Suspended Sediment Loads in the South Fork of the Albion River, Mendocino County, California

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South Fork Albion River

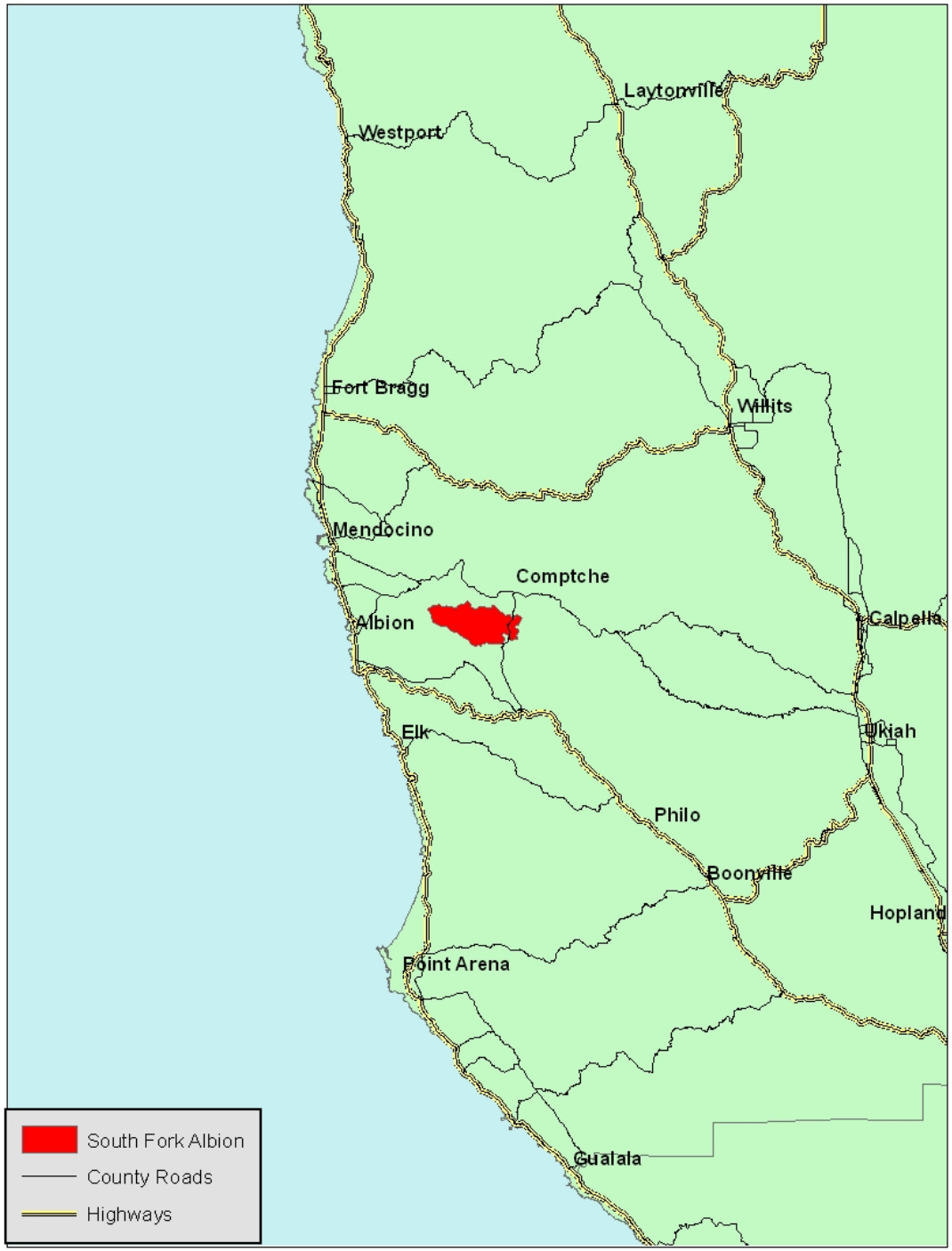
- Why there?
  - 303d listed for sediment
  - MRC majority owner
  - Actively managed for timber harvest
  - Road network in decent shape
  - Productive coho watershed
  - Two stations total
    - Little North Fork Navarro (more impaired?)

Hypothesis
(Habitat Conservation Plan)

Conservation measures for mass wasting, roads, skid trails, and landings will measurably reduce sediment amounts affecting instream habitat for covered aquatic species as compared with sediment amounts from baseline instream sediment measurements.

Other goals of monitoring

- What do the suspended sediment loads look like?
- Are our assumptions about the health of this watershed correct?
- How do the loads compare with Caspar and other watersheds?
- What are the impacts to fisheries?



South Fork of the Albion River

- 5831 acres (9.1 square miles), of which MRC owns roughly 80%
- Average annual precipitation approximately 40 inches
- Headwaters 11 miles from coast
- Approximately 70 miles of road
- Road density 7.8 miles per square mile
- Core coho watershed

Watershed characteristics:

Exposed bedrock in lower mainstem (confined)

Marshy habitat in middle mainstem (less confined)

Good canopy

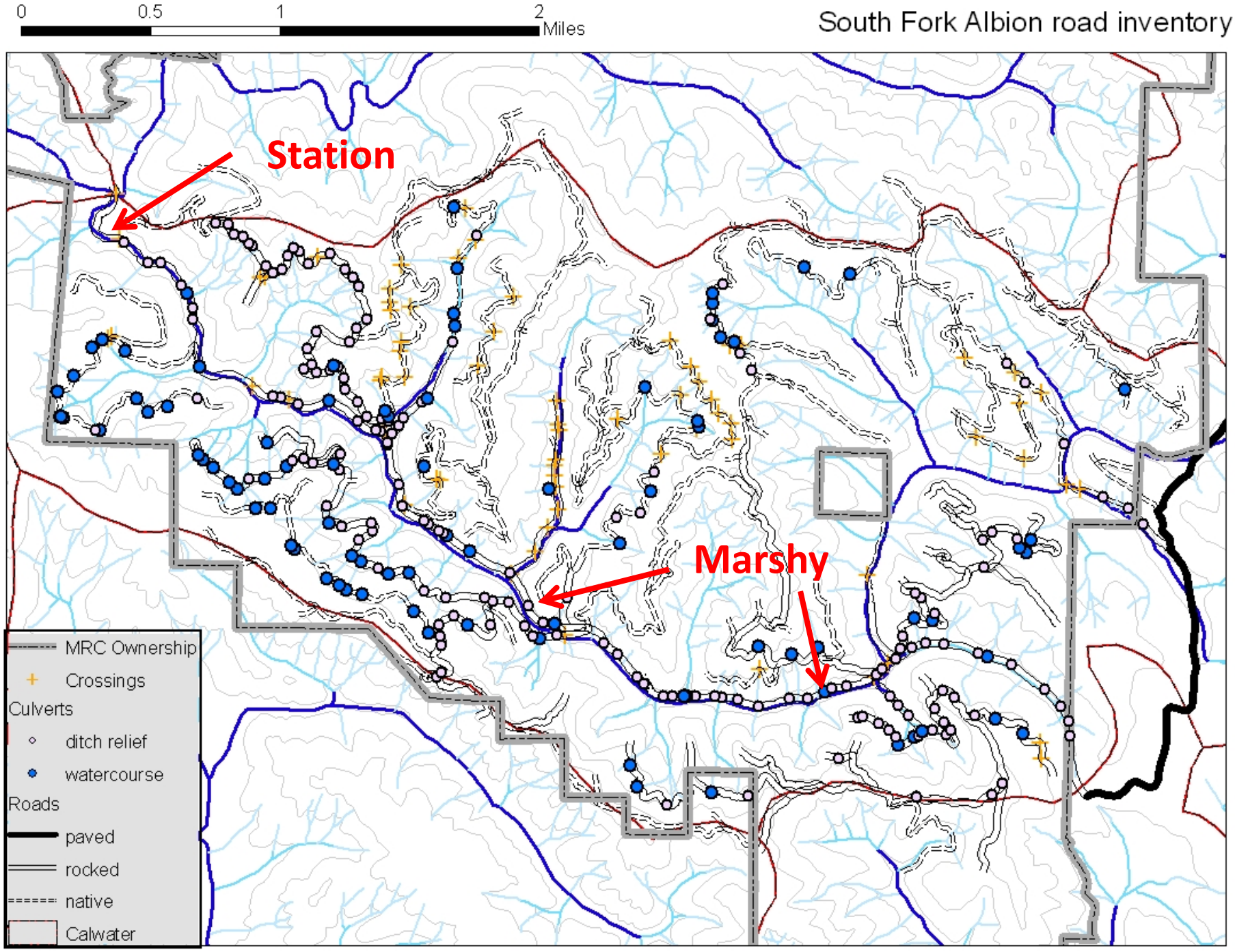
Marshy habitat

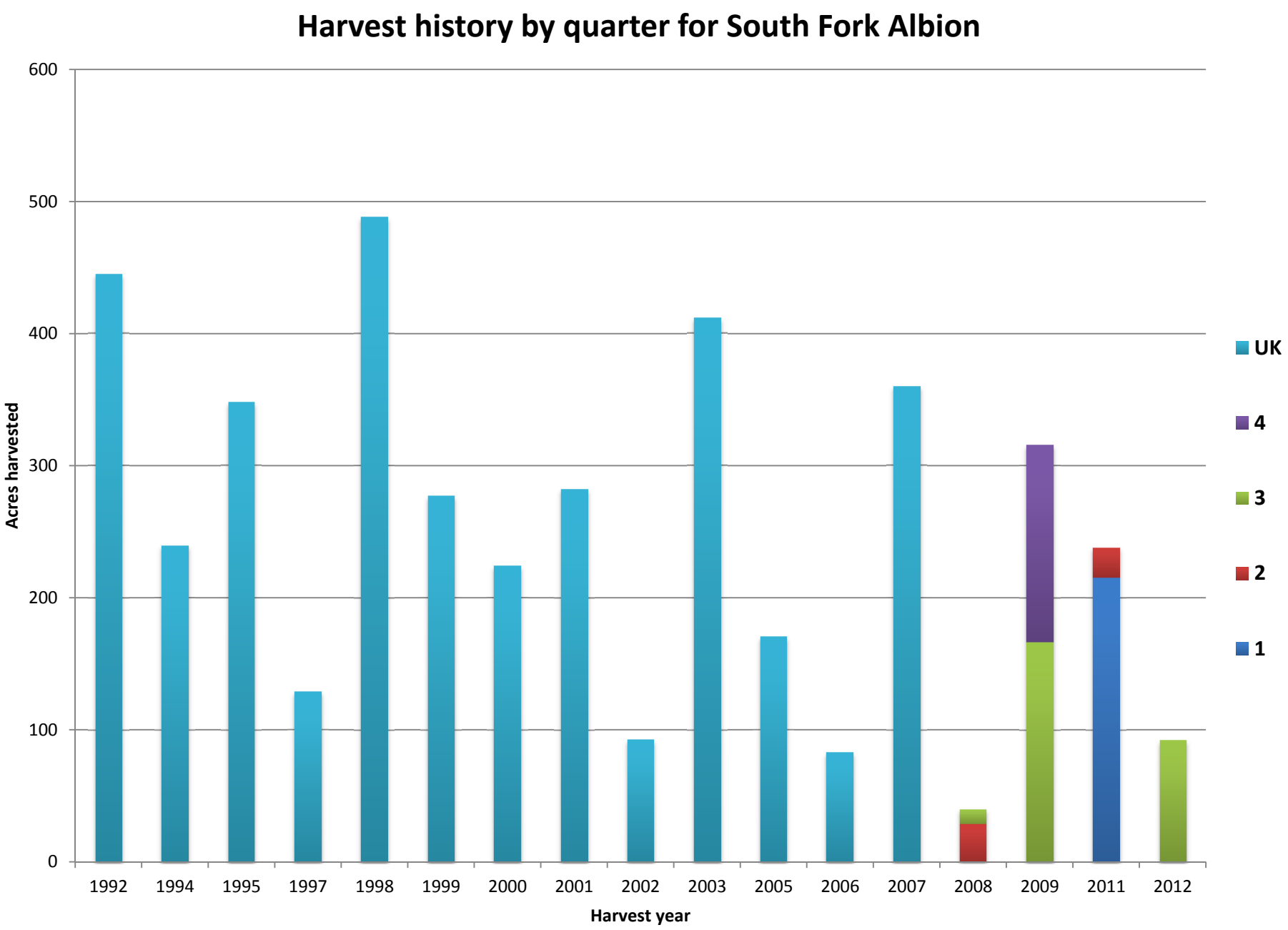
Approximately three miles upstream from the confluence with mainstem Albion

Wider floodprone area (valley width)

Fish population monitoring in South Fork Albion

Hydro year	Coho		Steelhead	
	Outmigrant	Redds	Outmigrant	Redds
2013	1,789 +/- 122	31	527 +/- 200	19
2012	2,579 +/- 192	7	520 +/- 173	4


0
0.5
1
2
Miles
South Fork Albion road inventory
Station
Marshy
MRC Ownership
Crossings
Culverts
ditch relief
watercourse
Roads
paved
rocked
native
Calwater

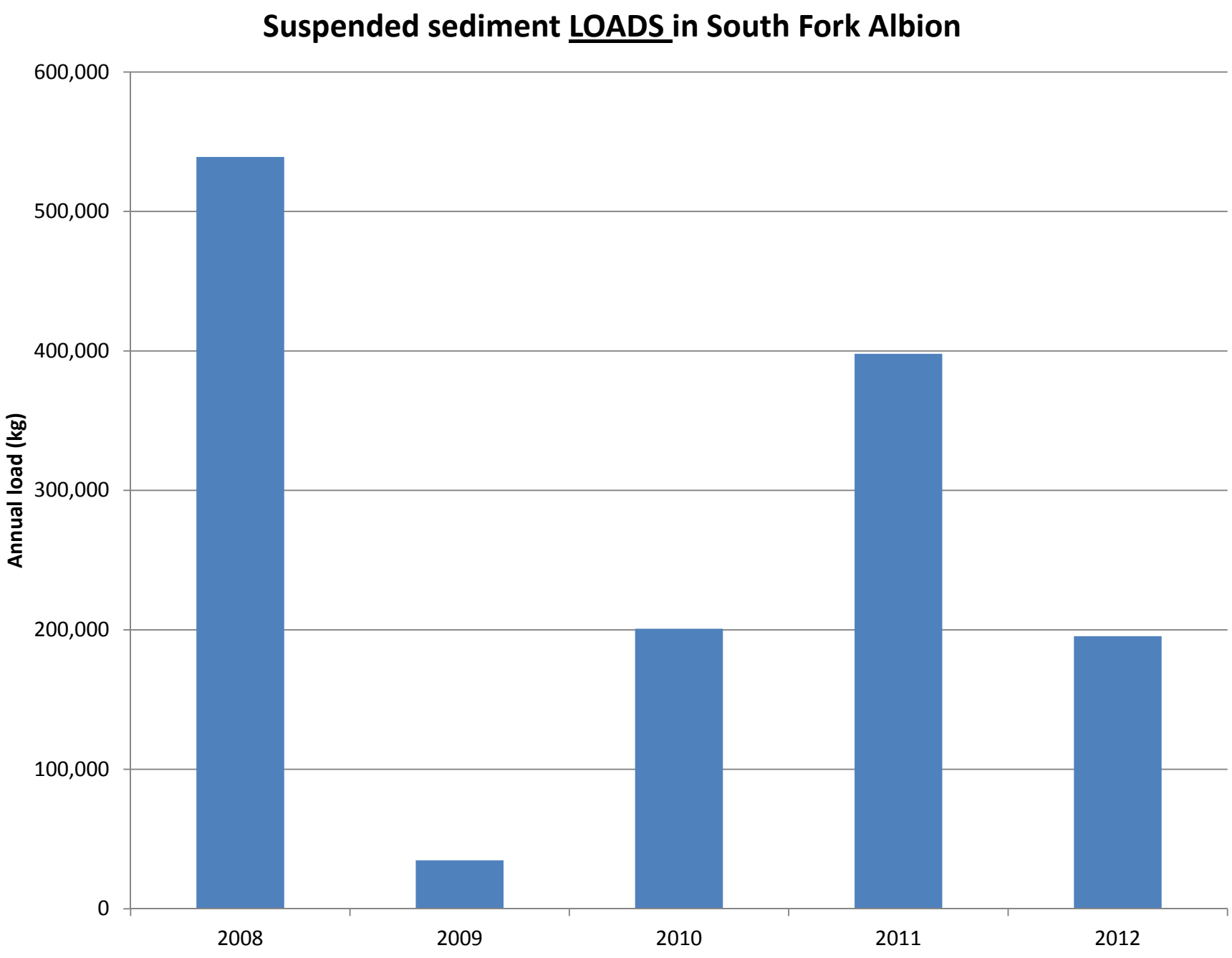

Harvest history by quarter for South Fork Albion
600
500
400
300
200
100
0
Acres harvested
1992
1994
1995
1997
1998
1999
2000
2001
2002
2003
2005
2006
2007
2008
2009
2011
2012
Harvest year
UK
4
3
2
1

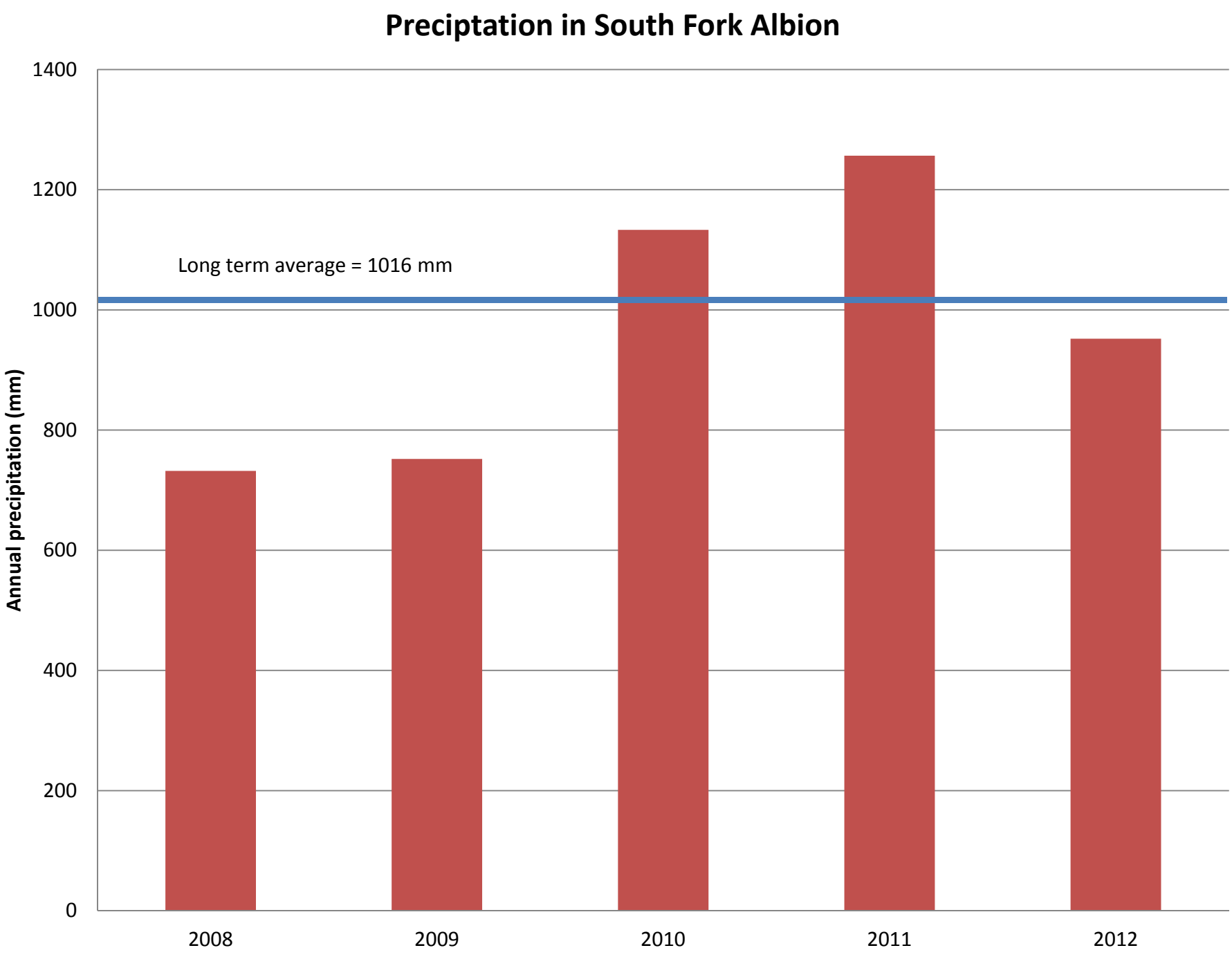
Albion River Watershed Analysis (MRC 2004)

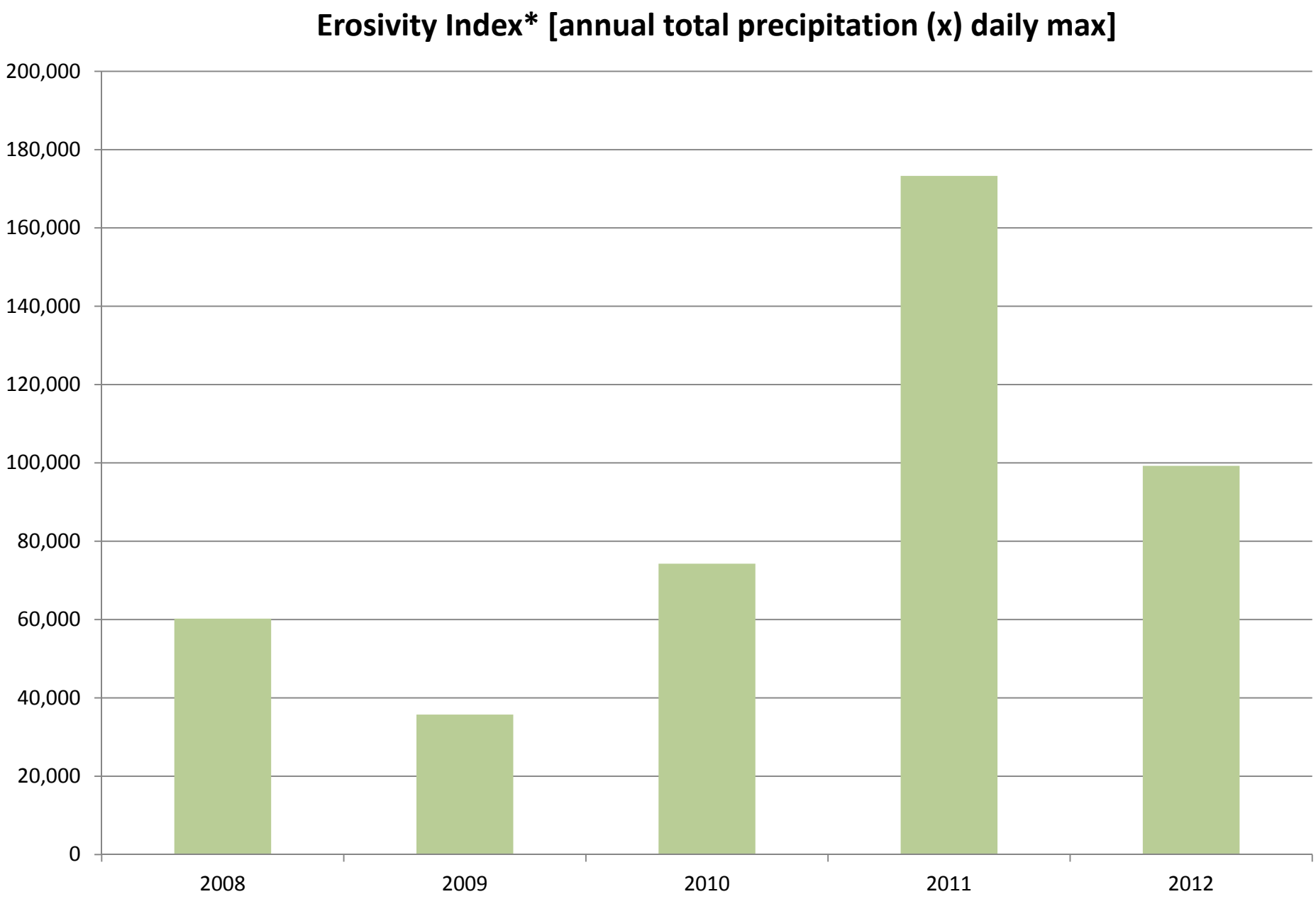
- Air photo analysis of landslides with a percentage of sites visited in field
- Standard surface erosion models applied to road inventory data
  - Sediment delivery from **mass wasting** sources
    - **490** tons / square mile / year
  - Sediment delivery from **road network**
    - **130** tons / square mile / year
  - Total = **620** tons / square mile / year
  - Does not include channel sources (headcuts, bank erosion, etc.)

Suspended sediment sampling

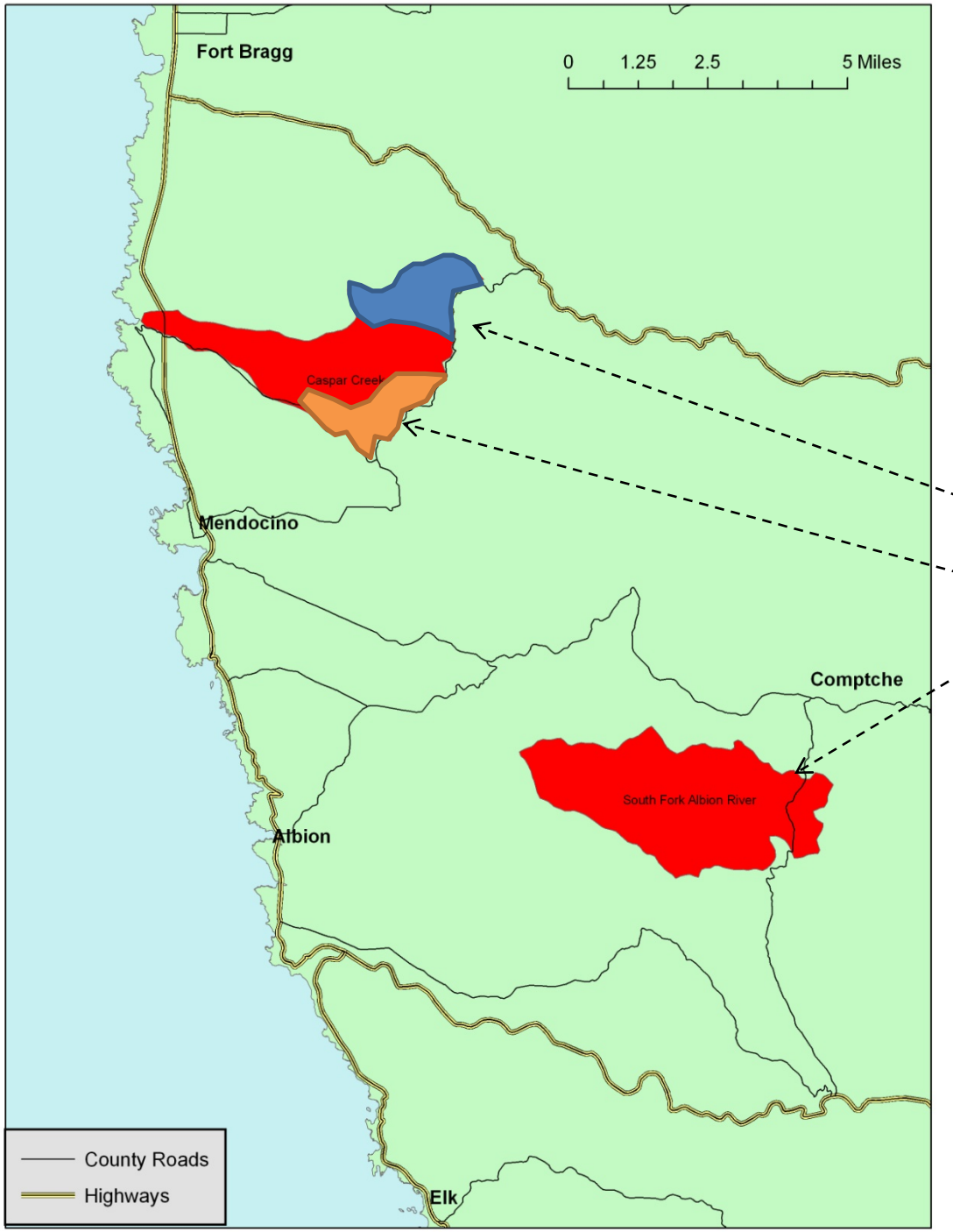
- Based on *Turbidity Threshold Sampling* methods developed in Caspar Creek (Lewis and Eads 2001)
- Rand Eads built station in 2007
- Laboratory analysis by Humboldt Redwood Company
- Worked with Jack Lewis on load and concentration-duration analyses


Suspended sediment LOADS in South Fork Albion
Annual load (kg)
600,000
500,000
400,000
300,000
200,000
100,000
0
2008
2009
2010
2011
2012

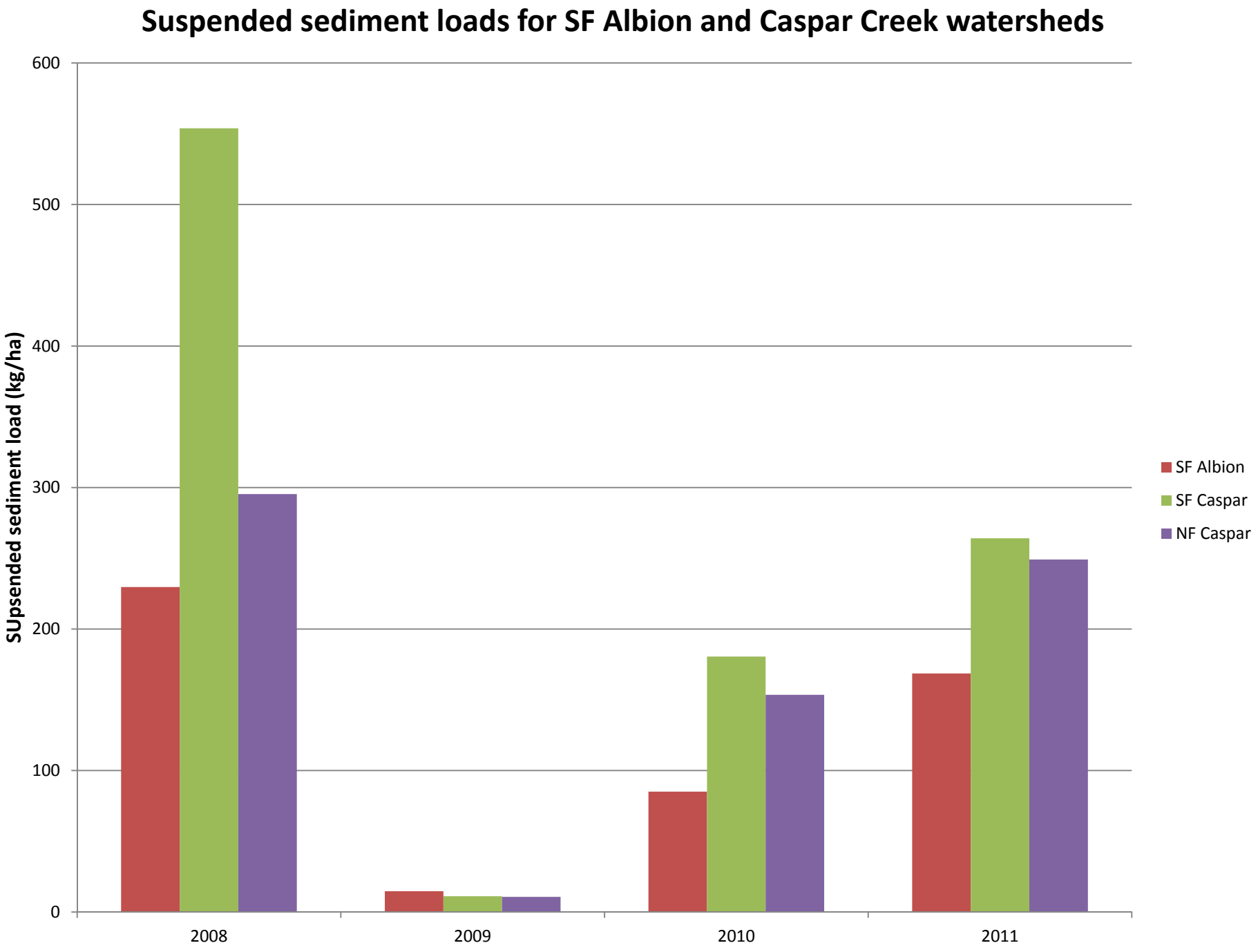

Preciptation in South Fork Albion
Annual precipitation (mm)
1400
1200
1000
800
600
400
200
0
Long term average = 1016 mm
2008
2009
2010
2011
2012

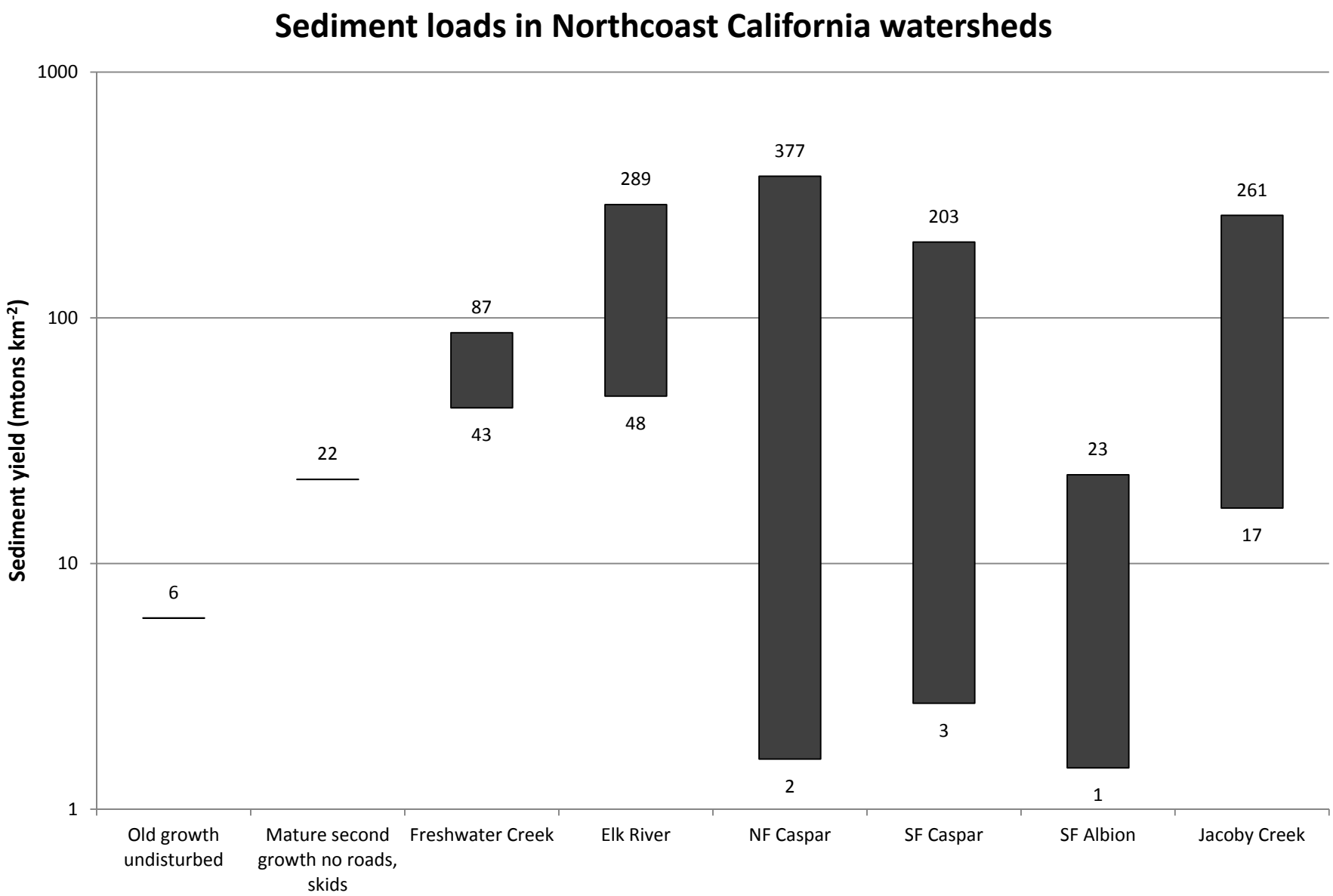


**Sullivan K., Manthorne D., Rossen R., Griffith A., 2012. Trends is sediment-related water quality after a decade of forest management implementing an aquatic habitat conservation plan. Technical Report. Humboldt Redwood Company, Scotia, CA. 187 pp.*



Watershed	Area (hectares)
NF Caspar	473
SF Caspar	424
SF Albion	2360

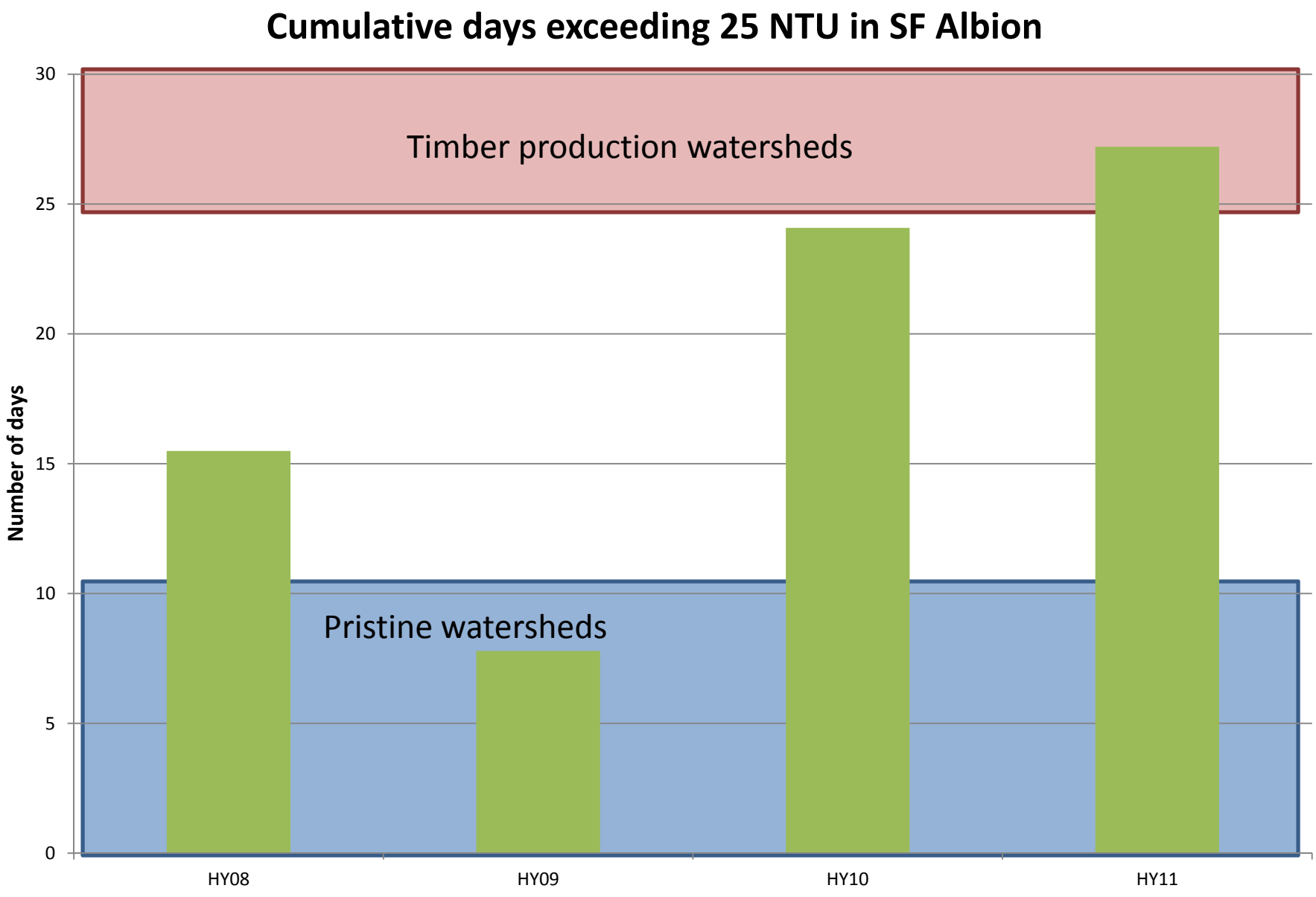

Suspended sediment loads for SF Albion and Caspar Creek watersheds
SUpsended sediment load (kg/ha)
600
500
400
300
200
100
0
2008
2009
2010
2011
SF Albion
SF Caspar
NF Caspar



Sullivan K., Manthorne D., Rossen R., Griffith A., 2012. Trends is sediment-related water quality after a decade of forest management implementing an aquatic habitat conservation plan. Technical Report. Humboldt Redwood Company, Scotia, CA. 187 pp.
Jacoby Creek data supplied by Randy Klein, Arcata, CA, May 2013.

Desired Salmonid Freshwater Habitat Conditions for Sediment-Related Indices *(NCRWQCB 2006)*

- 27 NTU turbidity exposure threshold (Trush 2001 and Klein 2001)
- Pristine creeks have 11-25 days in which turbidity exceeds this threshold
- <u>Personal communication with Klein: 1-10 days above 25 NTU</u>
- Timber production watersheds > 25-50 days
- Newcombe and Jensen (1996) metanalysis of fish response to suspended sediment

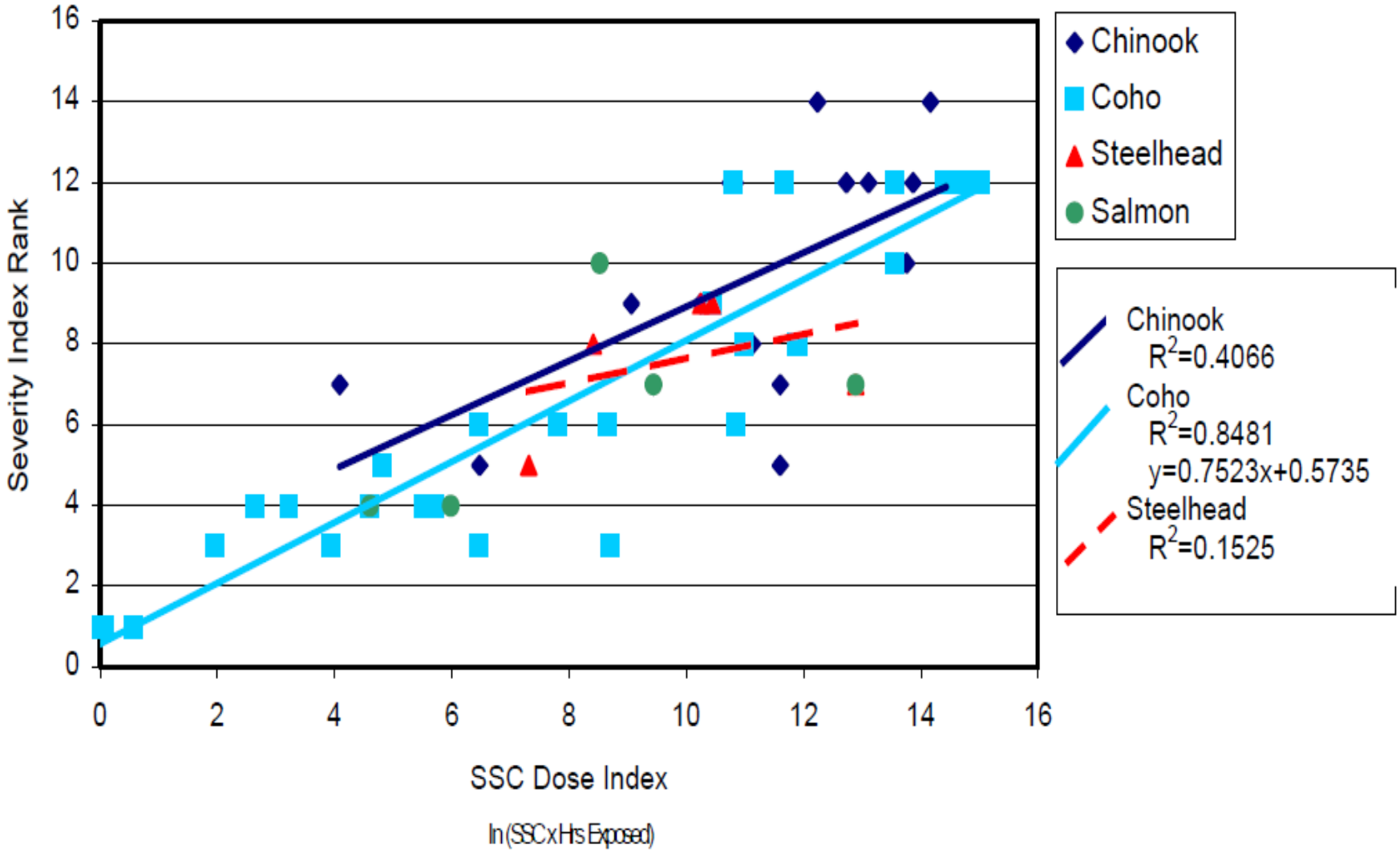


Data for the "timber production" and "pristine watersheds" supplied by Randy Klein, Arcata, CA, May 2013

Newcombe and Jensen (1996)

- Metanalysis of 80 published reports of fish responses to suspended sediment
- Six empirical equations that relate biological response to duration of exposure and suspended sediment concentration
- The responses (severity of ill effects) range from no effect through behavioral and sublethal to lethal effects

Figure 1
SSC Dose vs. Severity Index Rank for Chinook, Coho, and Steelhead
(data from Newcombe & Jensen 1996)



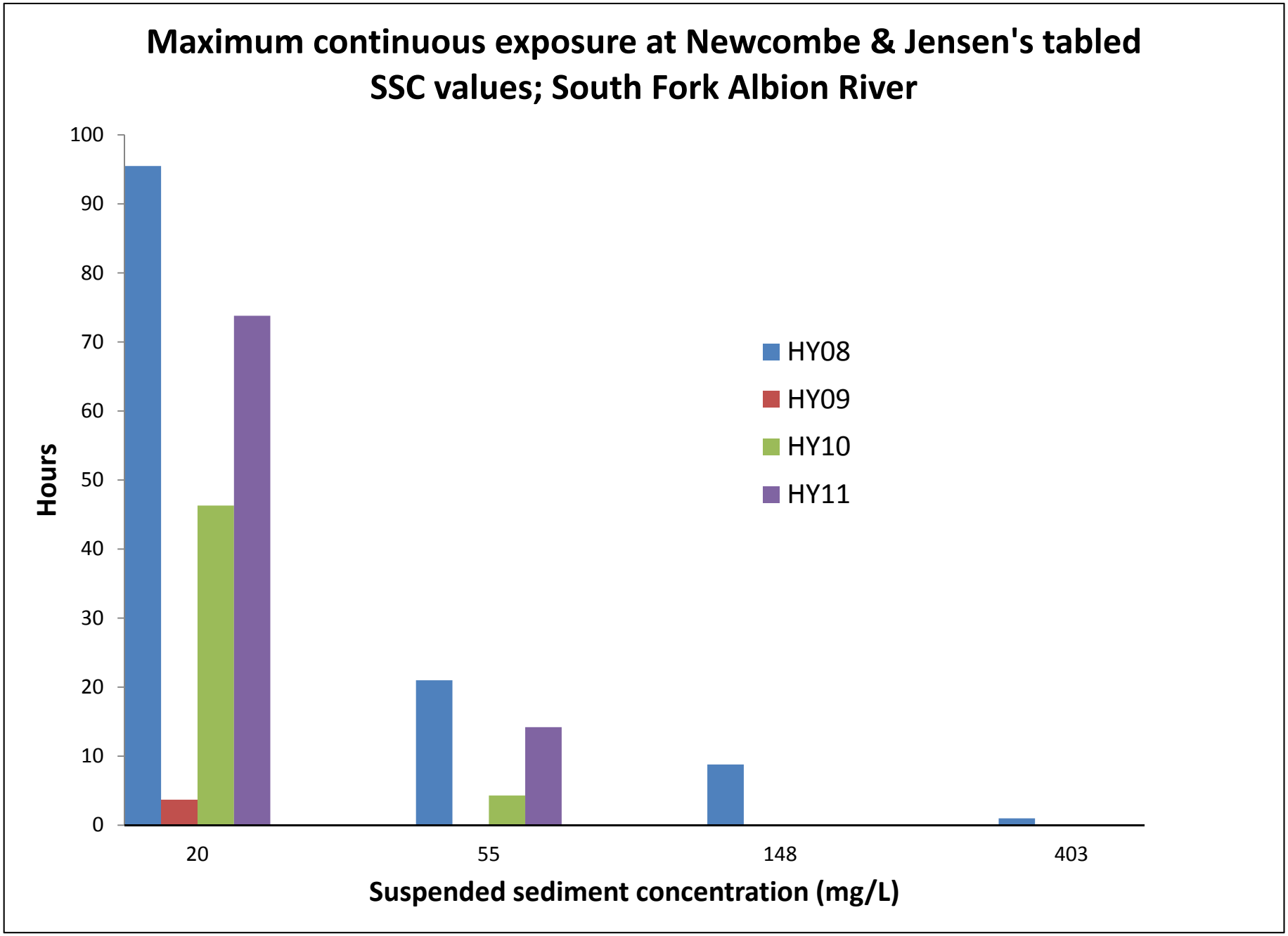
Scale of the severity (SEV) of ill effects associated with excess suspended sediment from Newcombe & Jensen (1996)	
SEV	**Description of Effect**
0	No Effect
1	Alarm Reaction
2	Abandonment of Cover
3	Avoidance Response
4	Short-term Reduction in Feeding Rates and/or Feeding Success
5	Minor Physiological Stress, Increased Coughing Rate, and/or Increased Respiration Rate
6	Moderate Physiological Stress
7	Moderate Habitat Degradation and/or Impaired Homing
8	Major Physiological Stress, Poor Condition, and/or Long-term Reduction in Feeding Rates and/or Feeding Success
9	Reduced Growth Rate, Delayed Hatching, and/or Reduced Fish Density
10	0 to 20% Mortality, Increased Predation, and/or Moderate to Severe Habitat Degradation
11	>20 to 40% Mortality
12	>40 to 60% Mortality
13	>60 to 80% Mortality
14	>80 to 100% Mortality

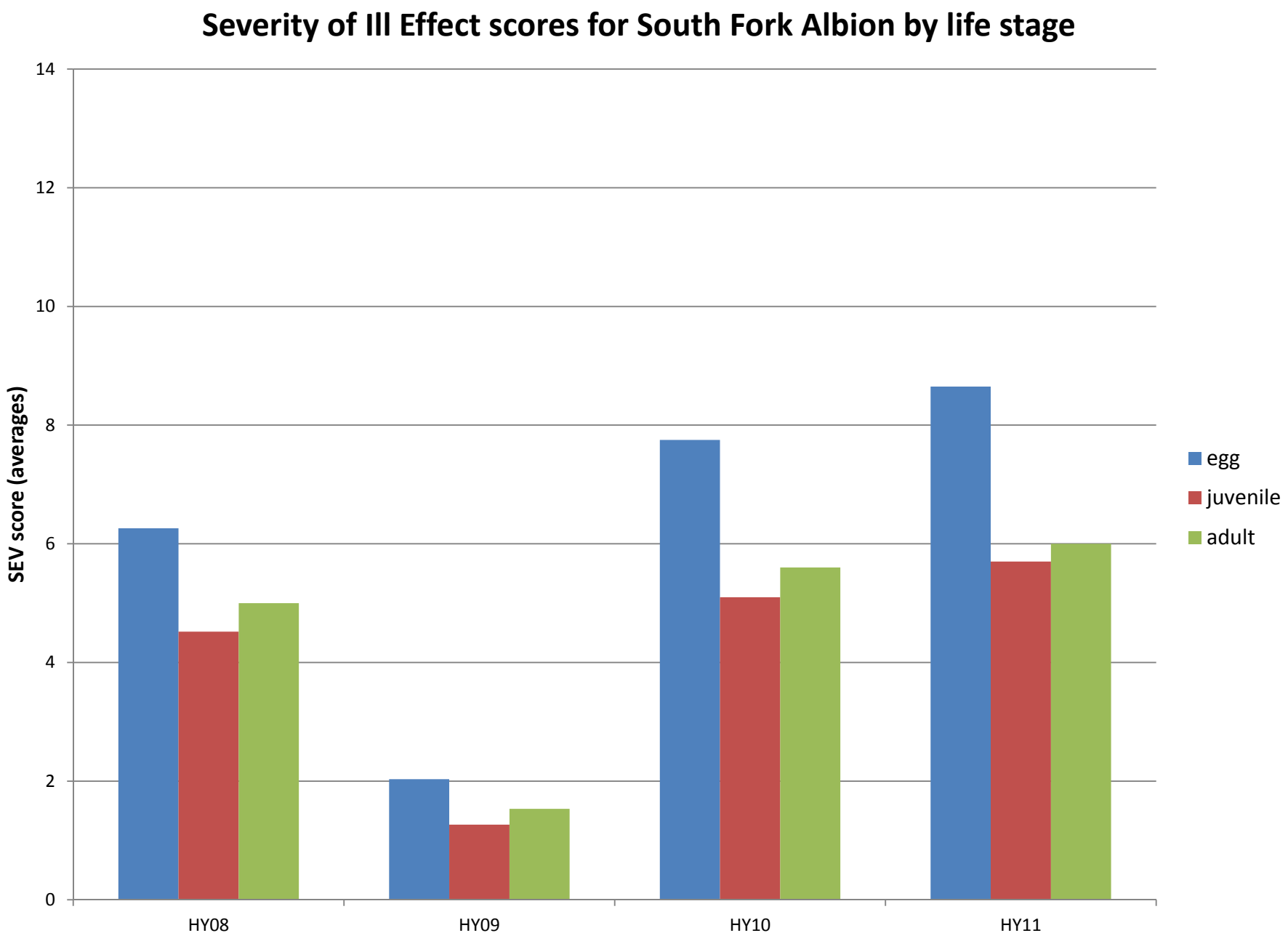
Juvenile and Adult Salmonids

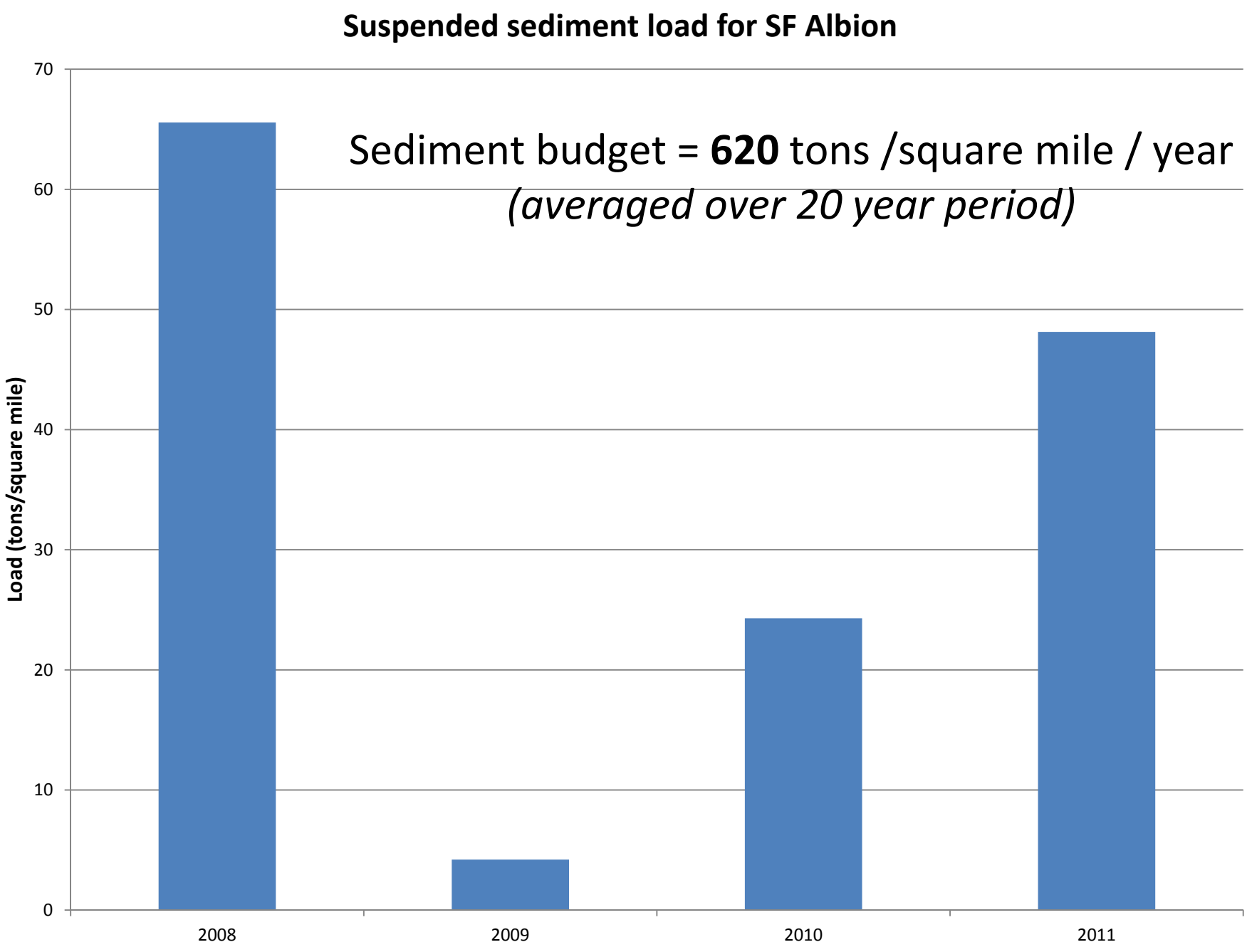
Duration of exposure to SS ($\log_e$ hours)

(A) Average severity-of-ill-effect scores (empirical)

Concentration (mg SS/L)	0	1	2	3	4	5	6	7	8	9	10	($\log_e$ mg SS/L)
162755	14	-	-	14	-	-	-	-	-	-	-	12
59874	-	-	12	10	14	12	-	-	-	-	-	11
22026	-	-	-	-	-	11	-	-	-	-	-	10
8103	3	-	-	10	12	10	-	11	-	14	-	9
2981	6	-	-	9	11	8	9	13	-	-	-	8
1097	4	-	-	-	10	9	11	8	-	14	8	7
403	4	5	8	-	-	8	10	9	10	-	-	6
148	4	-	6	9	-	8	9	9	-	-	-	5
55	2	4	5	-	-	7	10	9	10	-	-	4
20	3	4	-	4	-	-	-	10	-	9	-	3
7	-	-	-	-	-	3	-	9	-	9	-	2
3	-	-	-	-	-	5	-	-	-	-	-	1
1	3	-	-	-	-	-	-	-	-	-	-	0
	1	3	7	1	2	6	2	7	4	11	30	
	Hours			Days			Weeks		Months			


Maximum continuous exposure at Newcombe & Jensen's tabled SSC values; South Fork Albion River
Hours
100
90
80
70
60
50
40
30
20
10
0
HY08
HY09
HY10
HY11
20
55
148
403
Suspended sediment concentration (mg/L)


Severity of Ill Effect scores for South Fork Albion by life stage
SEV score (averages)
14
12
10
8
6
4
2
0
HY08
HY09
HY10
HY11
egg
juvenile
adult


Suspended sediment load for SF Albion
Sediment budget = **620** tons /square mile / year
(averaged over 20 year period)
Load (tons/square mile)
70
60
50
40
30
20
10
0
2008
2009
2010
2011

Summary

- South Fork Albion is exhibiting smaller sediment loads (on a per-area basis) than the nearby Caspar Creek system even though it is actively managed for timber production
- Suspended sediment impacts to salmonids seem to be highest at the egg life stage
- Sediment budget load estimates of inputs are orders of magnitude larger than what is actually being transported out of the system
- Unique topography/geology of system may be influencing sediment loads/storage (estuary-like habitat in the upper portion of the mainstem)