Robin Loznak (Coho Pair)

Early Logging Period (1860s - 1915)



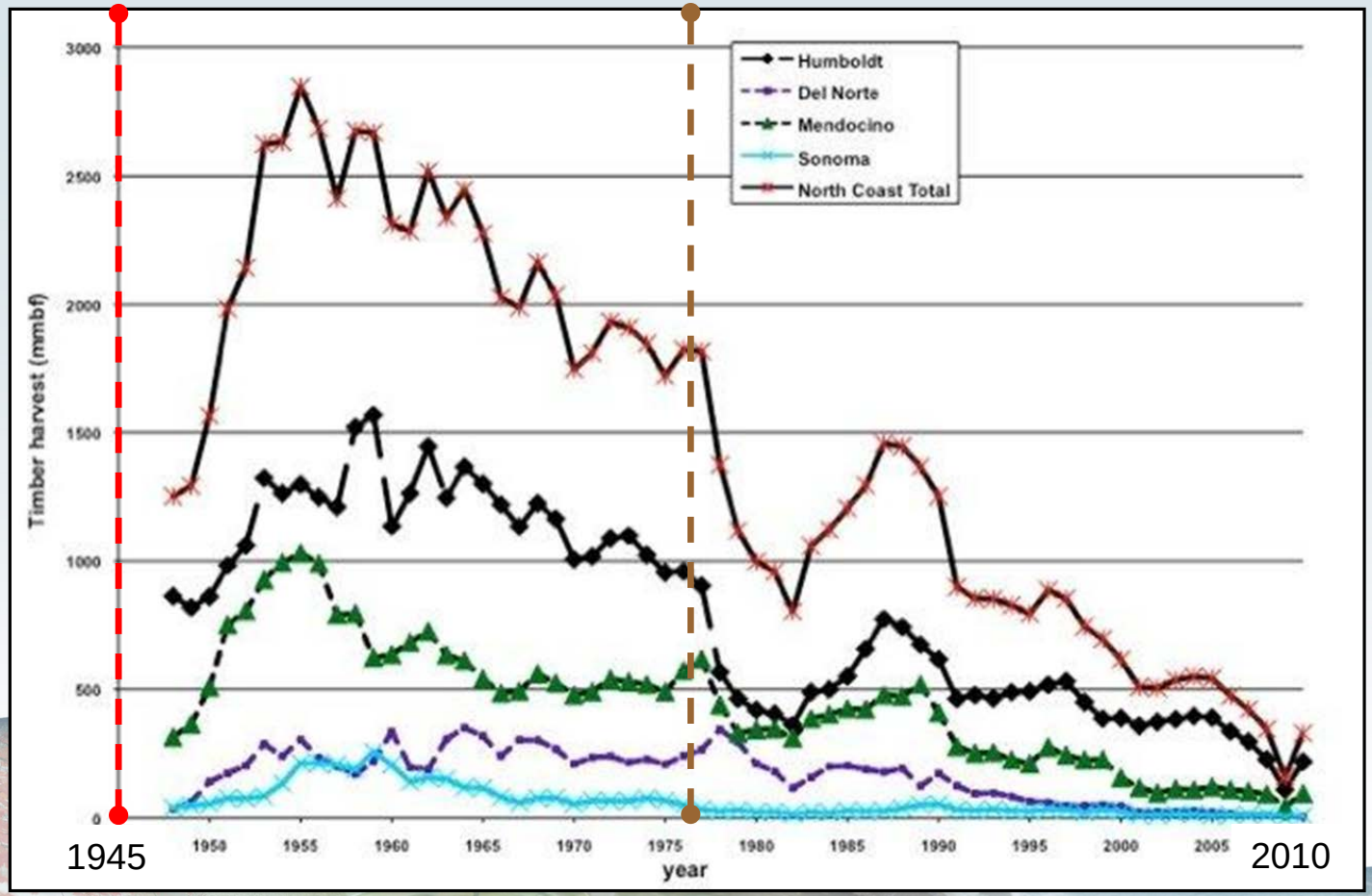
Post-WWII Logging Era (1940-70s)



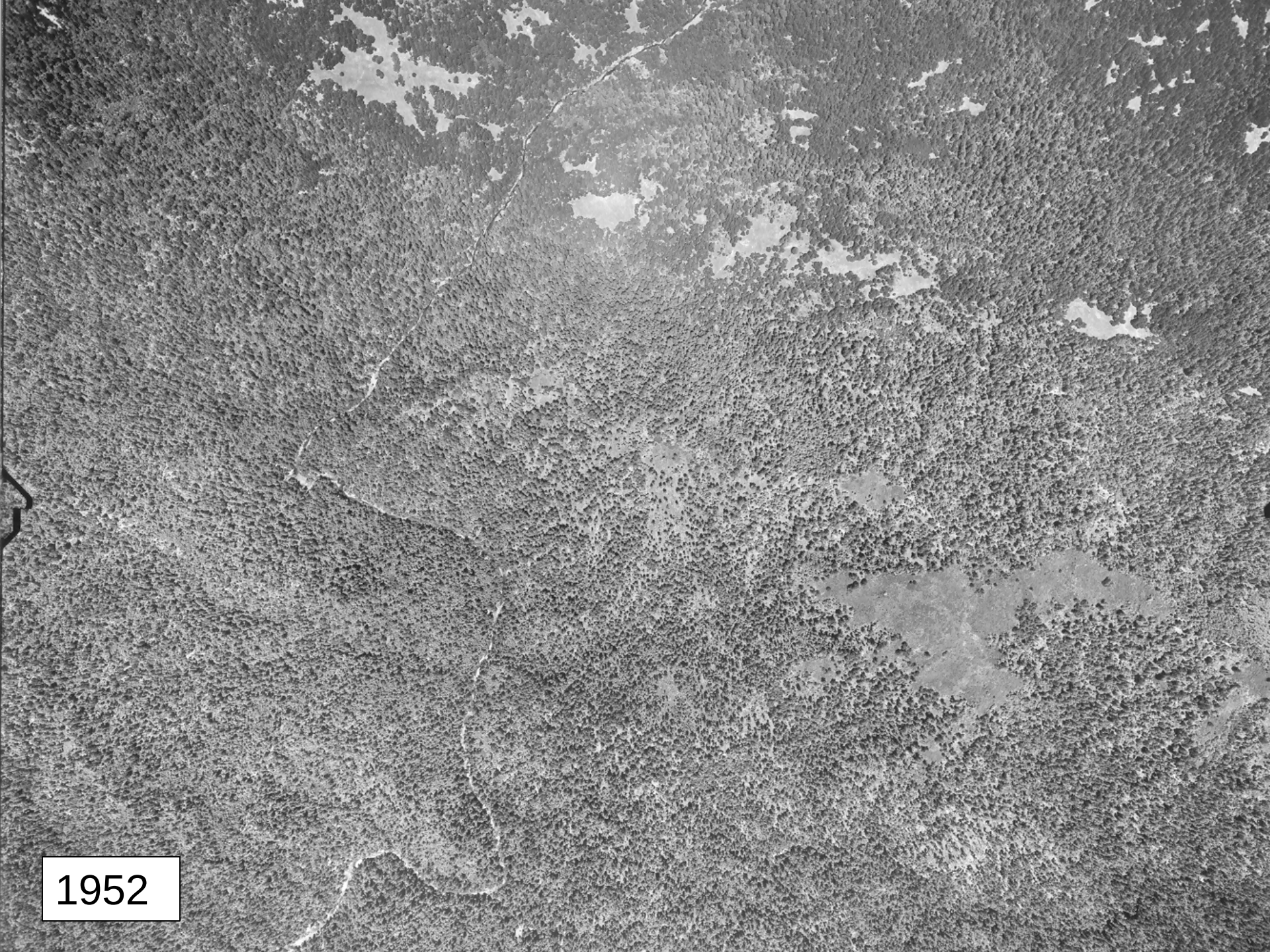
North Coast Timber Harvesting (1945 - 2010)

***Ad Valorem* Timber Property Tax 1945**

Forest Practice Rules Sustained Yield Tax 1976



UCCE Forestry (2012)


1952


1963

CDFG Stream Damage Survey - July 1966

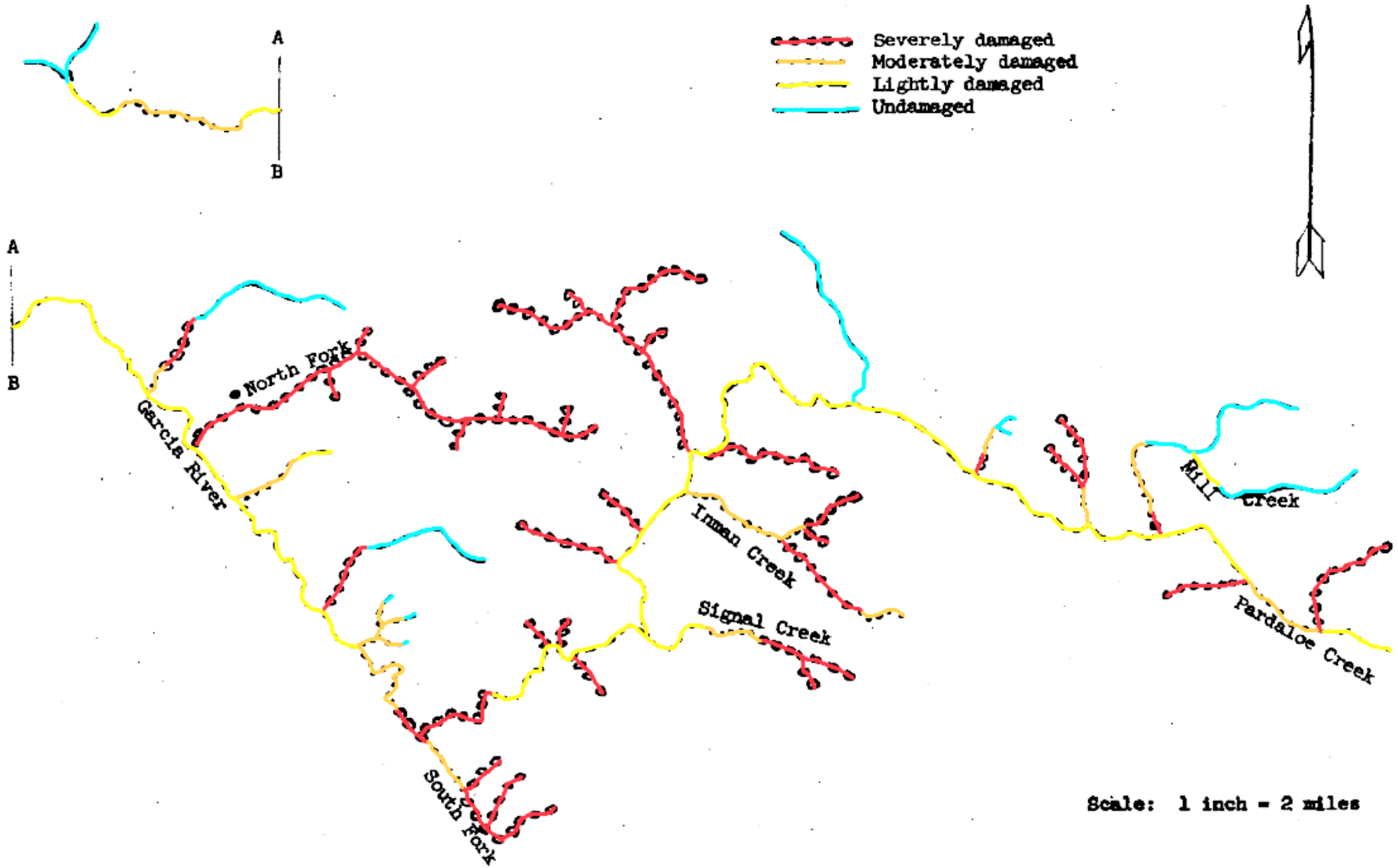


FIGURE 1. Garcia River, Mendocino County, stream damage.

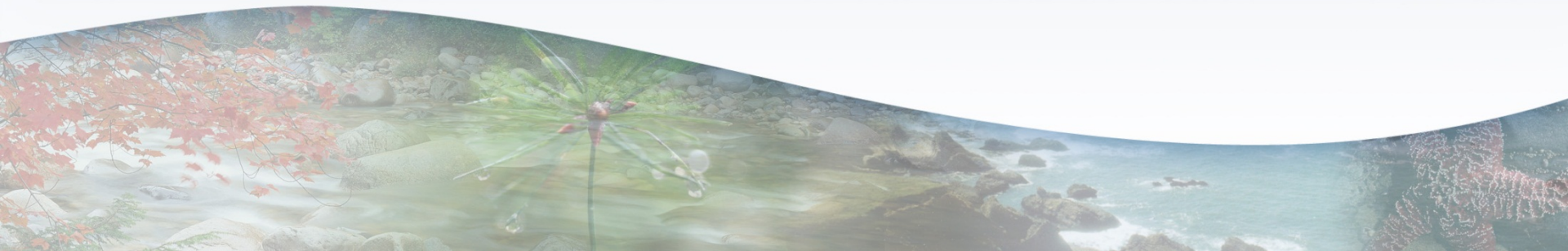
Other Land Use Impacts

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

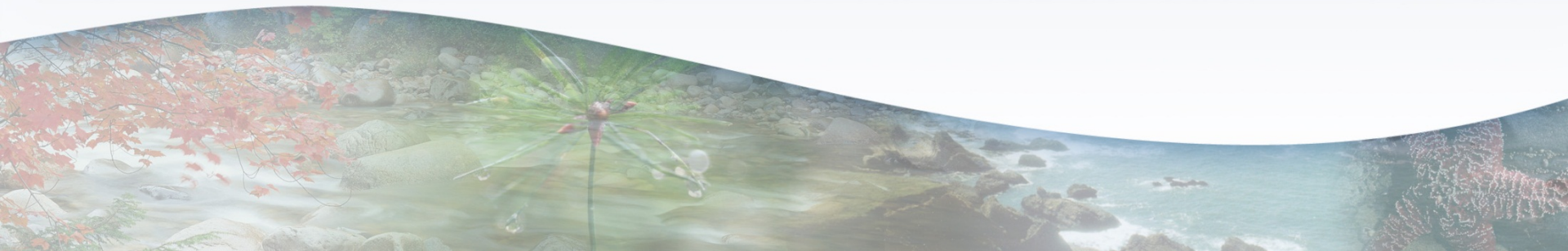
Cumulative Effects

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

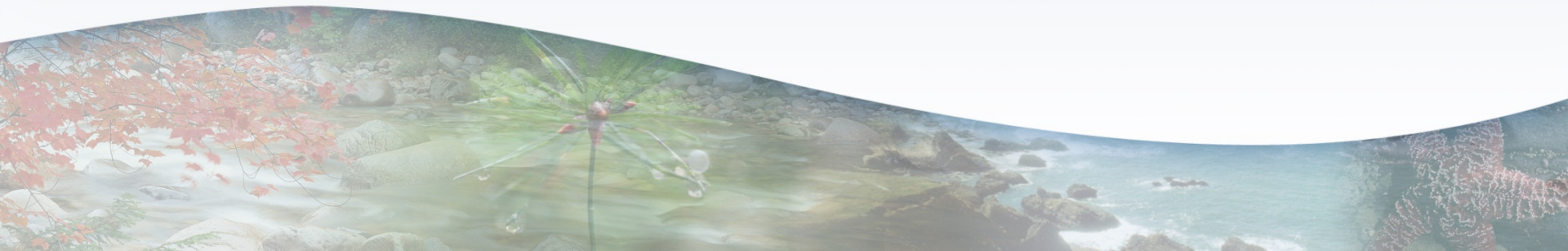
- Adopted into North Coast Basin Plan in January 2002
- First sediment TMDL with an action strategy
- GOAL: Reduce the amount of controllable sediment delivery into the watershed

TMDL Compliance Options

1. Comply with the Waste Discharge Prohibitions

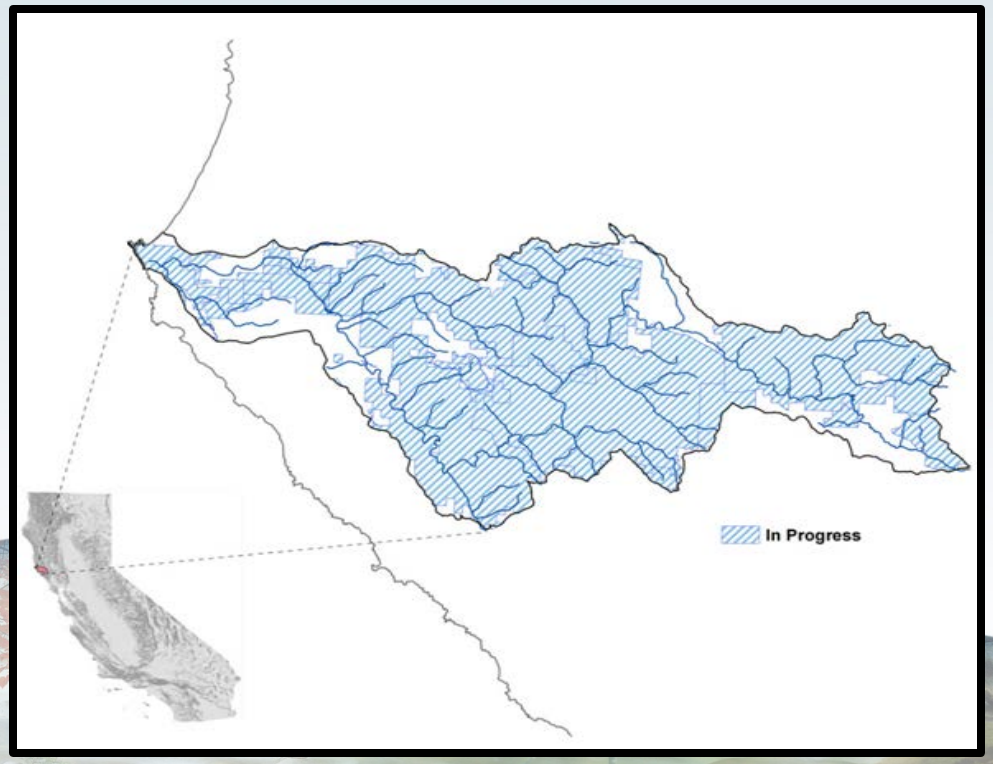
2. Develop and implement an Erosion Control Plan and a Site-Specific Management Plan

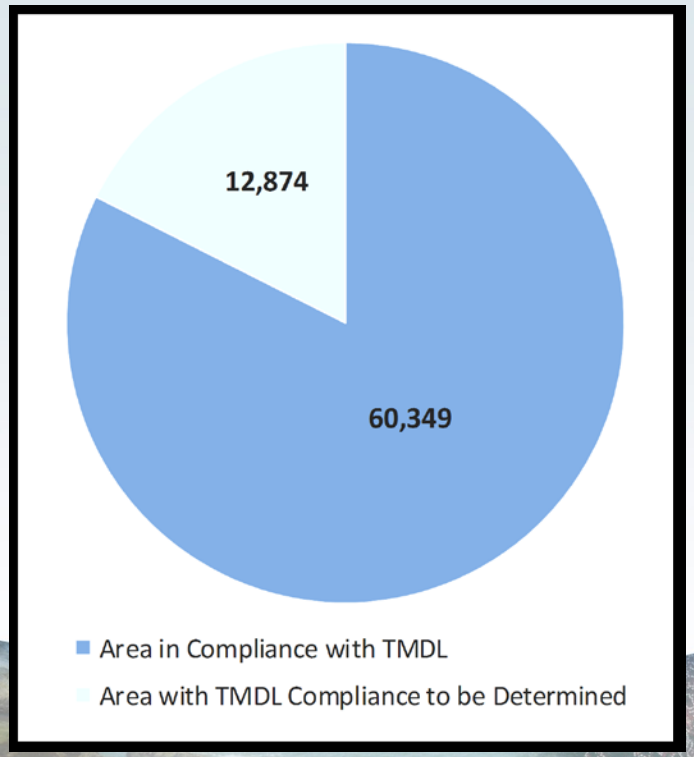
3. Develop and implement an Erosion Control Plan and *follow* the Garcia River Management Plan



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





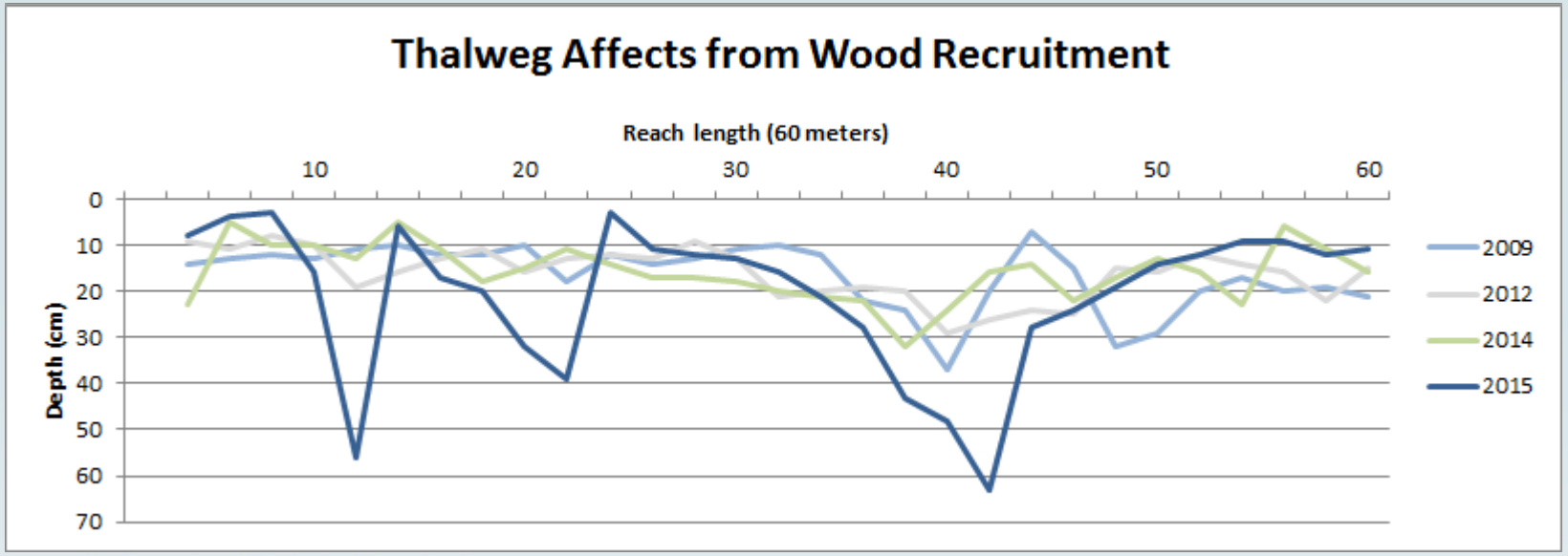
Annual Load Reduction

1,275 dump truck loads = (12,750 yds^3)

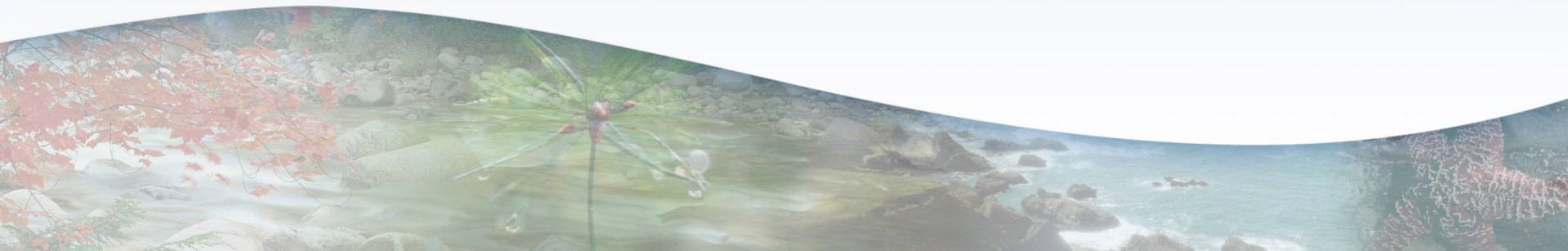
>50,000 dump truck loads of sediment over life of TMDL

Accelerated Wood Recruitment

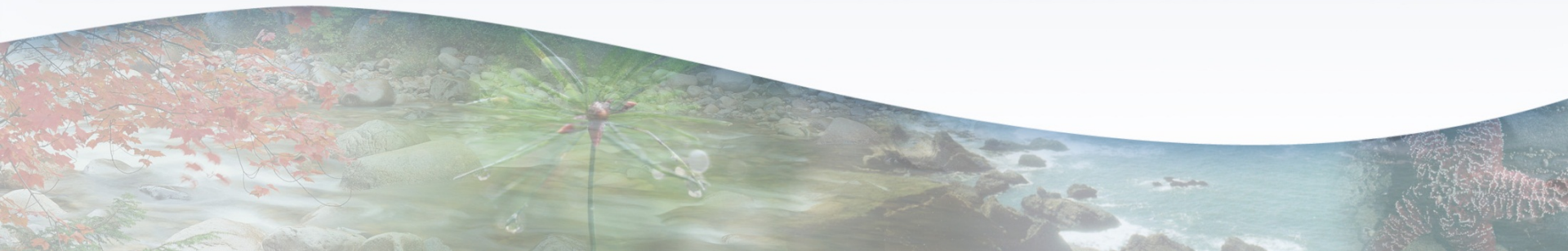
- Twelve miles of stream treated since 2008
- The Nature Conservancy, The Conservation Fund, Mendocino Redwood Co., Trout Unlimited


Thalweg Affects from Wood Recruitment
Reach length (60 meters)
10
20
30
40
50
60
0
10
20
30
40
50
60
70
Depth (cm)
2009
2012
2014
2015

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



III. Garcia River Monitoring Program (GRMP)



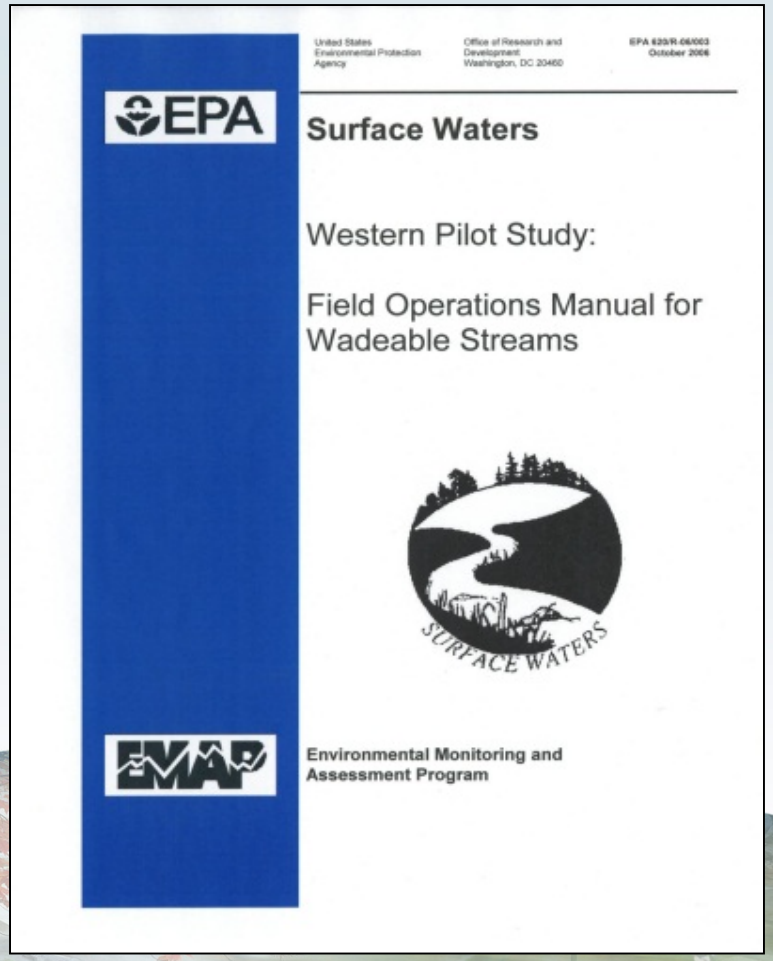
GRMP Genesis

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

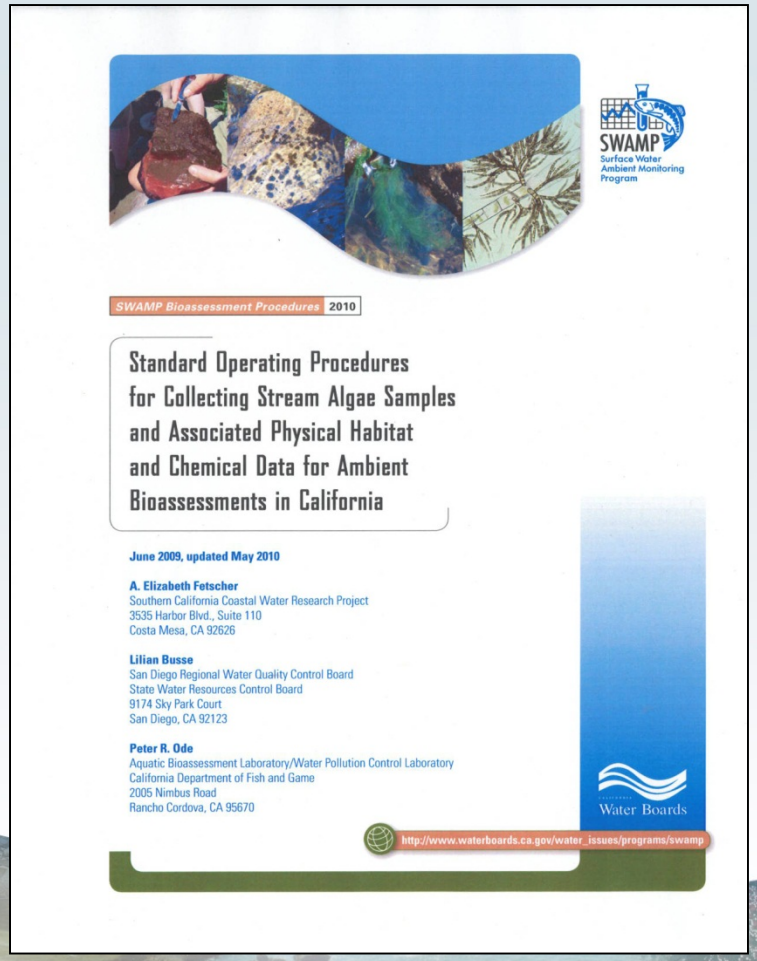
- TNC needed a program to assess management objectives and strategies per the Garcia River Forest Management Plan

Garcia River Monitoring Program

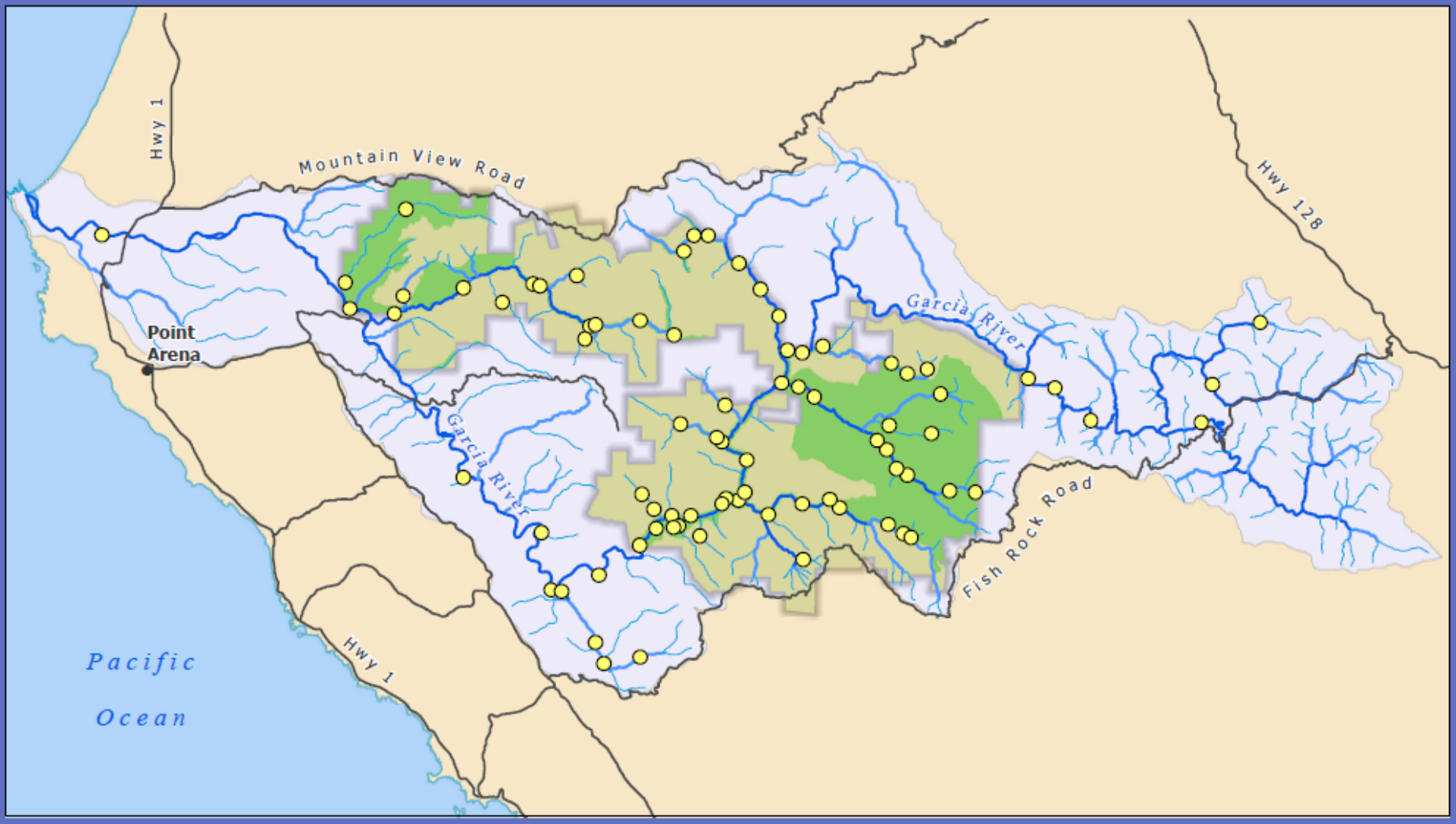
Environmental Monitoring and Assessment Program (EMAP–West)



Surface Water Ambient Monitoring Program (SWAMP)



Random Probabilistic Survey Design (GRTS)



Public Roads & GRF Maintained Roads

Garcia River Forest Ecological Reserve Network

Garcia River Forest

Garcia River Watershed

0 0.5 1 2 Miles

N

The Nature Conservancy
Protecting nature. Preserving life.

Monitoring Metrics

TMDL

- Embeddedness
- Substrate composition
- Median particle size (D50)
- Large woody debris
- Width-to-depth ratio
- Aerial photos of canopy
- Primary pool frequency
- Thalweg profile

- V*
- Migration barriers

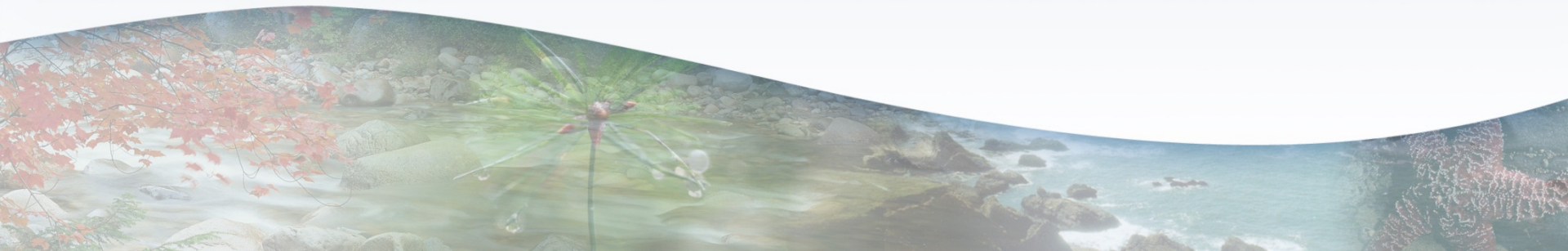
GRMP

- 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.

Relative Bed Stability

- Baseline **relative bed stability** (observed mean particle size/critical diameter) measurements for all three stream categories **met the "preferred range"** (Kaufmann et al. 2009)

Statistically Significant Changes

- **RBS** values in low-gradient tributaries **decreased** although they continued to **meet the "preferred range"** (p=0.01)
- **RBS** values for high-gradient tributaries **decreased**, shifting the scores to the upper end of the **"fair range"** (p=0.00)
- Probably driven by increase in shear stress (↑ flows; ↓ LWD)

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

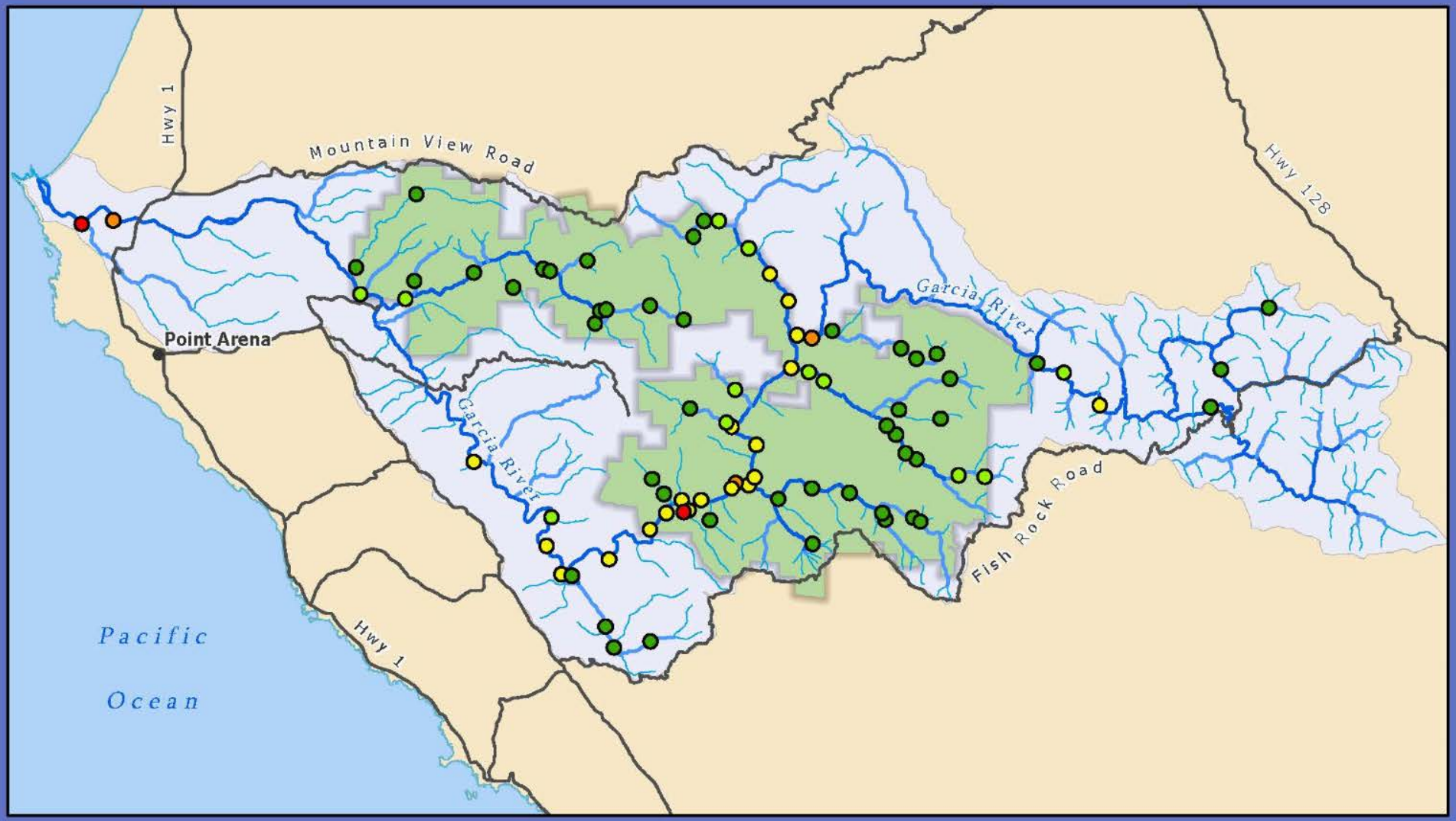
Additional Hypothesis Testing

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.

Baseline: Percent Canopy Cover Mid-Channel



Canopy Cover and Riparian Vegetation Structure

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

<u>Statistically Significant Results</u>

- 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.

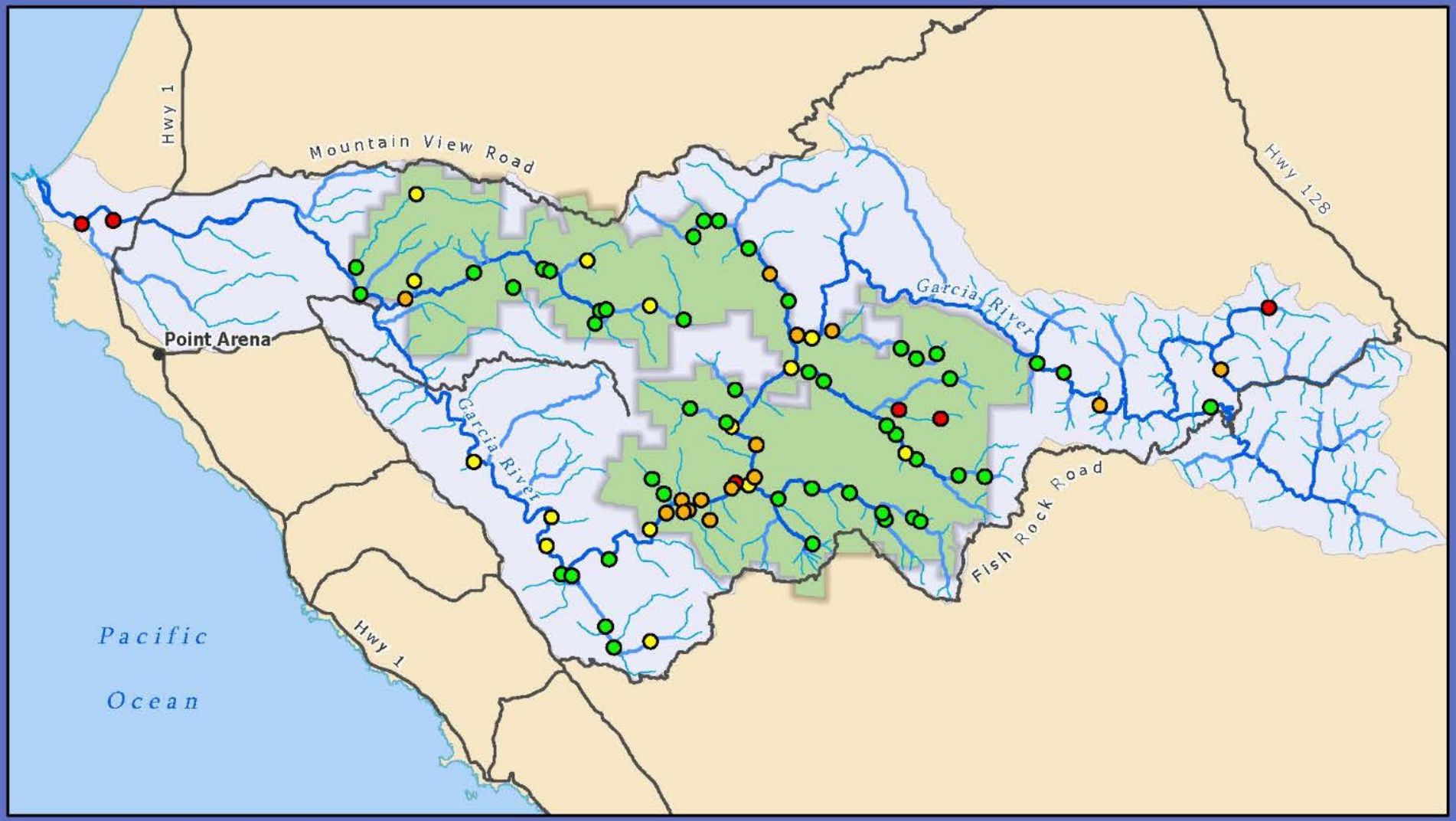
Benthic Macroinvertebrates:
California Stream Conditions Index (CSCI)

- 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

Benthic Macroinvertebrates: California Stream Conditions Index (CSCI)



Public Roads

Garcia River Watershed

Garcia River Forest

CSCI

- 0 - 0.62 very likely altered condition
- 0.63 - 0.79 likely altered condition
- 0.80 - 0.91 possibly altered condition
- ≥0.92 likely intact condition

0 0.5 1 2 Miles

N

Other BMI Metrics

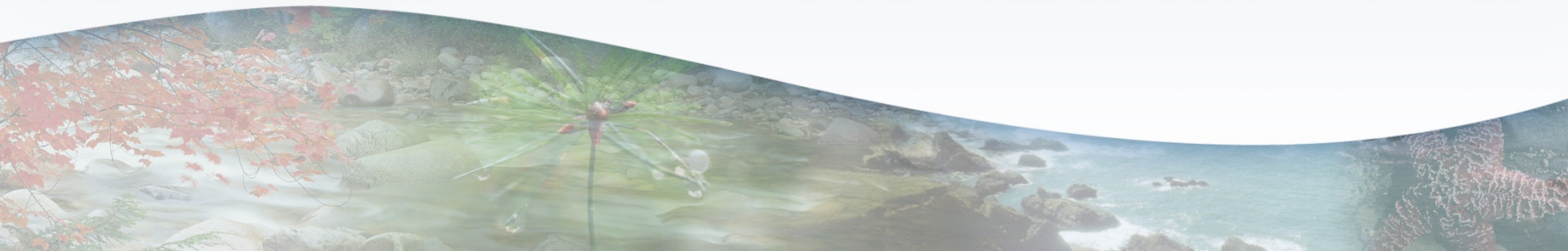
Metric	Garcia mean metric score	Low Grad. Trib. mean metric score	High Grad. Trib. mean metric score
EPT Richness	6	9	9
% Intolerant Ind.	4	4	5
% Non-Insect Taxa	7	8	8

*On a scale from 1 to 10, from NC B-IBI scoring metrics, Rehn et al. 2005

Salmonid Distribution

- Salmonids spawning and rearing widely but in small numbers
- Coho salmon maintaining all three cohorts (2013,-14,-15,-16)
- Steelhead trout widely distributed throughout watershed
- Spawning Chinook salmon found by CDFW (2010,-11,-13)
- 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

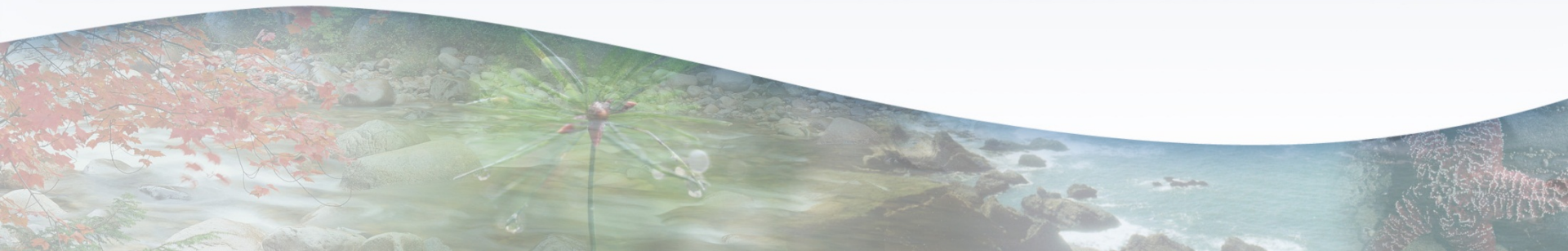
- Tributaries are improving or meeting targets
  - Thalweg depths and variability **increasing**
  - Residual depths **increasing**
  - Substrate composition **meeting targets**
  - Canopy cover **improving**
  - Large wood restoration **increasing** habitat
  - Benthic macroinvertebrates **meeting targets**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

Lessons Learned

- The Garcia River's impairment took a long time to occur. Similarly, recovery is on a decadal (or longer) time scale.
- Conservation and restoration actions are working…but natural factors are the primary driver of recovery.
- The implementation of the Garcia TMDL is a success due to strong partnerships and large private/public investments.
- To succeed, a TMDL implementation strategy should be both a catalyst for action and a mechanism of support.

Lessons Learned

- A watershed recovery strategy should include: pollution controls, riparian protections, and habitat restoration.
- Tracking watershed recovery requires a robust, scientifically-based, adaptable, sustained, and well-funded monitoring program.
- 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