Lt. Stan DeSilva November 18, 1980

Mark West Creek, Sonoma County - Siltation Investigation

On October 24, 1980 an investigation of siltation in the headwaters of Mark West Creek was undertaken at your request. The area investigated was within Section 27, Township 3 North, Range 7 West.

I drove to Mark West Creek on the Ranchero Mark West (7125 St. Helena Road) owned by a Mr. Doersken. The caretaker, Mike, gave me permission to park my truck on the ranch and to survey the stream.

Upstream from the Ranchero Mark West the stream flows through a deep steep-sided, and heavily wooded canyon. The stream flows in series of cascades at an average gradient of 4%. Downstream from the Ranchero Mark West the canyon becomes less deep and steep-sided but remains heavily wooded; the flow is no longer cascading, the gradient averages 2.5%.

Observations

I first walked upstream for about ¼ mile from the ranch houses to determine the character of the stream in an undisturbed state. I estimated the flow to be .2-.4 cubic feet per second, water temperature was 54°F. The stream is about 70% riffle (70% boulder, 30% coarse gravel) and 30% pool (20% boulder 40% fine gravel, 40% sand with a small portion of silt). Pools average about 25' x 10' x 1.5' deep with excellent cover of undercut banks, boulders, and exposed root masses. Riparian canopy ranged from 15 to 100% providing excellent shading. Numerous juvenile steelhead trout were seen. In general the area appeared to be an excellent spawning and nursery area for steelhead.

I then walked downstream past two stream crossings to a point about 100 yards downstream of Mr. Doerksen's (sic) property line. The character of the downstream section is very similar to that observed above except that the gradient is a little less. At the upper crossing a layer of fine, light colored silt (all fine enough to pass through a 0.83 mm sieve) had been deposited over the entire width of the stream to a depth of about 34" average. The silt deposits were evident in the stream bed for about 400' downstream (to the lower crossing); most of the material had settled within the first 200'. At the lower crossing a layer of similar material had been deposited of the width of the stream to a depth of about 1" average. The silt deposits were evident for 700' downstream with most of the material having settled within the first 300'. With an average stream width of 10', I calculate that about 75 cubic feet of silt is now sitting on the stream bed in the immediate impact area; considerably more, undoubtedly, was carried downstream for up to several miles. The source of the silt was, according to Mike, leakage from the earth mover which made approximately 50 stream crossings.

No direct loss of fish life was observed due to siltation. Juvenile steelhead and crayfish were observed in the stream just below each of the crossings.

Discussion

Modification of streambed habitat by deposition of sand and silt-sized particles undoubtedly poses the most serious threat to our fishery resources. It is on the streambed that the bulk of the food required by trout and young salmon is produced.

Trout and salmon production is directly related to the presence of suitable streambed materials. Salmonids deposit their eggs in nests or "redds" which they excavate in the gravel. The redds are backfilled after spawning in such a manner that water is permitted to flow continuously over and around developing eggs, thereby satisfying their need for oxygen.

The addition of fins sediments to spawning beds decreases the permeability of spawning gravel and thus limits the amount of oxygen available for developing eggs (Cordone and Kelley 1961; McNeil and Ahnell 1964; Hall and Lantz 1969; Phillips 1971). The relationship between the permeability of spawning gravel and the fraction of total stream bottom material less than 0.85 mm in diameter has been diagramed by McNeil and Ahnell (1964) and is reproduced in Figure 1. The relationship between the permeability of spawning beds and survival of pink and chum salmon reported by Wickett (1958) is reproduced in Figure 2 from McNeil and Ahnell (1964). Field experiments have indicated that higher intragravel oxygen concentrations mean better survival of steelhead eggs and alevins (Coble 1961). Additionally, steelhead embryos grow faster at higher oxygen concentrations (Shumway, Warren and Doudorff 1964). Having adequate oxygen is directly related to substrate permeability.

Fine sediments may also reduce the survival of fry by impeding their emergence from the gravel. In experiments reported by Hall and Lantz (1969), the ability of steelhead and coho salmon fry to emerge from gravels containing varying amounts of fine sand, 1-3 mm in diameter, was measured, the relationship found between survival (emergence) and the percentage of fine sediments in their study is reproduced in Figure 3.

After emergence, salmonid fry may still be affected by fine sediment. Crevices and interstices in gravel are used as cover by salmonid fry to avoid predation. When fine sediments fill these spaces, escape cover is eliminated (Phillips, 1971). Additionally, spaces between boulders and rubble in pools and runs may be filled, reducing cover needed by larger trout (Cordone and Kelley 1961).

The mainstay of the diet of salmonid fishes is composed of insects such as stoneflies, mayflies or caddisflies. These insects develop on the clean surfaces of large gravels and cobbles and depend to a large degree on water turbulence on which they feed. The deposition of sand or clay around and over streambed rubble eliminates both the area upon which aquatic insects may develop and the turbulence required for effective feeding, thus eliminating those insects.

Silt and sand can also rapidly fill the very areas steelhead and salmon prefer to reside, namely undercut banks, the lee of large rocks or bottom of shaded pools. Trout unable to find sheltered resting places in streams become so stressed that they soon die of exhaustion.

Once deposited, fine sediments often become compacted and defy transport even under very heavy streamflow conditions. This is particularly true in the case of sediments from excavated sources such as roadways and fills which are essentially unweathered, flat or angular, or which demonstrate an especially cohesive nature such as clays. Under these circumstances the "fines" tend to "cement" the gravels together and once this has occurred, adult fish are no longer able to dig nests to lay their eggs. It may take as long as five to ten years for gravels to recover their original spawning potential (Calhoun, 1967).

Suspended particles in the sand-silt size class seriously compromise respiratory tissues. Sherk et al (1974) found that natural weathered sediments tend to clog gill spaces while unweathered mineral solids coat gill filaments impeding water contact and thus proper gas exchange*

Suspended particles also dislodge insects and algal populations sufficiently to inhibit primary and secondary productivity to the detriment of the stream's carrying capacity (Iwamoto, 1978). A sand or mud bottom provides habitat for burrowing invertebrates, but they are not as available to salmonids for food as are forms such as mayflies, caddisflies and Stoneflies that inhabit gravel areas.

Other aquatic residents are also affected by siltation. Salamanders and other amphibians can become trapped along with fish and eggs beneath cemented gravels and rocks (Branson and Hatch, 1972).

Productive spawning beds generally contain no more than 15-20 percent fines; materials less than 0.833 mm in diameter (McNeil and Ahnell, 1964; Tagart, 1976). The presence of up to 33.3 percent fines was found to reduce steelhead and coho salmon biomass by 42 and 65 percent respectively. (Burns, 1972).

Conclusions

While there has been no observed direct loss of fish in Mark West Creek, it is to be expected, from a review of the large body of scientific literature on the subject of siltation, that there will be a significant reduction in the stream's productivity for steelhead trout and other aquatic life. Steelhead survival in egg, alevin, and fry stages will be reduced through reduced gravel permeability, clogged interstitial spaces in the gravel, reduced cover, and reduced food availability.

The real impact of this case of silt deposition can only be appreciated, however, when evaluated as part of the cummulative impact of thousands of similar cases throughout the county and the state. The seemingly minor stream modifications resulting from single road building, logging, agricultural, or other operations have cummulatively lead to severe degradation of our streams and to corresponding declines in our salmon and steelhead runs and in some cases to the loss of entire runs.

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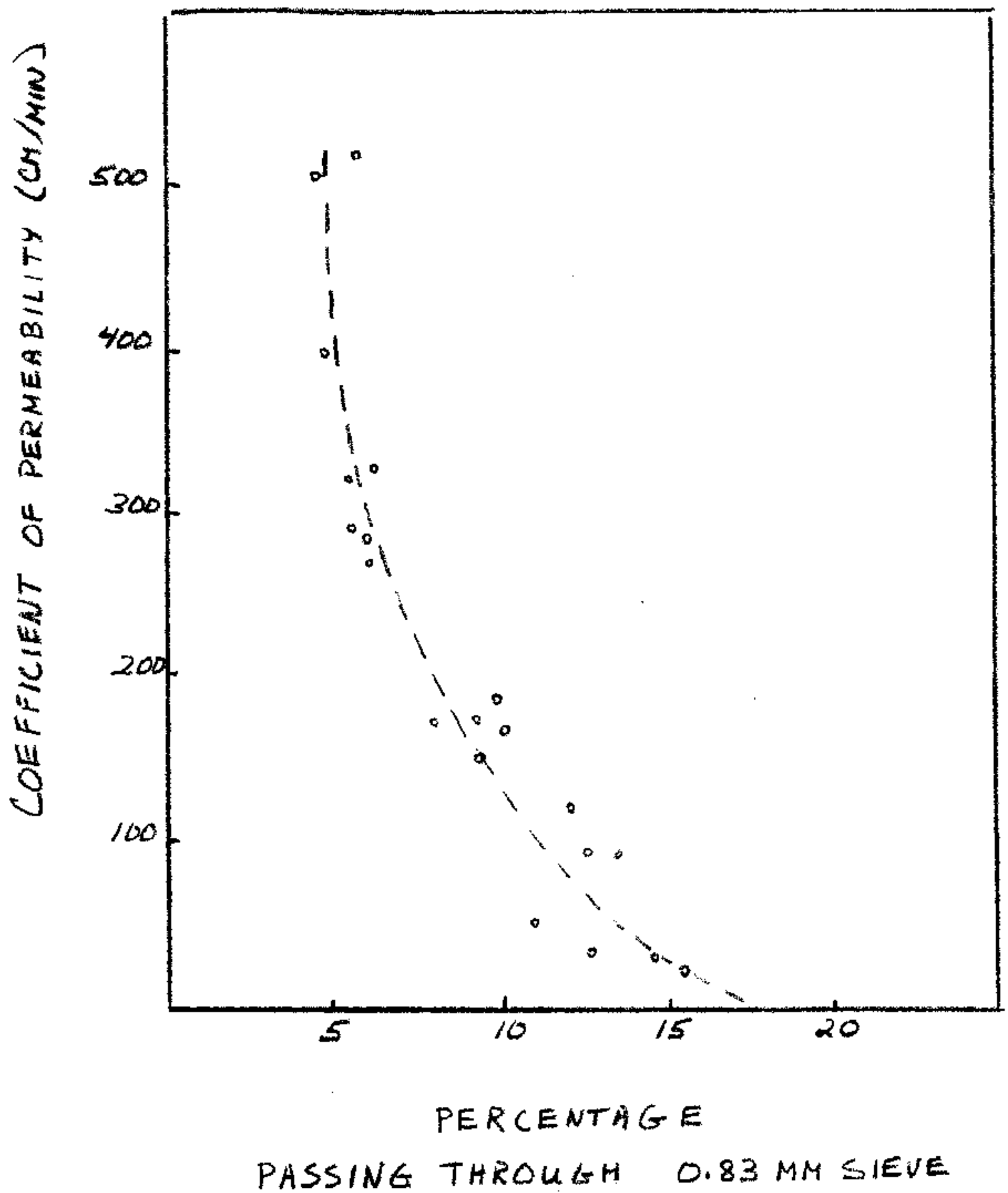


Figure 1. Relationship between coefficient of permeability and the fraction of the total volume of the stream bottom materials passing through a 0.83 mm sieve. (Curve fitted by eye). (From McNiel and Ahnell, 1964).

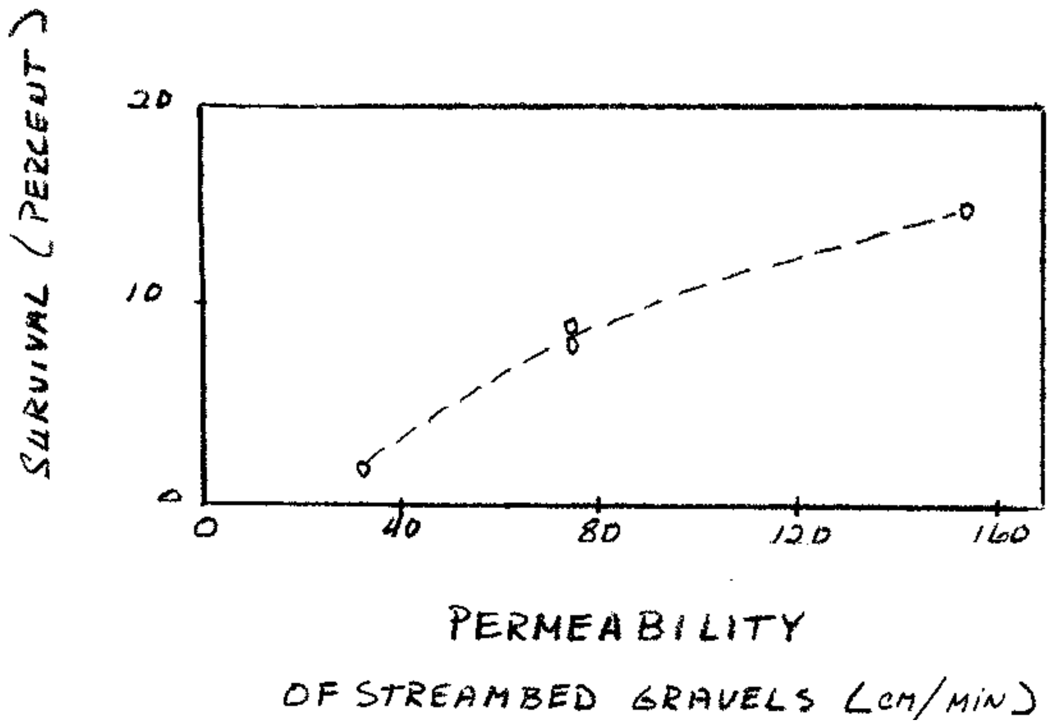
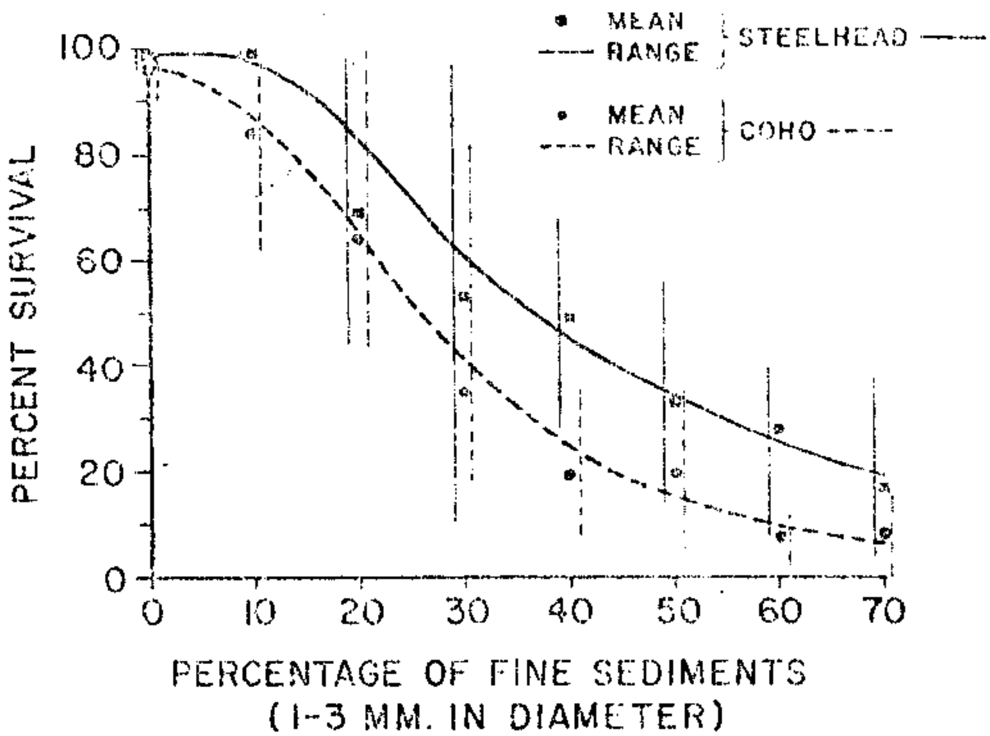


Figure 2. Relationship reported by Wickett (1958) between permeability of spawning beds and survival of pink and chum salmon to migrant fry stage. (From McNiel and Ahnell, 1964).



<u>Figure 3</u>. The relation between percentage of fine particles in an artificial gravel bed and the ability of Coho salmon and steelhead trout fry to emerge through the gravel.

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