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Environmental Science 310
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Turbidity Testing in Freshwater Creek
With Salmon Forever

Table Of Contents

1 Problem Statement

Anadromous fish stocks on the North Coast of California have recently declined form historically high levels. Elevated levels of sediment is considered to be a primary cause of for their decline by clogging spawning gravels, filling in pools, reducing channel capacity, as well as directly impacting growth rates. Freshwater creek is listed as impaired, according to section 303.d of the Clean Water Act due to elevated levels of sediment.

Although sediment is implicated as a primary problem in the basin, long-term consistent monitoring data has not been established, which is the reason for us getting involved with this project.

2 Background Information

Large areas of the forest within the freshwater watershed have been cut, or scheduled to be cut, using industrial forestry methods. As storm events occur, the quantity of sediment generated in tributary watersheds, like McCready and Cloney (see Appendix A-1), and transported through the stream systems towards Humboldt Bay is expected to further increase beyond background levels.

Excessive sediment loading causes:

- Turbidity to increase beyond background levels and basin plan standards
- High turbidity levels to be maintained for longer durations
- Channel aggradations; bank erosion and channel migration
- Reduced Channel capacity and conveyance, and subsequent flooding
- Degraded fish habitat
- Impaired water quality for domestic and agricultural uses

(Information from the Technical Advisory Panel)

Regulatory agencies, like the Water Quality Control Board and the EPA, have been questioning residents on the obvious changes in Freshwater creek like rising water levels, flooding, and declining fish populations. In the town of Freshwater many houses were flooded where water levels never used to come. Public forums were also held where residents could express their concern for their domestic water source and their declining

property values. But it's the concerned residents and nonprofit organizations who have organized themselves and are gathering the technical data needed to make good management decisions and for further studies.

We were given the opportunity to work with some dedicated people from Salmon Forever and the Technical Advisory Panel who are gathering data on turbidity and sediment levels. They have been testing various sample methods for the past 2 years and they taught us their system of sample collection and processing.

3 Procedure Outline for Salmon ForeverLaboratory to Determine Suspended Sediment Concentrations

3.1 Scope

Depending on the size of a sediment particle, a stream transports the sediment by maintaining the particle in suspension with turbulent currents or by rolling or skipping the particle along the streambed. In general, fine-grain sediment (silt and clay) is transported suspended in the water by the supporting action of turbulence. This Standard Operating Procedure covers the proper handling of samples and suspended sediment concentration determination for the Watershed Watch Program. Salmon Forever established the Sunny Brae Sediment Lab in the spring of 1998 to process water samples for a start-up-cost just under $9,000. Community members assist in the analysis of samples after undergoing standardized training by the laboratory manager. Laboratory Protocols from the EPA and RSL are used to assure compliance with the standard methods and procedures used in this lab. The lab has processed over 1,000 samples that were collected during the year 1998-1999 from seven watersheds in Humboldt and Mendocino Counties. The watersheds included are the South Fork of the Eel, Freshwater Creek, North and South Forks of Elk River, Jacoby Creek and tributaries in Humboldt Redwoods State Park. For our purpose we will focus on Freshwater Creek and its tributary McCready.

3.2 Apparatus

- Mettler H2OT Analytical Balance S/N 418151 and appropriate Checkweight AND FY 3000 scale S/N 5608313
- Filters- Gelman P/N 61631 Type A/E 47mm, 1 micron, glass Fiber
- Grieve Laboratory Oven LR270C
- Dessicator /Sanplatec Co.
- Desiccant
- Humidity Reader
- Vacuum Pump and 47mm-filter assembly
- Forceps
- Distilled Water, spray bottles
- Timer
- Drying Racks

3.3 Calibration

The calibration records are kept by the lab manager and are available upon request. The only equipment used in this SOP that requires calibration are the Mettler H20T Analytical Balance S/N 418151 and the AND FY 3000 scale S/N 5608313. The lab manager documents all calibrations records need to be kept for at least 10 years.

3.4 Sample Processing

Samples are brought into the Sunny Brae Sediment Lab and processed for Turbidity determination and/or suspended sediment concentration. A Hatch 2100P Turbidimeter is used for turbidity processing and suspended sediment concentration is determined by vacuuming water samples through a glass fiber 1-micron filter with a vacuum assembly. Filters are then dried in an oven, cooled in a dessicator and then weighed on a Mettler H2OT Balance scale. The filters are dried at 105C and cooled in a dessicator before weighing. The sample water weight and sediment weight is then used to calculate suspended sediment concentrations in Mg/L and parts per Mill.

3.5 Types of Samples

- **TTS (Turbidity Threshold Sample)** Samples are collected in ISCO 100ml plastic bottles. These samples are collected under data logger program control where pre-established turbidity threshold criteria are met.
- **AUX (Auxiliary Samples)** AUX samples are collected when too few samples have been collected during a storm and when equipment has malfunctioned.
- **DI (Depth Integrated Samples)** Samples are collected in 500ml glass like milk bottles in intervals across width of the entire stream. These samples represent the cross-sectional average of sediment concentration and are used as "truth" to correct the TTS pumped samples.
- **Grab (Grab Samples) - Sample we used in Sunny Brae Sediment Lab:** Samples that are collected in HACH sample cells, 2 by 6 plastic bottles, 3 by 8 plastic bottles, and 500ml glass, as well as any other useful container around. These samples are then taken by hand from shore. These samples are almost always collected by volunteers.

3.6 Grab Sample Data Sheet

First the sample bottles need to be arranged by location and then by chronological order. A new data sheet is started for each days work in the lab. Each person running the sample needs to record their name, date, and location. As each sample is processed we transfer location, date, and time from label and turbidity from the sign-in sheet onto the data form. Last you run the suspended Sediment Determination per sample and mark it off.

3.7 Preparing Filters

Check for tares and holes by turning on vacuum and listening for any whistling sounds. Keep prepared filters away from dust particles by putting them in a container, jar, or in an aluminum covered pan.

3.8 Suspended Sediment Determination for Sunny brae Sediment Lab

First put prepared filters in numerical order. Put first filter on vacuum manifold record the ID #. Weigh the sample with cap on and record. Turn the vacuum on and

wet the filter with distilled water. Then Pour the sample from the bottle into the4 funneling beaker. Rinse the rest of the sample bottle until cleaned of any sediment. Take grab sample bottle and record bottle and cap weight. After all the sample is poured through the filter, take forceps and place filter on wire rack to dry. Last, record any spills, errors, or notes onto the data form, the three of us were fortunate to participate in this highly debatable group project. We did this Laboratory work 2-3 days a week, for a period of about 2 and half months. It was well worth the time and effort because we were exposed to laboratory procedures. Also it's a non-profit organization that basically runs on the local citizens and students, along with Americorp volunteers.

3.9 QA / QC (Quality Assurance, Quality Control)

The Quality Assurance Manager is responsible for implementing, recording, and analyzing these measures that are taken have and still are taking place. The Quality Control measures are activities undertaken to demonstrate the accuracy of how close are we to the actual results. The precision needs to be measured so we can see how reproducible the results are. The Quality Control consists of steps needed to determine the validity of specific sampling and the analytical procedures Salmon Forever has been dedicated to, in order to answer Freshwater Creek citizen's questions and deep concerns of their home shared with a diversity of life forms.

4 What is turbidity?

Turbidity is a measure of the collective optical properties of a water sample that cause light to be scattered and absorbed rather than transmitted in straight lines.
The higher the intensity of scattered light, the high the turbidity. Primary contributors to turbidity include clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, and microscopic organisms. The measurement is qualitative and cannot be correlated directly as micrograms per liter of suspended solids. In surface water, the clarity of a natural body of water is used routinely as an indicator of the condition and productivity of the water system.

5 Why test turbidity?

The more suspended solids in the water, the murkier it becomes. The increased turbidity of water can reduce the diversity of life in three ways.

1. Suspended particles absorb heat from sunlight and warm the water. Warmer water holds less oxygen and organisms begin to suffer. Also, some organisms cannot live in the warmer water.
2. Particles also block sunlight. Plants and algae grow less and release less oxygen from photosynthesis.
3. Particles also settle on the bottom and can cover and suffocate fish eggs and insect larvae.

6 What can you find out from the data collected?

6.1 Turbidity Effects on Salmon

The salmon is an indicator species of the overall health of a stream or creek. Salmon suffer if they are exposed to higher levels of turbidity for short periods or low levels for long periods, and they suffer a lot if they experience high turbidity for a long time. In fact, the young salmon probably die if they cannot find refuge in clean water elsewhere. The Exposure Index was developed to show the combined duration and intensity of exposure to turbidity and suspended sediment research by Newcombe and MacDonald found that exposure to:

NTU	Time	Effect
20	1 month	
58	1 week	0-20% mortality
109	3 days	
132	1 month	

383	1 week	80-100% mortality
715	3 days	

This study set several thresholds:

40 NTU – the salmon cannot see, their growth is stunted, they survival rate decreases.

400 NTU - They usually die

(Noell, 1999)

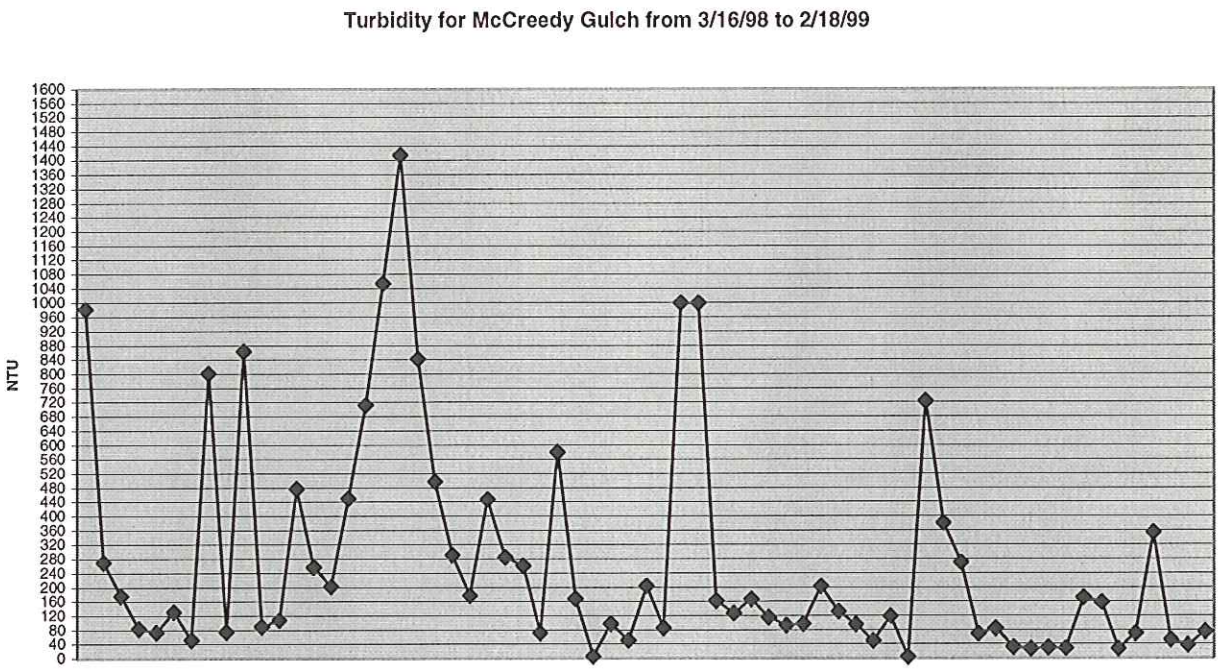

Figure 1: Graph showing the number of days the turbidity was over the threshholds throughout one year.

6.2 Comparison of recently unharvested sites and recently logged sites

Once the samples are processed and quality control procedures are completed, the suspended sediment concentration, turbidity, time, date, site, velocity, stage, and other information are entered into a computer database. Discharge is estimated from velocity, stage, and cross-sectional area. Finally turbidity is plotted against discharge to allow

interpretation of the results. When plotted like this the data from each stream or group of similar streams falls along a line (See Appendix A-2). The lines from turbid streams plot higher than those for clean streams, and the difference in levels of the lines provide a measure of how dirty a stream is compared to a clean stream. Scientists and foresters to determine the health of the watershed can use this data.

7 Conclusion

Overall we learned a great deal from our experience. It is people like Salmon Forever who are doing the research to save our watersheds. Without these grassroots organizations we would be at the mercy of the logging companies and their regulatory systems. They are not upholding their part of the deal set by CEQA and the FPA to assess the overall impacts of their projects, past, present and future (Mount, 1995) . Turbidity is one of the major impacts and still needs a lot of research done to set parameters that the logging companies have to abide by. Pacific Lumber, our local logging company, is responsible for the unhealthy conditions of the Freshwater Creek watersheds and tributaries. The citizens of these areas are taking a stand against this big bad wolf. Environmentalists have been taking action to help restore watersheds that are in danger from logging practices, which includes the spraying of herbicides. These herbicides enter into the ecosystems causing detrimental degradation to the pristine Northern California habitat.

8 References

Mount, J. F. 1995. California Rivers and Streams: The Conflict between Fluvial Process and Land Use. University of California Press. London, England.

Noell, Jesse. 1999. Watershed Watch Recap: Salmon Forever Reports on 1999. Voices of Humboldt County. Vol. 2, No. 8. p. 9.

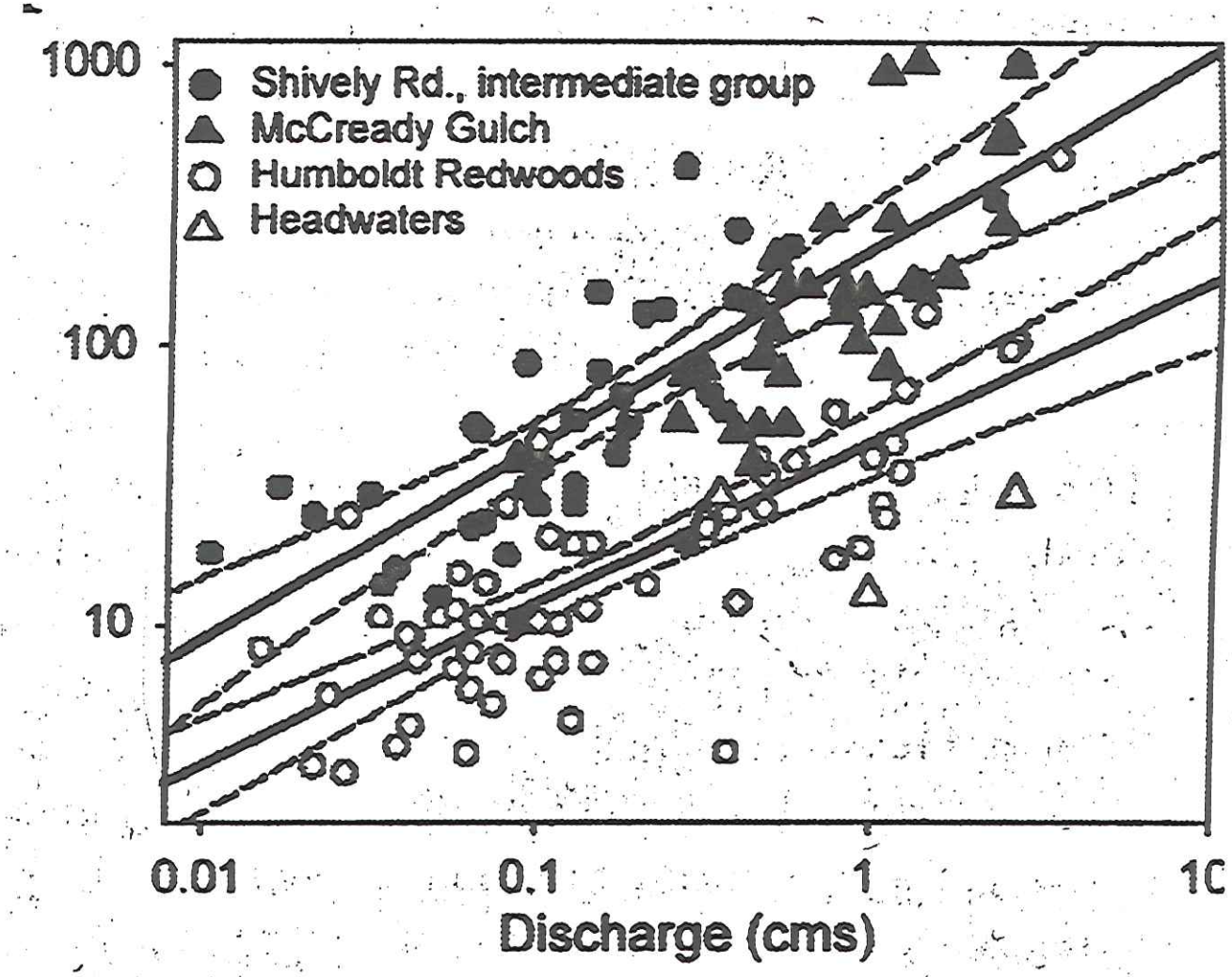

Fig. 1 compares the turbidity response from harvested areas along Shively Road and McCready Gulch with the turbidity response from unharvested Humboldt State Redwoods park and Headwaters Forest. Note the 500% increase in turbidity.

Graph courtesy of Jesse Nuell, Voices of Humboldt County, Vol. 2, No. 8; September 1994, p. 9

A-2