Petition to the State Water Board

Petitioners:
Elk River Residents

Kristi Wrigley
2550 Wrigley Rd.
Eureka, CA. 95503
707-443-1496
kwrigley@hughes.net
alternate email: kristi_turner@dot.ca.gov

Ralph & Nona Kraus
2479 Wrigley Rd.
Eureka, CA. 95503
707-443-1469

Christina & Norm Pasteris
2492 Wrigley Rd.
Eureka, CA. 95503
707-442-1270

2. Action:
Tier 1 approval of Unit 1 of THP 1-08-072 Hum in the Elk River watershed under Watershed-wide Waste Discharge Requirements for Elk River[Order No. R1-2006-0039 Amended by Order No. R1-20087-0100 to reflect new ownership.]

3. Date:
May 2, 2011

4. Why action is inappropriate:
Because the Unit is enrolled as Tier 1 the plan permits a 125% increase in the likelihood of a landslide and debris flow that threatens the Kraus, Pasteris and Wrigley real properties. Tier 2 allows for no increase in likelihood of landslide and debris torrent. This action is arbitrary, capricious, and irrational because it permits the highest likelihood of landslide and debris torrent on residentially occupied land located below the timber harvest. It is wrong for the government to subject certain residents to higher risk.
This action is also inappropriate because the permit increases the likelihood of land sliding and debris torrent that threatens occupied homes. The negative declaration and findings for the WWDR are based on the reduction in rates of land sliding, torrents ,erosion and peak flow; not an increase.
This action is inappropriate at this time because it is unreasonable and unconstitutional for the RWCB's EO to permit Elk River residents to be severely impacted by increased sedimentation causing unnatural flooding, loss of riparian water rights, loss of historical use of property and increased risk to health and safety.
This past winter a large amount of unnatural sediment was deposited on our property. These deposits were permitted by the WWDR allowing the commercial upstream owners to invade and occupy our land without our approval. For 2 decades the North Coast Regional Water Quality

Control Board has failed to provide residents a remedy for all the damage they have permitted. The harm from these and other sediments coming from this Unit are preventable. The EO knows that none of WQ's actions; the WWDR, the cleanup and abatement orders or other restrictive requirements have been sufficiently effective at reducing or even controlling the ever increasing flooding of residents' property, access roads and homes.
Furthermore, this Unit is adjacent to or directly upstream of residents' property and will increase runoff directly onto residents' fields, ditches, roads and homes; and into the North Fork Elk River at residents' domestic water intake location. Logging this Unit adjacent to residents' property will deposit added sediment conveyed by the increased runoff directly onto residents' property resulting in immediate and irreversible harm to residents.
Discharge is a privilege, not a right. We are denied equal protection under the law and Basin Plan because the EQ has not enforced the Basin Plan prohibition on discharge of materials in amounts deleterious or that result in deposits. It is inappropriate for the EO to follow only the WWDR while ignoring the Basin Plan prohibitions.

5. How the petitioner is aggrieved:
Petitioners will be affected by the runoff and deposition of sediment, and exposed to increased risk of landslide and torrent. The impacts created by this Unit fall directly onto our forest land, fields, ditches, fences, roads and homes. These impacts cause extra time and work to maintain our property and extra worry. Extra runoff means extra time paying attention to the possible effects of this runoff to our real property, added worry when we cannot be there to pay attention and take any required action.
Petitioners and others with similarly situated water supply will be adversely affected. Some of the sediment laden runoff water will go into the North Fork Elk River directly above water intakes and some will be directed through ditches directly into North Fork Elk River at residents' water intake location. Any sediment in the ditch leading to the river would be mobilized by rain events delivering added sediment at the point of withdrawal. This would burden the complicated water systems we now have to use requiring even more maintenance time, energy and attentiveness on our part. The closeness of this Unit makes any and all effects immediate, muddying the river immediately upon any rainfall event.
Residents will suffer even longer and more directly from the decades of accelerated adverse cumulative effects of logging in our upstream watershed. This Unit1 along with other WWDR units is part of the only treed areas that protect against the runoff from existing logged over area. This are has somewhat healed over from the last logging[1992, 1997, and 2002, possibly 2007] in the area. Opening the roads and disturbing the ground again will just recreate the mess we have had to deal with all over again.

6. The action the petitioner requests:
Petitioners request that the logging this Unit 1 be denied in either Tier 1 or Tier 2 enrollment until petitioners have recovered historical riparian water rights, recovered the historical use of our property for orchard and gardens, recovered the natural flooding of our access road and controlled the flooding of our property to its natural level before the over logging of the upstream watershed that started in the mid 1980's. At the very least this area and any areas close to residents' property and water intakes should not be logged till after the final phase of analysis and plan for our watershed, the TMDL is completed.

7. Statement of points and authorities for legal issues raised in the petition:

Article 10, Section 2 of the California Constitution, establishing priority domestic use of water as domestic as to quantity and quality.

Section 1983 et sec USC, establishes that individuals acting under the color of law must not discriminate against classes of people on the basis of property rights and or deny equal protection under the law; they cannot knowingly and intentionally deny property and riparian water rights. WQ knows our property and water rights have been denied and they have acted to continue and further degrade the situation.

Deetz v. Carter [232 Cal. App. 2nd 851]

People v. Gold Run Ditch and Mining Co.,4P. 1152 [cal. 1884]
Woodruff v. N. Bloomfield Gravel Mining Co., 18 FF. 753[d. Cal.1884]

WWDR Findings and Resolution. R1-2006-0039 & R1-2006-0038

WWDR CEQA negative declaration of the .

33 U.S.C. Sect.1365(a) et. seq.
Sect. 1311(a) et. seq.
Sect. 301(a) et. seq.
Sect. 1362(6) et. seq.
Sect. 502(14)
Sect. 1342(p)(2)(B).

Keystone Bituminous Coal Association v. Bennedictis 107 S. Ct 1232(1987)

RCAA_2008 Report

Nineth Circuit Court...Northwest Environmental Defense Center v. Marvin Brown No. 07 35266 D.C.-06-01270-GMK

8. Copies of this petition have been sent to the Regional Board and Humboldt Redwood Co.

9. The issues in this petition have been sent to the regional Board before they acted.
The residents of Wrigley Road have informed the Board on this Unit since it was first submitted. Through comments, email, letters and direct communication with staff.

Petition for an immediate stay of the Executive Officer's enrollment of Unit 1 of THP 1-08-072 Hum in the Watershed-wide Waste Discharge requirements for Elk River [R1-2006-0039 amended to R1-2008-0100]

There will be substantial harm to petitioners and the public interest if the stay is not granted:

Failure to provide an immediate stay of the Executive Officer's enrollment will result in direct irreversible harm to the health, safety, property and liberty of the petitioners and others similarly situated in the watershed.

Petitioners have been harmed by all past logging in this watershed to the point that they do not have the free enjoyment of their property. This Unit will deposit silt and runoff directly and indirectly onto petitioners property causing even greater harm to their fields, ditches, water supply, access and possibly endangering a home. Once the trees are gone they cannot be put back on the hillside...all the protection to the down-slope owners' lands and water they provide will be lost at a time which is very critical to the land owners in the area. There are few areas left with mature trees to protect down slope land owners property from existing logged over areas. Runoff from this area not only goes through a culvert under the County Road but it goes under the road directly, around the culvert. Any increased flow and sedimentation will adversely affect this tenuous condition. Increased runoff may overflow the ditch and threaten a resident's home. Any increased runoff of water, sediment and debris makes it more demanding of petitioners to manage their lands safely and satisfactorily in a timely manner. Every time this area or areas similarly situated are logged the runoff has increased and caused us more work and worry.

The public interest of water quality will be adversely impacted by the runoff directly into the river where residents withdraw water.

The County infrastructure will be threatened by the increased runoff and debris.

2. There will be no substantial harm to discharger or to the public interest if a stay is granted

There would be minimal harm to the upstream landowner, the plan proponent, because this Unit entails a small proportion of his cut in the watershed and the trees grow faster than their present rate of interest. The delay might even lead to greater economic return when the market recovers sufficiently. They could make up for this cut in other harvest plans in the watershed.

3. The EO's Action raises substantial questions of law on which Petitioners are likely to prevail.

The WWDR was supposed to control flooding; it has not done so. Residents are subjected to ever increasing flood levels and ever increasing deposition of sediment on their property. It is a question of fact under what circumstances would ever increasing sedimentation and flooding not violate the Basin Plan.

It is a question of law under what circumstances the EO should privilege a discharger to invade and pollute a neighbor's property or increase the threat of landslides and torrents directly above their homes?

It is a question of fact and law whether the WWDR gives the EO the authority to not merely fail to relieve existing and ongoing harm but rather actively and knowingly subject the residents to new harm which would otherwise not exist.

It s a question of fact and law whether discharger can be permitted to pollute North Fork Elk Rive by discharging through a road and culvert system that does not have a NPDES permit.

It is a question of fact and law whether the EO has legitimate police power reason to permit a public and private nuisance.

It is question of fact and law whether the EO has the authority to knowingly permit trespass of harmful sediments and debris directly onto neighbors property..

It is a question of fact and law whether malice or incompetence for the EO to permit activities creating and maintenance of nuisance conditions that threaten health, safety and the property of certain residents.

Petitioners:

Kristi Wrigley

2550 Wrigley Rd.

Eureka, CA. 95503

Ralph and Nona Kraus

2479 Wrigley Rd.

Eureka, CA. 95503

Christina and Norm Pasteris

2492 Wrigley Rd.

Eureka, CA 95503

Declaration of Kristi Wrigley Unit 1 THP 1-08-072 Hum

1 I am Kristi Wrigley. I live at 2550 Wrigley Rd., Eureka, CA. 95503; the family (un)apple farm where I grew up. I am over the age of 18. I am of sound mind and body. I work as a Transportation Surveyor for Caltrans. I have a BS in Nutrition from UC Berkeley. If called to testify I would attest to the following:

2.I have seen the muddy runoff overfill the ditch along the County Road[Wrigley Rd.] below Unit 1 of THP 1-08-072 Hum.

3 I have seen large amounts of muddy runoff from the hill slope of Unit 1 and watched it overflow across the road in numerous places several times in my life..

4 I have cleaned ditches below this Unit of debris during rainstorms to keep the runoff from overflowing onto and then down the road.

5 I have seen the large amounts of runoff overflow the ditch at the base of the hill on the County Rd. just before my driveway ,and flow across to my neighbor's driveway leading down to her garage which is below the county road elevation.

6 I have seen the muddy runoff go under the road and emerge near but not necessarily from the outlet of the culvert. I have seen it pour out so full and so fast that it overflows the ditch onto my field and also spreads out so much that it threatens to go toward my neighbors house.

7 I have cleaned ditches below this Unit of debris during rainstorms to keep the runoff from overflowing onto and then down the road.

8 My neighbor has cleaned the main ditch around my field after the last logging in this area to keep the runoff from flowing across my field and to help drain the fields when high water recedes.

9 This past winter I saw my fields fill up with muddy runoff water from up-slope instead of back filling with muddy water from the flooded river which it usually does.

10 I have gotten stuck in the mud deposited in these fields with my tractor.

11 I have been prevented from entering my fields because of the soft wet mud, late Spring into early Summer when I would ordinarily have been able to mow.

12 All of my apple trees in the area below this plan are already stressed and severely damaged. More sediment and runoff will cause more harm to these trees.

13 Added sediment and runoff from this plan and others in the area all runs downhill to our property rendering it useless for an orchard.

14 I saw more sediment deposited on the orchard floor after high flow events this past winter than in recent previous years.

15 I have observed the continuing deposition of sediment on the banks of North Fork Elk River around, above and below my water intake and all around my property along the river.

16 I have seen the results of the last 2 decades of logging in the upstream watershed on my property. I fear the runoff from this plan and from the increased runoff from above this plan because the trees have been removed

17 I am afraid of the continually worsening situation.

18 No agency is willing to recognize the damage past and present logging has had on our property; destroyed my orchard, destroyed my water rights and increased health and safety risks.

19 This logging cannot be addressed by itself as a stand alone project when more logging all around it is planned. The cumulative effect of all plans in the area should be assessed against the backdrop of the severely harmed residents.

20 I have seen that the calculations made by the agencies and the upstream lumber company underestimate quantity of the harmful effects of logging that we have to endure.

21 This Tier 1 WWDR permitted logging allows sediment deposition in amounts deleterious to health and safety. And violates the limitations designed to address cumulative effects.

22 We longtime landowners, homeowners and residents know how we are affected by logging especially logging adjacent to our property. Our knowledge should be acknowledged by all agencies.

23 I have not wanted to log my property adjacent to this Unit because of the effect that logging would have on my neighbors.

24 Salmon Forever monitoring data[RCAA 2008 Report] demonstrates continuing aggradation of the North Fork Elk River.

25. I have seen huge amounts of runoff jet out of a culvert into the North Fork of Elk River that this Unit will drain through.

26. I do not believe that this discharge of polluted runoff through the culvert is permitted under CWA.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Kristi Wrigley

Kristi Wrigley 5/31/2011

5/31/2011

I declare as follows:

My name is Christina Pasteris. I have lived at 2492 Wrigley Rd. for over forty years. I am over the age of 18 and of sound mind. If called to testify, I would testify competently to the following:

I live below this enrolled to be logged Unit1 1-08-072 Hum

We are already overburdened by the silt and sediment that the upstream logging has deposited in the North Fork Elk River.

I have walked the road by the river for years and have watched it steadily get worse, more mud in the river , ever increasing flooding and inundation of our access road.

The flooding worries me because I have my mother who is 87 who lives in town to take care of and my own health sometimes requires emergency care. I cannot get through the floodwater and no emergency services will go through the water to help us if we need it.

I have had to clean out the ditch across from my property along Wrigley Rd so that the existing runoff will not overfill the ditch and spill across the road.

I have seen the water flow across the road and into my garage.

I have seen the water flow out of the forest and across my neighbor Ralph Kraus' field and into the ditch along Wrigley Rd. It then must flow along the ditch and eventually goes under the road and flows in a ditch on my other neighbor, Kristi Wrigley's property right next to my property. This ditch already runs full and will go under my house if it overflows the ditch. I am worried that the added sediment and runoff from this Unit [and others I may not know about] will compound the problem.

My husband cleans the ditch every year now, all along my neighbor's[Kristi Wrigley] property and then along the our back boundary, about 800 feet of ditch.

Our water intake along with 3 other neighbors is located just below where this ditch dumps runoff into the North Fork of Elk River. Recent years it has been difficult to find a place deep enough to put our intake hose in from Summer to late Fall.

Any new sediment will make finding a pool even more challenging.

Every year even without this Unit being logged we see more sediment deposited in the river. I see it when I walk the dogs in the valley and I see it down by our intake.

I wonder and worry when will it end; will it ever stop getting worse?

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Christina Pasteris

Christina Pasteris 5/31/2011

5/31/2011

I declare as follows:

My name is Christina Pasteris. I have lived at 2492 Wrigley Rd. for over forty years. I am over the age of 18 and of sound mind. If called to testify, I would testify competently to the following:

I live below this enrolled to be logged Unit1 1-08-072 Hum

We are already overburdened by the silt and sediment that the upstream logging has deposited in the North Fork Elk River.

I have walked the road by the river for years and have watched it steadily get worse, more mud in the river , ever increasing flooding and inundation of our access road.

The flooding worries me because I have my mother who is 87 who lives in town to take care of and my own health sometimes requires emergency care. I cannot get through the floodwater and no emergency services will go through the water to help us if we need it.

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I have seen the water flow out of the forest and across my neighbor Ralph Kraus' field and into the ditch along Wrigley Rd. It then must flow along the ditch and eventually goes under the road and flows in a ditch on my other neighbor, Kristi Wrigley's property right next to my property. This ditch already runs full and will go under my house if it overflows the ditch. I am worried that the added sediment and runoff from this Unit [and others I may not know about] will compound the problem.

My husband cleans the ditch every year now, all along my neighbor's[Kristi Wrigley] property and then along the our back boundary, about 800 feet of ditch.

Our water intake along with 3 other neighbors is located just below where this ditch dumps runoff into the North Fork of Elk River. Recent years it has been difficult to find a place deep enough to put our intake hose in from Summer to late Fall.

Any new sediment will make finding a pool even more challenging.

Every year even without this Unit being logged we see more sediment deposited in the river. I see it when I walk the dogs in the valley and I see it down by our intake.

I wonder and worry when will it end; will it ever stop getting worse?

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Christina Pasteris

5/31/2011

Ralph Kraus
2479 Wrigley Road
Eureka, CA 95503

May 31, 2011

TO: California State Water Resources Control Board

FROM: Ralph and Nona Kraus

RE: Enrollment of THP 1-08-072 by NCRWQCB Executive Officer

I, Ralph Kraus, Declare the following:

1. I am of sound mind and if called to testify I would testify as follows.

2. I am over the age of 18.

3. I have resided at 2479 Wrigley Road with my wife Nona since 1958.

4. I worked in the woods on the South Fork of Elk River for Hammond Lumber Company during 1951, 1952, 1953, 1954 and 1955 as a peeler and choker setter and truck driver.

5. I was employed as a science teacher by the Eureka City School District between the years 1954 to 1984.

6. I have attended numerous site visits of timber operations located within the North Fork of Elk River since 1997.

7. As my children were growing up, I commonly walked with my children along the North Fork Elk River to the Scout Camp and visited my friend Jack Branham who was the son of the caretaker of the Scout Camp.

8. I have maintained rainfall records since 1997 from rainfall collected at my house.

9. I have collected water samples using the grab sample technique in Elk River for Salmon-Forever. Salmon-Forever processed many of these samples in their laboratory.

10. On 11/21/98 I photographed water flowing from a culvert located about ¼ mile or less inside the timber company gate at post # 736. A second photo shows the water from the culvert entering the North Fork of Elk River. I believe that this culvert is located in the road accessing THP 1-08-072.

11. As residents immediately downstream of the proposed logging on unit one of THP 1-08-072 HUM, we are very concerned that increased runoff of sediments will be generated from the plan.

12. Our domestic water system will be adversely impacted by the increased sediment discharge.

13. Increased runoff further contributes to the evermore frequent flooding of our road, thus denying us access to and from town.

14. The Elk River continues to fill with sediment. I see further deposition and burial of benchmarks and staff plates and decreasing channel capacity.

15. We are among the aging populus living along the North Fork of Elk River that anticipates and is deeply concerned about being denied emergency services during the periods of flooding, which can last anywhere from half a day to several days.

16. Because of the proximity of the plan to our property, the effects will be immediate; therefore, we consider the Action (Tier 1 approval of Unit 1 of THP 1-08-072 HUM) inappropriate. This plan is upslope from our property and our home. Our home is located on an alluvial fan and a portion of the runoff from the plan flows around the back and side of our house and through our orchards and fields.

17. I declare under the penalty of perjury that the foregoing is true and correct to the best of my ability.

Signed Ralph Haus Dated 5/31/11

60	2/1/2002	Regional Water Board internal memorandum Re: Elk River Peak Flow Analysis.

INTEROFFICE MEMORANDUM

TO: DIANA HENRIOULLE-HENRY, P.E., HEADWATERS UNIT SENIOR

FROM: ADONA WHITE, WATER RESOURCES CONTROL ENGINEER

SUBJECT: ELK RIVER PEAK FLOW ANALYSIS

DATE: FEBRUARY 1, 2002

Malle
Raugh

INTRODUCTION

This memo provides additional discussion to the memo dated January 30, 2002. Please include this in the official files for Elk River THPs.

I have reviewed the peak flow analysis conducted by California Department of Forestry and Fire Protection (CDF) for both Freshwater and Elk River watershed. CDF has employed partial methodology as presented by Drs. Lisle, Reid, and Ziemer of Redwood Sciences Laboratory in their October 25, 2000 *Addendum: Review of Freshwater Flooding Analysis Summary* (Lisle et al., 2000).

Lisle et al. (2000) presents an explanation of the likely cumulative effect on increased flood frequency in Freshwater Creek resulting from past harvesting and various future harvesting scenarios. The cumulative effect results from the combination of hydrologic changes resulting from canopy removal and sediment inputs associated with the hydrologic changes (rilling, scour of low order channels, landsliding) and roads.

I have applied the model described in Lisle et al. (2000) to Elk River watershed conditions, as discussed and presented in this memo. I have attempted to be consistent in this memo by using the same terms as those used in Lisle et al. (2000). These are preliminary calculations and may change if errors or ways to validate or modify assumptions are discovered; consequently, additional conclusions may also result.

METHODOLOGY AND RESULTS

These analyses are based upon harvesting road construction between 1967 and 2015. The results presented herein demonstrate flood frequency changes between 1983 and 2015.

HYDROLOGIC CHANGES IN ELK RIVER WATERSHED

Removal of canopy results in reduced rainfall interception and reduced evapo-transpiration capacity. The combination of these effects results in increased runoff associated with peak flow events. The model estimating the increased peak flows was developed by Lewis et al. based on data from the Caspar Creek watershed, a coastal redwood watershed, not dissimilar to Elk River in terms of geology, vegetation, and rainfall patterns. The model offers information about the relative magnitudes of harvest-related peakflow changes relative to background conditions for the watershed being modeled.

This model is mathematically represented as:

$$E(r) = \exp\{[1 + B_2(t-1)]c[B_4 + B_5\ln(y_c) + B_6\ln(w)]\}$$

Where:

B_2	= Logging recovery coefficient
B_4	= constant
B_5	= storm size coefficient
B_6	= watershed wetness coefficient
RI	= recurrence interval
Y_{ncf}	= control peak flow
y_c	= expected peak flow
w	= wetness index
c	= portion of watershed canopy removed
t	= time since harvest that calculation is made

This equation estimates the expected increase in volume of water associated with a given recurrence interval peak flow. The effects of harvest are greatest immediately following harvest and follow an exponential decay after harvest (i.e., hydrological recovery).

Using the harvest history provided by CDF (Munn, 2002) and the Pacific Watershed Associates (PWA) report (1999), the peak flow increases, due to hydrologic changes only, were determined for the 2-year recurrence interval flow and are shown in Figure 1. It should be noted that similar percent increases were observed at Caspar Creek for the highest flows on record at the time the paper was written (i.e., up to the 8-year recurrence interval flow) (Lewis et al., 2000). Data indicate that up to the 8-year recurrence interval peak flow is affected by harvesting. The model shows increases in peak-flows for even greater return interval peak flows.

CDF Analysis

The methodology employed by CDF (Munn, 2002) is based solely upon increased peak flow. Their analyses does not also include the increase in flood frequency due to aggradation of sediment, a key factor in increase flood frequency. CDF determined that 600 clearcut equivalent acres would be acceptable in the Elk River watershed and would not worsen the existing flooding problem. However, this hydrologic component is but a portion of the flooding problem in the Elk River and Freshwater Creek watersheds, as the following analysis demonstrate.

Further, Figure 1 shows that CDF's proposed harvest scenario will, in fact, increase existing flood frequency in Elk River due solely to hydrologic changes, and that current flood frequency is greater than background levels. Figure 1 also demonstrates that if harvesting is deferred after 2001, the hydrologic changes due to canopy removal will stabilize in approximately 2015. This is because the modeled hydrologic effects due to harvesting approach zero after 14 years.

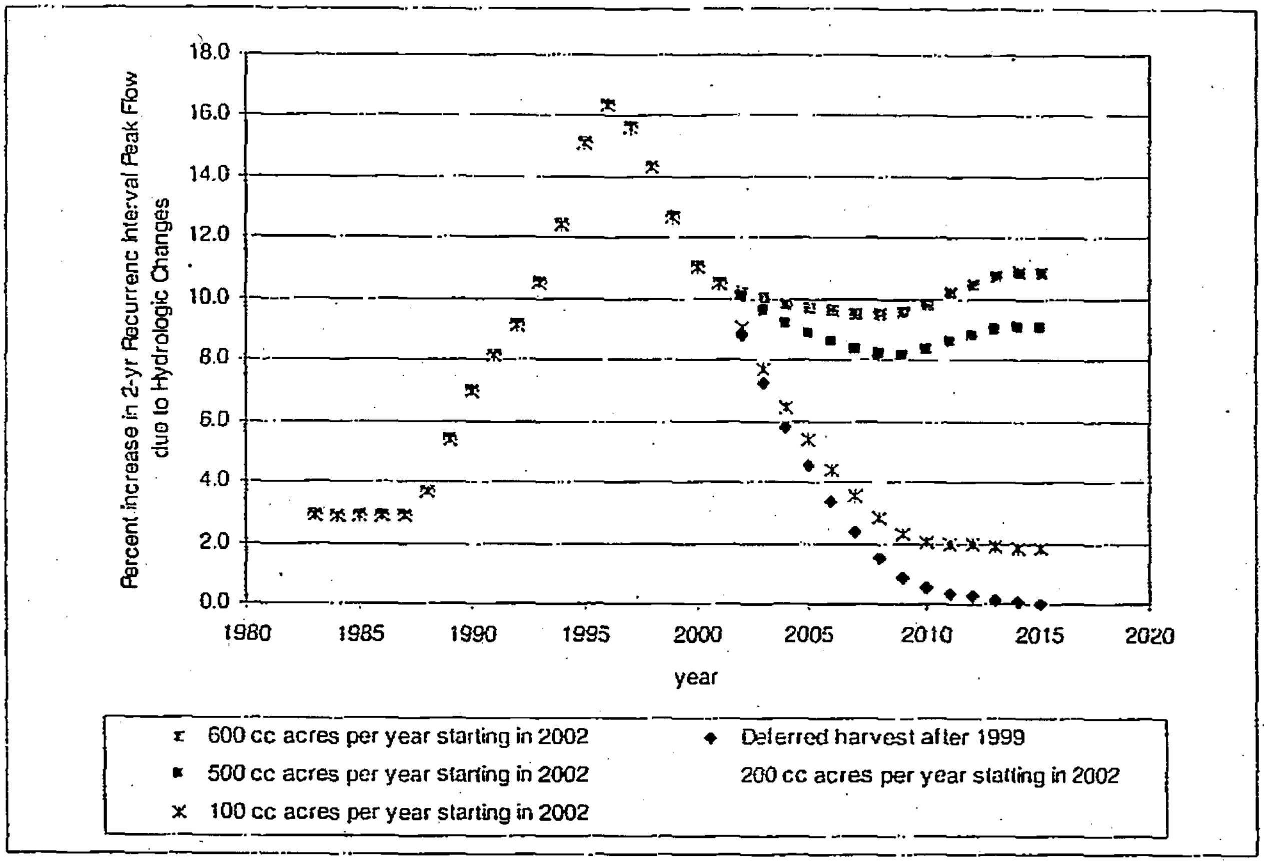


Figure 1. Estimated percentage increase in 2-year recurrence interval peak flow based upon one past harvesting and four future harvesting scenarios.

SEDIMENT INPUTS OVER BACKGROUND

Lisle et al. (2000) identify two types of sediment inputs which result due to the timber harvest and related activities: silviculturally-related and road-related sediment inputs. Both of these activities increase the sediment inputs above background levels. It should be noted that in this context increases above background levels are relative to those of the specific watershed being modeled.

Silviculturally Related Sediment Inputs

The increased peak flows not only result in increased runoff of water, but also result in increased sediment inputs by two primary mechanisms: silviculturally-related hillslope landsliding and rilling and scour of low order channels. These sediment inputs were modeled using the following equations, as presented by Lisle et al. (2000). The equations are based upon information contained in the PWA report (1998).

Pre-Pacific Lumber Company (PL) Habitat Conservation Plan (HCP) silviculturally-related landslide inputs are based upon data in the PWA report (1998) indicating a 1300% increase in landsliding on recently harvested areas in North Fork Elk River. Post-PL HCP sediment inputs are based on the assumption that the mass-wasting strategy is completely effective at preventing increased rates of landslides on all areas except planar slopes and breaks in slope. This assumption has not been validated. The landslide rates on harvested portions of the watershed are assumed to return to background levels 15 years after harvesting. This assumption has not been validated.

Hydrologically associated erosion inputs (i.e. rilling and scour of low order channels) are based upon Lewis et al. (1998) and are presented in Lisle et al. (2000). These inputs are the same for pre- and post-PL HCP conditions and are assumed to stabilize and decrease over time after harvest (as the canopy grows back), following the same recovery-rate as the hydrologic change recovery.

$$P = \sum_{i=1}^{15} C_i(1400 - 92.9i) \text{ (Pre-HCP conditions)}$$

$$P = \sum_{i=1}^{15} C_i(219 - 20.9i) \text{ (Post-HCP conditions)}$$

Where:

$P =$	proportional increase in sediment input over background in a given year
$C =$	portion of watershed canopy removed in a given year
$i =$	number of years prior to the year of calculations that harvesting took place

Road Related Sediment Inputs

The presence of roads on the landscape results in sediment delivery via surface erosion and road-related landsliding. Lisle et al. (2000) estimate sediment inputs associated with non-storm-proofed roads in Freshwater as 20% over background for the roaded area. Sediment delivery from storm-proofed roads is assumed only 4% over background for the roaded area. This assumption may not be valid because storm proofing may not be as effective as indicated.

The area of the watershed comprised of roads was based upon road construction rates in the North Fork Elk River, as presented on Page 13 of the PWA report (1998). These same road construction rates are assumed for the South Fork Elk River watershed. Road widths are assumed to be 14 feet.

The rates of storm-proofing are based upon Table 1, on Page 3 of (Miller, 2000) which indicate that in the Elk River watershed 47.17 miles were storm-proofed by 2000. It was assumed that storm-proofing began in 1998 and continued at the same rate until all the roads were storm-proofed.

It should be noted that the results presented here do not include any additional road construction, though approximately 11 miles of new roads are proposed associated with pending timber harvest plans. Further analyses are necessary to model the inputs from the proposed roads.

Combined Sediment Inputs

The silviculturally-related and road-related sediment inputs are summed to estimate the total percent sediment inputs over background resulting from harvest-related activities. Figure 2 shows the modeled sediment inputs over background levels for two harvest scenarios (deferred harvest beginning in 2001 and 600 clearcut (CC) equivalent acres annually beginning in 2002, as proposed by CDF). Figure 2 also shows that modeled sediment inputs from harvest and roads reach a peak in 1996.

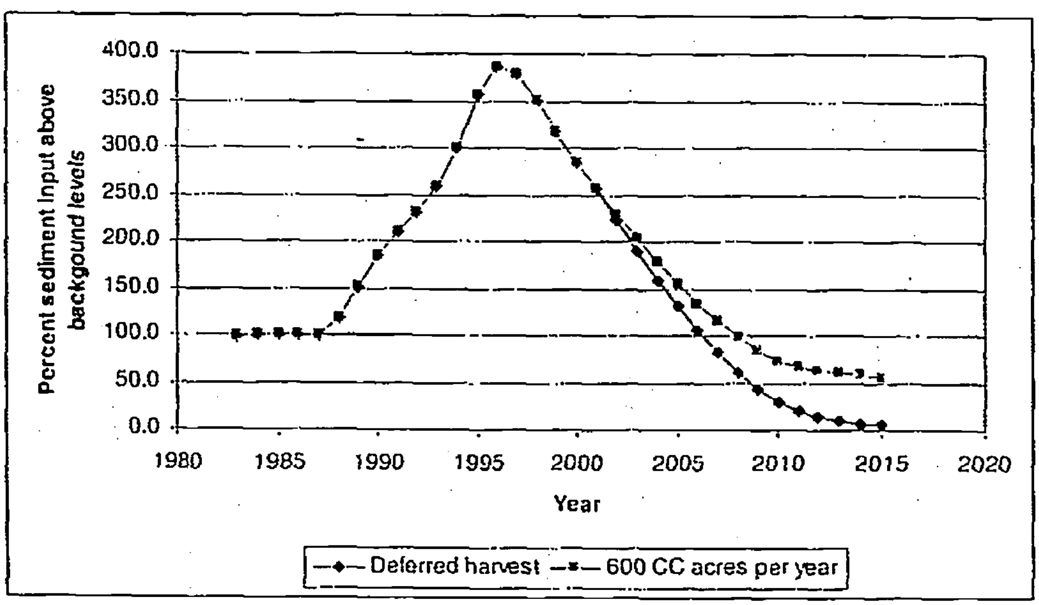


Figure 2. Annual percent sediment input over background for two harvest scenarios.

Aggradable Sediment

Both the silviculturally-related and road-related sediment deliveries increase the total deliveries over background sediment delivery levels. A stream has a certain capacity for sediment transport; once the capacity is exceeded by sediment inputs, aggradation occurs. Aggraded sediment may eventually be flushed out of the system if the inputs are abated. If inputs continue to exceed the threshold for aggradation, further aggradation will occur. The cumulative effect on the channel is not limited to increased flood frequency due to channel capacity reduction but also includes increased bank erosion.

While the exact threshold above background at which sediment began to aggrade in the Elk River watershed is not defined, evidence indicates it was somewhere less than 90-160% over background. Lisle et al. (2000) discuss observations by long-time Elk River residents indicating that the channel was noticeably filling with sediment and degradation of water quality had occurred in the early 1990's. By the time these effects were noticeable, the threshold for aggradation had already been surpassed by sediment inputs. A family of curves for four threshold levels above background is shown in Figure 3, assuming harvest is deferred following 2001. Figure 3 indicates that for the thresholds shown, the cumulative aggradable sediment curves have a similar shape. However, greater aggradation occurs for lower thresholds and consequently, recovery is greatest for higher thresholds. Additionally, Figure 3 shows that under deferred harvest conditions for all aggradation thresholds modeled, the river could begin to flush out aggraded sediment within the time period modeled.

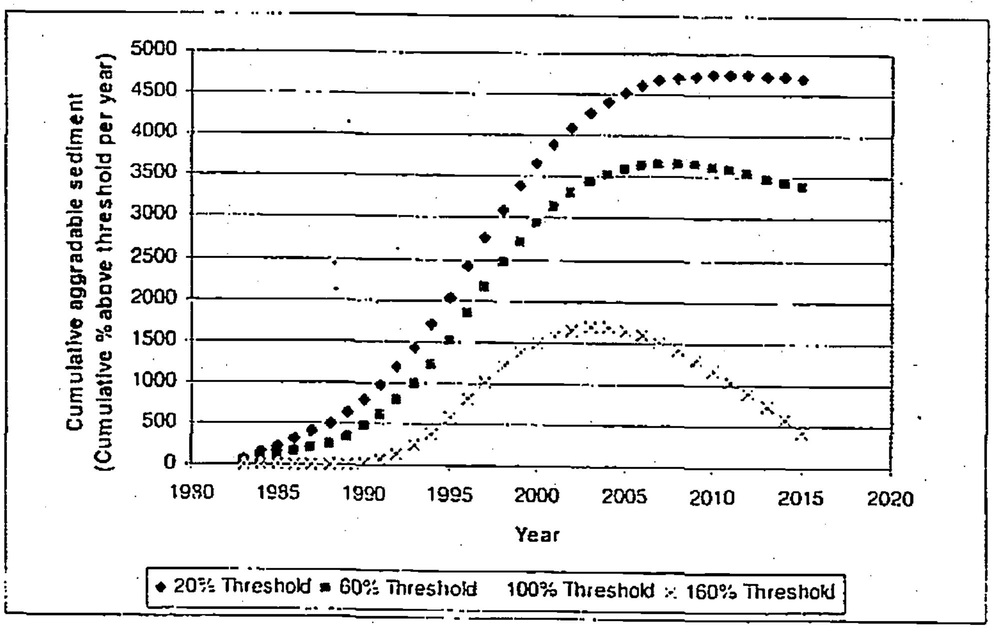


Figure 3. Cumulative aggradable sediment (sediment inputs above the stream's transport capacity above background levels). The depicted harvest scenario assumes that harvest is deferred after 2001.

In Figures 4-6, a threshold for aggradation of 60% is assumed. This assumption has not been validated. Figure 4 shows the cumulative aggradable sediment over time for two harvest scenarios, assuming aggradation occurs if sediment inputs exceed 60% over background levels annually:

1) deferred harvest beginning in 2001 and
2) 600 clearcut (CC) equivalent acres annually beginning in 2002, as proposed by CDF.

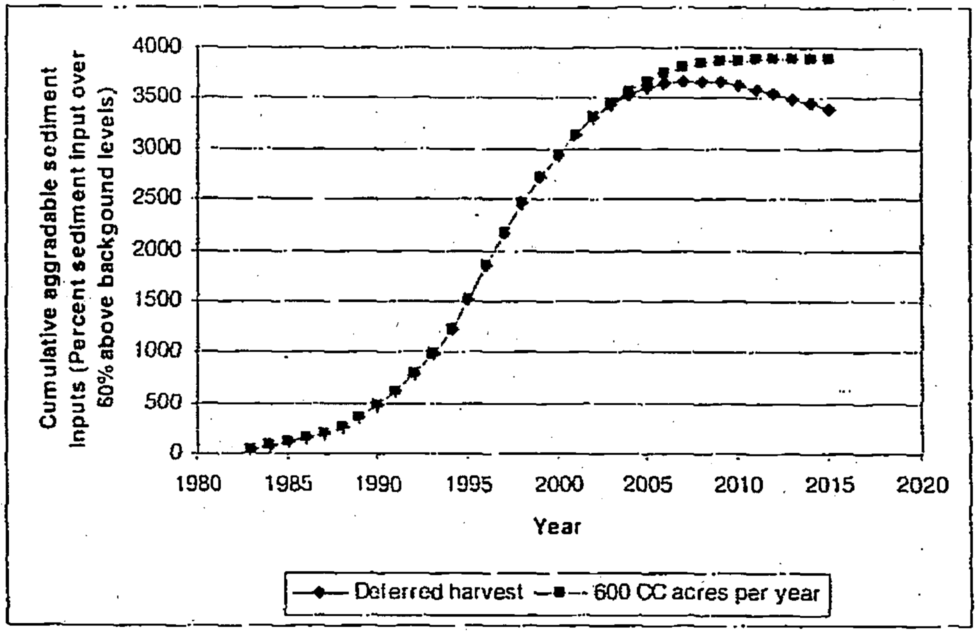


Figure 4. Cumulative aggradable sediment for two harvest scenarios, assuming the aggradation begins at 60% over background.

FLOOD FREQUENCY INDEX

The change in flood frequency is a result of the combined effects of increased peak flow volumes and increased sediment aggradation in the channel. In order to demonstrate the change in channel capacity between current and historic conditions, I relied on the review of Conroy (1998) conducted by Lisle et al. (2000). The review refers to historical data documented by USGS and recent data from Conroy (1998) pertaining to the same cross-section at the gage station on the mainstem Elk River just below the confluence of North Fork and South Fork Elk River. The USGS record indicates that between 1959 and 1967 bankfull discharge was 63 cubic meters per second (cms). Conroy indicates that in 1997 bankfull discharge was 25 cms.

The historic information indicates the bankfull channel capacity was reduced by 60% between 1967 and 1997. Figure 1 shows in 1997 there was a 15% increase in the 2-year recurrence interval flow compared to background conditions. Thus, in 1997, 85% of the change in flood frequency is attributable to reduction in channel capacity due to aggradation and the remainder of the impact is due to hydrologic changes.

It is imperative to note that 1997 is used as an index year because there were data to represent the relative portion of the total flood frequency increase attributable to sediment aggradation and to hydrologic changes. Figures 5 and 6 illustrate over time 1) the change in flood frequency due to hydrologic changes, 2) the change in flood frequency due to aggraded sediment, and 3) the total change in flood frequency. The total change in flood frequency is simply the summation of the hydrologic and aggradation effects.

A flood frequency index of 100% corresponds to 1997 conditions when conditions were significantly different than background: there was a 15% increase in the 2-year recurrence interval peak flow, silvicultural and road-related sediment inputs were 378% over background levels (silviculturally-related inputs were 316% over background levels and road-related sediment inputs were 61% over background levels), and cumulative aggraded sediment was 2169% over background levels (assuming a 60% over background sediment input threshold for aggradation). Figures 5 and 6 differ after 2001. Figure 5 shows results assuming harvest is deferred after 2001. Figure 6 shows results assuming 600 clearcut equivalent acres are harvested annually beginning in 2002 and continuing over the modeled time period.

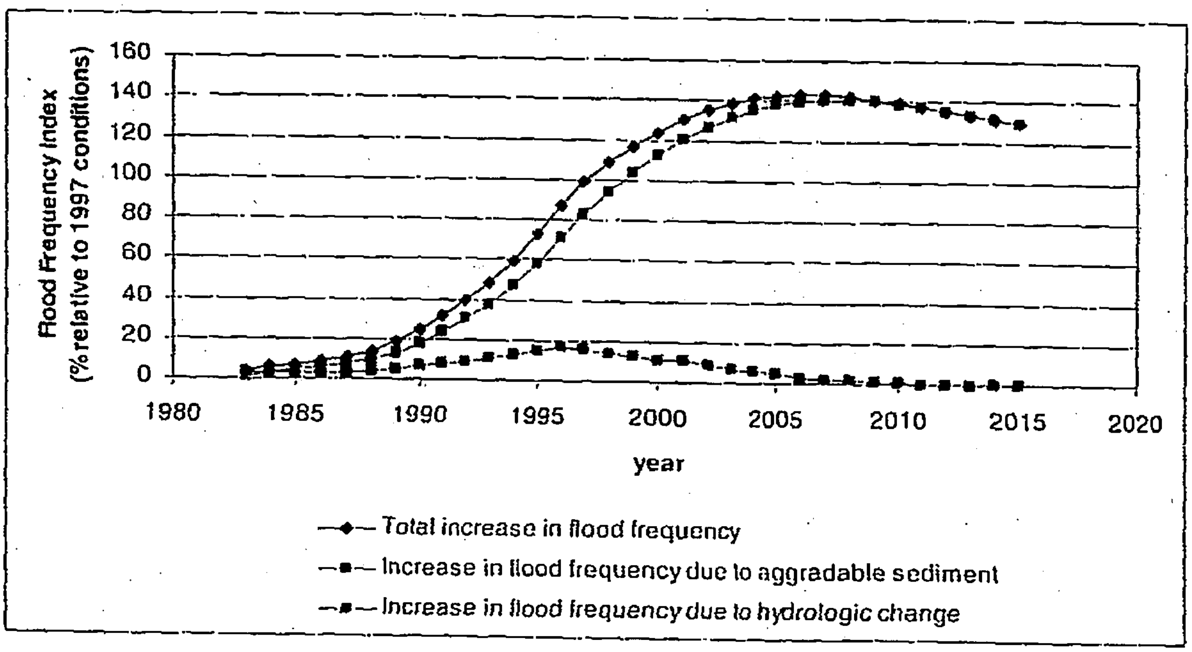


Figure 5. Flood frequency index for Elk River if harvest is deferred after 2001. Note that an index value of 100% corresponds to 1997 channel conditions.

Figures 5 and 6 indicate the current flood frequency is 135% greater than in the early 1980s. Figure 5 shows that if harvest is deferred after 2001, impacts will worsen until recovery begins in 2005, however flood frequency will remain greater than pre-2001 levels over the time period modeled. Figure 6 shows if harvest commences in 2002 at a rate of 600 clear cut equivalent acres per year, flood frequencies will increase over current conditions and stabilize at a level of 159% greater than observed in the early 1980s.

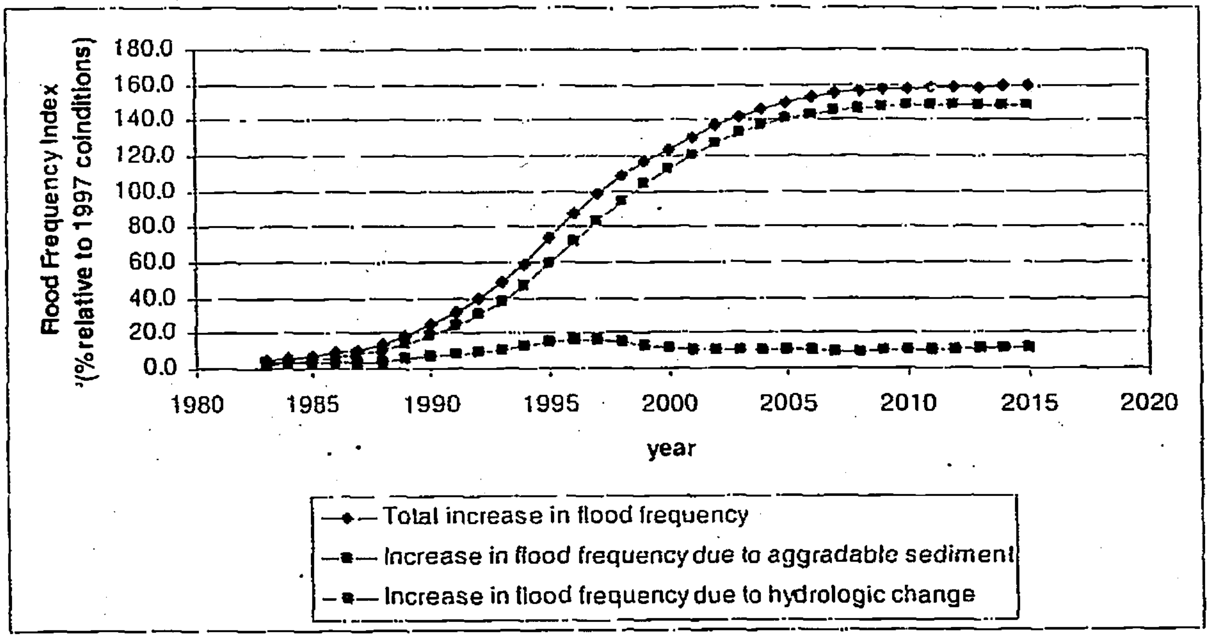


Figure 6. Flood frequency index for Elk River assuming annual harvest of 600 clearcut acres. Note that an index value of 100% corresponds to 1997 channel conditions.

FURTHER EVALUATIONS

Further evaluations should be conducted beyond those described in this memo. These include:

- Further evaluation of flood frequency changes under different harvest scenarios
- Incorporation of new road construction
- Evaluations under different antecedent wetness conditions

Conclusions

The results of this evaluation indicate the following:

- The flood frequency in Elk River has increased significantly (135%) as compared to historic conditions and will continue to increase until after sediment inputs are abated and after conditions stabilize at an unprecedented high level of flood frequency.
- The evaluation conducted by Munn (2002) apparently lead CDF to conclude that allowing 600 clearcut equivalent acres to be harvested annually would not exacerbate the existing significant impact. However did CDF not evaluate sediment impacts on flood frequency, which is the primary contributor to the impacts. In addition, Munn (2002) did not extend the calculation far enough into the future to observe the cumulative impact resulting from harvesting. Figure 1 indicates an increase in peak flow will result solely from the hydrologic change if 600 acres are clearcut annually and peak flow increases will stabilize at a level greater (10.9% % increase in 2-year recurrence interval peak flow) than current conditions (10.3% increase in 2-year recurrence interval peak flow) as long as that harvest scenario continues. The results presented in this analysis indicate that if harvest commences in 2002 at a rate 600 clear cut equivalent acres per year, flood frequency will increase over current conditions and stabilize at a level of 159% greater than observed in the early 1980s.
- The CDF proposed harvest scenario would slow the rate of recovery for Elk River.
- The flooding frequency in 2002 is 27% greater than in 1997.
- If 600 clearcut equivalent acres are harvested annually starting in 2002, there will be no decrease in the aggradable sediment inputs in the foreseeable future. Because sediment is the same pollutant impairing beneficial uses of water, there will be no recovery of impaired beneficial uses in the foreseeable future under the CDF-proposed harvest scenario.

References

Conroy, W.J. 1998. A comparison of rainfall-runoff relations in Elk River, a small coastal northern California watershed. Master's Thesis. Humboldt State University, Arcata, California.

Lewis, J., S.R. Moori, E.T. Keppeler, and R.R. Ziemer. Impacts of logging on storm peak flows, flow volumes and suspended sediment loads in Caspar Creek, California.

Lisle, T.E., L.M. Reid, and R.R Ziemer. 2000. Review of: Master's Thesis authored by Mr. William John Conroy: "A comparison of rainfall-runoff relations in Elk River, a small coastal northern California watershed". Unpublished review prepared for National Marine Fisheries Service, California Department of Forestry and Fire Protection, and the North Coast Regional Water Quality Control Board.

Lisle, T.E., L.M. Reid, and R.R Ziemer. 2000. Review of: Freshwater flooding analysis summary. Unpublished review prepared for California Department of Forestry and Fire Protection and the North Coast Regional Water Quality Control Board.

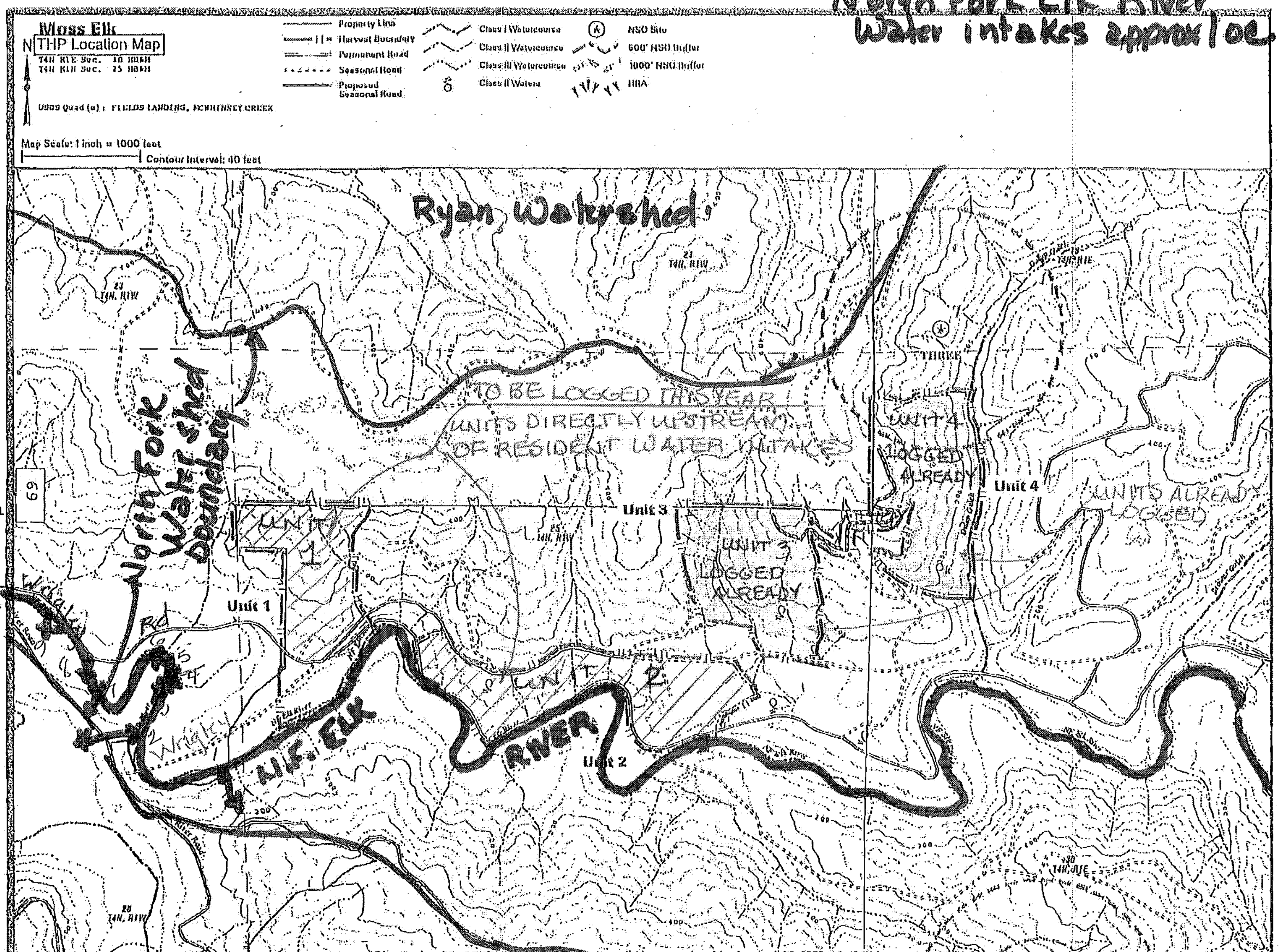
Lisle, T.E., L.M. Reid, and R.R Ziemer. 2000. Addendum: Review of: Freshwater flooding analysis summary. Unpublished review prepared for California Department of Forestry and Fire Protection.

Miller, R. 2001. Proposed Testimony of Ray Miller in the Public Hearing for Pacific Lumber Company's and Scotia Pacific Company LLC's Timber Harvest and Related Activities in the North Fork Elk River, Stitz Creek, Bear Creek, Jordan Creek, and Freshwater Creek Watersheds.

Munn, J. R. January 14, 2002. Memorandum to Dean Lucke: Elk River Peak Flow Analysis. California Department of Forestry and Fire Protection.

Pacific Watershed Associates. 19998. Sediment Source Investigation of the North Fork Elk River. Prepared for the Pacific Lumber Company.

North Fork Elk River
Water intakes approx loc.



X = water intake : 10 locations shown on this map

FOR PUBLICATION

UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

NORTHWEST ENVIRONMENTAL DEFENSE CENTER, an Oregon non-profit corporation,
Plaintiff-Appellant,

and

OREGON FOREST INDUSTRY COUNCIL; AMERICAN FOREST & PAPER ASSOCIATION,
Intervenors,

v.

MARVIN BROWN, Oregon State Forester, in his official capacity; STEPHEN HOBBS; BARBARA CRAIG; DIANE SNYDER; LARRY GIUSTINA; WILLIAM HEFFERNAN; WILLIAM HUTCHISON; JENNIFER PHILLIPPI, (members of the Oregon Board of Forestry, in their official capacities); HAMPTON TREE FARMS, INC., an Oregon domestic business corporation; STIMSON LUMBER COMPANY, an Oregon domestic business corporation; GEORGIA-PACIFIC WEST INC., an Oregon domestic business corporation; SWANSON GROUP, INC., an Oregon domestic business corporation; TILLAMOOK COUNTY,
Defendants-Appellees.

No. 07-35266

D.C. No. CV-06-01270-GMK

ORDER WITHDRAWING OPINION AND DENYING REHEARING AND OPINION

Appeal from the United States District Court
for the District of Oregon
Garr M. King, District Judge, Presiding

Argued and Submitted
November 19, 2008—Portland, Oregon

Filed May 17, 2011

Before: William A. Fletcher and Raymond C. Fisher, Circuit Judges, and Charles R. Breyer,* District Judge.

Opinion by Judge William A. Fletcher

*The Honorable Charles R. Breyer, United States District Judge for the Northern District of California, sitting by designation.

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ORDER

This court's opinion filed August 17, 2010, and reported at 617 F.3d 1176, is withdrawn, and is replaced by the attached Opinion.

With the filing of the new opinion, the panel has voted unanimously to deny the petitions for rehearing. Judges Fletcher and Fisher have voted to deny the petitions for rehearing en banc, and Judge Breyer so recommends.

The full court has been advised of the petitions for rehearing en banc and no judge of the court has requested a vote on whether to rehear the matter en banc. Fed. R. App. P. 35.

The petitions for rehearing and rehearing en banc, filed October 5, 2010, are DENIED.

No further petitions for rehearing or rehearing en banc will be accepted.

OPINION

W. FLETCHER, Circuit Judge:

Northwest Environmental Defense Center ("NEDC") brings suit against the Oregon State Forester and members of the Oregon Board of Forestry in their official capacities (collectively, "State Defendants") and against various timber companies ("Timber Defendants," and collectively with State Defendants, "Defendants"). NEDC contends that Defendants have violated the Clean Water Act ("CWA") and its implementing regulations by not obtaining permits from the Environmental Protection Agency ("EPA") for stormwater — largely rainwater — runoff that flows from logging roads into systems of ditches, culverts, and channels and is then discharged into forest streams and rivers. NEDC contends that these discharges are from "point sources" within the meaning of the CWA and that they therefore require permits under the National Pollutant Discharge Elimination System ("NPDES").

The district court concluded that the discharges are exempted from the NPDES permitting process by the Silvicultural Rule, 40 C.F.R. § 122.27, promulgated under the CWA to regulate discharges associated with silvicultural activity. The district court did not reach the question whether the discharges are exempted by amendments to the CWA made in 1987. We reach both questions and conclude that the discharges require NPDES permits.

I. Background

NEDC contends that discharges from systems of ditches, culverts, and channels that receive stormwater runoff from two logging roads in the Tillamook State Forest in Oregon are point source discharges under the CWA. The roads are the Trask River Road, which runs parallel to the South Fork Trask River, and the Sam Downs Road, which runs parallel to the Little South Fork of the Kilchis River. The roads are owned by the Oregon Department of Forestry and the Oregon Board of Forestry. They are primarily used by the Timber Defendants to gain access to logging sites and to haul timber out of the forest. The Timber Defendants use the roads pursuant to timber sales contracts with the State of Oregon. These contracts designate specific routes for timber hauling and require that the Timber Defendants maintain the roads and their associated stormwater collection systems.

Both of the logging roads were designed and constructed with systems of ditches, culverts, and channels that collect and convey stormwater runoff. For most of their length, the roads are graded so that water runs off the road into ditches on the uphill side of the roads. There are several ways these ditches then deliver water into the adjacent rivers. At intervals, the ditches empty into "cross-drain" culverts that cross under the roads. Where the roads are close to the rivers, these culverts deliver the collected stormwater into the rivers. Where the roads are at some distance from the rivers, the roadside ditches connect to culverts under the roads that deliver the collected stormwater into channels, and these channels then discharge the stormwater into the rivers. When tributary streams cross under the roads, the roadside ditches deliver the collected stormwater into these streams. These streams then carry the collected stormwater to the rivers.

The stormwater runoff that flows off the roads and through these collection systems deposits large amounts of sediment into streams and rivers. This sediment adversely affects fish — in particular, salmon and trout — by smothering eggs, reducing oxygen levels, interfering with feeding, and burying insects that provide food.

Timber hauling on the logging roads is a major source of the sediment that flows through the stormwater collection systems. Logging trucks passing over the roads grind up the gravel and dirt on the surface of the road. Small rocks, sand, and dirt are then washed into the collection system and discharged directly into the streams and rivers. NEDC alleged in its complaint that it sampled stormwater discharges at six points along the Trask River Road and five points along the Sam Downs Road where the Defendants use ditches, culverts, and channels to collect and then discharge stormwater runoff. Each sample contained significant amounts of sediment.

None of the Defendants has sought or received NPDES permits for these discharges into the streams and rivers. NEDC brought suit under the citizen suit provision of the CWA, 33 U.S.C. § 1365(a), which provides that "any citizen may commence a civil action on his own behalf . . . against any person" alleged to be in violation of the CWA. NEDC claims that Defendants have violated the CWA by not obtaining NPDES permits. On March 1, 2007, the district court dismissed NEDC's complaint with prejudice under Federal Rule of Civil Procedure 12(b)(6) for failure to state a claim. NEDC has timely appealed.

II. Subject Matter Jurisdiction

In the original version of our opinion, we did not discuss our subject matter jurisdiction. None of the parties to the suit had raised an objection to subject matter jurisdiction. In an amicus brief, however, the United States had contended that the challenged Silvicultural Rule was unambiguous and that, as a consequence, citizen-suit jurisdiction under 33 U.S.C. § 1365(a) was improper. Instead, the United States had argued, the suit should have been brought under 33 U.S.C. § 1369(b). A defect in subject matter jurisdiction is, of course, not waivable.

Without discussing subject matter jurisdiction, we held on the merits that the Silvicultural Rule is ambiguous. After we published our opinion, one of our colleagues asked us to discuss our subject matter jurisdiction. We asked for supplemental briefing. In light of our holding that the Rule is ambiguous, the United States now concedes, in a second amicus brief, that we have subject matter jurisdiction under § 1365(a). We agree with the United States.

A citizen can bring a suit under § 1365(a) against any person, including the United States, who is alleged to be in violation of "an effluent standard or limitation" under the CWA. A citizen suit may be brought against a person or entity illegally discharging a pollutant into covered waters without an NPDES permit. *Id.* at § 1365(f)(6). Suits under § 1365, however, are limited by the CWA's judicial review mechanism at § 1369(b). Section 1369(b) provides for the review of various actions of the EPA Administrator, including the promulgation of effluent standards, prohibitions, or limitations, as soon as those actions take place. *Id.* at § 1369(b)(1). Such suits must be brought within 120 days from the date of the Administrator's "determination, approval, promulgation, issuance or denial," unless the basis for the suit arose more than 120 days after the agency action. *Id.* Any action that could have been brought under § 1369(b) "shall not be subject to judicial review in any civil or criminal proceeding for enforcement." *Id.* at § 1369(b)(2).

The basis for NEDC's challenge to the Silvicultural Rule arose more than 120 days after the promulgation of the Rule. As we discuss in greater detail below, the Silvicultural Rule is susceptible to two different readings. Under one reading, the Rule does not require permits for silviculture stormwater runoff. Under this reading, the Rule is inconsistent with the CWA and hence invalid. Under the other reading, the Rule requires permits for the runoff and is consistent with the CWA. The United States adopted the first reading of the Silvicultural Rule for the first time in its initial amicus brief in this case. Until the United States filed that brief, there was no way for the public to know which reading of the Silvicultural

Rule it would adopt. As the government states in its second amicus brief to us,

> At the time an ambiguous regulation is promulgated . . . the public cannot reasonably be expected to challenge potential regulatory interpretations that are textually plausible but that the agency has not contemporaneously offered and may never adopt. Indeed, a rule encouraging such challenges to hypothetical interpretations would likely only foster unnecessary litigation.

Because the Silvicultural Rule was subject to two readings, only one of which renders the Rule invalid, and because the government first adopted its interpretation of the Rule in its initial amicus brief in this case, this case comes within the exception in § 1369(b)(1) for suits based on grounds arising after the 120-day filing window. Section 1369(b) therefore does not bar a citizen suit challenging EPA's Silvicultural Rule interpretation first adopted in its initial amicus brief in this case. We thus have subject matter jurisdiction under 33 U.S.C. § 1365(a).

III. Standard of Review

We review de novo a district court's dismissal under Rule 12(b)(6). *Knievel v. ESPN*, 393 F.3d 1068, 1072 (9th Cir. 2005). We accept as true all of NEDC's allegations of material facts and we construe them in the light most favorable to NEDC. *Id.*

We review de novo the district court's interpretation of the CWA and its implementing regulations. *League of Wilderness Defenders/Blue Mts. Biodiversity Project v. Forsgren*, 309 F.3d 1181, 1183 (9th Cir. 2002). We defer to an agency's interpretation of its own regulations unless that interpretation is plainly erroneous, inconsistent with the regulation, or based on an impermissible construction of the governing statute.

Auer v. Robbins, 519 U.S. 452, 457, 461-62 (1997). We review EPA's interpretations of the CWA under *Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc.*, 467 U.S. 837, 842-43 (1984). At *Chevron* step one, if, employing the "traditional tools of statutory construction," we determine that Congress has directly and unambiguously spoken to the precise question at issue, then the "unambiguously expressed intent of Congress" controls. *Id.* at 843. At *Chevron* step two, if we determine that the statute is "silent or ambiguous with respect to the specific issue," we must determine whether the agency's interpretation is based on a permissible construction of the statute. *Id.* at 843. An agency interpretation based on a permissible construction of the statute controls. *Id.* at 844.

IV. Discussion

NEDC contends that stormwater runoff from logging roads that is collected in a system of ditches, culverts, and channels, and is then delivered into streams and rivers, is a point source discharge subject to NPDES permitting under the CWA. Defendants, however, contend that the Silvicultural Rule exempts such runoff from the definition of point source discharge, and thus exempts it from the NPDES permitting process. Alternatively, Defendants contend that the 1987 amendments to the CWA and regulations implementing those amendments exempt such runoff from the definition of point source discharge and from the permitting process. We discuss, in turn, the definition of point source discharge, the Silvicultural Rule, and the 1987 amendments to the CWA.

A. Definition of Point Source Discharge

[1] In 1972, in the Federal Water Pollution Control Act ("FWPCA"), Congress substantially revised federal law governing clean water. Pub. L. No. 92-500, 86 Stat. 816 (1972). In 1977, the statute was renamed the Clean Water Act ("CWA"). Pub. L. No. 95-217, 91 Stat. 1566 (1977). Congress enacted the FWPCA to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" by replacing water quality standards with point source effluent limitations. 33 U.S.C. § 1251(a); *Or. Natural Desert Ass'n v. Dombeck*, 172 F.3d 1092, 1096 (9th Cir. 1998). Section 301(a) of the Act provides that, subject to certain exceptions, "the discharge of any pollutant by any person shall be unlawful." 33 U.S.C. § 1311(a). One of these exceptions is a point source discharge authorized by a permit granted pursuant to the NPDES system under § 402 of the Act. 33 U.S.C. § 1342. The combined effect of §§ 301(a) and 402 is that "[t]he CWA prohibits the discharge of any pollutant from a point source into navigable waters of the United States without an NPDES permit." *N. Plains Res. Council v. Fid. Exploration & Dev. Co.*, 325 F.3d 1155, 1160 (9th Cir. 2003); *see also Nw. Envtl. Advocates v. EPA*, 537 F.3d 1006, 1010 (9th Cir. 2008). "Pollutants" include "rock" and "sand." 33 U.S.C. § 1362(6). Defendants do not contest that sediment discharges from logging roads constitute pollutants within the meaning of the CWA.

[2] "It is well settled that the starting point for interpreting a statute is the language of the statute itself." *Gwaltney of Smithfield, Ltd. v. Chesapeake Bay Found., Inc.*, 484 U.S. 49, 56 (1987). Section 502(14) of the Act defines "point source" as

> any *discernible, confined and discrete conveyance*, including but not limited to *any pipe, ditch, channel, tunnel, conduit*, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

33 U.S.C. § 1362(14) (emphasis added). The term "nonpoint source" is left undefined.

[3] Stormwater that is not collected or channeled and then discharged, but rather runs off and dissipates in a natural and unimpeded manner, is not a discharge from a point source as defined by § 502(14). As we wrote in *League of Wilderness Defenders/Blue Mountains Biodiversity Project v. Forsgren*, 309 F.3d 1181, 1184 (9th Cir. 2002):

> Although nonpoint source pollution is not statutorily defined, it is widely understood to be the type of pollution that arises from many dispersed activities over large areas, and is not traceable to any single discrete source. Because it arises in such a diffuse way, it is very difficult to regulate through individual permits. The most common example of nonpoint source pollution is the residue left on roadways by automobiles. Small amounts of rubber are worn off of the tires of millions of cars and deposited as a thin film on highways; minute particles of copper dust from brake linings are spread across roads and parking lots each time a driver applies the brakes; drips and drabs of oil and gas ubiquitously stain driveways and streets. When it rains, the rubber particles and copper dust and gas and oil wash off of the streets and are carried along by runoff in a polluted soup, winding up in creeks, rivers, bays, and the ocean.

However, when stormwater runoff is collected in a system of ditches, culverts, and channels and is then discharged into a stream or river, there is a "discernable, confined and discrete conveyance" of pollutants, and there is therefore a discharge from a point source. In other words, runoff is not inherently a nonpoint or point source of pollution. Rather, it is a nonpoint or point source under § 502(14) depending on whether it is allowed to run off naturally (and is thus a nonpoint source) or is collected, channeled, and discharged through a system of ditches, culverts, channels, and similar conveyances (and is thus a point source discharge).

Our caselaw has consistently recognized the distinction between nonpoint and point source runoff. In *Natural Resources Defense Council v. California Department of Transportation*, 96 F.3d 420, 421 (9th Cir. 1996), we were asked to enforce an already-issued NPDES permit requiring a state agency using storm drains "to control polluted stormwater runoff from roadways and maintenance yards[.]" In *Natural Resources Defense Council v. EPA* ("*NRDC v. EPA*"), 966 F.2d 1292, 1295 (9th Cir. 1992), we wrote, "This case involves runoff from diffuse sources that eventually passes through storm sewer systems and is thus subject to the NPDES permit program." In *Trustees for Alaska v. EPA*, 749 F.2d 549 (9th Cir. 1984), we explicitly agreed with a decision of the Tenth Circuit, *United States v. Earth Sciences, Inc.*, 599 F.2d 368 (10th Cir. 1978). We wrote:

> The [Tenth Circuit] observed that Congress had classified nonpoint source pollution as runoff caused primarily by rainfall around activities that employ or create pollutants. Such runoff could not be traced to any identifiable point of discharge. The court concluded that point and nonpoint sources are not distinguished by the kind of pollution they create or by the activity causing the pollution, but rather by *whether the pollution reaches the water through a confined, discrete conveyance*. Thus, when mining activities release pollutants from a discernible conveyance, they are subject to NPDES regulation, as are all point sources.

749 F.2d at 558 (emphasis added) (internal citation omitted). Finally, in *Environmental Defense Center v. EPA*, 344 F.3d 832 (9th Cir. 2003), we wrote: "Storm sewers are established point sources subject to NPDES permitting requirements. . . . Diffuse runoff, such as rainwater that is *not* channeled through a point source, is considered nonpoint source pollution and is not subject to federal regulation." *Id.* at 841, 842 n.8 (emphasis added) (internal citations omitted).

The clarity of the text of § 502(14), as well as our caselaw, would ordinarily make recourse to legislative history unnecessary. The "unambiguously expressed intent of Congress" controls. *Chevron*, 467 U.S. at 842-43. However, because EPA relied on the legislative history of the FWPCA in promulgating the Silvicultural Rule at issue in this case, we recount some of that history as background to our analysis of the Rule.

The FWPCA established "distinctly different methods to control pollution released from point sources and that traceable to nonpoint sources." *Pronsolino v. Nastri*, 291 F.3d 1123, 1126 (9th Cir. 2002). The Senate Committee elected to impose stringent permitting requirements only on point sources because "[t]here is no effective way as yet, other than land use control, by which you can intercept [nonpoint] runoff and control it in the way that you do a point source. We have not yet developed technology to deal with that kind of a problem." 117 Cong. Rec. 38825 (Nov. 2, 1971) (statement of Sen. Muskie).

The House and Senate committees made clear that the term "point source" was not to be interpreted narrowly. "By the use of the term 'discharge of pollutants' this provision [§ 402] covers any addition of any pollutant to navigable waters from any point source." H.R. Rep. No. 92-911, at 125 (1971). The Senate Committee Report instructed that

> the [EPA] Administrator should not ignore discharges resulting from point sources other than pipelines or similar conduits. . . . There are many other forms of periodic, though frequent, discharges of pollutants into the water through point sources such as barges, vessels, feedlots, trucks and other conveyances.

S. Rep. No. 92-414, at 51 (1971). Senator Dole explained his understanding of the distinction as it related to the problem of agricultural pollution:

> Most of the problems of agricultural pollution deal with non-point sources. Very simply, a non-point source of pollution is one that does not confine its pollution discharge to one fairly specific outlet, such as a sewer pipe, a drainage ditch or a conduit; thus, a feed-lot would be considered to be a non-point source as would pesticides and fertilizers.

S. Rep. No. 92-414, at 98-99 (1971) (Supplemental Views of Sen. Dole).

Congress did not provide the EPA Administrator with discretion to define the statutory terms. Senator Randolph, the Chairman of the Senate Committee, explained, "We have written into law precise standards and definite guidelines on how the environment should be protected. We have done more than just provide broad directives [for] administrators to follow." 117 Cong. Rec. 38805 (Nov. 2, 1971). Senator Muskie, another major proponent of the legislation, clarified that EPA would provide "[g]uidance with respect to the identification of 'point sources' and 'nonpoint sources.' " 117 Cong. Rec. 38816 (Nov. 2, 1971). However, "[i]f a man-made drainage, ditch, flushing system or other such device is involved and if measurable waste results and is discharged into water, it is considered a 'point source.' " *Id.*

[4] Congress also sought to require permits for any activity that met the legal definition of "point source," regardless of feasibility concerns. For example, Congressman Roncalio of Wyoming proposed an amendment to exempt irrigated agriculture from the NPDES permit program because it was "virtually impossible to trace pollutants to specific irrigation lands, making these pollutants a nonpoint source in most cases." 118 Cong. Rec. 10765 (Mar. 29, 1972). Opponents objected that the amendment would exclude large point source polluters simply because the channeled water originally derived from irrigated agriculture. Congressman Waldie explained:

> In California there is a vast irrigation basin that collects all the waste resident of irrigation water in the Central Valley and places it in a drain— the San Luis Draining—and transport[s] it several hundreds of miles and then dumps it into the San Joaquin River which flows into the estuary and then into San Francisco Bay. It is highly polluted water that is being dumped in waters already jeopardized by pollution.
>
> Will the gentleman's amendment establish that as a nonpoint source pollution or will it come under the point source solution discharge?

Id. Congressman Roncalio responded that his amendment would not require permitting for this type of activity — that is, that it would redefine these agricultural point sources as nonpoint source pollution. His amendment was then rejected on the House floor. *See id.*

Congress eventually adopted a statutory exemption for agricultural irrigation in 1977, five years after the passage of the FWCPA. *See* CWA § 402(*l*), 33 U.S.C. § 1342(*l*) ("The Administrator shall not require a permit under this section for discharges composed entirely of return flows from irrigated agriculture, nor shall the Administrator directly or indirectly, require any State to require such a permit."); CWA § 502(14), 33 U.S.C. § 1362(14) ("This term does not include return flows from irrigated agriculture."). Congress did so to alleviate EPA's burden in having to issue permits for every agricultural point source. "The problems of permitting every discrete source or conduit returning water to the streams from irrigated lands is simply too burdensome to place on the resources of EPA." 123 Cong. Rec. 38956 (Dec. 15, 1977) (statement of Rep. Roberts). Congress did not, however, grant EPA the discretion to exempt agricultural discharges from the general statutory definition of point source discharges. Rather, Congress exempted such discharges by amending the statute.

Congress has never granted a similar statutory exemption for silvicultural discharges from the general definition of point source discharges.

Despite the foregoing, Defendants contend that stormwater runoff from logging roads that is collected in a system of ditches, culverts, and channels, and is then discharged into streams and rivers, is a nonpoint source discharge. Defendants contend that the Silvicultural Rule exempts such discharges from the definition of point source discharge contained in § 502(14), and therefore from the NPDES permitting system. Alternatively, Defendants contend that the 1987 amendments to the CWA exempted such discharges from the permitting system. We discuss defendants' two contentions in turn.

B. The Silvicultural Rule

1. Adoption of the Rule

In 1973, one year after the passage of the FWPCA, EPA promulgated regulations categorically exempting several kinds of discharges from the NPDES permit program. Exempted discharges included discharges from storm sewers composed entirely of storm runoff uncontaminated by industrial or commercial activity, discharges from relatively small animal confinement facilities, discharges from silvicultural activities, and irrigation return flow from point sources where the flow was from less than 3000 acres. The exemption for discharges from silvicultural activities provided:

> The following do not require an NPDES permit:
>
> . . .
>
> (j) Discharges of pollutants from agricultural and silvicultural activities, including irrigation return flow and runoff from orchards, cultivated crops, pas-

> tures, rangelands, and forest lands, except that this exclusion shall not apply to the following:
>
> . . .
>
> (5) Discharges from any agricultural or silvicultural activity which have been identified by the Regional Administrator of the Director of the State water pollution control agency or interstate agency as a significant contributor of pollution.

40 C.F.R. § 125.4 (1975). The Natural Resources Defense Council challenged the regulations as inconsistent with the statute. *See Natural Res. Def. Council v. Train*, 396 F. Supp. 1393 (D.D.C. 1975).

EPA defended the challenged regulations on the ground "that the exempted categories of sources are ones which fall within the definition of point source but which are ill-suited for inclusion in a permit program." *Id.* at 1395. The district court wrote that EPA has authority to clarify by regulation the definition of nonpoint and point source discharges, but only so long as its regulations comply with the statutory text. *Id.* at 1395-96. In the court's view, the challenged regulations categorically exempted "entire classes of point sources from the NPDES permit requirements." *Id.* at 1396. The court therefore held that the regulations were fatally inconsistent with the definition contained in § 502(14), writing "that the Administrator [of the EPA] cannot lawfully exempt point sources discharging pollutants from regulation under NPDES." *Id.* at 1402.

EPA appealed to the D.C. Circuit. While the appeal was pending, EPA grudgingly promulgated revised regulations. For example, in soliciting public comment on a proposal for a "system for separate agricultural and silvicultural storm sewers" rule in December 1975, EPA wrote:

> In promulgating the [earlier] regulations EPA stated its belief that while some point sources within the excluded categories may be significant contributors of pollution which should be regulated consistent with the purposes of the FWPCA, it would be administratively difficult if not impossible, given Federal and State resource levels, to issue individual permits to all such point sources. . . . Essentially, these [earlier] regulations providing for exemptions were based on EPA's view (*a view which it continues to maintain is correct*) that most sources within the exempted categories present runoff-related problems not susceptible to the conventional NPDES permit program including effluent limitations. *EPA's position was and continues to be* that most rainfall runoff is more properly regulated under section 208 of the FWPCA [which does not require NPDES permits], whether or not the rainfall happens to collect before flowing into navigable waters. Agricultural and silvicultural runoff, as well as runoff from city streets, frequently flows into ditches or is collected in pipes before discharging into streams. EPA contends that most of these sources are nonpoint in nature and should not be covered by the NPDES permit program.

40 Fed. Reg. 56932 (Dec. 5, 1975) (emphasis added).

[5] Two months later, in February 1976, EPA proposed a revised Silvicultural Rule and solicited public comment. EPA wrote,

> [T]he Agency has carefully examined the relationship between the NPDES permit program (which is designed to control and eliminate discharges of pollutants from discrete point sources) and water pollution from silvicultural activities (which tends to result from precipitation events). It has been deter-

> mined that most water pollution related to silvicultural activities is nonpoint in nature.

41 Fed. Reg. 6282 (Feb. 12, 1976).

EPA continued:

> Those silvicultural activities which are specified in the regulations (rock crushing, gravel washing, log sorting and log storage facilities), and are thus point sources, are subject to the NPDES permit program. Only those silvicultural activities that, as a result of controlled water used by a person, discharge pollutants through a discernible, confined and discrete conveyance into navigable waters are required to obtain a § 402 pollution discharge permit.

Id. This passage provides EPA's central criterion for distinguishing between silvicultural point and nonpoint sources. EPA proposed to characterize discharges of pollutants through a discernible, confined and discrete conveyance as point source discharges only when they were "a result of controlled water used by a person." Under this criterion, the proposed rule named as point source discharges only those related to "rock crushing, gravel washing, log sorting, [and] log storage facilities." *Id.* 6283 (Proposed Rule); 41 Fed. Reg. 24711 (Jun. 18, 1976) (Final Rule); 40 C.F.R. § 124.85 (1976). Any other silvicultural discharge of pollutants, even if made through a discernible, confined and discrete conveyance, was considered a nonpoint source of pollutants. In effect, this meant that any natural runoff containing pollutants was not a point source, even if the runoff was channeled and controlled through a "discernible, confined and discrete conveyance" and then discharged into navigable waters.

In its "response to comments" accompanying the final version, EPA provided more general criteria by which to distinguish nonpoint from point sources of pollution. It wrote:

> Basically, nonpoint sources of water pollution are identified by three characteristics:
>
> (i) The pollutants discharged are induced by natural processes, including precipitation, seepage, percollation [sic], and runoff;
>
> (ii) The pollutants discharged are not traceable to any discrete or identifiable facility; and
>
> (iii) The pollutants discharged are better controlled through the utilization of best management practices, including process and planning techniques.
>
> In contrast to these criteria identifying nonpoint sources, point sources of water pollution are generally characterized by discrete and confined conveyances from which discharges of pollutants into navigable waters can be controlled by effluent limitations. It is these point sources in the silviculture category which are most amenable to control through the NPDES permit program.

41 Fed. Reg. 24710 (Jun. 18, 1976). EPA specifically noted that the single criterion for point sources—resulting from "controlled water used by a person"— was underinclusive. EPA pointed out that some point source discharges take place "regardless of any [prior] contact with water," such as discharges of wood chips and bark directly into navigable water. *Id.*

[6] However, the actual text of the final version of the Silvicultural Rule was little changed from the version proposed in February. *See* 41 Fed. Reg. 24711 (Jun. 18, 1976). The revised Rule provided in pertinent part:

> Silvicultural activities.

(a) Definitions. For the purpose of this section:

(1) The term "silvicultural point source" means any discernible, confined and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into navigable waters of the United States.

Comment: This term does not include nonpoint source activities inherent to silviculture such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, and road construction and maintenance from which runoff results from precipitation events.

40 C.F.R. § 124.85 (1976). Even though there was no longer a single criterion for identifying point source discharges, the same four activities were specified as producing point source discharges—rock crushing, gravel washing, log sorting and log storage. *Id.* And even though there were now three general criteria for identifying nonpoint sources, the effect of the Rule was to treat all natural runoff as nonpoint pollution, even if channeled and discharged through a discernible, confined and discrete conveyance.

In comments accompanying the proposed Silvicultural Rule in February 1976, EPA provided, in concise form, its justification for the Rule. It wrote:

Technically, a point source is defined as a "discernible, confined and discrete conveyance, including but not limited to any pipe, ditch [or] channel * * *" (§ 502(14) of the FWPCA) and includes all such conveyances. However, a proper interpretation of the

> FWPCA as explained in the legislative history and supported by the [district] court in *NRDC v. Train* is that not every "ditch, water bar or culvert" is "means [sic] to be a point source under the Act [FWCPA]." It is evident, therefore, that ditches, pipes and drains that serve only to channel, direct, and convey non-point runoff from precipitation are not meant to be subject to the § 402 permit program.

41 Fed. Reg. 6282 (Feb. 12, 1976). A sentence-by-sentence analysis shows the weakness of EPA's justification.

In the first sentence, EPA wrote that "[t]echnically, a point source is defined as a 'confined and discrete conveyance, including but not limited to any pipe, ditch, [or] channel.' " The words quoted by EPA in this sentence were a direct (though partial) quotation of the statutory definition of "point source" contained in § 502(14) of the FWPCA. EPA's choice of the word "technically" is somewhat odd and even misleading; perhaps EPA hoped that the word would diminish the force of the statutory definition. But whatever its motive, EPA would have been more accurate if it had written "textually" instead of "technically."

In the second sentence, EPA wrote that "a proper interpretation of the FWCPA as explained in the legislative history and supported by the court in *NRDC v. Train* is that not every 'ditch, water bar or culvert' is 'mean[t] to be a point source under the Act [FWCPA].' " EPA was putting words into the district court's mouth. The district court did not hold that "not every 'ditch, water bar or culvert' is 'meant to be a point source.' " Rather, the court wrote only that the plaintiff in the case, NRDC, had not made that argument. *See Train*, 396 F. Supp. at 1401 ("NRDC does not contend that every farm ditch, water bar, or culvert on a logging road is properly meant to be a point source under the Act."). Further, and more important, everyone understands that a "ditch, water bar or culvert" *that does not discharge into navigable waters* is not a point source. But the regulation does not exempt only such ditches, water bars or culverts. Instead, it categorically exempts collected runoff from silviculture, whether or not there is a discharge into navigable waters.

[7] Finally, in the last sentence EPA wrote, "It is evident, therefore, that ditches, pipes and drains that serve only to channel, direct, and convey nonpoint runoff from precipitation are not meant to be subject to the § 402 permit program." The text of § 502(14), quoted in the first sentence of the paragraph, is flatly inconsistent with this statement. Under § 502(14), a pollutant comes from a point source if it is collected and discharged through ditches, pipes, channels, and similar conveyances. Section 502(14) says nothing, either explicitly or implicitly, about the source of the water contained in the discharge. Further, even though not every "ditch, water bar, or culvert" is a point source within the meaning of the statute, it hardly follows that a system of ditches, pipes and channels that collects "controlled water used by a person" and discharges it into a river is a point source, while an identical system that collects and discharges natural precipitation is not.

[8] After EPA promulgated the revised Silvicultural Rule, the Court of Appeals for the D.C. Circuit affirmed the district court's disapproval of the 1973 regulations, including the original Silvicultural Rule. *Natural Res. Def. Council v. Costle*, 568 F.2d 1369 (D.C. Cir. 1977). The court did not review the revised Silvicultural Rule promulgated in 1976. The court held that EPA did not have the authority categorically to exempt point source discharges. It wrote:

> Under the EPA's interpretation the Administrator would have broad discretion to exempt large classes of point sources from any or all requirements of the FWCPA. This is a result that the legislators did not intend. Rather they stressed that the FWCPA was a

> tough law that relied on explicit mandates to a degree uncommon in legislation of this type.

Id. at 1375.

The court responded to EPA's argument that a literal interpretation of the FWCPA's definition of "point source" "would place unmanageable burdens on the EPA":

> There are innumerable references in the legislative history to the effect that the Act is founded on the "basic premise that a discharge of pollutants without a permit is unlawful and that discharges not in compliance with the limitations and conditions for a permit are unlawful." *Even when infeasibility arguments were squarely raised, the legislature declined to abandon the permit requirement.*

Id. at 1375-76 (emphasis added). The court concluded:

> The wording of the statute, legislative history, and precedents are clear: the EPA Administrator does not have authority to exempt categories of point sources from the permit requirements of § 402. Courts may not manufacture for an agency a revisory power inconsistent with the clear intent of the relevant statute.

Id. at 1377.

[9] Although the D.C. Circuit did not address the revised Silvicultural Rule in its opinion, its reasoning is no less applicable to the new version of the Rule. The court concluded that EPA does not have the authority to "exempt categories of point sources" from the permitting requirements of § 402. This is so even if EPA contends that the literal terms of the statute would place "unmanageable burdens" on the agency.

The FWCPA was a "tough law" that EPA was not at liberty to ignore.

2. The Revised Silvicultural Rule

The current text of the revised version of the Silvicultural Rule is different in only minor respects from the version promulgated in 1976. In pertinent part, the current version provides:

> (b) *Definitions*. (1) *"Silvicultural point source"* means any discernible, confined and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States. The term does not include non-point source silvicultural activities such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance from which there is natural runoff.

40 C.F.R. § 122.27.

The text of the CWA distinguishes between point and non-point sources depending on whether the pollutant is channeled and controlled through a "discernible, confined and discrete conveyance." CWA § 502(14), 33 U.S.C. § 1362(14). The Silvicultural Rule, by contrast, categorically distinguishes between the two types of discharges depending on the source of the pollutant. Under the Rule, "silvicultural point source" discharges are those discharged through "discernible, confined and discrete conveyance[s]," but only when they are direct discharges of wood chips, bark, and the like, or discharges resulting from "controlled water used by a person." *See* 41 Fed. Reg. 24710 (Jun. 18, 1976); 41 Fed. Reg. 6282

(Feb. 12, 1976). All other discharges of "natural runoff" are nonpoint sources of pollution, even if such discharges are channeled and controlled through a "discernible, confined and discrete conveyance."

A nonexhaustive list of silvicultural point source discharges under the Rule includes discharges "related to rock crushing, gravel washing, log sorting, [and] log storage facilities." A nonexhaustive list of silvicultural nonpoint sources of pollution under the Rule includes "silvicultural activities such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance."

[10] The original Silvicultural Rule, which was struck down by the district court in *Train* and on appeal in *Costle*, categorically exempted all discharges from silvicultural activities. The current Rule categorically exempts all discharges from silvicultural activities resulting from natural runoff. The categorical exemption in the current Rule is somewhat smaller than the exemption in the original Rule, but it is a categorical exemption nonetheless. Indeed, in a later rulemaking proposal EPA specifically characterized it as a categorical exemption. *See* 64 Fed. Reg. 46058, 46077 (Aug. 23, 1999) ("Currently, runoff from [the list of "non-point source silvicultural activities"] is categorically excluded from the NPDES program."). The question before us is whether the categorical exemption from the NPDES permit program in the current Rule is based on a permissible interpretation of § 502(14).

We have dealt with the Silvicultural Rule once before. In *League of Wilderness Defenders/Blue Mountain Diversity Project v. Forsgren* ("*Forsgren*"), 309 F.3d 1181 (9th Cir. 2002), several environmental groups sued to enjoin unpermitted aerial spraying of insecticide to combat the Douglas Fir Tussock Moth. Some of the insecticide was sprayed onto the surface of streams. Plaintiffs contended that the aerial spraying was a discharge from a point source requiring an NPDES permit. Relying on the Silvicultural Rule and on two letters and a guidance document from EPA, the Forest Service took the position that the spraying was not a point source discharge, and that a permit was therefore not required. We disagreed with EPA and the Forest Service.

The core of the EPA and Forest Service argument was that "pest . . . control" was one of the activities listed in the Silvicultural Rule as not constituting a point source discharge. We wrote:

> The Forest Service's argument fails because the statute itself is clear and unambiguous. The statutory definition of point source, "any discernible, confined and discrete conveyance, including but not limited to any . . . vessel," 33 U.S.C. § 1362(14), clearly encompasses an aircraft equipped with tanks spraying pesticide from mechanical sprayers directly over covered waters. The Forest Service cannot contravene the will of Congress through its reading of administrative regulations.

Forsgren, 309 F.3d at 1185-86.

We pointed out that the Rule characterized a pest control discharge as nonpoint only when it was "silvicultural pest control *from which there is natural runoff*." *Id.* at 1186 (emphasis in original). If pest control activity resulted in natural runoff, that runoff was not a point source discharge under § 502(14). But it was undisputed in *Forsgren* that aerial spraying of pesticide into streams was not "natural runoff." We had no occasion to rule on, and did not discuss, whether silvicultural activities from which there is natural runoff *that is channeled, controlled, and discharged through a "discernible, confined and discrete conveyance"* is a point source under § 502(14).

[11] We emphatically "reject[ed] the Forest Service's argument that the EPA has the authority to 'refine' the definitions of point source and nonpoint source pollution in a way that contravenes the clear intent of Congress as expressed in the statute." *Id.* at 1190. We wrote:

> We agree with the D.C. Circuit that the EPA has some power to define point source and nonpoint source pollution where there is room for reasonable interpretation of the statutory definition. However, the EPA may not exempt from NPDES permit requirements that which clearly meets the statutory definition of a point source by "defining" it as a non-point source. Allowing the EPA to contravene the intent of Congress, by simply substituting the word "define" for the word "exempt," would turn *Costle* on its head.

Id. We now reach the question not reached or discussed in *Forsgren* — whether discharge of natural runoff becomes a point source discharge when it is channeled and controlled through a "discernible, confined and discrete conveyance" in a system of ditches, culverts, and channels. We conclude that it does.

[12] In our view, the answer to the question before us is as clear as the answer to the questions presented in *Costle* and in *Forsgren*. The CWA prohibits "the discharge of any pollutant by any person" without an NPDES permit. 33 U.S.C. § 1311(a). The term "discharge of a pollutant" means "*any* addition of any pollutant to navigable waters from *any* point source." 33 U.S.C. § 1362(12)(A) (emphasis added). A "point source" is

> any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or

> vessel or other floating craft, from which pollutants are or may be discharged.

33 U.S.C. § 1362(14). The definition in no way depends on the manner in which the pollutant arrives at the "discernible, confined and discrete conveyance." That is, it makes no difference whether the pollutant arrives as the result of "controlled water used by a person" or through natural runoff.

We agree with the analysis of the district court in *Environmental Protection Information Center v. Pacific Lumber Co.* ("*EPIC*"), 2003 WL 25506817 (N.D. Cal.). Relying on *Forsgren*, Judge Patel concluded that stormwater runoff from logging roads that was collected in a system of ditches, culverts, and channels, and then discharged into protected water, was a point source discharge requiring an NPDES permit. After an extensive analysis, the district court wrote:

> The water runoff system this action addresses is an elaborate and extensive one. Blending a variety of drainage methods, the system covers a substantial amount of land and addresses a significant amount of water. Where this runoff system involves "surface drainage[ ] or road construction from which there is natural runoff," section 122.27 [the Silvicultural Rule] may control. But where the system utilizes the kind of conduits and channels embraced by section 502(14), section 122.27 does not control: It cannot control, for one, because section 502(14) of the CWA trumps section 122.27's operation, as EPA may not alter the definition of an existing "point source." And it cannot control, for another, because section 122.27's own terms are unsatisfied; once runoff enters a conduit like those listed in section 502(14), the runoff ceases to be the kind of "natural runoff" section 122.27 expressly targets. In this latter context, section 122.27 does not—and cannot—

> absolve silvicultural businesses of CWA's "point source" requirements.

Id. at *15 (internal citations omitted).

As pointed out by the district court in *EPIC*, there are two possible readings of the Silvicultural Rule. The first reading reflects the intent of EPA in adopting the Rule. Under this reading, the Rule exempts all natural runoff from silvicultural activities such as nursery operations, site preparation, and the other listed activities from the definition of point source, irrespective of whether, and the manner in which, the runoff is collected, channeled, and discharged into protected water. If the Rule is read in this fashion, it is inconsistent with § 502(14) and is, to that extent, invalid.

[13] The second reading does not reflect the intent of EPA, but would allow us to construe the Rule to be consistent with the statute. Under this reading, the Rule exempts natural runoff from silvicultural activities such as those listed, but only as long as the "natural runoff" remains natural. That is, the exemption ceases to exist as soon as the natural runoff is channeled and controlled in some systematic way through a "discernible, confined and discrete conveyance" and discharged into the waters of the United States.

[14] Under either reading, we hold that the Silvicultural Rule does not exempt from the definition of point source discharge under § 512(14) stormwater runoff from logging roads that is collected and channeled in a system of ditches, culverts, and conduits before being discharged into streams and rivers.

C. 1987 Amendments to the CWA

Defendants contend in the alternative that even if the discharges from a system of ditches, culverts, and channels are point source discharges within the meaning of § 502(14), and even if the Silvicultural Rule does not exempt such discharges from § 502(14), the discharges are nonetheless exempt from the permitting process because of the 1987 amendments to the CWA. Defendants made this contention in the district court, but that court did not decide the question.

We can affirm the decision of the district court on any ground supported by the record, even one not relied on by that court. *Thompson v. Paul*, 547 F.3d 1055, 1058-59 (9th Cir. 2008). Defendants urge us, if we hold that the Silvicultural Rule does not exempt the discharges, to affirm the district court based on the 1987 amendments. No factual development is necessary given that the district court dismissed under Rule 12(b)(6). The parties have briefed the question in this court. We therefore reach the question.

1. Congressional Approval or Acquiescence

As a threshold matter, we consider whether, in adopting the 1987 amendments to the CWA, Congress *sub silentio* approved of, or acquiesced in, the Silvicultural Rule. We conclude that Congress did not.

In some instances, congressional re-enactment of statutes can be persuasive evidence of approval of longstanding administrative regulations promulgated under that statute. In *NLRB v. Bell Aerospace Co.*, 416 U.S. 267, 274-75 (1974), the Court wrote, "[A] court may accord great weight to the longstanding interpretation placed on a statute by an agency charged with its administration. This is especially so where Congress has re-enacted the statute without pertinent change. In these circumstances, congressional failure to revise or repeal the agency's interpretation is persuasive evidence that the interpretation is the one intended by Congress." *See also Commodity Futures Trading Comm'n v. Schor*, 478 U.S. 833, 846 (1986) (quoting and paraphrasing *Bell Aerospace*). But this case is very different from *Bell Aerospace* and *Schor*. First, in both *Bell Aerospace* and *Schor*, the legislative histories made clear that when Congress re-enacted the statutes at issue it was well aware of the existing administrative interpretation of the statutes. Here, by contrast, there is no indication that Congress was aware of the Silvicultural Rule when it adopted the 1987 amendments. There is no mention of, or even allusion to, the Rule anywhere in the legislative history of the amendments. Second, in both *Bell Aerospace* and *Schor*, the relevant portions of the statutes at issue were re-enacted essentially without change. Here, as we explain below, the 1987 amendments fundamentally changed the statutory treatment of stormwater discharges. Third, the language of the original and the re-enacted statutes in both *Bell Aerospace* and *Schor* was readily susceptible to the administrative interpretations of those statutes. Here, by contrast, the relevant statutory language is flatly inconsistent with the Silvicultural Rule.

In other instances, congressional action or inaction can constitute acquiescence in an existing regulation. The Supreme Court has cautioned strongly against finding congressional acquiescence. In *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 531 U.S. 159, 162 (2001), it wrote, "Although we have recognized congressional acquiescence to administrative interpretations of a statute in some circumstances, we have done so with extreme care." After discussing a case in which there had been congressional hearings on the precise issue, and in which thirteen bills had been introduced in unsuccessful attempts to overturn the regulation, the Court wrote, "Absent such overwhelming evidence of acquiescence, we are loath to replace the plain text and original understanding of a statute with an amended agency interpretation." *Id.* at 169-70, n.5. Here, there is no evidence whatsoever of congressional acquiescence in the Silvicultural Rule, let alone "overwhelming evidence."

2. The 1987 Stormwater Amendments

[15] Congress amended the CWA in 1987 to deal specifically with stormwater discharges. Pub. L. No. 100-4, 101 Stat.

7 (1987). Congress added § 402(p) to the CWA, establishing a "phased and tiered approach" to NPDES permitting of stormwater discharges. *See* 55 Fed. Reg. 47994 (Nov. 16, 1990) (describing 33 U.S.C. § 1342(p)). Section 402(p) fundamentally redesigned the CWA's approach to stormwater discharges.

Under the framework created by the FWCPA in 1972, EPA was required to establish a permitting system for all point source discharges of stormwater. Senator Durenberger explained that the Conference Bill that would become the 1987 amendment focused on stormwater point sources.

> The [FWPCA] of 1972 required all point sources, including stormwater dischargers, to apply for NPDES permits within 180 days of enactment by 1973. Despite this clear directive, EPA has failed to require most stormwater point sources to apply for permits which would control the pollutants in their discharge.

132 Cong. Rec. 32380, 32400 (Oct. 16, 1986). Senator Stafford, the Chairman of the Committee on Environment and Public Works reiterated, "EPA should have developed this [stormwater] program long ago. Unfortunately, it did not." 132 Cong. Rec. 32381 (Oct. 16, 1986).

Congress recognized that EPA's difficulties stemmed in part from the large number of stormwater sources falling within the definition of a point source. *See, e.g.*, 131 Cong. Rec. 19846, 19850 (Jul. 22, 1985) (statement of Rep. Rowland) ("Under existing law, the [EPA] must require [NPDES] permits for anyone who has stormwater runoff on their property. What we are talking about is potentially thousands of permits for churches, schools, residential property, runoff that poses no environmental threat[.]"); 131 Cong. Rec. 15616, 15657 (Jun. 13, 1985) (Statement of Sen. Wallop) ("[EPA regulations] can be interpreted to require everyone who has a device to divert, gather, or collect stormwater runoff and snowmelt to get a permit from EPA as a point source. . . . Requiring a permit for these kinds of stormwater runoff conveyance systems would be an administrative nightmare.").

In § 402(p), adopted as part of the 1987 amendments, Congress required NPDES permits for the most significant sources of stormwater pollution under so-called "Phase I" regulations. *See* 133 Cong. Rec. 983, 1006 (Jan. 8, 1987) (statement of Rep. Roe) ("[Section 402(p)] establishes an orderly procedure which will enable the major contributors of pollutants to be addressed first, and all discharges to be ultimately addressed in a manner which will not completely overwhelm EPA's capabilities."). Section 402(p) lists five categories of stormwater discharges, including discharges "associated with industrial activity," that are covered in Phase I. 33 U.S.C. § 1342(p)(2)(B). NPDES permits are required for all five categories of discharges. *Id.* §§ 1342(p)(1)-(2). A permit was required for such discharges by 1990. *Id.* § 1342(p)(4)(A).

All remaining stormwater discharges are to be covered by "Phase II" regulations. During Phase II, EPA is to study stormwater discharges not covered by Phase I and to issue regulations based on its study. *Id.* § 1342(p)(5)-(6). In 1999, EPA promulgated a Phase II regulation requiring NPDES permits for discharges from small municipal storm systems and small construction sites. We upheld most of that regulation in *Environmental Defense Center v. EPA*, 344 F.3d 832 (9th Cir. 2003), and remanded for further proceedings. EPA has not yet responded to the remand.

Stormwater discharges from churches, schools and residential properties, through rain gutters or otherwise, and from other relatively de minimus sources, are covered under Phase II rather than Phase I. It is within the discretion of EPA to promulgate Phase II regulations requiring, or not requiring, permits for such discharges.

3. Phase I Stormwater Regulations

In 1990, EPA promulgated "Phase I" regulations for the storm water discharges specified in § 402(p). 55 Fed. Reg. 47990 (Nov. 16, 1990); 40 C.F.R. § 122.26. For discharges "associated with industrial activity," which require NPDES permits, EPA's regulations provide:

> Storm water discharge associated with industrial activity means the discharge from any conveyance that is used for collecting and conveying storm water and that is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program under this part 122.

40 C.F.R. § 122.26(b)(14). The last sentence of this regulation refers to the Silvicultural Rule, thereby purporting to exempt from the definition of "discharges associated with industrial activity" any activity that is defined as a nonpoint source in the Silvicultural Rule. *See id.*

The preamble to the Phase I regulations makes clear EPA's intent to exempt nonpoint sources as defined in the Silvicultural Rule from the permitting program mandated by § 402(p). The preamble provides:

> The definition of discharge associated with industrial activity does not include activities or facilities that are currently exempt from permitting under NPDES. EPA does not intend to change the scope of 40 CFR 122.27 in this rulemaking. Accordingly, the definition of "storm water discharge associated with industrial activity" does not include sources . . . which are excluded under 40 CFR 122.27.

55 Fed. Reg. 47990, 48011 (Nov. 16, 1990).

[16] In the 1987 amendments, Congress exempted many stormwater discharges from the NPDES permitting process. However, Congress made clear in § 402(p) that it did not exempt "discharges associated with industrial activity." 33 U.S.C. § 1342(p)(2)(B). Indeed, Congress specifically mandated that EPA establish a permitting process for such discharges. *See* 33 U.S.C. § 1342(p)(4)(A) ("[T]he Administrator *shall* establish regulations setting forth the permit application requirements for stormwater discharges described in paragraphs (2)(B) ["discharge[s] associated with industrial activity"] and (2)(C)." (emphasis added)). In *NRDC v. EPA*, 966 F.2d 1292 (9th Cir. 1992), we struck down a part of EPA's Phase I regulations exempting point source discharges from construction sites of less than five acres. We wrote, "[I]f construction activity is industrial in nature, and EPA concedes that it is, EPA is not free to create exemptions from permitting requirements for such activity." *Id.* at 1306. Similarly, if silvicultural activity is "industrial in nature," § 402(p) requires that discharges from such activity obtain NPDES permits.

[17] Industries covered by the Phase I "associated with industrial activity" regulation are defined in accordance with Standard Industrial Classifications ("SIC"). The applicable (and unchallenged) regulation provides that facilities classified as SIC 24 are among "those considered to be engaging in 'industrial activity.' " 40 C.F.R. § 122.26(b)(14)(ii). It is undisputed that "logging," which is covered under SIC 2411 (part of SIC 24), is an "industrial activity." SIC 2411 defines "logging" as "[e]stablishments primarily engaged in cutting timber and in producing . . . primary forest or wood raw materials . . . in the field."

The regulation further defines the term "stormwater discharge associated with industrial activity" as follows:

> For the categories of industries identified in this section, the term includes, but is not limited to, storm water discharges from industrial plant yards; *imme-*

> *diate access roads* and rail lines *used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility*; material handling sites; . . . .

40 C.F.R. § 122.26(b)(14)(ii) (emphasis added).

The Timber Defendants contend that logging roads are not "immediate access roads" because they are not confined to the immediate area of the site where the logging takes place. We disagree. The Timber Defendants misunderstand the meaning of the term "immediate" as it is used in the regulations. The preamble to the Phase I regulations provides that "immediate access roads" means "roads which are exclusively or primarily dedicated for use by the industrial facility." 55 Fed. Reg. 47990, 48009 (Nov. 16, 1990).

The Timber Defendants also contend that logging roads are not "primarily dedicated" for use by the logging companies. Again, we disagree. We recognize that logging roads are often used for recreation, but that is not their primary use. Logging companies build and maintain the roads and their drainage systems pursuant to contracts with the State. Logging is also the roads' *sine qua non*: If there were no logging, there would be no logging roads.

Finally, the Timber Defendants contend that, even if the logging industry is classified by the Phase I rule and SIC 2411 as industrial, the logging sites are not "industrial facilities" because they are not typical industrial plants. Therefore, according to the Timber Defendants, any roads serving logging sites cannot be the "immediate access roads" covered by this rule. We continue to disagree. The definition of a "facility" engaging in "industrial activity" is very broad. The applicable Phase I rule provides that many industrial facilities beyond traditional industrial plants "are considered to be engaging in 'industrial activity,' " including mines, landfills, junkyards, and construction sites. 40 C.F.R. § 122.26(b)(14)(iii), (v), (x).

EPA's comments to the Phase I rules explain the breadth of the definition:

> In describing the scope of the term "associated with industrial activity", several members of Congress explained in the legislative history that the term applied if a discharge was "directly related to manufacturing, processing or raw materials storage areas at an industrial plant."

55 Fed. Reg. at 48007. However, EPA stated that it was not limiting the coverage of the rule to discharges referenced in this legislative history. It explained:

> Today's rule clarifies the regulatory definition of "associated with industrial activity" by adopting the language used in the legislative history and supplementing it with a description of various types of areas that are directly related to an industrial process (*e.g.*, industrial plant yards, immediate access roads and rail lines, drainage ponds, material handling sites, sites used for the application or disposal of process waters, sites used for the storage and maintenance of material handling equipment, and known sites that are presently or have been in the past used for residual treatment, storage or disposal).

Id.

[18] We therefore hold that the 1987 amendments to the CWA do not exempt from the NPDES permitting process stormwater runoff from logging roads that is collected in a system of ditches, culverts, and channels, and is then discharged into streams and rivers. This collected runoff constitutes a point source discharge of stormwater "associated with industrial activity" under the terms of § 502(14) and § 402(p). Such a discharge requires an NPDES permit. As we explained in *NRDC v. EPA*, 966 F.2d at 1306, "if [logging] activity is industrial in nature, and EPA concedes that it is [*see* SIC 2411], EPA is not free to create exemptions from permitting requirements for such activity." The reference to the Silvicultural Rule in 40 C.F.R. § 122.26(b)(14) does not, indeed cannot, exempt such discharges from EPA's Phase I regulations requiring permits for discharges "associated with industrial activity."

4. Effect of Remand in *Environmental Defense Center, Inc. v. EPA*

In *Environmental Defense Center,* 344 F.3d at 863, in 2003 we remanded to EPA a portion of its Phase II stormwater regulations to allow EPA to consider, *inter alia*, whether stormwater discharges from logging roads should be included in Phase II regulations. Amicus United States suggests that we delay ruling on the question whether stormwater discharges from logging roads must obtain permits under § 402(p) — that is, under Phase I regulations — until EPA has responded to the remand. We have just held that § 402(p) provides that stormwater runoff from logging roads that is collected in a system of ditches, culverts, and channels is a "discharge associated with industrial activity," and that such a discharge is subject to the NPDES permitting process under Phase I. Whether EPA might, or might not, provide further regulation of stormwater runoff from logging roads in its Phase II regulations does not reduce its statutory obligation under § 402(p). We therefore see no reason to wait for EPA's action in response to our remand in *Environmental Defense Center*.

D. Summary

In some respects, we are sympathetic with EPA. When the FWCPA was passed in 1972, EPA was faced with a near-impossible task. The breadth of the definition of point source discharge contained in § 502(14) meant that EPA was suddenly required to establish an administrative system under which enormous numbers of discharges would be subject to a new and untested permitting process. Faced with this task, EPA exempted several large categories of point source discharges from the process in order to avoid the burden imposed by the breadth of the definition contained in § 502(14).

Recognizing the burden on EPA, as well as on some of the entities subject to the NPDES permitting requirement, Congress subsequently narrowed the definition of point source discharge by providing specific statutory exemptions for certain categories of discharges. For example, in 1977, Congress exempted return flows from irrigated agriculture to alleviate the EPA's burden in having to permit "every source or conduit returning water to the streams from irrigated lands," which was what the text of the statute had required. 123 Cong. Rec. 38949, 38956 (Dec. 15, 1977) (Statement of Rep. Roberts); *see* CWA §§ 402(*l*), 502(14), 33 U.S.C. §§ 1341(*l*), 1362(14). Then in 1987, ten years later, Congress comprehensively revised stormwater regulation. It did so in part because the existing broad definition of point source discharge risked creating an "administrative nightmare" for the EPA. 131 Cong. Rec. 15616, 15657 (Jun. 13, 1985) (Statement of Sen. Wallop). It also did so in part because under the existing definition a vast number of de minimus stormwater sources, many of which posed no environmental threat, required NPDES permits. As part of the 1987 amendments, Congress enacted § 402(p), which gives discretion to EPA to exclude from the permitting process de minimus sources of stormwater pollution.

However, in cases where Congress has not provided statutory exemptions from the definition of point source, federal courts have invalidated EPA regulations that categorically exempt discharges included in the definition of point source discharge contained in § 502(14). The most directly relevant example is *Costle*, in which the D.C. Circuit invalidated the original version of the Silvicultural Rule which had exempted all discharges from silvicultural activities. Other examples include *National Cotton Council of America v. EPA*, 553 F.3d 927, 940 (6th Cir. 2009) (invalidating EPA rule exempting pesticide residue from permitting requirements because "the statutory text of the Clean Water Act forecloses the EPA's Final Rule"); *Northern Plains Resource Council v. Fidelity Exploration and Development Co.*, 325 F.3d 1155, 1164 & n.4 (9th Cir. 2003) (refusing to grant deference to EPA's approval of Montana's permitting program that exempted groundwater pollutants from permitting requirements because "[o]nly Congress may amend the CWA to create exemptions from regulation"); *NRDC v. EPA*, 966 F.2d 1292, 1304-06 (9th Cir. 1992) (holding arbitrary and capricious EPA rule exempting various types of light industry and construction sites of less than five acres from permitting requirements). Not all examples involve invalidation of recently promulgated regulations. In *Northwest Environmental Advocates v. EPA*, 537 F.3d 1006 (9th Cir. 2008), we invalidated an EPA regulation that exempted sewage discharges from vessels from the permitting process. In that case, the invalidated EPA regulation had been on the books since 1973.

Congress intentionally passed a "tough law." *Costle*, 568 F.2d at 1375. But Congress did not intend that the law impose an unreasonable or impossible burden. Congress has carefully exempted certain categories of point source discharges from the statutory definition. For those discharges that continue to be covered by the definition, the permitting process is not necessarily onerous, either for EPA or for an entity seeking a permit. For example, in appropriate circumstances a discharge may be allowed under a "general permit" requiring only that the discharger submit a "notice of intent" to make the discharge. As we explained in *Natural Resources Defense Council v. EPA*, 279 F.3d 1180, 1183 (9th Cir. 2002):

> NPDES permits come in two varieties: individual and general. An individual permit authorizes a spe-

> cific entity to discharge a pollutant in a specific place and is issued after an informal agency adjudication process. *See* 40 C.F.R. §§ 122.21, 124.1-124.21, 124.51-124.66. General permits, on the other hand, are issued for an entire class of hypothetical dischargers in a given geographical region and are issued pursuant to administrative rulemaking procedures. *See id.* §§ 122.28, 124.19(a). General permits may appropriately be issued when the dischargers in the geographical area to be covered by the permit are relatively homogenous. *See id.* § 122.28(a)(2). After a general permit has been issued, an entity that believes it is covered by the general permit submits a "notice of intent" to discharge pursuant to the general permit. *Id.* § 122.28(b)(2). A general permit can allow discharging to commence upon receipt of the notice of intent, after a waiting period, or after the permit issuer sends out a response agreeing that the discharger is covered by the general permit. *Id.* § 122.28(b)(2)(iv).

Until now, EPA has acted on the assumption that NPDES permits are not required for discharges of pollutants from ditches, culverts, and channels that collect stormwater runoff from logging roads. EPA has therefore not had occasion to establish a permitting process for such discharges. But we are confident, given the closely analogous NPDES permitting process for stormwater runoff from other kinds of roads, that EPA will be able to do so effectively and relatively expeditiously.

Conclusion

For the foregoing reasons, we conclude that stormwater runoff from logging roads that is collected by and then discharged from a system of ditches, culverts, and channels is a point source discharge for which an NPDES permit is required.

We therefore **REVERSE** the district court's grant of Defendants' motion to dismiss, and we **REMAND** to the district court for further proceedings consistent with this opinion.

Salmon Forever's 2008 Annual Reporting for SWRCB Agreement No. 07-508-551-0

and

Update for 2012 California Integrated Report – Surface Water Quality Assessment and List of Impaired Waters [Clean Water Act Sections 305(b) and 303(d)]

April, 2011

Photo: Thomas Dunklin

2003-2008 Continuous Suspended Sediment Concentrations, Turbidity, Discharge, Suspended Sediment Loads, Sand Fractions and Loads, Rainfall, Channel Surveys

in

Elk River and Freshwater Creek, Humboldt County, California

Submitted to Redwood Community Action Agency

Submitted by Salmon Forever
Project Director: Jesse Noell
Analyst: Jack Lewis
Report Preparation: Jack Lewis, Randy Klein

Contents

INTRODUCTION

This document is best viewed electronically as it contains hyperlinks to all the essential elements of this package. The package consists of water, sediment discharge, and ancillary data and analyses for HY2003 through HY2008 from four stream gaging stations on Freshwater Creek and Elk River, tributaries to Humboldt Bay, in the North Coast District. Two gaging stations in each watershed are operated using the Turbidity Threshold Sampling (TTS) system (Lewis and Eads, 2009). Gaging station locations are South Fork Elk River at Jesse Noell's house (SFM), North Fork Elk River at Kristi Wrigley's house (KRW), Freshwater Creek at Terry Roelofs' house (FTR), and Freshwater Creek at Howard Heights Bridge (HHB). Maps and aerial photos can be found in the folder Maps to roughly locate stations and cross sections. Suspended sediment loads were determined for 64 storm events at SFM, KRW, and FTR, and 44 events at HHB, which was started later in HY2005. Inter-storm loads were also computed and added to storm loads to obtain annual sediment loads. Suspended sediment concentration (SSC) from more than 5000 pumped samples were included in the computation of storm loads. A subset of nearly 700 samples was analyzed for sand fraction, and the percent sand (> 0.063 mm) of the suspended load was determined for 3 years at FTR and HHB, and 2 years at SFM and KRW. As a byproduct of the analysis, a record of SSC was produced at 10-minute intervals for all stations, from which quantiles of SSC and exceedence durations were extracted at various levels. Newcombe and Jensen's (1996) severity-of-ill-effects index was computed for a matrix of concentrations and continuous exposure periods at each station and year. In addition to the gaging station data, cross-sections have been surveyed at many locations on both streams, and differences in mean elevation and cross-sectional area were computed between successive surveys at the same location.

WATERSHED DESCRIPTIONS

Freshwater Creek. The Freshwater Creek watershed drains into the northern end of Humboldt Bay in Northern California just north of Eureka. The Redwood and Douglas-fir forested watershed trends southeast to northwest. The watershed is mainly underlain by Franciscan, Yager and Wildcat geological formations. Portions of the northeast watershed are composed of Franciscan melange formation. Until recently, Maxxam Corporation was the major landowner in the Freshwater Creek Watershed. Since their bankruptcy, these areas have been taken over by Humboldt Redwoods Co. Salmon-Forever maintains two continuous TTS monitoring stations in Freshwater Creek. Station HHB is in the lower portion of the watershed at Howard Heights bridge and the FTR station is higher on the mainstem Freshwater Creek 400 yards above Freshwater Park. The watershed area above Site FTR covers 13.2 square miles. The watershed area draining to site HHB is 27.8 square miles. TTS Monitoring commenced at site FTR in 1999 and at site HHB in 2005. The average suspended sediment yield from sites HHB (HY2005-2008) and FTR (HY 2003-2008) has been 285 and 470 tons per square mile, respectively.

Elk River. The Elk River Watershed drains into Humboldt Bay just south of Eureka. The watershed area is 56.1 square miles. The Redwood and Douglas-fir forested watershed also trends northwest to southeast. The main geologic units are the Wildcat Group underlain by the Yager Formation. Maxxam Corporation, Green Diamond Corporation, and the BLM / Headwaters Preserve were the primary landowners in Elk River watershed until recently when Maxxam lands were acquired by Humboldt Redwoods Co. Elk River is the largest watershed to drain into Humboldt Bay. Salmon-Forever operates two continuous TTS monitoring stations in Elk River. TTS monitoring commenced at sites SFM and KRW in HY 2003. Site KRW is located on the North Fork Elk River 1.0 miles above the confluence of North and South Fork Elk

Rivers. The watershed area above site KRW is 22.2 square miles. Site SFM is located on the South Fork Elk River approximately 0.5 miles above the confluence. The watershed area above site SFM is 19.3 square miles. The average suspended sediment yield from sites SFM and KRW for HY 2003-2008 has been 807 and 499 tons per square mile, respectively.

METHODS

Gaging Station Operations

All four gaging stations are operated as described in the TTS Implementation guide (Lewis and Eads, 2009) and field sampling has been undertaken in accordance with the following Standard Operating Procedures provided with this data package.

- Depth-Integrated Sampling
- Discharge Measurements
- Field Instrumentation
- Turbidity Threshold Sampling

During the period HY03-08 each gaging station had a Campbell CR10X or CR510 data logger, an ISCO Model 3700, 6700 or 6712 pumping sampler; Druck 1830 pressure transducers were standard. Turbidity sensors were suspended from a bridge-mounted or bank-mounted boom. OBS-3 turbidity sensors were used prior to HY05 at KRW and SFM, and prior to HY04 at FTR. Beginning in HY05, DTS-12 sensors were standard, but an OBS-3 was substituted occasionally during malfunctions. The DTS-12 sensors generally produce higher quality data because they have built-in mechanical wipers that clean the optics before each reading. The DTS-12 sensors also can record water temperature as well as turbidity. If turbidity is to be analyzed as a measure of water quality, it is important to remember that these two types of sensors operate according to different principles and their output is not equivalent without adjustment (Lewis, 2007). In developing relationships between turbidity and SSC, data from different sensor types are never combined without adjustment. Once SSC has been determined, differences in sensor types are no longer relevant.

Site FTR had continuous rainfall data recorded by a Campbell TR525I tipping bucket rain gage through HY08.

Laboratory Operations

Samples from water years HY03-06 were processed at the Sunnybrae Sediment Laboratory in Arcata, managed by Clark Fenton. Samples from water years HY07-08 were processed at the Laboratory in Elk River, managed by Kristi Wrigley. SSC is determined by vacuum filtration through tared 1-micron glass fiber filters. Filters are oven-dried at 105° C, cooled in a dessicator, and weighed on a Precisa XB-120-A balance to the nearest 0.0001 g. Sample water weight and sediment weight is used to calculate SSC in mg/L. A subset of samples is washed through a 0.063 mm sieve prior to vacuum filtration for determination of sand content. Laboratory methods are in accordance with the Standard Operating Procedures for Laboratory SSC provided with this data package.

Cross Section Surveys

Stream cross sections have been established in low gradient reaches of Freshwater Creek and Elk River as a result of a number of different efforts over the years.

During 2001, cross sections were established by Ed Schillinger, licensed surveyor, on the North Fork of Elk River, the South Fork of Elk River, and along Elk River below the confluence. During 2002, Keith

Barnard resurveyed the Schillinger cross sections. Salmon Forever volunteers began surveying Elk River cross sections during 1999 and have continued to date. Other cross section locations have been surveyed by the Army Corp of Engineers, ACOE (USGS gage site, 1957-67), Pacific Lumber Company and HSU student Bill Conroy.

In Freshwater Creek cross section were established in the low gradient reaches in conjunction with the FEMA flood mapping (circa 1975). Some ACOE sections have been resurveyed in 1999 by Cafferata of CalFire and at various intervals by Salmon Forever. HSU professor Andre Lehre established some sections in 1999 along the stream reach defined by the property of Dr. Terry Roelofs. Many of these have been resurveyed by Salmon Forever. Paul Bigelow, HSU student, established more cross sections during 1999 and 2000 along the Roelofs reach and at another study area upstream.

Analysis of cross sections includes comparisons of cross section area change between surveys for both the entire cross section surveyed and just the active channel area. These cross section scour and aggradation change calculations are then summed to provide an estimate of average channel change.

RESULTS

Data Access

FILE FORMATS

Data files in a TTS database consist of plain ASCII text only. These files have various extensions but are simply text files that can be opened with any text editor or easily be imported into any spreadsheet, database, or statistical program. See File Formats.doc for a description of the standard files in a TTS database.

PLOTTING THE DATA

The stage and turbidity data in the appended/corrected **.flo** data files can be plotted using the TTS Adjuster program, which can be started from the preceding hyperlink. When prompted for a starting month, enter August. On the initial screen, click on the "Browse" button, and specify the "Data" directory of this package as the TTS Home directory. After selecting a station, file, and start/end dates or dumps, click correspondingly on "Read Dates" or "Read Dumps" to view a plot. Zooming in and out can be accomplished by dragging the mouse. Scatterplots of SSC and turbidity for the displayed time window can be obtained by clicking on the"Scatterplot" button. Additional instructions are found in the TTS Adjuster manual.

The primary data products of this report are water and sediment discharge for both storm events and water years, as well as a 10-minute record of flow and SSC for each gaging station. Channel changes are also evaluated, and weekly time series plots of rainfall, turbidity and stage are provided.

In addition to the data products, this report includes an analysis of errors in suspended sediment loads, an analysis of trends in storm event loads, calculations of SSC distributions, computation of severity-of-ill-effects indexes relating to salmonids, and calculation of selected cross-section changes between 2001 and 2008. Summary tables and plots are also embedded within this document to help convey the primary conclusions drawn from the data collected.

Annual Maximum Peak Discharges

Table 1 provides the annual maximum instantaneous peak discharges for HY2003-2008. The largest magnitude stormflows occurred in HY2003 and HY2006.

Table 1. Annual maximum instantaneous peak discharges (cubic feet per second, or cfs) at Freshwater Creek and Elk River gaging stations, HY2003-2008.

HY	SFM	KRW	FTR	HHB
2003	1460	1205	1737	---
2004	884	974	832	---
2005	1021	1086	1091	1953
2006	1226	1322	1438	2191
2007	1032	1082	900	1677
2008	1206	1183	965	1760

Sediment Loads

All sediment loads and associated sample sizes are tabled in the spreadsheet Event totals.xls in the "Data" folder. Sediment loads were computed in the R software environment using R procedures developed for TTS, which are described at a general level in the TTS Implementation Guide (Lewis and Eads, 2009). Detailed documentation including commands, scatterplots and estimated loads and statistics for alternative models, as well as graphs of discharge, turbidity, and SSC for each event are provided in this data package by water year within the Data Correction and Load Calculations folder in documents titled "...Event Load.doc". Similar documentation is provided for annual loads in documents titled "...Annual Load.doc". Annual loads were estimated by summing storm loads and inter-storm loads. Inter-storm loads were calculated using a single relationship between SSC and turbidity, and if any turbidity data were missing, a single relationship between SSC and discharge was employed wherever turbidity was missing. Figure 1 shows annual loads for the subject streams and Figure 2 shows these same data expressed on a unit area basis (kg/km^2).

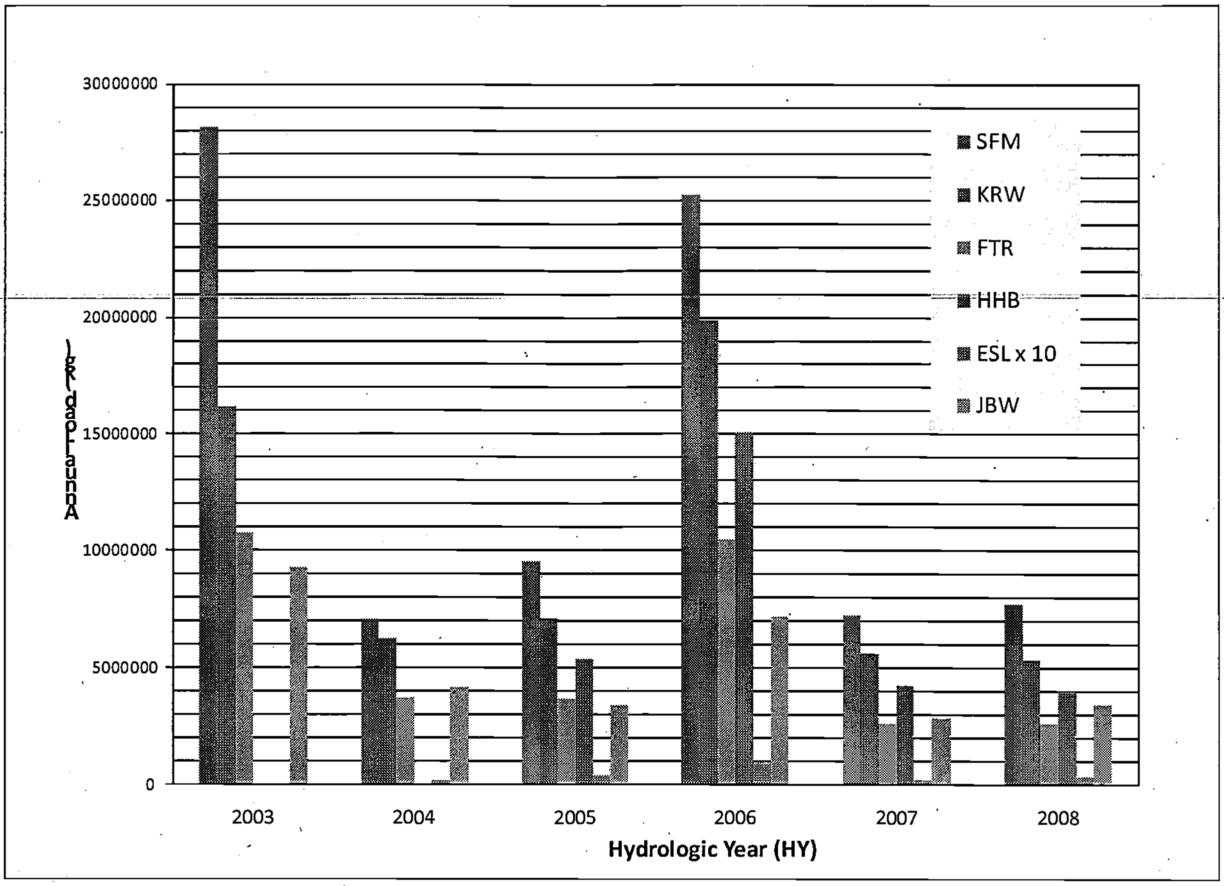

Figure 1. Annual suspended sediment loads for focal sites and another managed site (JBW) and a relatively pristine site (ESL). Note that loads for ESL are multiplied by 10 so they appear visible on the graph.

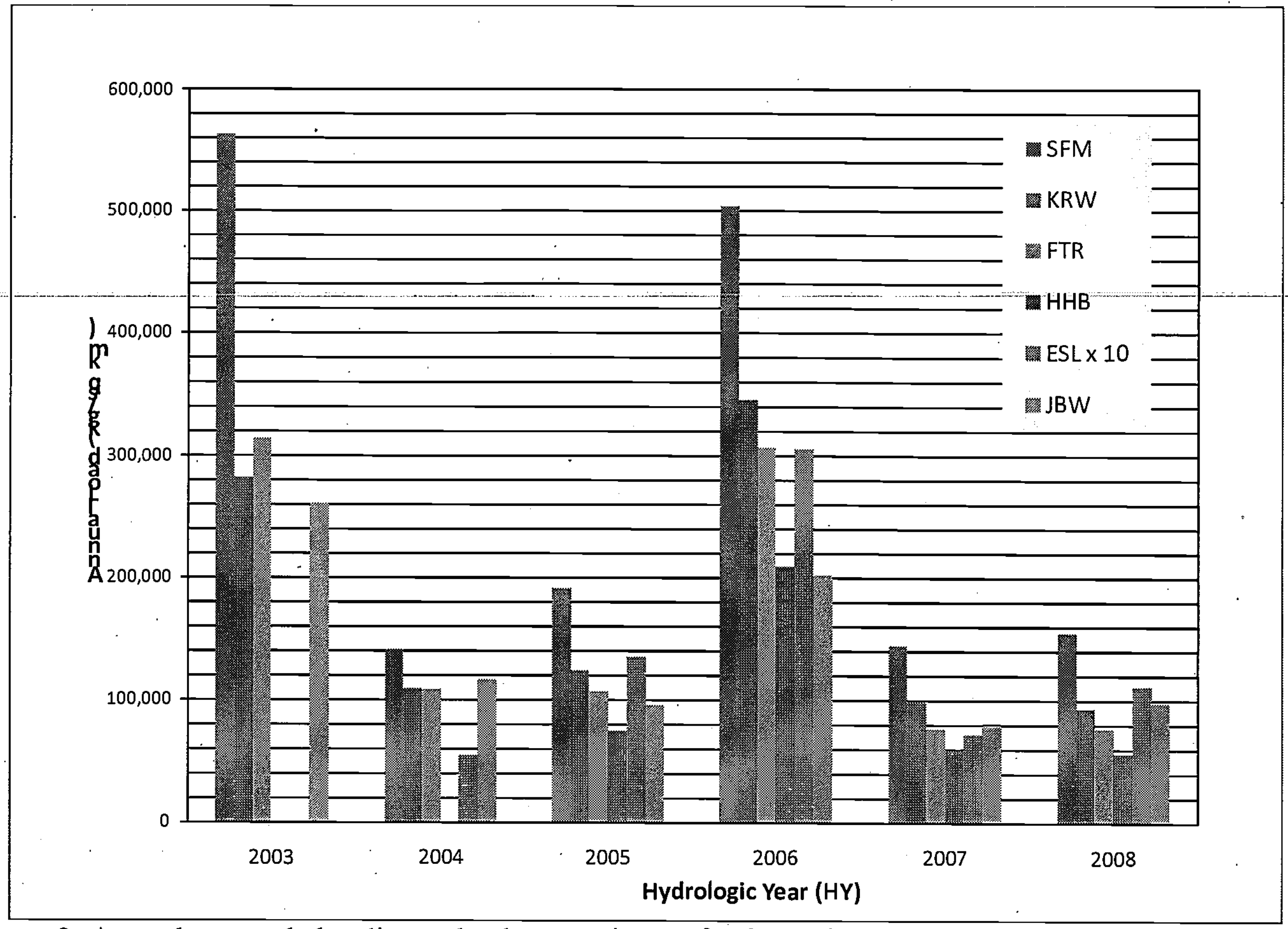

Figure 2. Annual suspended sediment loads per unit area for focal sites and another managed site (JBW) and a relatively pristine site (ESL). Note that loads for ESL are multiplied by 10 so they appear visible on the graph

Loads for the four sites in Elk River and Freshwater Creek that are the subject of this report can be compared with those for Little South Fork Elk River (ESL, note that no load exists for this site for HY2003) generously provided by Humboldt Redwoods Co. (HRC). ESL loads are multiplied by 10 so they can be seen in Figures 1 and 2. ESL is a small watershed (3.11 km^2) located in upper NF Elk within the Headwaters Preserve and the area above the gaging station is mostly old-growth redwood forest and thus relatively pristine.

Table 2 shows the percentages by which the area-weighted Elk River and Freshwater Creek loads were above those of ESL.

Table 2. Percentages by which annual loads (in kg/km^2) for Elk River and Freshwater Creek sites exceeded those of Little South Fork Elk River (ESL) (no data for HY2004 for HHB).

HY	SFM	KRW	FTR	HHB
2004	2470	1887	1870	
2005	1320	821	694	456
2006	1551	1032	905	586
2007	1911	1259	960	721
2008	1284	733	585	404

Figure 3 plots annual maximum peak discharges against annual suspended sediment loads for the four sites. Although the utility of annual maximum peak discharge as an index of hydrologic stress is far from perfect, there appears to be some predictive value judging by the linearity of points in Figure #.

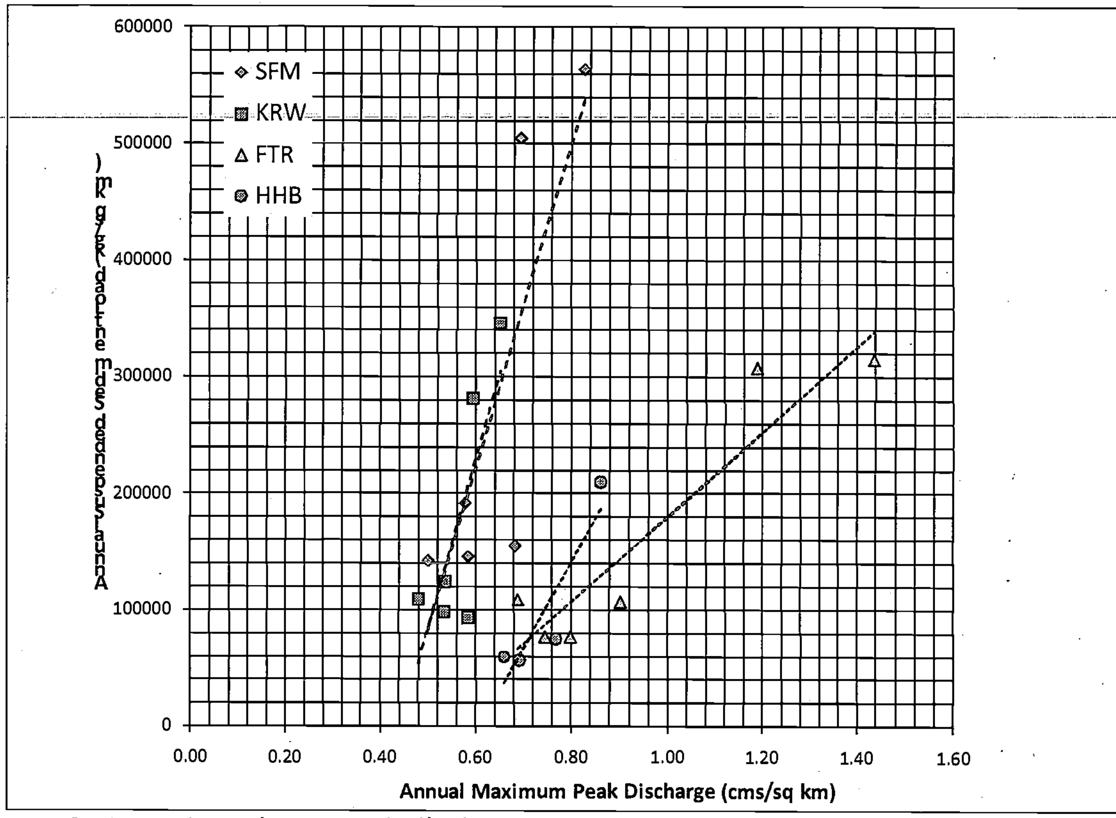

Figure 3. Annual maximum peak discharge versus annual suspended sediment loads for Freshwater Creek and Elk River sites, HY2003-2008 (no data available for HHB for HY2003-2004).

Both the Elk River sites plot much higher and steeper in Figure # than the Freshwater Creek sites, indicating greater watershed erodibility, sensitivity to disturbance, and possibly sediment transport capacity.

Sand Fractions

Sand fractions and associated sample sizes are tabled in the spreadsheet Event totals.xls in the "Data" folder. The proportion of sand in the annual load was calculated by first computing the annual load of fines (< 0.063 mm), then subtracting the annual load of fines from the total annual load to arrive at annual sand load, and finally dividing by the total annual load. The reason for arriving at the sand loads by subtraction is that fine sediment is much better correlated with turbidity than sand is, therefore fine sediment can be more reliably estimated using the turbidity data. Both the fines and total loads were estimated from the subset of samples for which sand and fine fractions were available (about 35% of all samples). The fines and total loads were each calculated using a single relationship between SSC and turbidity, and if any turbidity data were missing, an additional relationship between SSC and discharge was employed. Detailed documentation including commands, scatterplots, estimated loads, and statistics for alternative models are provided in this data package by water year within the Data Correction and Load Calculations folder in documents titled and "…Annual Sand Load.doc.

Scatterplots showing sand fraction plotted against total SSC and water discharge are provided in the document Sand Fraction Plots.doc. There appear to be no relationships between sand fraction and either SSC or discharge at the Elk River stations, SFM and KRW. There appear to be weak positive correlations, at least in 2006 and 2008, between sand fraction and both SSC and discharge at the Freshwater stations, FTR and HHB.

Analysis of Errors

A detailed analysis of errors in the annual suspended sediment loads was undertaken and is described in the document Error Analysis.doc. Total error in the annual loads is estimated to average about 13%. TTS successfully reduced errors due to sampling and modeling so that they are smaller than the uncertainty in discharge. By contrast, in typical sampling programs with no turbidity monitoring and infrequent storm sampling, errors due to sampling and modeling dominate and can easily reach or exceed 50% of the estimated load.

Trend Analysis

The storm event loads can be used to investigate trends in sediment by computing a regression of storm event loads between two stations then looking for a trend in residuals versus time. This has been done for KRW/SFM, HHB/FTR, FTR/ SFM, and FTR/KRW. Among tests for linear trends, none are significant at the 0.05 level. Results of the analysis are contained in the file Trend Analysis Results.doc. Results along with the commands used in the analysis are contained in the file Trend Analysis with Commands.doc. Equivalent trend analyses for KRW/SFM and HHB/FTR are also shown in the worksheets of Event totals.xls.

Hydrologic trends are also analyzed here relative to Little South Fork Elk River (Station ESL). Humboldt Redwoods Co. (HRC) generously provided stream gaging records from Little South Fork Elk River (ESL), a 3.02 km^2 sub-basin of the South Fork Elk River that has never been harvested. A 1.6 kilometer section of road was constructed in the early 1990s for proposed logging. After the area was included in the Headwater Forest Reserve, the road was decommissioned in 2003 with complete slope restoration. The gaging station was originally installed and maintained by Peter Manka, a graduate student at Humboldt State University (Manka, 2005) and taken over by HRC in 2007. Because the site is very remote and responsibilities for station operation have shifted more than once, data quality has varied (Tables 3-4).

Table 3. HRC assessment of data quality from Little South Fork Elk gaging station

	HY 2004	HY 2005	HY 2006	HY 2007	HY 2008
Stage	Excellent	Very good	Fair	Excellent	Fair/Good
Discharge	Excellent	Very good	Fair	Very good	Fair
Turbidity	Very good	Excellent	Poor/Fair	Very good	Good
Phys samples	Very good	Very good	Fair	Very good	Good

Table 4. Number of discharge measurements and automatic sediment samples collected

	HY 2004	HY 2005	HY 2006	HY 2007	HY 2008
Discharge	12	12	7	7	8
Pump samples	57	91	18[a]	56	8

[a]All HY 2006 samples were collected prior to Jan 1, 2006

The data provided by HRC include 10-minute values of stage, discharge, turbidity, SSC, and sediment flux. The SSC values were computed by HRC using annual regressions of SSC versus turbidity, borrowing samples from other years when necessary. In 2007, three different regressions were applied to different periods. For all the analyses below, we extracted the periods of record corresponding to the storm events previously defined for the Salmon Forever gaging stations. In the future, it would be desirable to recompute the storm event loads using relationships based upon corresponding storm samples (when available), in the same manner as was done for Salmon Forever.

Because of its unmanaged condition and proximity to Elk and Freshwater Creeks, ESL has the potential to be a good control for the other Salmon-Forever gaging stations (focal watersheds). Any hydrologic changes occurring at ESL are likely driven by forces (primarily rainfall) that would cause correlated changes in the focal watersheds. To evaluate the suitability of ESL as a control watershed, we examined regression scatterplots of storm variables (Fig 3). Regressions with the least scatter provide the best opportunities for detecting changes and trends. In general, the Elk River gages correlate better to ESL than do the Freshwater gages, and HHB correlates better than FTR. The relationships are stronger for storm peaks and flow volumes than for sediment loads, and the weakest relationships are for mean SSC. Therefore we might anticipate that it will be easiest to identify changes in SFM and KRW peaks and flow volumes.

Since the focal watersheds have been subject to logging for years, they are likely undergoing more rapid change than ESL. Some of the scatter in the regressions may be due to short-term hydrologic changes related to harvesting, revegetation, road use, silvicultural and road treatments. A regression residual is the vertical difference between a point in the scatterplot and the regression line. We can evaluate hydrologic change in the focal watersheds by plotting the sequence of residuals against time. In Figure 4, the storm sequence number is plotted on the horizontal axis and the regression residuals from Figure 5 are plotted on the vertical axis.

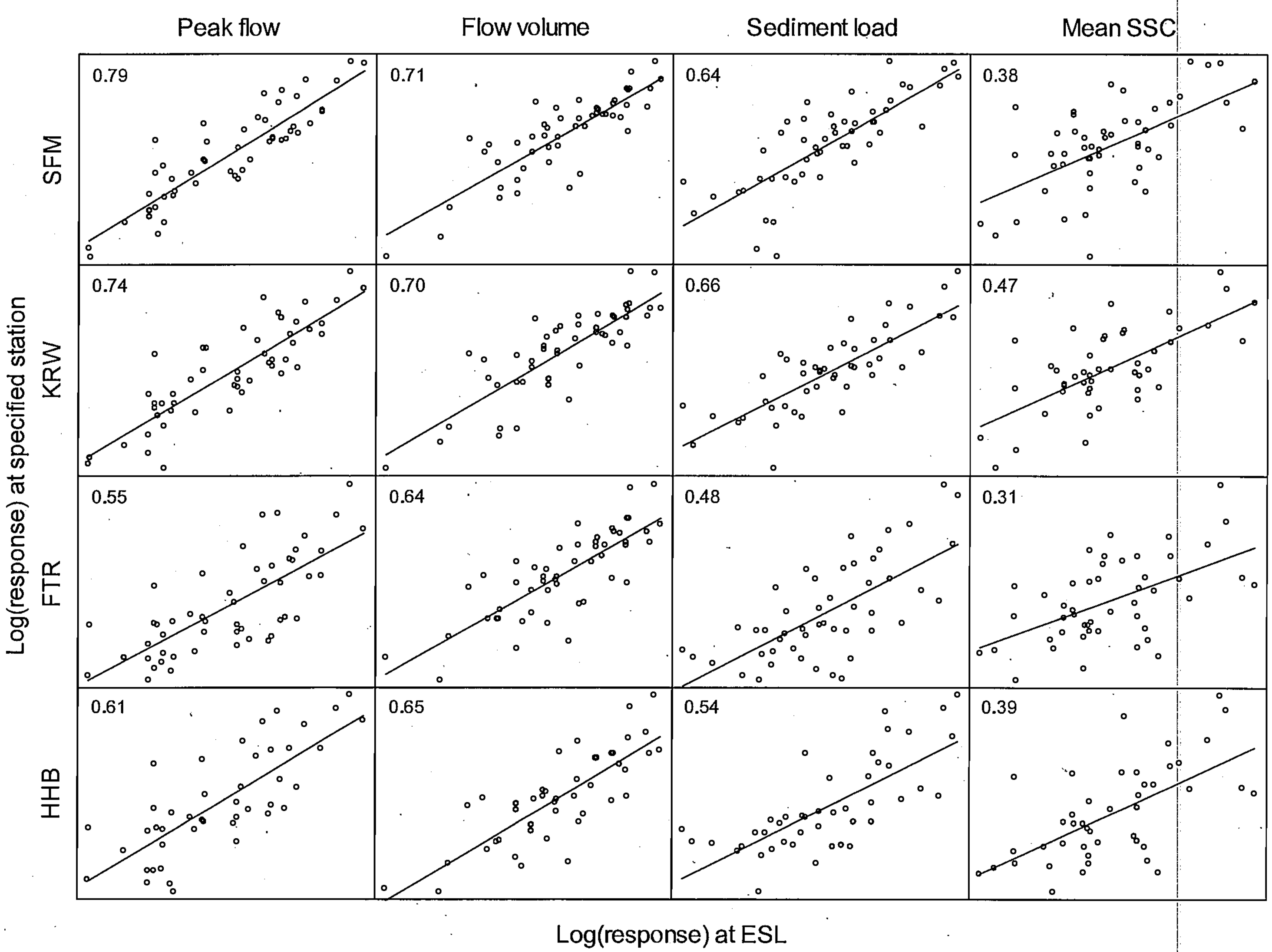

Figure 4. Scatterplots showing the storm responses at the four Salmon Forever gaging stations (SFM, KRW, FTR, and HHB) relative to those at ESL. Responses are peak flow, flow volume, suspended sediment load, and mean SSC (sediment load divided by flow volume). Axes are log-transformed and regression lines are fitted to the log-transformed responses. The coefficient of determination (r^2) is displayed in the upper left-hand corner of each graph, and represents the proportion of variation explained by the response at ESL.

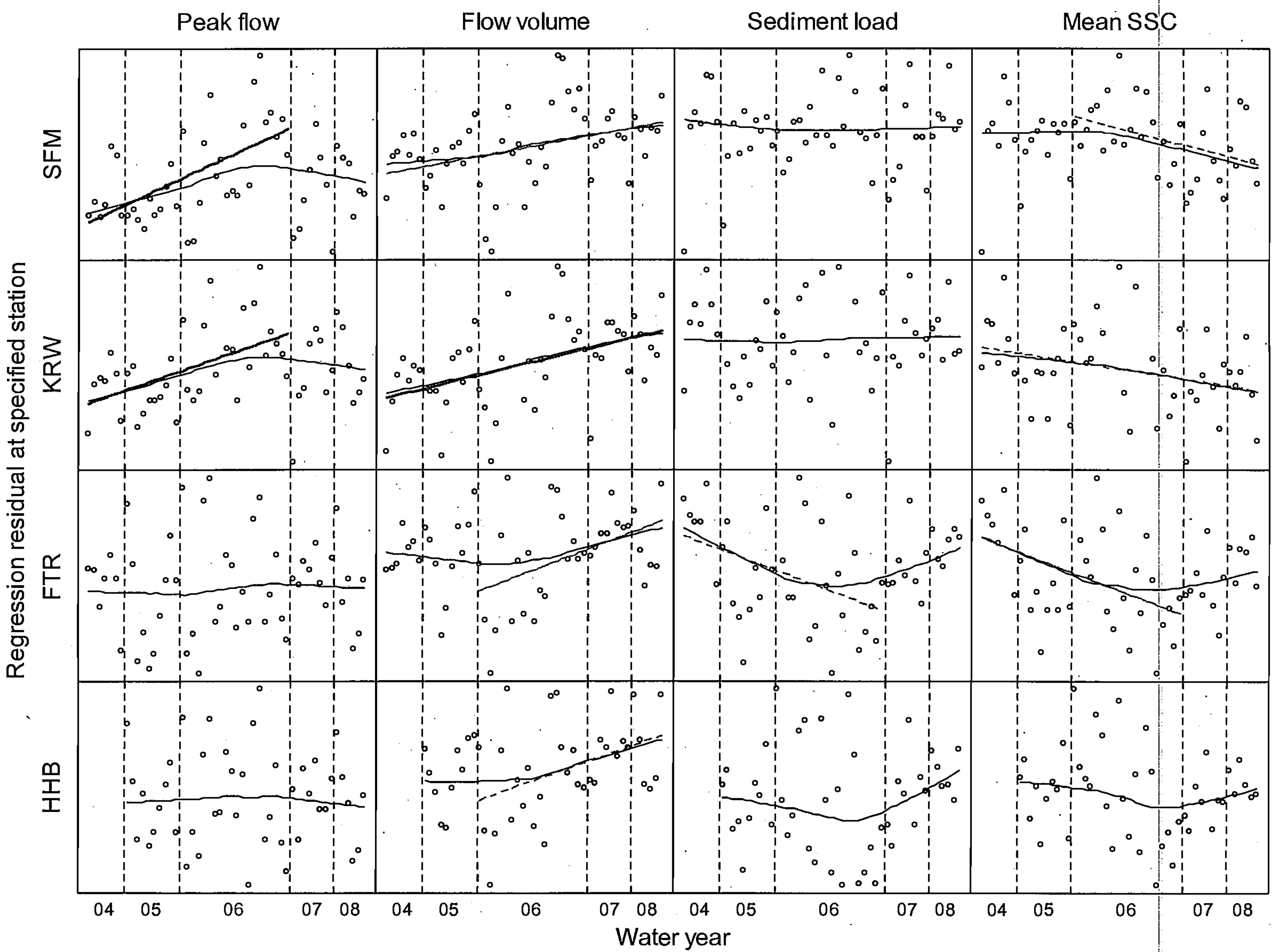

Figure 5. Trends in residuals from the regressions of Figure 4. Horizontal axis represents sequential storm number, labeled by water year. Trends are represented by loess curves with span=0.8. Red line segments highlight periods with linear trends at significance levels $p < 0.05$ (thin dashed), $p < 0.01$ (medium solid), and $p < 0.001$ (heavy solid).

The curves in Figure 5 are trends fitted by "loess", a form of non-parametric locally weighted regression (Cleveland and Devlin 1988). The "wiggliness" of the loess curves is somewhat arbitrary, being controlled by a user-specified smoothness parameter, the "span". In calculation of each point on the curve, a regression is computed on a neighborhood of points, giving greater weight to nearby points than distant points. For Figures 4 and 5, the span was set to 0.8, so beyond a neighborhood that includes 80% of the data, points have zero weight. Despite the arbitrary nature of the smoothness parameter, loess is an excellent method for identifying non-linear trends, because it can assume any functional shape. There is certainly no reason to expect continuous linear trends in these data. Indeed, the loess curves suggest that continuous linear trends are present in only 3 of 16 cases considered. We can test apparent linear trends using linear regression for the appropriate periods of record.

The line segments shown in red on the graphs depict linear trends of various statistical significance. The heaviest lines represent significance levels with $p < 0.001$. The medium lines represent significance levels with $0.01 < p < 0.001$, and the thin dashed lines represent levels with $0.05 < p < 0.01$. These significance values are subject to two important sources of error:

1. Multiple testing. Since multiple tests were performed, there is a strong probability that at least one test would be significant by chance alone (i.e. in the absence of a real trend). In fact assuming 16 independent tests and a rejection level of α=0.05, that probability, known as the experiment-wise error rate, is $1-(0.95)^{16} = 0.56$. To reduce the probability to 0.05 of at least one false rejection out of 16 requires reducing the rejection level to 0.003.
2. Letting the data determine the hypotheses. The procedure of looking at graphs and then testing the trends that look most pronounced is also likely to produce spurious results. There are many tests that could have been performed using different subsets of years. What we have done is only test the subsets with the most obvious trends. An honest calculation of experiment-wise error rates should include all subsets of years that might have been considered. For example, assuming we were willing to accept any trends of 2 or more consecutive years, there are 1(5yr) + 2(4yr) + 3(3yr) + 4(2yr) = 10 trends that could be tested in any given 5-year period. That increases the number of tests to 160 in the entire 4 × 4 matrix. The rejection level should be reduced even further to control the ballooning experiment-wise error rate. However, because of overlapping time periods, these tests cannot be considered independent so the experiment-wise error rate cannot be easily calculated for any given rejection level.

Because of these problems, the p-values for trends should be considered only as relative measures rather than having specific probabilistic interpretations. Hence the heavy red line segments indicate more probable trends than the thinner and dashed lines. The most significant trend lines indicate increases in SFM and KRW peak flows from 2004-2006 and increases in their flow volumes throughout the 5-year period. The most intriguing trends are of course those that have the most longevity, and the fact that flow volumes show a 5-year trend while peak flows show only a 3-year trend is unexpected but could be an artifact of the timing and magnitude of storm events. Storms occurring early in the wet season or after extended rainless periods, especially small storms, usually exhibit greater relative responses to harvesting (Lewis et al., 2001; Reid and Lewis, in review), so the timing and abundance of such events each year can potentially influence the residuals trend.

To investigate the influence of timing and abundance of events occurring after extended rainless periods, an antecedent precipitation index (*API*) and an antecedent discharge index (*AQI*) were computed. A slow-decaying *API* was suggested by Reid and Lewis (in review) as being associated with high-response peak flow events due to differences in transpiration and soil moisture deficits that build up between logged and unlogged watersheds. It's definition is as follows:

$$API_i = P_{i-2} + 0.99API_{i-1} \quad (1)$$

where API_i represents the index on day i, and P_{i-2} represents the daily precipitation two days before the peak flow. The index has a half-life of 70 days, meaning that if no rain falls for 70 days, the index drops by 50%. API_i was computed from rainfall at both KRW and SFM, and the two versions were virtually identical (r=0.9999). The index based on SFM rainfall was selected for these analyses.

Lewis et al. (2001) found that an antecedent wetness index based on discharge was a very important explanatory variable in modeling peakflows at Caspar Creek. The index was defined as

$$AQI_i = Q_i + 0.97716AQI_{i-1} \quad (2)$$

where AQI_i represents the index on day i, and Q_i represents the mean daily flow on day i. The index, which has a half-life of 30 days, was computed from discharge at both stations SFM and ESL. These were substantially different, with a correlation of only 0.64. The *API* and *AQI* variables based on SFM data were well-correlated (r = 0.90).

The correlations of storm sequence number with API and AQI were, respectively, 0.35 and 0.53, suggesting that time trends might be confounded with the antecedent wetness conditions that existed when storms occurred. Over a period of only 5 years climate change should be insignificant, so any correlation between time and *API* or *AQI* in this data set would be an entirely spurious result of the timing of storm events each year. We know from the cited studies that seasonal wetness is related to peak flow differences between logged and unlogged watersheds, so confounded variability in peak flows should only be attributed to trend if it cannot be attributed to seasonal wetness index. The trend can be evaluated graphically by adding one of the seasonal wetness indexes to the regressions shown in Figure 4, and examining the relationship between the new residual and storm sequence.

The following regression model was fitted to the storm peaks and flow volumes data.

$$\ln(y_n) = \beta_0 + \beta_1 \ln(y_{cn}) + \beta_2 w_n + \varepsilon_n \quad (3)$$

where n is the storm sequence number, $\ln(y_n)$ is the natural logarithm of the nth storm peak or flow volume, $\ln(y_{cn})$ represents the corresponding response at the control watershed (Little South Fork), w_n is the value of *API* or *AQI* immediately preceding the nth storm, and ε_n is a random error (assumed to be normally distributed). The β terms represent parameters estimated using the method of least squares regression.

In order to confirm or disprove the most significant trends of Figure 4, equation (3) was fitted to the storm peaks and flow volumes at SFM and KRW to create 4 models. The *API* variable was a highly significant predictor for peak flows at both SFM (p = 0.000009) and KRW (p = 0.0009). The square of *API* was used to linearized the relationship at SFM. Antecedent wetness did not explain as much variability in flow volumes as in peak flows, and the square root of the *AQI* was the best wetness variable found for predicting flow volumes at both SFM (p=0.001) and KRW (p=0.0004). Storm sequence number was not significant (at the 5% level) when added to any of the 4 regression models represented by equation (3).

Partial residual plots, also known as "component plus residual" plots (Cook and Weisberg, 1999) show the relationship of each variable in a multiple linear regression model to the response, after accounting for the influence of all other variables in the model. $\beta_k x_k + \varepsilon$ is plotted against the predictor x_k for each k, i.e. for all predictors. In effect, all predictor terms but $\beta_k x_k$ are subtracted from the response, and the partial residual plot displays the result plotted against x_k. The first two columns of Figure 6 show the partial residual plots for $\ln(y_{cn})$ and w_n in equation (3). They demonstrate strong linear dependencies of the responses on the predictors. The third column shows the residual from equation (3) plotted against n, the storm sequence number, i.e. it depicts the temporal trends in the response that cannot be attributed to the ESL response or antecedent wetness.

Figure 6 indicates that storm sequence number has little relation to peak flows or flow volumes at SFM and KRW after accounting for the response at ESL and either *API* or *AQI*. The apparent 3-year trends in peak flow and 5-year trends in flow volume that were seen in Figure 4 are no longer visible. The most pronounced periods of change suggested by the loess curves are 2006-2008 for flow volumes. Fitting a linear regression to these subsets of the data yields conventionally significant results at SFM (p= 0.008) and KRW (p=0.034). However it is important to bear in mind the caveats discussed earlier. There are 6 trends of 3 or more years that could be tested in a 5-year period, if years are not subdivided. Testing for 6 trends in 4 responses is likely to give a spurious result (false rejection of the null hypothesis) unless the rejection level is reduced to about 0.002 (assuming independent tests), a significance level at which no temporal trends were found. Another consideration is that the wetness variables used in these analyses were optimized for Caspar Creek; it is very possible that indices tailored to Freshwater and Elk River could be formulated that would explain more of the variability in flow volumes and flatten the trends further.

Trends in suspended sediment load and mean SSC are not as easily attributed to the sequence of storm events. The reasoning applied to peaks and flow volumes above is relevant insofar as sediment loads and mean SSC are positively correlated with flow volumes, but it will be more difficult to detect confounding influences and we have elected to leave that for subsequent analyses. In any case, over the 5-year period there are no persistent trends in suspended sediment load (Fig 5). The barely statistically significant 3-year decline at FTR apparently reversed direction in 2007-2008. The marginally significant declines in mean SSC at 3 of 4 stations will require further analysis of 2009 and subsequent years to substantiate and interpret.

An unexpected result of these analyses is that flow responses (after accounting for event magnitude at the control) were positively related to the seasonal wetness indexes, both *API* and *AQI*. The signs of the coefficients were opposite of those reported from Caspar Creek (Lewis et al., 2001), challenging the generally accepted concept that harvested areas experience enhanced flow response after extended dry periods. The harvested watersheds in this study include a mix of species and age classes, while the forest in the control watershed is old-growth, dominated by redwood. At Caspar Creek, in contrast, harvested and control watersheds were initially very similar second-growth stands composed of mainly redwood and Douglas-fir, and the aforementioned result reflects conditions during only the first 6 years after clearcut logging. At Freshwater and Elk River, the positive coefficient on the wetness index in eq. (3) implies that soil moisture deficits after extended dry periods are greater in the harvested watersheds than in the old-growth. This could be a result of the different composition of species and rooting depths in harvested watersheds, where there would be more Douglas-fir, tanoak, alder, and brushy species. Or it could result if fog drip is much greater in the old-growth forest than in the harvested watersheds; soil moisture deficits would be reduced where shallow roots had access to fog drip. In any case, this finding indicates that peak flows are probably not being enhanced as a result of reduced transpiration in harvested watersheds of Freshwater and Elk River, relative to old-growth. However, there is likely to be some enhancement resulting from reduced interception (Reid and Lewis in review) associated with canopy removal. Reid and Lewis (2009) identified redwood bark as an important rainfall interception reservoir in

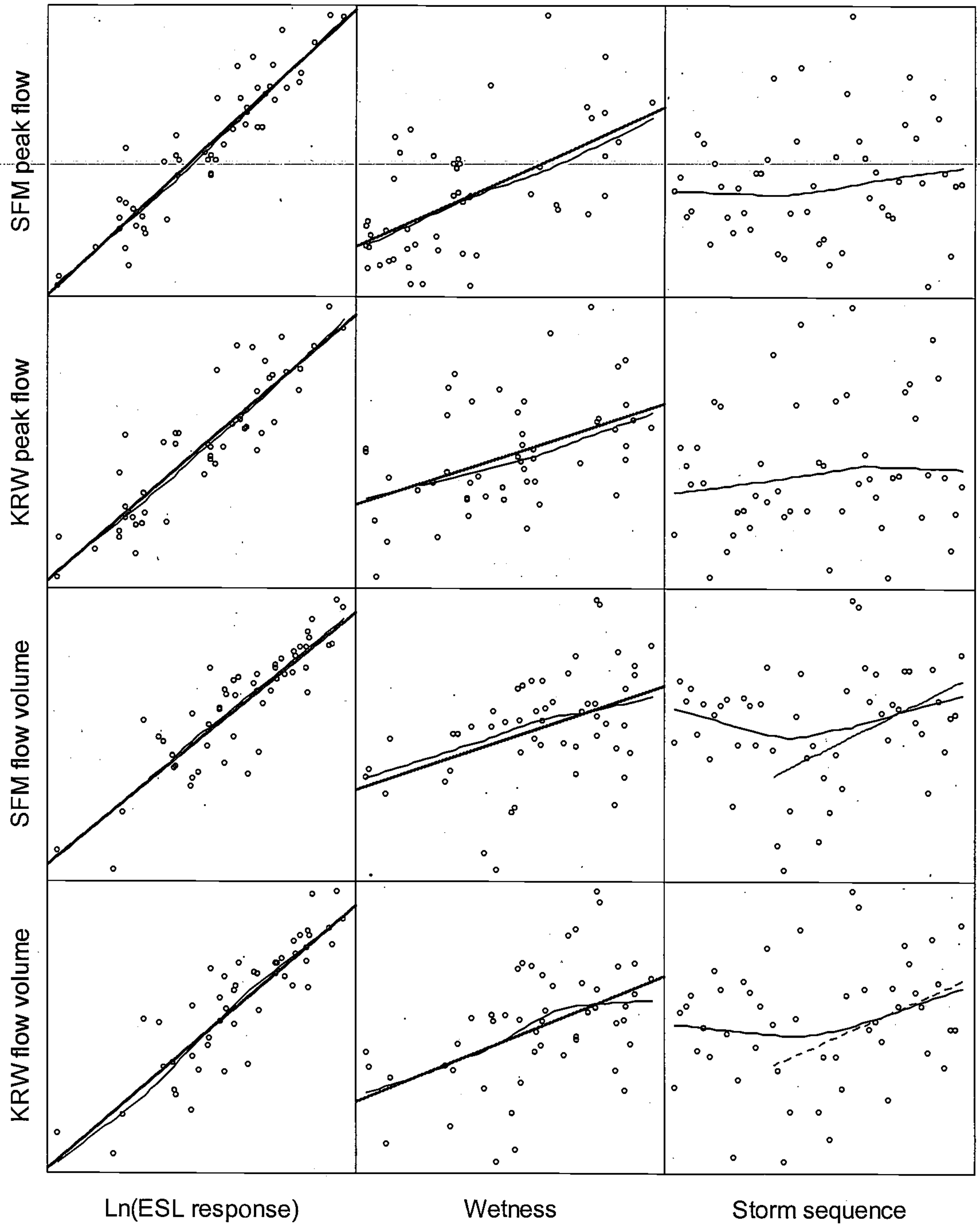

Figure 6. Plots showing the influences of (a) response at ESL, (b), antecedent wetness, and (c) storm sequence number on storm peak flows and volumes at SFM and KRW. The first two columns show partial residual plots for eq (3). The third column shows the residual from eq (3) plotted against the storm sequence number. Wetness indices used in eq (3) were API^2 for SFM peaks, API for KRW peaks, and $AQI^{0.5}$ for SFM and KRW flow volumes. Curves are fitted by loess with span=0.8. Red line segments highlight periods with linear trends at significance levels $p < 0.05$ (thin dashed), $p < 0.01$ (medium solid), and $p < 0.001$ (heavy solid).

second growth, and its influence would be even greater in old growth redwood. Therefore, comparing Freshwater and Elk River to old growth redwood forest, peak flows are likely to be enhanced by loss of interception. As yet we have no direct measurements in these basins to confirm the interception effect, and the evidence we do have exonerates transpiration.

For flooding in these basins, channel aggradation is probably a more important factor than flows (Patenaude, 2004). A trend analysis of peak stage could more directly address the flooding issue than an analysis of peak flows. Because the staff plate was moved at ESL in 2006, and because channel aggradation and scour occurs even in old growth watersheds, it would make sense to use ESL peak flow (as opposed to peak stage) as the predictor in a model for peak stage in the managed watersheds. The same rating equations were used at KRW and HHB during all years considered in this analysis. Therefore peak flow was a simple function of peak stage at those gages, and substituting one for the other would have no bearing on the trend analysis. In contrast, at FTR and SFM, one rating equation was applied to the years 2003-2005 and another equation to 2006-2008. To the extent that the new rating equations differ from the old ones, a trend analysis of peak stage might differ from an analysis of peak flow. However, the discharge rating curves changed minimally at both stations (Fig. 7), so there seemed little point in pursuing a separate trend analysis of peak stage. This discussion illustrates that a comparison of discharge rating measurements over time can in itself provide evidence for trends in flooding. In general, however, cross section surveys should also be utilized because they are not limited to a single location.

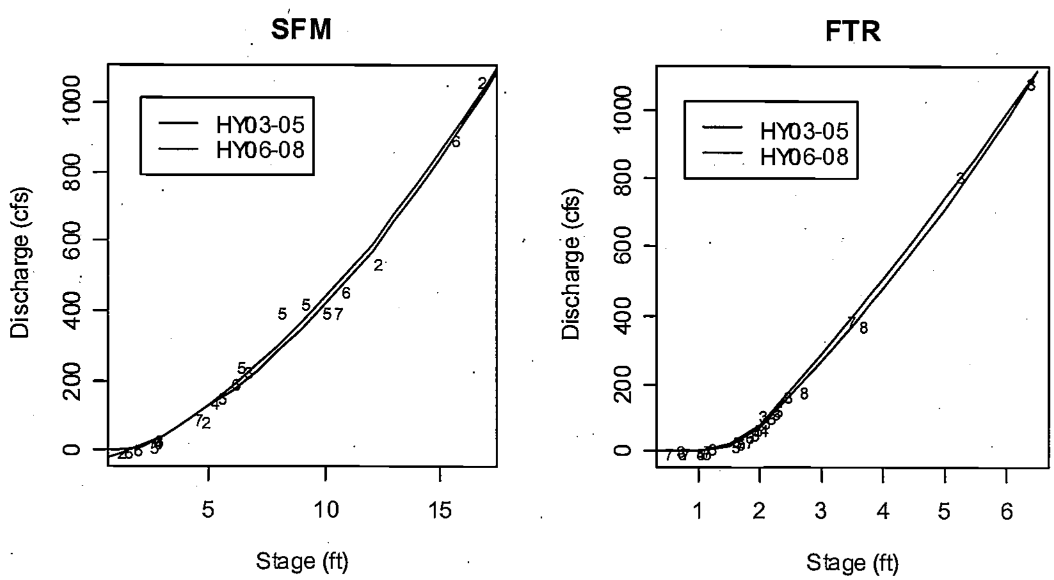

Figure 7. Stage-discharge rating curves applied at stations SFM and FTR for water years 2003-2005 and 2006-2008. Symbols identify the water year of measured discharges (e.g. "6" denotes 2006).

Five years is a relatively short period for a hydrologic trend analysis and, amidst the scatter present in the regression residuals, trends so far seem rather subtle. It would be pure speculation at this point to interpret any trends as manifestations of management or re-vegetation. These data represent a good start for a long-term monitoring program. If significant trends are detected in the future, it will be essential that they be related to management history. Only with continued monitoring, however, will the long-term trajectories become clear. The availability of high quality data from an unmanaged watershed such as Little South Fork will continue to be invaluable for identifying hydrologic trends in Freshwater Creek and Elk River.

Near-continuous Record of SSC

In the process of estimating sediment loads, SSC was estimated for each 10-minute interval during the study period, except when stations were down for the summer. The result has been compiled into data files that contain the final flow, turbidity, and estimated SSC at 10-minute intervals. These data files are located in the Ten minute SSC folder under "Data". This product is highly unusual (perhaps the only data set of its kind in the world) in that the SSC estimates are not simply a rescaled version of turbidity or flow; instead many relationships representative of individual storms or sections of storms were used to produce the estimated SSC for each station and year, resulting in relatively accurate, nearly continuous representations of SSC that have considerable value for scientific purposes such as model validation and sampling simulation. These SSC data compose a new and powerful data product on which further analyses of watershed processes and response to disturbance could be performed, although further analyses were beyond the scope of this project.

Further details about the contents of these files are given in File Formats.doc. In addition, all the R commands needed to recreate these output files have been saved in the R commands folder within the "Ten minute SSC" folder.

SSC Statistics and Graphs

Tables and graphs summarizing the 10-minute SSC data are found in the document SSC Graphs and Stats.doc. Because the stations have been started up and closed down at varying dates, but often opening in November and closing in May, all statistics are computed for a winter season from Dec. 1 through Apr 30. The tables in the document show

1. SSC exceeded various percentages of the winter season
2. Total hours that various concentrations were exceeded for each station and year.
3. Maximum continuous hours that various concentrations were exceeded for each station and year.

The graphs in SSC Graphs and Stats.doc show the cumulative frequency distributions of SSC for each year by station. In most years the ordering of stations by SSC from lowest to highest is FTR, HHB, KRW, and SFM.

Severity of Ill Effects

Maximum annual durations of continuous exposure at different levels of SSC are shown in Table 5. These data were used to compute severity-of-stress indexes developed by Newcombe and MacDonald (1991) and Newcombe and Jensen (1996), which relate the duration and concentration of sediment exposure to stress on aquatic organisms. The latter publication includes 4 models of severity for different groupings of salmonid life stages. The annual maximum continuous exposure hours and severity of ill-effect scores are shown below in Table 6 and are also provided in Severity index tables.doc.

Table 5. Maximum continuous hours above various SSC levels.

	Maximum Continuous Hours above specified SSC					
Site/HY	2981	1097	403	148	55	20
SFM/03	6.2	41.5	62.7	174.2	303.8	1157.2
KRW/03	0	18.3	46	68.2	154.8	547.3
FTR/03	0	13	39	51.7	63.7	245.5
SFM/04	0	4.7	29.5	80.7	110	252.2
KRW/04	0	2	27.3	64.7	91.3	459.3
FTR/04	0	2.5	15.2	48.7	65.8	135
SFM/05	0	8.3	27.7	83.7	215.8	569
KRW/05	0	8.7	18	35.3	163	718
FTR/05	0	4.2	15.7	28	58.2	164.2
HHB/05	0	1.3	9.3	29.8	49.3	206
SFM/06	0.3	22.8	111.2	480	1067.8	1362.7
KRW/06	0	8.8	37	77	337	1311.3
FTR/06	3	9.2	17.7	45.3	135.2	478.5
HHB/06	0	4.8	18.8	57	154.7	448
SFM/07	0	13.8	39.8	76.7	255.2	518.2
KRW/07	0	2	22.8	46.2	257.3	391
FTR/07	0	1	15.2	29.8	61.3	257.5
HHB/07	0	0	11.2	29.7	101.5	273.8
SFM/08	0	15	37.3	114.8	255.5	1349.2
KRW/08	0	3.2	16.7	38	211.5	389
FTR/08	0	3.7	10.2	22.2	89.5	253.2
HHB/08	0	2.5	9	23.7	56.5	264.3

Table 6. Severity-of-ill-effects (SEV) scores for four models based on SSC durations (Model 1: adult and juvenile salmonids combined; Model 2: adult salmonids only; Model 3: juvenile salmonids only; Model 4: salmonid eggs and larvae).

Model 1	Suspended Sediment Concentration (mg/L)					
Site/HY	2981	1097	403	148	55	20
SFM/03	8.1	8.5	8	7.9	7.5	7.6
KRW/03	0	8	7.8	7.3	7.1	7.1
FTR/03	0	7.8	7.7	7.1	6.5	6.6
SFM/04	0	7.2	7.5	7.4	6.9	6.6
KRW/04	0	6.7	7.5	7.3	6.8	7
FTR/04	0	6.8	7.1	7.1	6.6	6.3
SFM/05	0	7.5	7.5	7.4	7.3	7.1
KRW/05	0	7.5	7.2	6.9	7.1	7.3
FTR/05	0	7.1	7.2	6.8	6.5	6.4
HHB/05	0	6.4	6.8	6.8	6.4	6.5
SFM/06	6.3	8.1	8.4	8.5	8.3	7.7
KRW/06	0	7.6	7.7	7.4	7.6	7.6
FTR/06	7.6	7.6	7.2	7.1	7	7
HHB/06	0	7.2	7.3	7.2	7.1	7
SFM/07	0	7.8	7.7	7.4	7.4	7.1
KRW/07	0	6.7	7.4	7.1	7.4	6.9
FTR/07	0	6.2	7.1	6.8	6.5	6.6
HHB/07	0	0	7	6.8	6.8	6.7
SFM/08	0	7.9	7.7	7.6	7.4	7.6
KRW/08	0	6.9	7.2	7	7.3	6.9
FTR/08	0	7	6.9	6.6	6.8	6.6
HHB/08	0	6.8	6.8	6.7	6.5	6.7

Model 2	Suspended Sediment Concentration (mg/L)					
Site/HY	2981	1097	403	148	55	20
SFM/03	8.6	8.8	8.2	7.9	7.4	7.3
KRW/03	0	8.4	8	7.5	7.1	7
FTR/03	0	8.2	8	7.3	6.7	6.6
SFM/04	0	7.7	7.8	7.6	7	6.6
KRW/04	0	7.3	7.8	7.5	6.9	6.9
FTR/04	0	7.4	7.5	7.3	6.7	6.3
SFM/05	0	8	7.8	7.6	7.3	7
KRW/05	0	8	7.6	7.2	7.1	7.1
FTR/05	0	7.7	7.5	7.1	6.7	6.4
HHB/05	0	7.1	7.3	7.1	6.6	6.5
SFM/06	7.2	8.5	8.5	8.4	8	7.4
KRW/06	0	8	7.9	7.5	7.5	7.4
FTR/06	8.3	8	7.6	7.3	7.1	6.9
HHB/06	0	7.7	7.6	7.4	7.1	6.9
SFM/07	0	8.2	8	7.5	7.4	6.9
KRW/07	0	7.3	7.7	7.3	7.4	6.8
FTR/07	0	7	7.5	7.1	6.7	6.6
HHB/07	0	0	7.4	7.1	6.9	6.6
SFM/08	0	8.3	7.9	7.7	7.4	7.4
KRW/08	0	7.5	7.6	7.2	7.3	6.8
FTR/08	0	7.6	7.3	6.9	6.9	6.6
HHB/08	0	7.4	7.3	7	6.6	6.6

Model 3	Suspended Sediment Concentration (mg/L)					
Site/HY	2981	1097	403	148	55	20
SFM/03	7.7	8.3	7.9	7.9	7.6	7.8
KRW/03	0	7.8	7.7	7.3	7.1	7.3
FTR/03	0	7.5	7.6	7.1	6.5	6.7
SFM/04	0	6.8	7.4	7.4	6.9	6.8
KRW/04	0	6.2	7.3	7.2	6.8	7.2
FTR/04	0	6.4	6.9	7	6.5	6.3
SFM/05	0	7.2	7.3	7.4	7.4	7.3
KRW/05	0	7.2	7	6.8	7.2	7.5
FTR/05	0	6.7	6.9	6.6	6.4	6.5
HHB/05	0	5.9	6.6	6.7	6.3	6.6
SFM/06	5.7	7.9	8.3	8.6	8.5	7.9
KRW/06	0	7.3	7.6	7.4	7.7	7.9
FTR/06	7.2	7.3	7	7	7	7.2
HHB/06	0	6.8	7.1	7.1	7.1	7.2
SFM/07	0	7.6	7.6	7.3	7.5	7.3
KRW/07	0	6.2	7.2	7	7.5	7.1
FTR/07	0	5.7	6.9	6.7	6.5	6.8
HHB/07	0	0	6.7	6.7	6.8	6.8
SFM/08	0	7.6	7.6	7.6	7.5	7.9
KRW/08	0	6.5	7	6.9	7.4	7.1
FTR/08	0	6.6	6.6	6.5	6.8	6.8
HHB/08	0	6.4	6.6	6.5	6.4	6.8

Model 4	Suspended Sediment Concentration (mg/L)					
Site/HY	2981	1097	403	148	55	20
SFM/03	8.2	10	10.1	11	11.3	12.4
KRW/03	0	9.1	9.8	9.9	10.5	11.6
FTR/03	0	8.7	9.6	9.6	9.5	10.7
SFM/04	0	7.6	9.3	10.1	10.1	10.7
KRW/04	0	6.7	9.2	9.9	9.9	11.4
FTR/04	0	6.9	8.6	9.6	9.6	10
SFM/05	0	8.2	9.3	10.1	10.9	11.6
KRW/05	0	8.3	8.8	9.2	10.6	11.9
FTR/05	0	7.5	8.6	9	9.4	10.3
HHB/05	0	6.2	8.1	9	9.3	10.5
SFM/06	5	9.4	10.8	12.1	12.6	12.6
KRW/06	0	8.3	9.6	10.1	11.4	12.5
FTR/06	7.4	8.4	8.8	9.5	10.4	11.4
HHB/06	0	7.7	8.8	9.7	10.5	11.4
SFM/07	0	8.8	9.6	10.1	11.1	11.5
KRW/07	0	6.7	9	9.5	11.1	11.2
FTR/07	0	5.9	8.6	9	9.5	10.8
HHB/07	0	0	8.3	9	10.1	10.8
SFM/08	0	8.9	9.6	10.5	11.1	12.6
KRW/08	0	7.2	8.7	9.3	10.9	11.2
FTR/08	0	7.4	8.2	8.7	9.9	10.7
HHB/08	0	6.9	8	8.8	9.4	10.8

Severity of ill-effects (SEV) scores in Table 6 have cells color-coded by impact level as follows: SEV8-8.9 (major physiological stress), SEV9-9.9 (reduced growth rate and density, delayed hatching), [redacted] (10-20% mortality), [redacted] (20-40% mortality), and SEV≥12 (40-60% mortality). It is obvious at a glance that the harshest effects of suspended sediment in Freshwater Creek and Elk River are on salmonid eggs and larvae (Model 4), with SEV scores above 8 occurring in all models. A severity of 7, indicating moderate habitat degradation and impaired homing, was exceeded every year at all stations.

Applying Newcombe and Jensen's Model 2 for adult salmonids we find a maximum severity of 8.8 for our period of record occurring at SFM in HY03. A severity of 9 is defined as a sublethal effect associated with reduced growth and population density. A severity of 8 was exceeded at SFM in all years except HY04. The same severity of 8 was exceeded in 3 of 6 years at KRW, 2 of 6 years at FTR, and 0 of 4 years at HHB. Newcombe and Jensen (1996) defined severity 8 as indicating major physiological stress with long-term reductions in feeding success.

Newcombe and Jensen's Model 3 indicates that conditions for juvenile salmonids are not as stressful as for adults. Annual maximum severity scores for juveniles varied from 7.4 to 8.6 at SFM, 7.3 to 7.9 at KRW, 6.8 to 7.6 at FTR, and 6.7 to 7.2 at HHB.

Their Model 4 for salmonid eggs and larvae assigns a maximum severity of 12.6 to conditions occurring at SFM in HY06 and HY08. A severity of 12 is defined as a lethal effect with 40-60% mortality and a severity of 13 is associated with 60-80% mortality. A severity of 11, associated with 20-40% mortality, was exceeded at SFM in all years but HY04, and at KRW in all years, but was only exceeded at the Freshwater stations in HY06. A severity of 10 was exceeded every year at all stations, suggesting 0-20% mortality, increased predation, and moderate to severe habitat degradation.

We did not have SSC data for the specific size fractions to which the models are said to pertain, therefore our calculations are based on the total SSC without regard to grain size. Our SSC data exclude some particles finer than 1μ but may include sizes coarser than 250μ; the former bias is more important at low concentrations and the latter more important at high concentrations. It might be possible to improve these calculations using our sand fraction data, since our sand break at 63μ is not far from the 75μ break used to define the upper limit of particle sizes for models 3 and 4. Adjusting the concentrations would be subject to significant errors, however, because there are no strong relationships between sand fraction and either total SSC or discharge. See Sand Fraction Plots.doc for data on sand fractions of SSC samples.

Turbidity

Continuous turbidity is a secondary product of this data set. The turbidity data have gaps and two different sensor types were used. However, the gaps are relatively few and of limited duration, and could be filled with estimates using relationships between turbidity and SSC. In addition, although the OBS-3 and DTS-12 sensors do not produce equivalent output, it is possible to convert the OBS-3 turbidity to DTS equivalents or vice versa. Such conversions are occasionally prone to large errors (Lewis, 2007), because they depend upon the sediment being measured. However using the Lewis (2007) data set, formulas have been developed specifically for each of the Salmon Forever watersheds. These formulas were applied by Klein et al. (2008) to an earlier (substantially similar) version of these data sets through HY05 when they compared turbidity duration and exceedence levels in 28 north coast watersheds. These data files are located in the Ten minute SSC folder under "Data" in a column alongside SSC.

Rainfall

Cumulative rainfall measured at Station FTR has been plotted beneath stage and turbidity from stations FTR, KRW, and SFM for years 2003, 2006, 2007, and station HHB for years 2006 and 2007. Generally, each plot represents a 6 or 7 day storm period. The plots display stage and turbidity data that have been reviewed and corrected using procedures described in the TTS Implementation Guide. They are included in this package to facilitate exploratory analysis of the lag times between rainfall bursts and responses of turbidity and discharge. They are located in the folder Rainfall plots under individual subfolders for each year.

Cross Section Changes

Changes in cross-sectional area and bed elevation have been determined through a series of surveys at 23 cross-sections on the mainstem, and North and South Forks of Elk River. The survey data and analyses can be found in the Elk Cross Sections subfolder under "Data" with tables and graphs in Elk Cross Section Changes.xls and summarized results are shown below in Tables 7-8.

Table 7. Cumulative changes in active channel mean bed elevations (units are in feet of elevation change; blank cells mean no survey was done that year).

	2001	2002	2003	2004	2005	2006	2007	2008	Net Change	**Reach Ave. Change**
MAIN STEM ELK										**0.14**
MLW2				X		0.01			0.01	
MA3	X						0.23		0.23	
MA2		X					0.58		0.58	
MA1	X	-0.51					0.25		-0.26	
NORTH FORK										**0.53**
NC5	X	-0.36					0.69		0.33	
NC4	X	0.29					0.96		1.25	
NC3	X	-0.12					0.66		0.54	
NC2	X	0.35					0.10		0.45	
NC1	X	0.19					0.43		0.61	
NA6						X	-0.07		-0.07	
NA5		X				0.30			0.30	
NA3	X	-0.03				0.74			0.71	
NA2	X	0.21				0.83		-0.02	1.02	
NA1	X	0.36		-0.44		0.24			0.17	
SOUTH FORK										**0.49**
SB1	X	0.31		0.55					0.87	
SB2	X	0.15							0.15	
SB3	X	0.33							0.33	
SB4	X	0.08							0.08	
SA5	X	0.57				-0.02	0.39		0.93	
SA4	X	0.51							0.51	
SA3	X	0.22							0.22	
SA2	X	0.30							0.30	
SA1	X	0.37		0.31	0.37				1.05	
	* X marks the first survey for a cross section									

Table 8. Cumulative changes active channel cross sectional area (units are in square feet; positive values represent channel filling; blank cells mean no survey was done that year).

	2001	2002	2003	2004	2005	2006	2007	2008	Net Change	**Reach Ave. Change**
MAIN STEM ELK										**14.3**
MLW2				X		0.5			0.5	
MA3	X						25.4		25.4	
MA2		X					40.8		40.8	
MA1	X	-18.9					-9.5		-9.5	
NORTH FORK										**29.3**
NC5	X	-25.6					23.4		23.4	
NC4	X	16.1					69.3		69.3	
NC3	X	-6.4					29.4		29.4	
NC2	X	19.3					25.0		25.0	
NC1	X	12.5					41.2		41.2	
NA6						0.0	-3.9		-3.9	
NA5		X				16.2			16.2	
NA3	X	-1.7				34.4			34.4	
NA2	X	9.3				46.5		45.5	45.5	
NA1	X	26.9		-5.9		12.3			12.3	
SOUTH FORK										**27.8**
SB1	X	15.6		43.2					43.2	
SB2	X	10.9							10.9	
SB3	X	30.5							30.5	
SB4	X	3.7							3.7	
SA5	X	15.3				14.7	25.2		25.2	
SA4	X	37.5							37.5	
SA3	X	23.6							23.6	
SA2	X	53.6							53.6	
SA1	X	7.8		14.3	22.2				22.2	
	* X marks the first survey for a cross section									

Positive values for reach-averaged bed elevations and cross sectional areas are indicative of the levels of aggradation that have occurred in all three reaches. Bed elevation in the active channel has increased an average of 0.53 ft in the North Fork, and aggradation has reduced the common surveyed cross-sectional areas by an average of 29 ft^2 (the common surveyed area is wider than the active area, and only 2 of the 5 cross sections aggraded significantly). In the South Fork, the mean bed elevation in the active channel increased 0.49 ft and aggradation has reduced the common surveyed cross-sectional areas by an average of 28 ft^2. Changes in the main stem appear to be smaller. The mean bed elevation in the active channel increased 0.14 ft and aggradation has reduced the common surveyed cross-sectional areas by an average of 14 ft^2. Inconsistent timing of cross section surveys limited the conclusions possible from this data set. Annual surveys of all cross sections would provide a stronger basis for evaluating channel changes in the monitoring reaches.

DISCUSSION

Hydrologic stress is the primary driver of sediment loads and channel changes. Annual maximum peak flows generally showed HY2003, HY2006 and HY2008 to be the wettest, with HY2004 being the driest. Suspended sediment loads generally behaved similarly, although loads in HY2005 exceeded those in HY2008. This could possibly be due to improved watershed erosional stability, but the differences were not large enough to warrant further investigation.

South Fork Elk River (SFM) was consistently the highest sediment producer among the four sites across all years, followed by North Fork Elk River (KRW). All four focal sites (SFM, KRW, FTR and HHB) exhibited loads far exceeding those of the control site (ESL), indicating severe and persistent watershed instability.

Channel cross section changes in Elk River were generally consistent with loads, i.e., elevated suspended sediment loads appear to be continuing to cause channel bed elevation increases and infilling. Annual trends in channel cross sections were difficult to assess given the inconsistency of surveys, however they provide a more compelling case for continuing channel bed aggradation than stage-discharge analysis at the gaging station. Channel cross section changes have not yet been determined for Freshwater Creek.

The development of continuous records of SSC has permitted application of Newcombe and Jensen's (1996) severity-of-ill-effects models based on continuous exposures to various SSC levels. Their model for adult salmonids indicates major physiological stress (SEV score at least 8) in all but one year at SFM, in half the years at KRW, in one-third of the years at FTR, and in no years at HHB. Their model for juveniles suggests that major physiological stress occurred only at SFM. Their model for salmonid eggs and larvae suggests that 40-60% mortality occurred in two years at SFM, at least 20% mortality occurred in all but one year at both Elk River stations, and eggs and larvae in all locations and years were subject to increased predation with at least moderate habitat degradation.

The gaging station data provide an excellent start for a long-term monitoring program. The availability of data from Little South Fork Elk (ESL) permitted a fairly rigorous analysis that, after accounting for the timing of storm events in relation to seasonal wetness, suggests no significant trends since 2004 in suspended sediment, mean SSC, peak flow or stage, or flow volume. Trends are difficult to predict because we are examining a system that was heavily impacted before monitoring began and, while re-forestation and stabilization is occurring in some parts of the watersheds, other areas are continuing to be disturbed by ongoing management under new ownership. It is likely that trends in water quantity and quality, if they occur, will only start to be identifiable after at least a decade or two of monitoring.

REFERENCES

Cleveland, W.S. and S.J. Devlin. 1988. Locally-weighted regression: an approach to regression analysis by local fitting. Journal of the American Statistical Association, 83: 596-610.

Cook, R. D. and S. Weisberg. 1999. Applied Regression, Including Computing and Graphics. Wiley.

Klein, R.D., Trush, W.J., and Buffleben. 2008. Watershed condition, turbidity, and implications for anadromous salmonids in north coastal California streams. Report to North Coast Regional Water Quality Control Board, Santa Rosa, CA. 105 p.

Lewis, Jack. 2007. Comparisons of turbidity data collected with different instruments. Report on a cooperative agreement between the California Department of Forestry and Fire Protection and USDA Forest Service--Pacific Southwest Research Station (PSW Agreement # 06-CO-11272133-041); July 6, 2007.

Lewis, Jack and Rand E.Eads. 2009. Implementation Guide for Turbidity Threshold Sampling: Principles, Procedures, and Analysis. General Technical Report PSW-GTR-212, U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Lewis, J., Keppeler, E., Ziemer, R.R., and S.R. Mori. 2001. Impacts of logging on storm peak flows, flow volumes and suspended sediment loads in Caspar Creek, California. In: Mark S. Wigmosta and Steven J. Burges (eds.) Land Use and Watersheds: Human Influence on Hydrology and Geomorphology in Urban and Forest Areas. Water Science and Application Volume 2, American Geophysical Union, Washington, D.C.; 85-125.

Manka, Peter. 2005. Suspended sediment yields in tributaries of Elk River, Humboldt County, CA. M.S. Thesis. Humboldt State University. 91 pp.

Newcombe, C.P. and D. D. Macdonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11: 72-82.

Newcombe, C.P. and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16: 693-727.

Patenaude, J.R. 2004. Preliminary assessment of flooding in lower North Fork Elk River. Prepared for North Coast Regional Water Quality Control Board: Elk River TMDL. 22 p.

Reid, L.M., Lewis, J. 2009. Rates, timing, and mechanisms of rainfall interception loss in a coastal redwood forest. Journal of Hydrology 375(3-4):459-470. doi:10.1016/j.jhydrol.2009.06.048

Reid, L.M. and J. Lewis. In Review. The effects of altered rainfall interception on peakflow generation after logging in a coastal redwood forest. Journal of Hydrology.

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Linda S. Adams
Acting Secretary for Environmental Protection

Edmund G. Brown Jr.
Governor

May 2, 2011

Jon Woessner
Humboldt Redwood Company, LLC
P. O. Box 712
Scotia, CA 95565

Dear Mr. Woessner:

Subject: Tier 1 enrollment of Unit 1 of THP 1-08-072 HUM in the Elk River watershed under Watershed-wide Waste Discharge Requirements for Elk River (Order No. R1-2006-0039) (As amended by Order No. R1-2008-0100 to reflect new ownership)

File: 1B108072HUM Moss Elk

Regional Water Board has completed its review of the enrollment request and Preharvest Planning Report received on December 28, 2010 for the subject THP under Order No. R1-2006-0039 (As amended by Order No. R1-2008-0100), the *Watershed-wide Waste Discharge Requirements for Timber Harvesting Plan Activities Conducted by Humboldt Redwood Company LLC in the Elk River Watershed* (Order).

Information previously submitted included the THP (as amended), an Erosion Control Plan (ECP), and a check for the annual fee. The total acreage enrolled in the Elk River watershed would remain under the limits promulgated in the Order.

Regional Water Board staff also participated in the pre-harvest inspection on June 4, 2008 and a followup field review of Unit 1 on March 5, 2011 with HRC representatives. At the time of CalFire review of the THP all Water Board recommendations were agreed to and incorporated into the THP. CalFire approved the THP on July 24, 2008. Subsequently the THP was transferred to Humboldt Redwoods Company, and the silviculture method amended from clearcutting to group selection. Proposed harvesting in this unit of the THP includes 14.1 total acres – 10 acres of Group Selection and 4.1 acres of shelterwood removal.

We have determined that the application is now complete and when the following additional conditions are incorporated into the plan, will comply with the WWDRs.

1 The potential for large openings anticipated under the group selection method of up to 2 ½ acres may result in large areas subject to increased runoff and bare soil subject to erosion. The review of trees marked in the field indicated that openings would be much smaller. However, to ensure that openings are left as small as possible, we request that silviculture for Unit 1 shall be changed to selection with a post harvest stocking to be 90 square feet basal area.

2. All bare mineral soil exposed during harvesting shall be minimized by application with adequate erosion control material to reduce erosion and prevent a sediment discharge. This could be accomplished by a combination of packing in slash material generated during harvesting, straw, or seed and mulch.

3. Winter operations shall be limited to felling of trees and no hauling or skidding.

4. Class II stream buffers shall be modified as follows:

- Increase no harvest to 0-40 feet, and
- Increase Equipment Exclusion Zone (EEZ) to 100 feet regardless of slope angle.

We also request that HRC provide a tour of the harvest area for the Elk residents and other interested parties before and after the harvest operation.

The effective date of enrollment is June 1, 2011. Determination of eligibility and enrollment is therefore based on and extends only to timber harvesting activities compliant with the approved Preharvest Planning Report as detailed below:

THP Number	Unit Number	Harvest Acres In Unit	Low Hazard	High Hazard
1-08-072 HUM	1	14.1	11.9	28.2

Any proposed harvest exceeding those acres must be reported and the Preharvest Planning Report modified and re-submitted to the Executive Officer for a determination of eligibility.

The THP is now subject to the requirements of the WWDRs. There are a number of requirements specified in these WWDRs and Monitoring and Reporting Program (MRP), including submittal of monthly summary reports by the tenth day of each month pursuant to section V.A.2. Pursuant to section V.A.2.(b), We urge you to review the WWDRs and familiarize yourself with all the provisions.

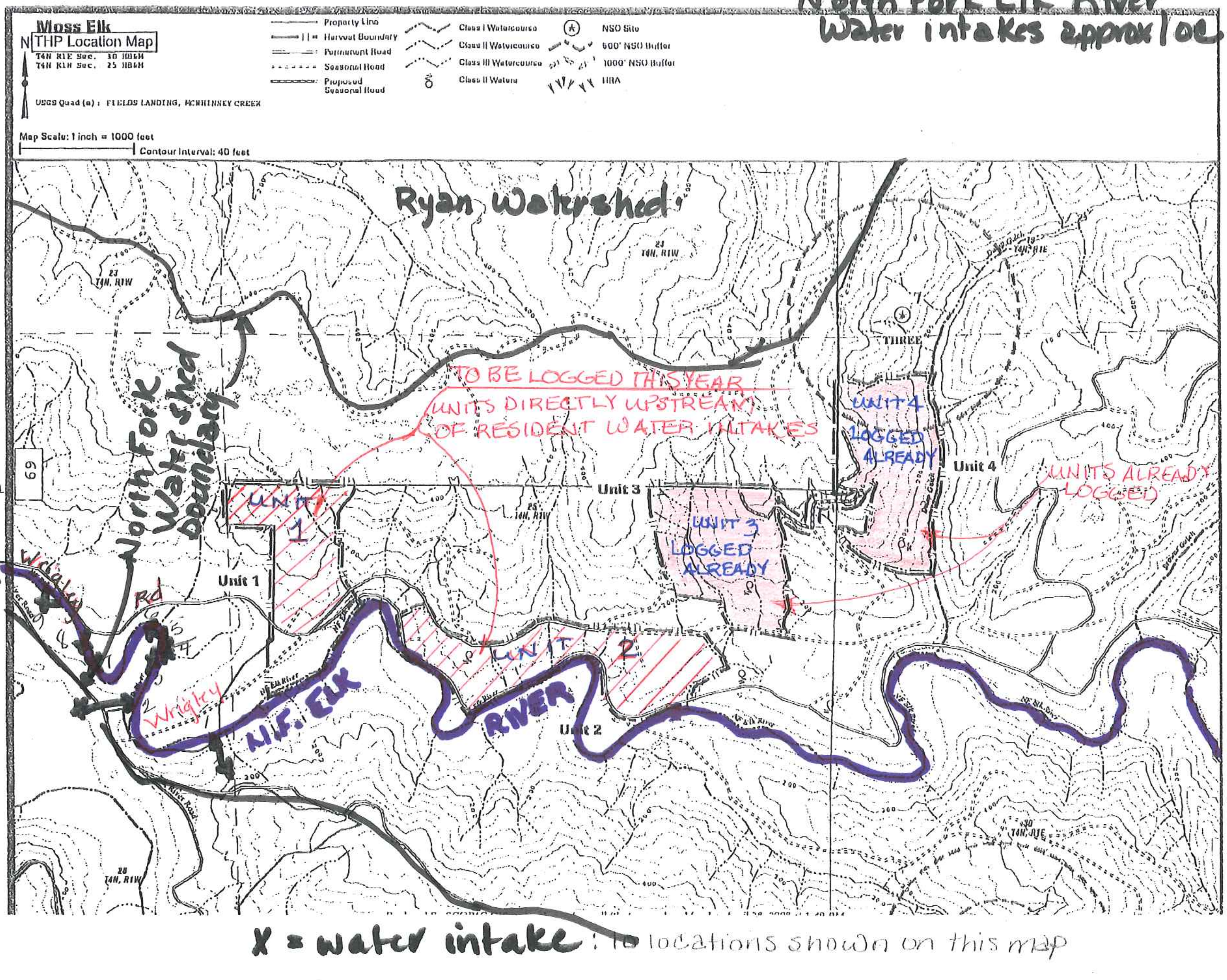
If you have any questions, please call David Engel of my staff at (707) 576-2082.

Sincerely,

Catherine Kuhlman
Executive Officer

110502_MJA_HRCWWDRenroll_1B108072HUM

North Fork Elk River
Water intakes approx loc.



X = water intake: 10 locations shown on this map

60	2/1/2002	Regional Water Board internal memorandum Re: Elk River Peak Flow Analysis.

INTEROFFICE MEMORANDUM

TO: DIANA HENRIOULLE-HENRY, P.E., HEADWATERS UNIT SENIOR

FROM: ADONA WHITE, WATER RESOURCES CONTROL ENGINEER

SUBJECT: ELK RIVER PEAK FLOW ANALYSIS

DATE: FEBRUARY 1, 2002

Malle reage

INTRODUCTION

This memo provides additional discussion to the memo dated January 30, 2002. Please include this in the official files for Elk River THPs.

I have reviewed the peak flow analysis conducted by California Department of Forestry and Fire Protection (CDF) for both Freshwater and Elk River watershed. CDF has employed partial methodology as presented by Drs. Lisle, Reid, and Ziemer of Redwood Sciences Laboratory in their October 25, 2000 *Addendum: Review of Freshwater Flooding Analysis Summary* (Lisle et al., 2000).

Lisle et al. (2000) presents an explanation of the likely cumulative effect on increased flood frequency in Freshwater Creek resulting from past harvesting and various future harvesting scenarios. The cumulative effect results from the combination of hydrologic changes resulting from canopy removal and sediment inputs associated with the hydrologic changes (rilling, scour of low order channels, landsliding) and roads.

I have applied the model described in Lisle et al. (2000) to Elk River watershed conditions, as discussed and presented in this memo. I have attempted to be consistent in this memo by using the same terms as those used in Lisle et al. (2000). These are preliminary calculations and may change if errors or ways to validate or modify assumptions are discovered; consequently, additional conclusions may also result.

METHODOLOGY AND RESULTS

These analyses are based upon harvesting road construction between 1967 and 2015. The results presented herein demonstrate flood frequency changes between 1983 and 2015.

HYDROLOGIC CHANGES IN ELK RIVER WATERSHED

Removal of canopy results in reduced rainfall interception and reduced evapo-transpiration capacity. The combination of these effects results in increased runoff associated with peak flow events. The model estimating the increased peak flows was developed by Lewis et al. based on data from the Caspar Creek watershed, a coastal redwood watershed, not dissimilar to Elk River in terms of geology, vegetation, and rainfall patterns. The model offers information about the relative magnitudes of harvest-related peakflow changes relative to background conditions for the watershed being modeled.

This model is mathematically represented as:

$$E(r) = \exp\{[1 + B_2(t-1)]c[B_4 + B_5 \ln(y_c) + B_6 \ln(w)]\}$$

Where:

B_2	= Logging recovery coefficient
B_4	= constant
B_5	= storm size coefficient
B_6	= watershed wetness coefficient
RI	= recurrence interval
Y_{ncf}	= control peak flow
y_c	= expected peak flow
w	= wetness index
c	= portion of watershed canopy removed
t	= time since harvest that calculation is made

This equation estimates the expected increase in volume of water associated with a given recurrence interval peak flow. The effects of harvest are greatest immediately following harvest and follow an exponential decay after harvest (i.e., hydrological recovery).

Using the harvest history provided by CDF (Munn, 2002) and the Pacific Watershed Associates (PWA) report (1999), the peak flow increases, due to hydrologic changes only, were determined for the 2-year recurrence interval flow and are shown in Figure 1. It should be noted that similar percent increases were observed at Caspar Creek for the highest flows on record at the time the paper was written (i.e., up to the 8-year recurrence interval flow) (Lewis et al., 2000). Data indicate that up to the 8-year recurrence interval peak flow is affected by harvesting. The model shows increases in peak-flows for even greater return interval peak flows.

CDF Analysis

The methodology employed by CDF (Munn, 2002) is based solely upon increased peak flow. Their analyses does not also include the increase in flood frequency due to aggradation of sediment, a key factor in increase flood frequency. CDF determined that 600 clearcut equivalent acres would be acceptable in the Elk River watershed and would not worsen the existing flooding problem. However, this hydrologic component is but a portion of the flooding problem in the Elk River and Freshwater Creek watersheds, as the following analysis demonstrate.

Further, Figure 1 shows that CDF's proposed harvest scenario will, in fact, increase existing flood frequency in Elk River due solely to hydrologic changes, and that current flood frequency is greater than background levels. Figure 1 also demonstrates that if harvesting is deferred after 2001, the hydrologic changes due to canopy removal will stabilize in approximately 2015. This is because the modeled hydrologic effects due to harvesting approach zero after 14 years.

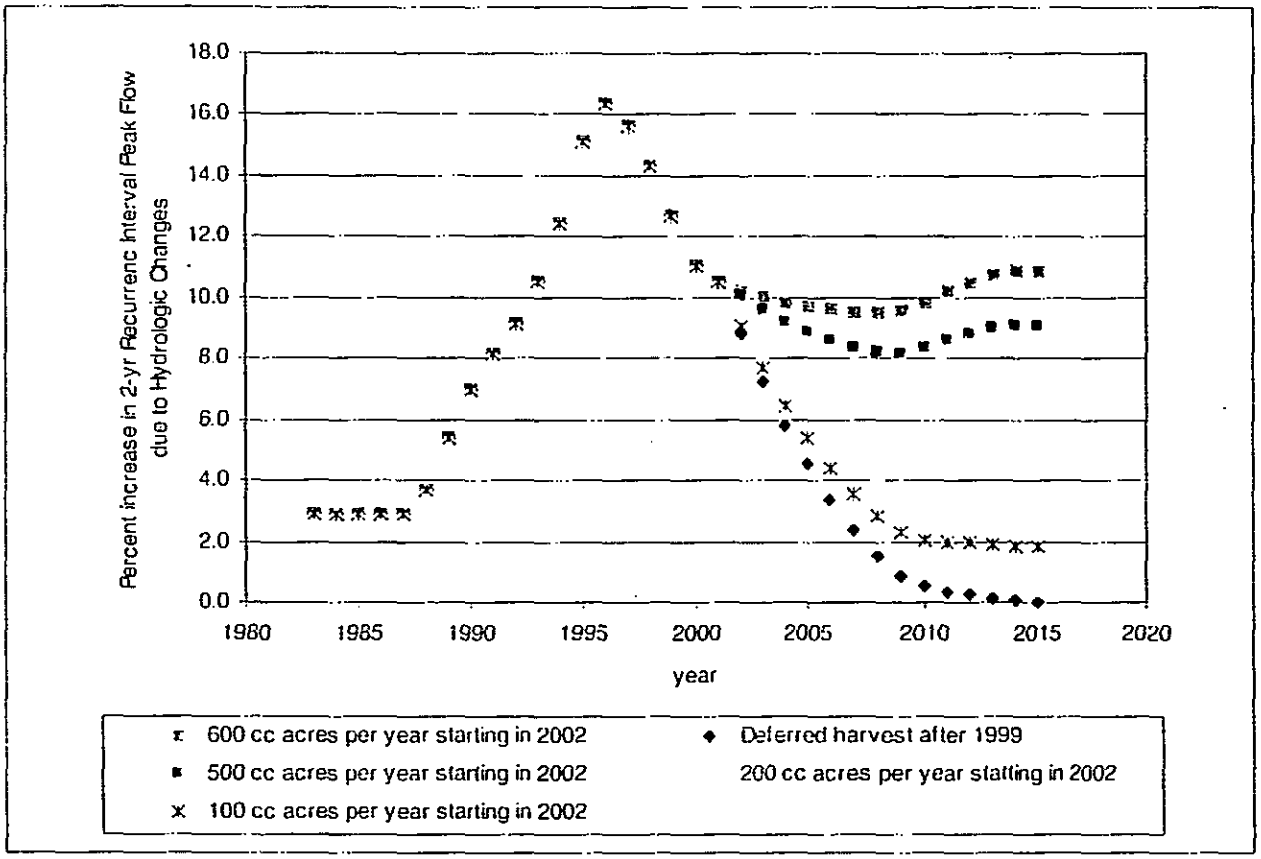


Figure 1. Estimated percentage increase in 2-year recurrence interval peak flow based upon one past harvesting and four future harvesting scenarios.

SEDIMENT INPUTS OVER BACKGROUND

Lisle et al. (2000) identify two types of sediment inputs which result due to the timber harvest and related activities: silviculturally-related and road-related sediment inputs. Both of these activities increase the sediment inputs above background levels. It should be noted that in this context increases above background levels are relative to those of the specific watershed being modeled.

Silviculturally Related Sediment Inputs

The increased peak flows not only result in increased runoff of water, but also result in increased sediment inputs by two primary mechanisms: silviculturally-related hillslope landsliding and rilling and scour of low order channels. These sediment inputs were modeled using the following equations, as presented by Lisle et al. (2000). The equations are based upon information contained in the PWA report (1998).

Pre-Pacific Lumber Company (PL) Habitat Conservation Plan (HCP) silviculturally-related landslide inputs are based upon data in the PWA report (1998) indicating a 1300% increase in landsliding on recently harvested areas in North Fork Elk River. Post-PL HCP sediment inputs are based on the assumption that the mass-wasting strategy is completely effective at preventing increased rates of landslides on all areas except planar slopes and breaks in slope. This assumption has not been validated. The landslide rates on harvested portions of the watershed are assumed to return to background levels 15 years after harvesting. This assumption has not been validated.

Hydrologically associated erosion inputs (i.e. rilling and scour of low order channels) are based upon Lewis et al. (1998) and are presented in Lisle et al. (2000). These inputs are the same for pre- and post-PL HCP conditions and are assumed to stabilize and decrease over time after harvest (as the canopy grows back), following the same recovery-rate as the hydrologic change recovery.

$$P = \sum_{i=1}^{15} C_i(1400 - 92.9i) \text{ (Pre-HCP conditions)}$$

$$P = \sum_{i=1}^{15} C_i(219 - 20.9i) \text{ (Post-HCP conditions)}$$

Where:

$P =$ proportional increase in sediment input over background in a given year
$C =$ portion of watershed canopy removed in a given year
$i =$ number of years prior to the year of calculations that harvesting took place

Road Related Sediment Inputs

The presence of roads on the landscape results in sediment delivery via surface erosion and road-related landsliding. Lisle et al. (2000) estimate sediment inputs associated with non-storm-proofed roads in Freshwater as 20% over background for the roaded area. Sediment delivery from storm-proofed roads is assumed only 4% over background for the roaded area. This assumption may not be valid because storm proofing may not be as effective as indicated.

The area of the watershed comprised of roads was based upon road construction rates in the North Fork Elk River, as presented on Page 13 of the PWA report (1998). These same road construction rates are assumed for the South Fork Elk River watershed. Road widths are assumed to be 14 feet.

The rates of storm-proofing are based upon Table 1, on Page 3 of (Miller, 2000) which indicate that in the Elk River watershed 47.17 miles were storm-proofed by 2000. It was assumed that storm-proofing began in 1998 and continued at the same rate until all the roads were storm-proofed.

It should be noted that the results presented here do not include any additional road construction, though approximately 11 miles of new roads are proposed associated with pending timber harvest plans. Further analyses are necessary to model the inputs from the proposed roads.

Combined Sediment Inputs

The silviculturally-related and road-related sediment inputs are summed to estimate the total percent sediment inputs over background resulting from harvest-related activities. Figure 2 shows the modeled sediment inputs over background levels for two harvest scenarios (deferred harvest beginning in 2001 and 600 clearcut (CC) equivalent acres annually beginning in 2002, as proposed by CDF). Figure 2 also shows that modeled sediment inputs from harvest and roads reach a peak in 1996.

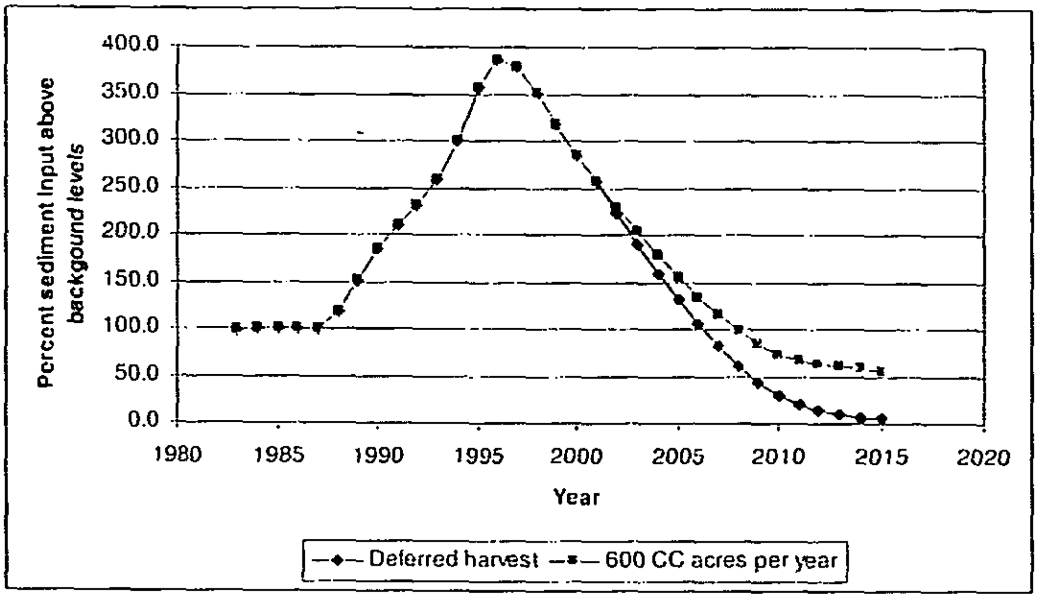


Figure 2. Annual percent sediment input over background for two harvest scenarios.

Aggradable Sediment

Both the silviculturally-related and road-related sediment deliveries increase the total deliveries over background sediment delivery levels. A stream has a certain capacity for sediment transport; once the capacity is exceeded by sediment inputs, aggradation occurs. Aggraded sediment may eventually be flushed out of the system if the inputs are abated. If inputs continue to exceed the threshold for aggradation, further aggradation will occur. The cumulative effect on the channel is not limited to increased flood frequency due to channel capacity reduction but also includes increased bank erosion.

While the exact threshold above background at which sediment began to aggrade in the Elk River watershed is not defined, evidence indicates it was somewhere less than 90-160% over background. Lisle et al. (2000) discuss observations by long-time Elk River residents indicating that the channel was noticeably filling with sediment and degradation of water quality had occurred in the early 1990's. By the time these effects were noticeable, the threshold for aggradation had already been surpassed by sediment inputs. A family of curves for four threshold levels above background is shown in Figure 3, assuming harvest is deferred following 2001. Figure 3 indicates that for the thresholds shown, the cumulative aggradable sediment curves have a similar shape. However, greater aggradation occurs for lower thresholds and consequently, recovery is greatest for higher thresholds. Additionally, Figure 3 shows that under deferred harvest conditions for all aggradation thresholds modeled, the river could begin to flush out aggraded sediment within the time period modeled.

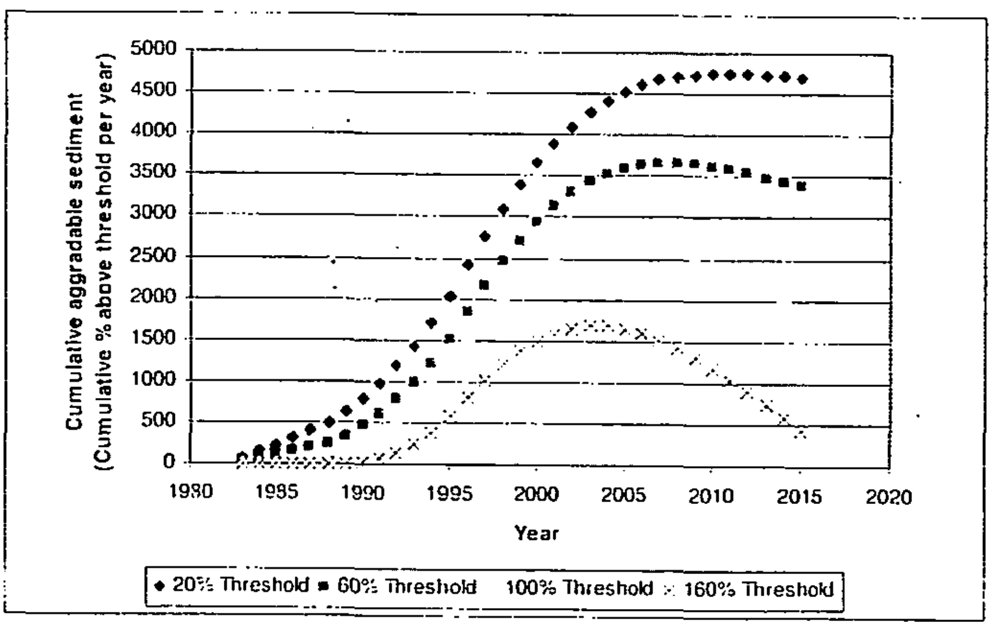


Figure 3. Cumulative aggradable sediment (sediment inputs above the stream's transport capacity above background levels). The depicted harvest scenario assumes that harvest is deferred after 2001.

In Figures 4-6, a threshold for aggradation of 60% is assumed. This assumption has not been validated. Figure 4 shows the cumulative aggradable sediment over time for two harvest scenarios, assuming aggradation occurs if sediment inputs exceed 60% over background levels annually:

1) deferred harvest beginning in 2001 and
2) 600 clearcut (CC) equivalent acres annually beginning in 2002, as proposed by CDF.

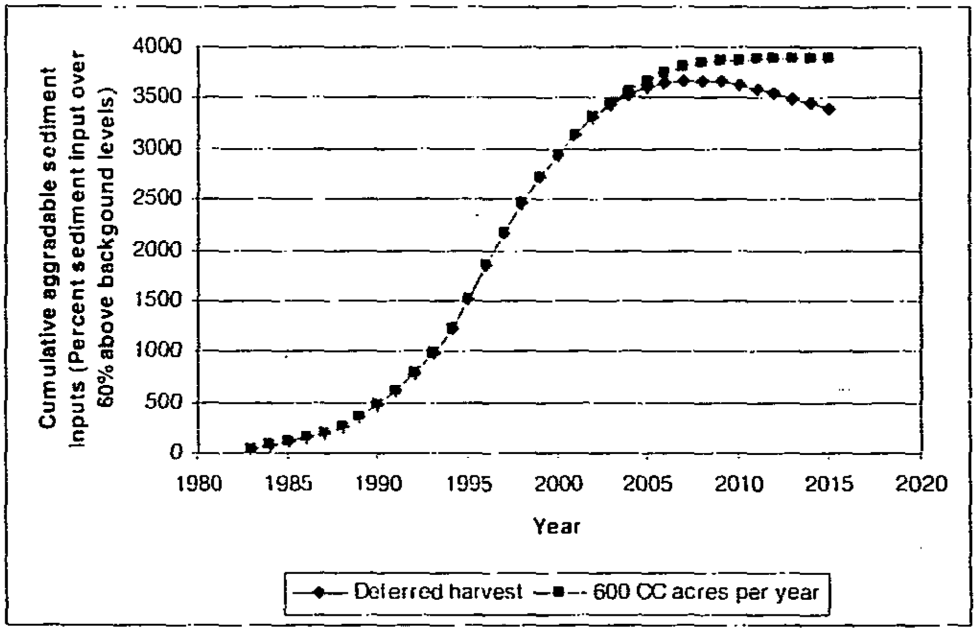


Figure 4. Cumulative aggradable sediment for two harvest scenarios, assuming the aggradation begins at 60% over background.

FLOOD FREQUENCY INDEX

The change in flood frequency is a result of the combined effects of increased peak flow volumes and increased sediment aggradation in the channel. In order to demonstrate the change in channel capacity between current and historic conditions, I relied on the review of Conroy (1998) conducted by Lisle et al. (2000). The review refers to historical data documented by USGS and recent data from Conroy (1998) pertaining to the same cross-section at the gage station on the mainstem Elk River just below the confluence of North Fork and South Fork Elk River. The USGS record indicates that between 1959 and 1967 bankfull discharge was 63 cubic meters per second (cms). Conroy indicates that in 1997 bankfull discharge was 25 cms.

The historic information indicates the bankfull channel capacity was reduced by 60% between 1967 and 1997. Figure 1 shows in 1997 there was a 15% increase in the 2-year recurrence interval flow compared to background conditions. Thus, in 1997, 85% of the change in flood frequency is attributable to reduction in channel capacity due to aggradation and the remainder of the impact is due to hydrologic changes.

It is imperative to note that 1997 is used as an index year because there were data to represent the relative portion of the total flood frequency increase attributable to sediment aggradation and to hydrologic changes. Figures 5 and 6 illustrate over time 1) the change in flood frequency due to hydrologic changes, 2) the change in flood frequency due to aggraded sediment, and 3) the total change in flood frequency. The total change in flood frequency is simply the summation of the hydrologic and aggradation effects.

A flood frequency index of 100% corresponds to 1997 conditions when conditions were significantly different than background: there was a 15% increase in the 2-year recurrence interval peak flow, silvicultural and road-related sediment inputs were 378% over background levels (silviculturally-related inputs were 316% over background levels and road-related sediment inputs were 61% over background levels), and cumulative aggraded sediment was 2169% over background levels (assuming a 60% over background sediment input threshold for aggradation). Figures 5 and 6 differ after 2001. Figure 5 shows results assuming harvest is deferred after 2001. Figure 6 shows results assuming 600 clearcut equivalent acres are harvested annually beginning in 2002 and continuing over the modeled time period.

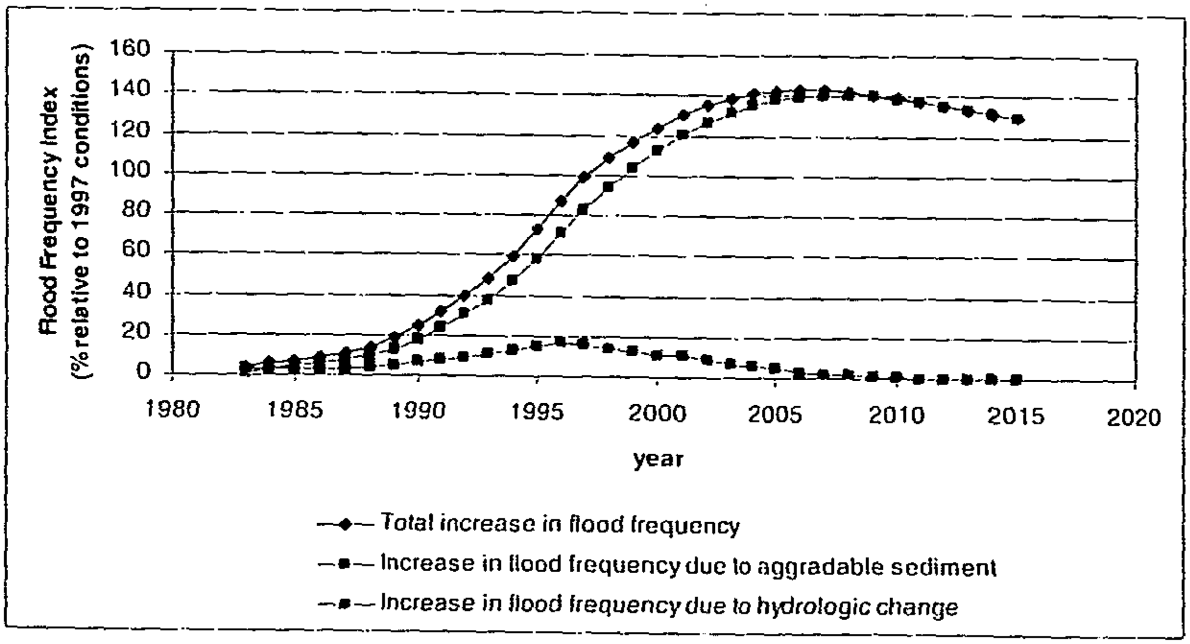


Figure 5. Flood frequency index for Elk River if harvest is deferred after 2001. Note that an index value of 100% corresponds to 1997 channel conditions.

Figures 5 and 6 indicate the current flood frequency is 135% greater than in the early 1980s. Figure 5 shows that if harvest is deferred after 2001, impacts will worsen until recovery begins in 2005, however flood frequency will remain greater than pre-2001 levels over the time period modeled. Figure 6 shows if harvest commences in 2002 at a rate of 600 clear cut equivalent acres per year, flood frequencies will increase over current conditions and stabilize at a level of 159% greater than observed in the early 1980s.

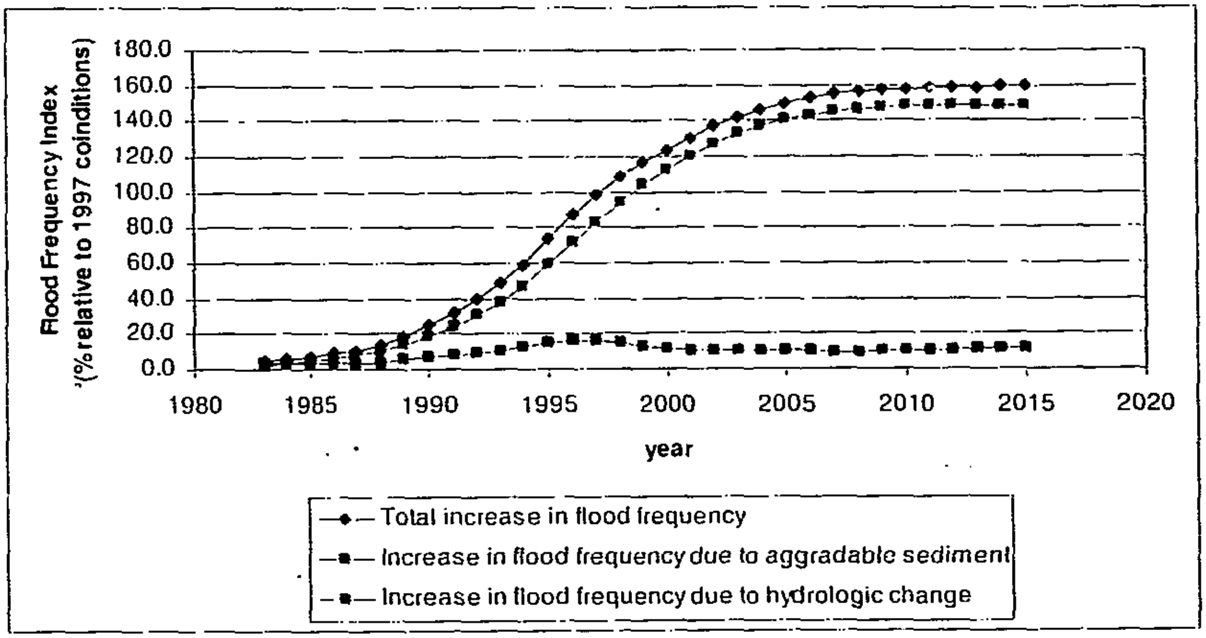


Figure 6. Flood frequency index for Elk River assuming annual harvest of 600 clearcut acres. Note that an index value of 100% corresponds to 1997 channel conditions.

FURTHER EVALUATIONS

Further evaluations should be conducted beyond those described in this memo. These include:

- Further evaluation of flood frequency changes under different harvest scenarios
- Incorporation of new road construction
- Evaluations under different antecedent wetness conditions

Conclusions

The results of this evaluation indicate the following:

- The flood frequency in Elk River has increased significantly (135%) as compared to historic conditions and will continue to increase until after sediment inputs are abated and after conditions stabilize at an unprecedented high level of flood frequency.

- The evaluation conducted by Munn (2002) apparently lead CDF to conclude that allowing 600 clearcut equivalent acres to be harvested annually would not exacerbate the existing significant impact. However did CDF not evaluate sediment impacts on flood frequency, which is the primary contributor to the impacts. In addition, Munn (2002) did not extend the calculation far enough into the future to observe the cumulative impact resulting from harvesting. Figure 1 indicates an increase in peak flow will result solely from the hydrologic change if 600 acres are clearcut annually and peak flow increases will stabilize at a level greater (10.9% % increase in 2-year recurrence interval peak flow) than current conditions (10.3% increase in 2-year recurrence interval peak flow) as long as that harvest scenario continues. The results presented in this analysis indicate that if harvest commences in 2002 at a rate 600 clear cut equivalent acres per year, flood frequency will increase over current conditions and stabilize at a level of 159% greater than observed in the early 1980s.

- The CDF proposed harvest scenario would slow the rate of recovery for Elk River.

- The flooding frequency in 2002 is 27% greater than in 1997.

- If 600 clearcut equivalent acres are harvested annually starting in 2002, there will be no decrease in the aggradable sediment inputs in the foreseeable future. Because sediment is the same pollutant impairing beneficial uses of water, there will be no recovery of impaired beneficial uses in the foreseeable future under the CDF-proposed harvest scenario.

References

Conroy, W.J. 1998. A comparison of rainfall-runoff relations in Elk River, a small coastal northern California watershed. Master's Thesis. Humboldt State University, Arcata, California.

Lewis, J., S.R. Moori, E.T. Keppeler, and R.R. Ziemer. Impacts of logging on storm peak flows, flow volumes and suspended sediment loads in Caspar Creek, California.

Lisle, T.E., L.M. Reid, and R.R Ziemer. 2000. Review of: Master's Thesis authored by Mr. William John Conroy: "A comparison of rainfall-runoff relations in Elk River, a small coastal northern California watershed". Unpublished review prepared for National Marine Fisheries Service, California Department of Forestry and Fire Protection, and the North Coast Regional Water Quality Control Board.

Lisle, T.E., L.M. Reid, and R.R Ziemer. 2000. Review of: Freshwater flooding analysis summary. Unpublished review prepared for California Department of Forestry and Fire Protection and the North Coast Regional Water Quality Control Board.

Lisle, T.E., L.M. Reid, and R.R Ziemer. 2000. Addendum: Review of: Freshwater flooding analysis summary. Unpublished review prepared for California Department of Forestry and Fire Protection.

Miller, R. 2001. Proposed Testimony of Ray Miller in the Public Hearing for Pacific Lumber Company's and Scotia Pacific Company LLC's Timber Harvest and Related Activities in the North Fork Elk River, Stitz Creek, Bear Creek, Jordan Creek, and Freshwater Creek Watersheds.

Munn, J. R. January 14, 2002. Memorandum to Dean Lucke: Elk River Peak Flow Analysis. California Department of Forestry and Fire Protection.

Pacific Watershed Associates. 19998. Sediment Source Investigation of the North Fork Elk River. Prepared for the Pacific Lumber Company.