Central Coast Steelhead Trout in the Salinas River Basin: Responses to Drought and Prospects with Climate Change

Lisa C. Thompson, Ph.D.

Wildlife, Fish, & Conservation Biology Department, UC Davis

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Take Home Points

- Key factors for South-Central Coast Steelhead are
  - Flow
  - Temperature
  - Passage
  - Habitat Structure
- Can we balance our water needs with those of fish?

Outline

- Natural history of steelhead and rainbow trout
- Distribution of steelhead in dry and wet time periods
- Factors affecting steelhead distribution
- Potential effects of climate change
- Local actions to aid in steelhead recovery

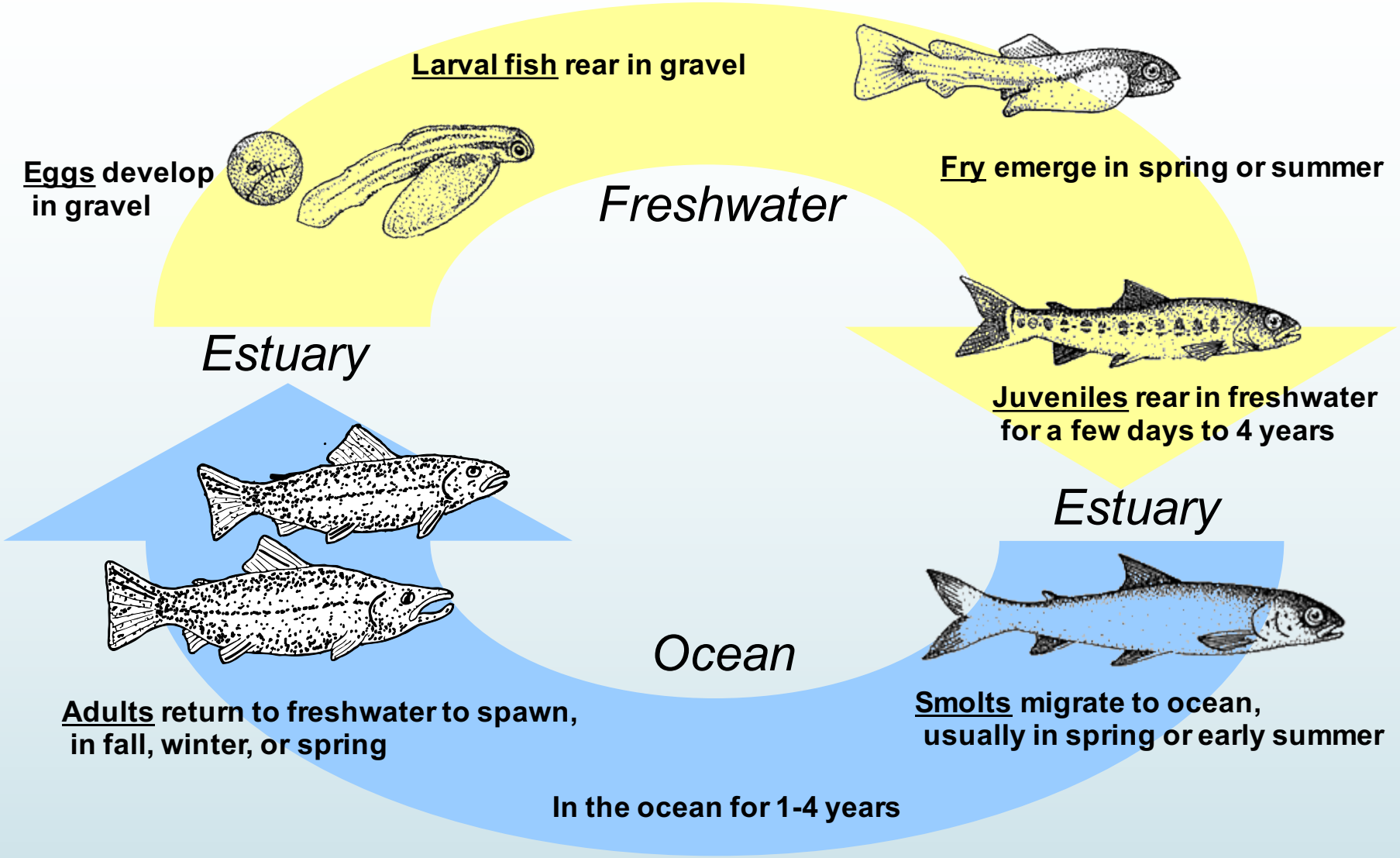
Photo by Jenna Voss

California Salmon & Steelhead Species

Steelhead & Rainbow Trout

- What's the difference?
  - Same species
  - *Oncorhynchus mykiss*
- Steelhead is anadromous form
- Rainbow trout remain in freshwater for entire life cycle
- Steelhead can have rainbow trout offspring & vice versa

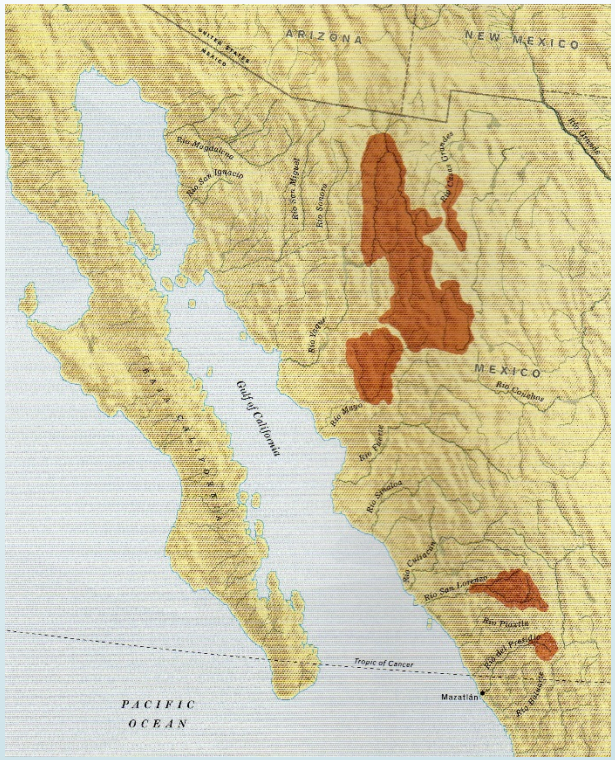
Anadromous Fish Life Cycle



Salmon & Trout Stats

Life History Characteristic	Chinook	Coho	Steelhead
Years in Stream	0 - 1	1	1 - 3
Years in Ocean	1 - 7	2	1 - 4
Spawner Age	4	3	2 – 7 (may spawn more than once)
Adult Size	Up to 100 lb.	7-12 lb.	Up to 27 lb.
Eggs per Female	5,000–12,000	2,000 – 5,000	200 – 12,000

Steelhead / Rainbow Trout Distribution in North America



Steelhead Status

- ESU (Evolutionarily Significant Unit)
  - South-Central California Coast ESU
  - Santa Cruz to Santa Maria
- Status
  - Species of Special Concern
  - Threatened
  - Endangered

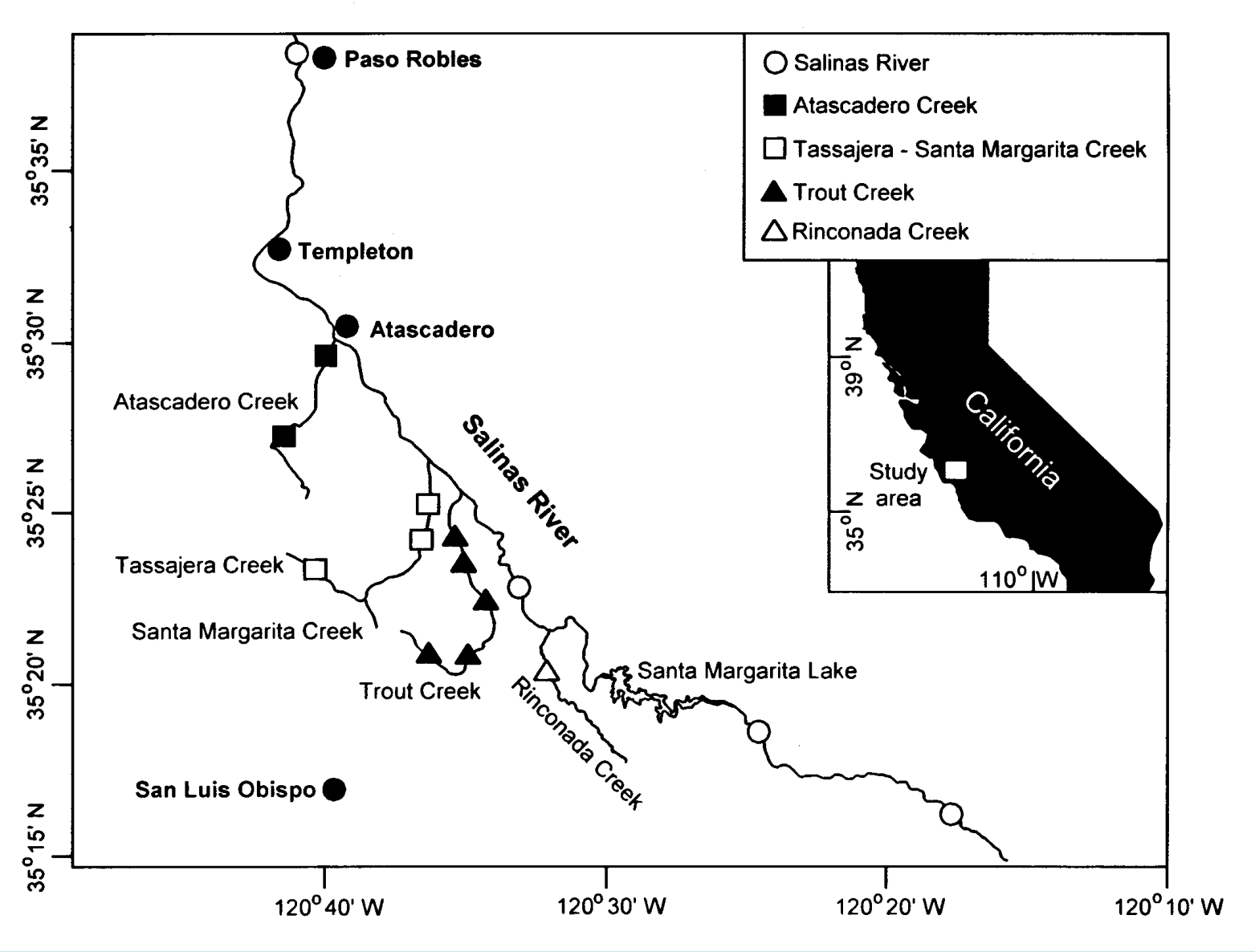
Steelhead Distribution Study: Research Questions

- What is the distribution of steelhead in the upper Salinas River watershed?
- How does distribution vary with water year?
- How do distribution & frequency relate to habitat variables?

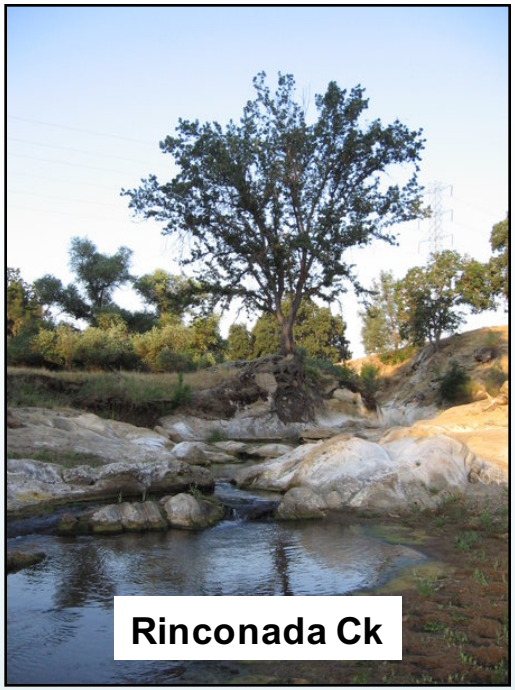
Steelhead Distribution Study: Different Water Year Types

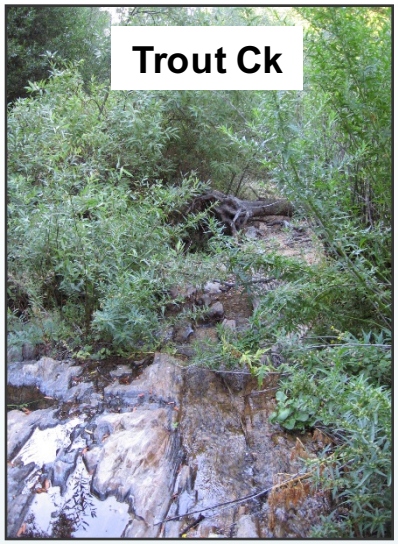
- June 2004 - August 2006
- 9 sampling trips
- Gradually worked with more landowners
- 16 sample sites
  - Mainstem Salinas River & 4 tributaries
- Initial focus on pool habitat
- Snorkel surveys

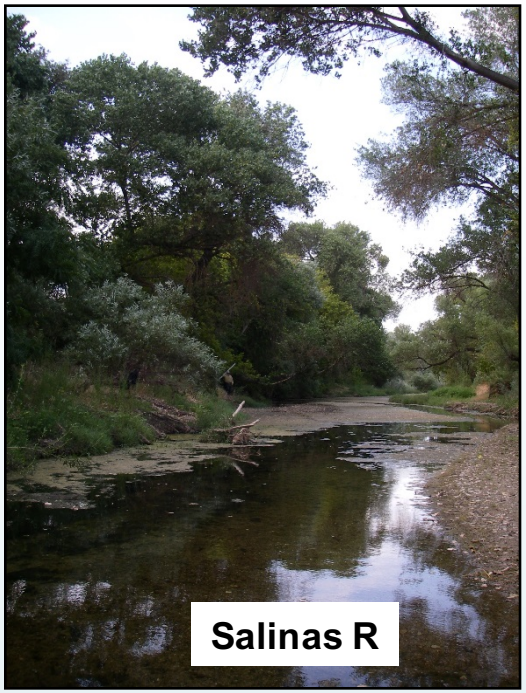
Upper Salinas River Watershed



Sites







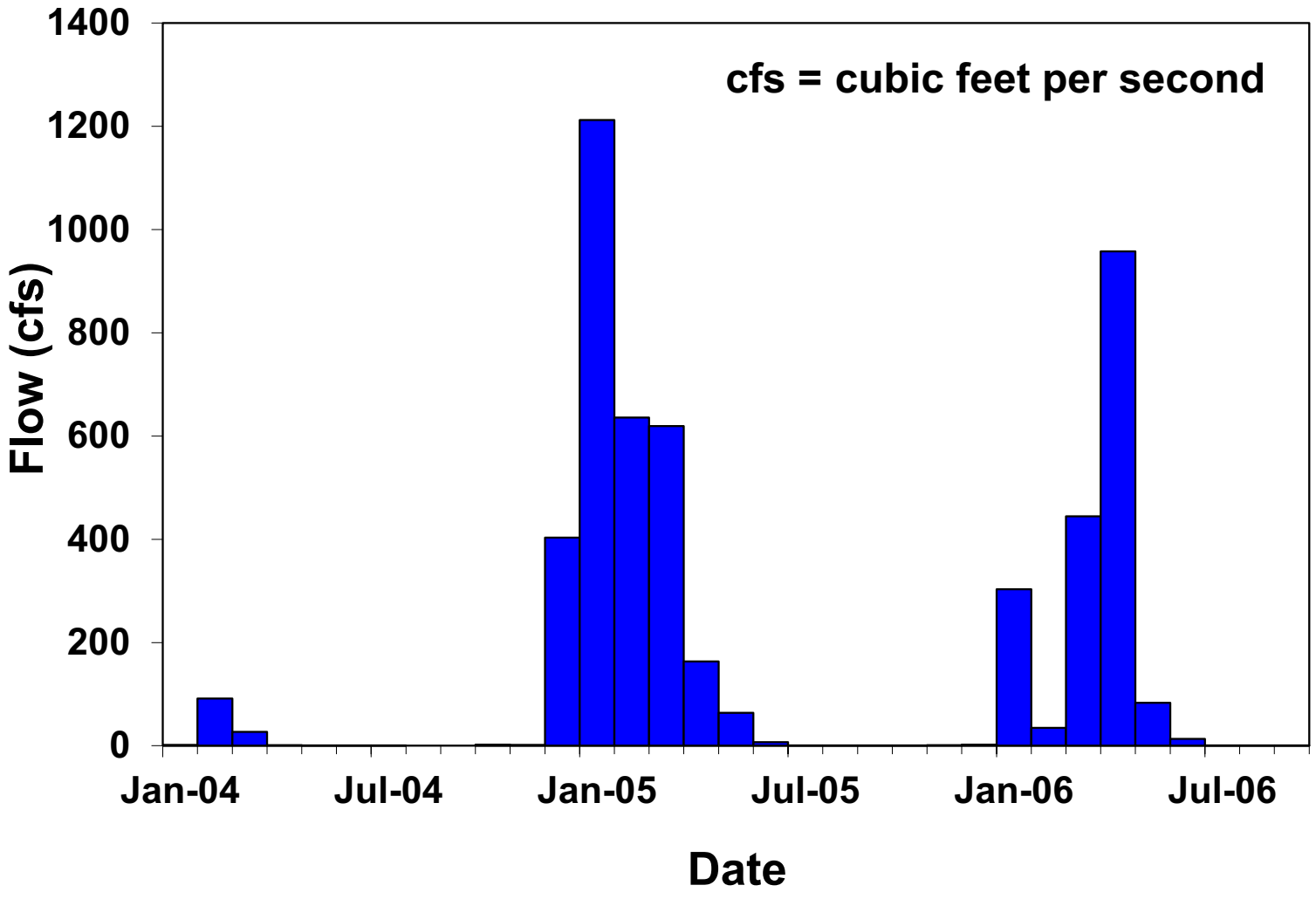
Photos by Jenna Voss

Water Years

- 2004 - Dry
- 2005 - Wet
  - Salinas River was connected well above Paso Robles
- 2006 - Wet



Salinas River Flow at Paso Robles



Gage # USGS 11147500 SALINAS R A PASO ROBLES CA

Steelhead/Rainbow Trout Snorkeling

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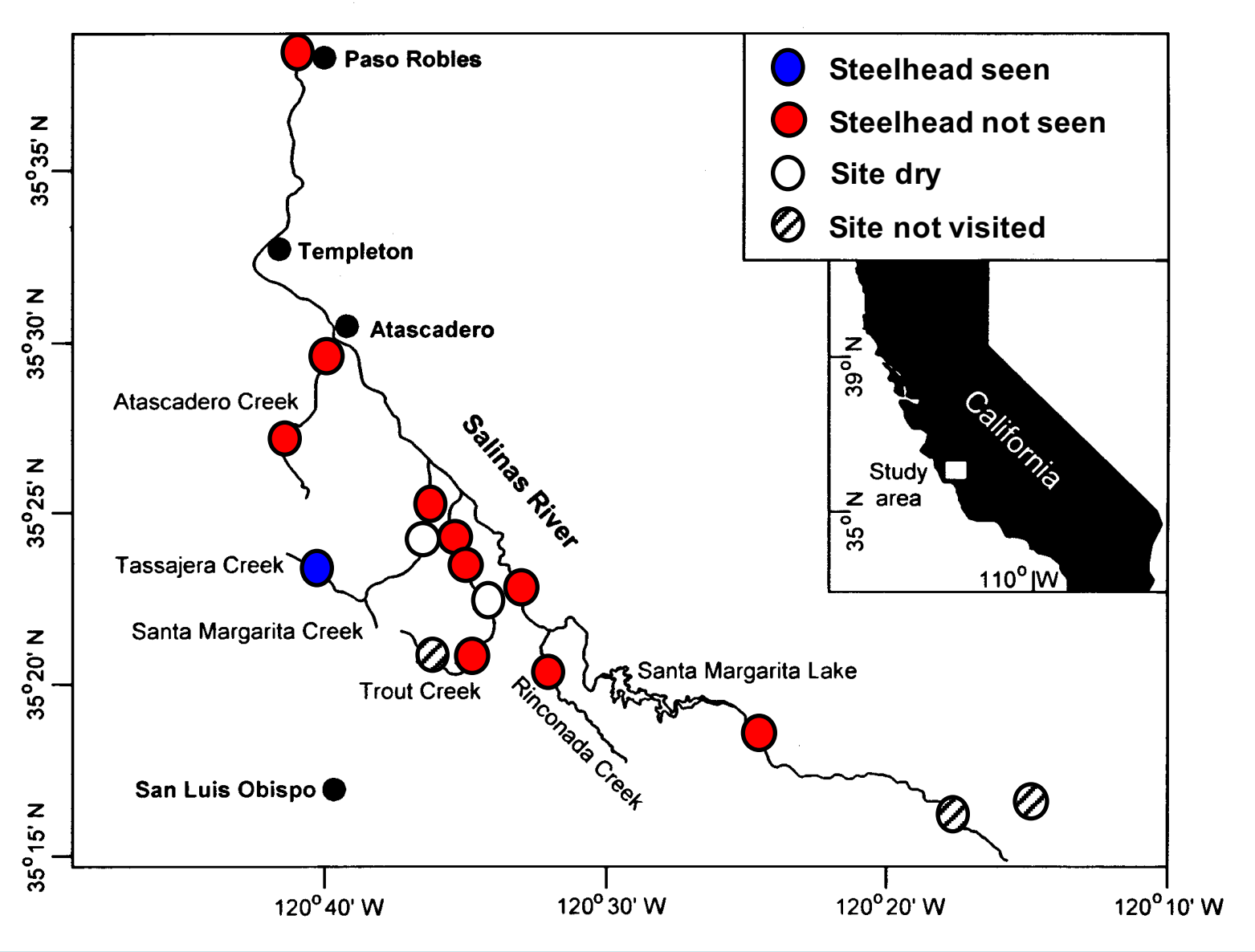
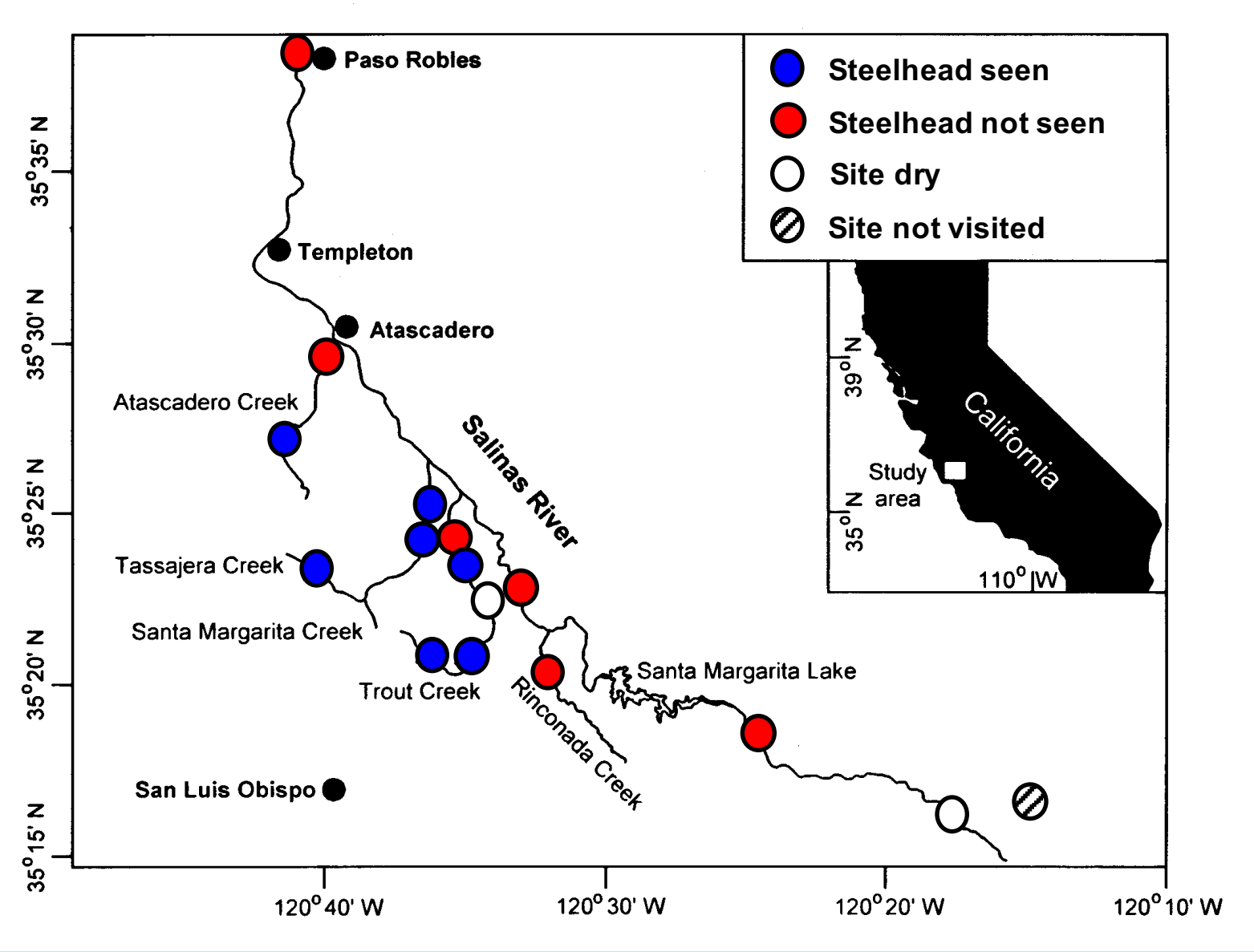
Steelhead/Rainbow Trout Snorkeling

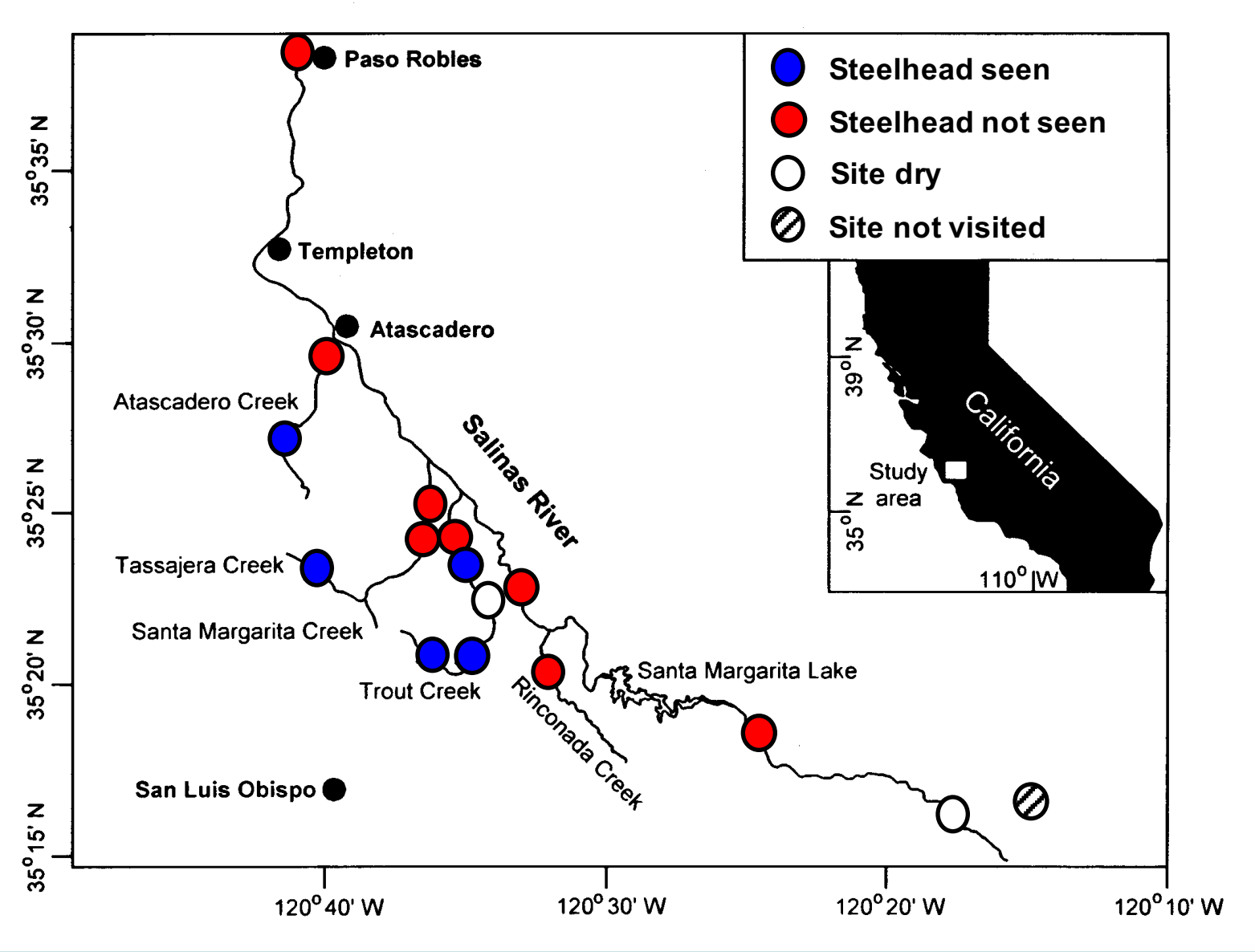
Steelhead Distribution – August 2004



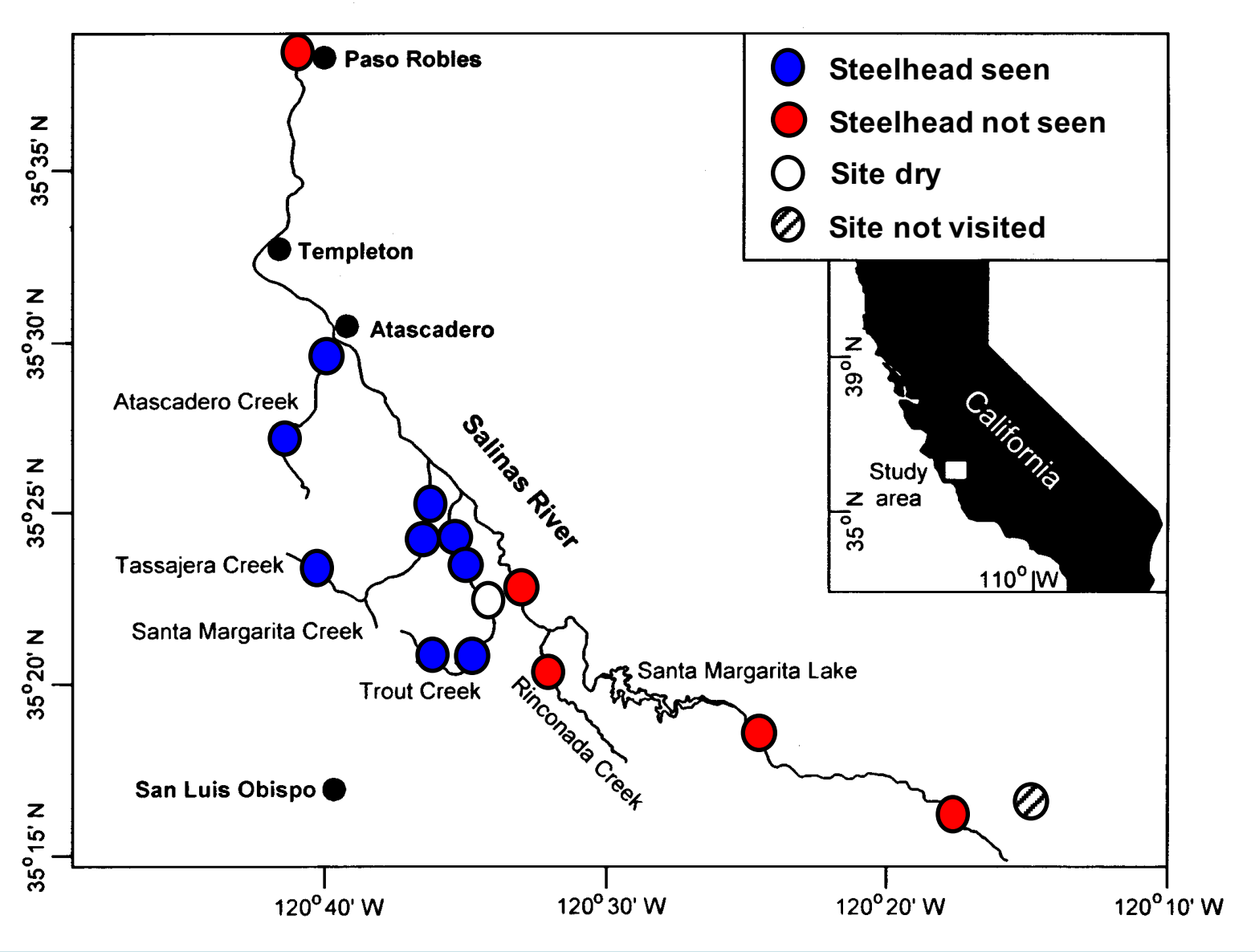
Steelhead Distribution – July 2005



Steelhead Distribution – August 2005



Steelhead Distribution – July/August 2006



Factors Affecting Distribution…

- Detailed habitat study in July - August 2006
- Mainstem Salinas River and four tributaries
- Initially interested in whether hardwood large wood in streams is important for steelhead, but looked a many habitat factors
- Surveyed fifteen 300-yard stream reaches
- Sites at elevations of 2,300 – 4,800 feet
- Recorded water flow, temperature, overhead cover, pool number and depth
- Snorkeled to count and identify fish by species and size class

Factors Affecting Distribution

- Measured the volume of large wood (length => 3 feet, diameter => 4 inches) within the bankfull width
- Identified tree species (if possible) and counted wood jams

Salinas Large Wood vs. Other Regions (Fallen Dead Wood only)

- We identified 14 tree species
- The main tree species contributing to large wood were hardwoods
  - Coast live oak, California sycamore, red willow, and valley oak
- Fallen dead large wood volumes (cubic feet per acre):

Region	n	Mean (ft^3/ac)	Maximum (ft^3/ac)
Pacific Northwest (BC, WA, OR) [a]	62	10,754	64,350
Sierra Nevada conifer [b]	12	2,288	5,463
No. CA hardwood, protected watersheds [c]	9	1,645	2,474
No. CA hardwood, private land [c]	23	601	2,088
So. CA hardwood (this study)	15	672	2,345

a. Andrus et al. 1988, Harmon et al. 1986, Keller and Tally 1979; b. Berg et al. 1998; c. Opperman 2005

Wood Jams Helped Form Pools

- We observed 70 wood jams across the 15 sites, with an average of 4.7 jams per site
- Large wood jams were important in pool formation and typically had red willow as their key pieces (45%)

Flows Low, Temperatures High

- Stream flow averaged 3.4 cfs
- One site, Trout 3, was dry throughout the study
- Temperatures were exceptionally warm during the study period
- Air temperatures at our sites peaked at 120 °F (at Salinas Site 2)
- Mean water temperature averaged 68 °F
- Maximum water temperature averaged 77 °F

Steelhead Distribution and Density

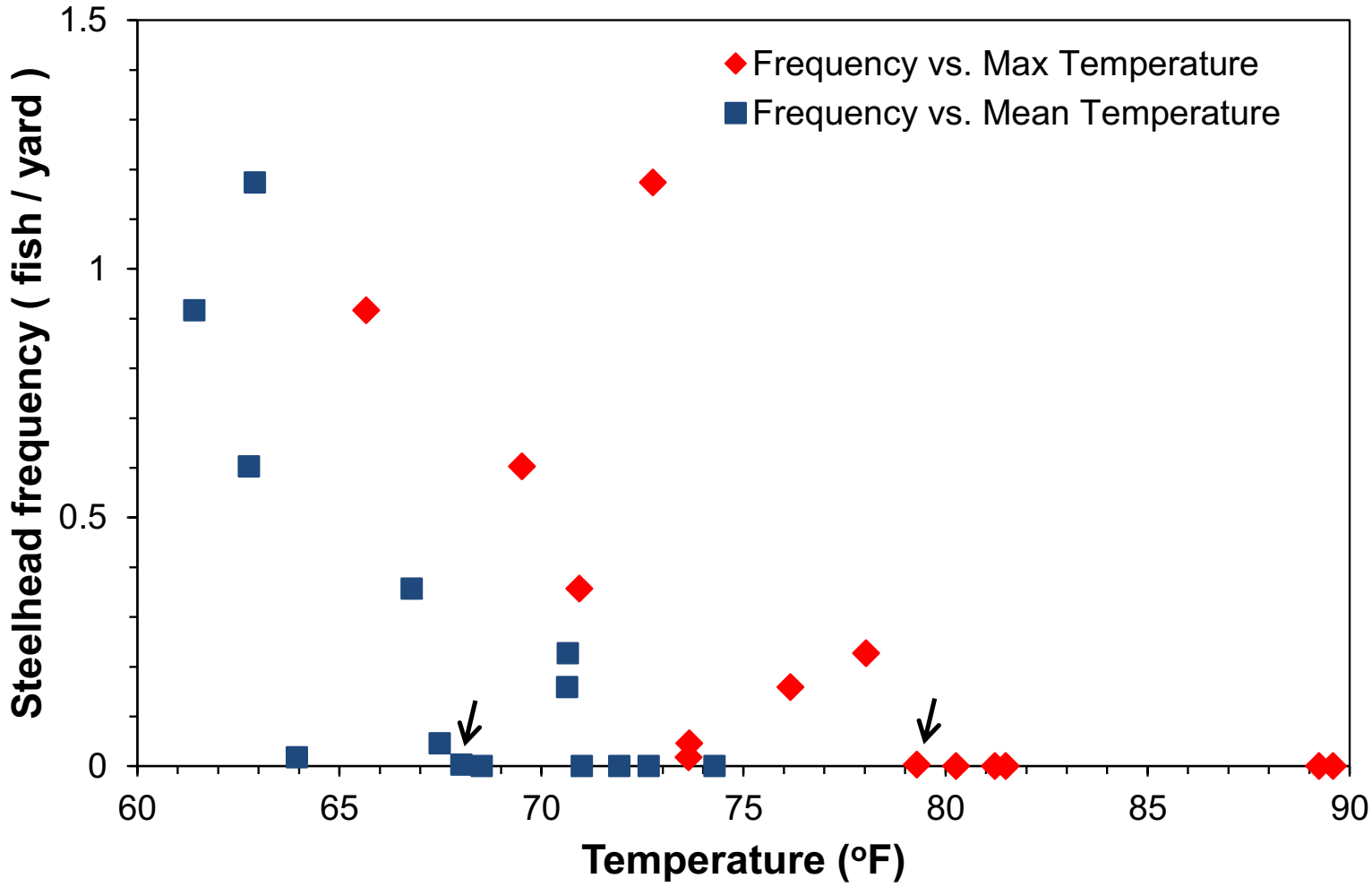
- We observed 7 native and 6 non-native fish species
  - www.calfish.ucdavis.edu
- Steelhead were observed at nine out of the fourteen sites with water

Native	**Non-Native**
Steelhead/Rainbow Trout	Bluegill
Hitch	Bullhead
Monterey roach	Carp
Pikeminnow	Green sunfish
Sculpin	Largemouth bass
Speckled dace	Mosquitofish
Stickleback	Smallmouth Bass
Sucker	

Steelhead-Habitat Patterns

- Saw more steelhead with
  - Cooler water temperatures
  - More overhead cover
  - Narrower stream width
    - Further upstream
    - Higher elevation
    - Higher velocity
  - Fewer non-native fish
    - Non-natives prefer warm, slow-moving water
- Wood jams correlated with volume of dead wood and with pools

Steelhead and Temperature



Global Climate Change & California

- Precipitation shifts from snow to rain
  - Sierra snowpack reduced 30-90%
- Heatwaves in Los Angeles 4-8 times more frequent
- Alpine/subalpine forests reduced 50-90%
- *Hayhoe et al. 2004, Proceedings of the National Academy of Sciences*

Potential Effects of Climate Change

- Climate change is likely to increase stress on steelhead
  - Increases in stream temperatures
  - Reduced summer flows
  - Effects of increased fire frequency on dry watersheds

Connectivity: Passage Barriers

Nacimiento Dam

Low head dam

Road culvert

Local Actions to Conserve and Restore Steelhead

- Maintain streamflow
  - Summer base flow
  - High flows during winter/spring migration period
- Keep summer water temperatures cool
  - Maintain shade along stream corridors
- Maintain and restore passage routes
- Maintain large wood in streams (where possible)
- South-Central California Steelhead Recovery Plan
  - http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/south_central_southern_california_coast/south_central_southern_california_salmon_recovery_domain.html

Water Flow

- Every stream has a characteristic natural water flow pattern
- Animals & plants evolve to be adapted to the natural flow regime
- More flow usually results in more habitat
  - Increased pool volume, side channel habitat

Bankfull Width

- Stream rises to this level about once every 1.5 years

Temperature

Species	Water Temperature (°F)					
	Migration	Spawning	Incubation	Juvenile Rearing		
				Preferred	Optimum	Lethal
Chinook (Fall run)	51.1-66.9	42.1-57.0	41.0-57.9	45.1-58.3	54.0	77.4
Chum	46.9-60.1	45.0-55.0	39.9-55.9	52.2-58.3	56.3	78.4
Coho	45.0-60.1	39.9-48.9	39.9-55.9	53.2-58.3	---	78.4
Steelhead	---	39.0-48.9	---	45.1-58.3	50.0	75.4

Source: Adapted from Beschta et al. (1987) Note: °C = (°F-32)/1.8

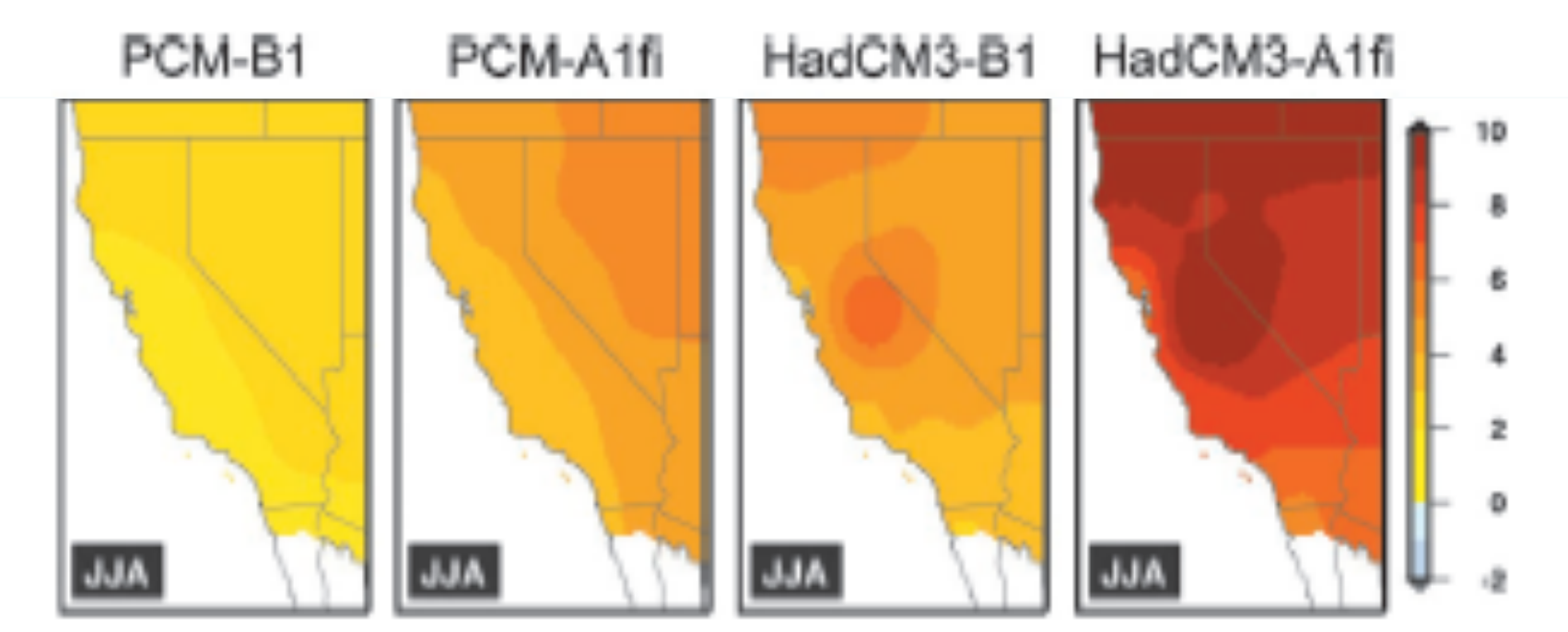
Dissolved Oxygen

Response	DO (ppm)	Percent Oxygen Saturation at Given Temperatures					
Temperatures		*32*	*41*	*50*	*59*	*68*	*77*
Function without impairment	7.75	76	76	76	76	85	93
Initial distress symptoms	6.00	57	57	57	59	65	72
Most fish affected by lack of oxygen	4.25	38	38	38	42	46	51

Adapted from Bjornn & Reiser (1991)

Note: Less oxygen can be dissolved in warm water than in cold water. Therefore the same amount of DO results in a higher percent saturation at higher temperatures.

Summer Temperature Increase
2070-2099 vs. 1961-1990



- Temperature shifts (°C) concentrated in Central Valley & North Pacific Coast
- Increased drought frequency & severity