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April 15, 2013

Testimony of Claudia Wise, Physical Scientist
To the
Oregon State Senate Environment and Natural Resources Committee

Chair Dingfelder, Members of the committee,

I oppose SB 838 and SB 401 and support SB 838-1

Please make my testimony part of the permanent record

My name is Claudia Wise, a retired U.S. EPA Physical Scientist. I am here today as a concerned citizen.

I have an Associate of Science in Science and Technology from LBCC, a Bachelors of Science with concentration in Plant Science from OSU, and post-Bach course work in Environmental Science.

I have 32-year of experience with the US Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, OR. I worked primarily in chemical and biological instrumentation methods studying phytotoxicity of soil and plant growth effects. For 8-years I was assigned to the Western Fish Toxicology Station where I coauthored journal articles dealing with bioaccumulation of heavy metals in invertebrates and fish. I contributed to many projects and have coauthored numerous journal articles for work performed in the Terrestrial, Ecotoxicology, Freshwater Branches. I concluded my EPA career while working in the Watershed Ecology Stable Isotope Research Facility in support of the Salmon habitat division.

I was an invited member of the California Department of Fish and Wildlife Subsequent Environmental Impact Report Public Advisory Committee for small-scale gold suction dredging. During the Public Advisory Committee meetings I presented a science based PowerPoint presentations to the committee titled **"Selenium Antagonism to Mercury", Does Methylmercury Cause Significant**

Harm to Fish or Human Health?"

I am acquainted with small-scale gold suction dredge mining around Oregon and California. I also have international experience working in Cambodia. I have 13 years experience observing and participated in suction dredge mining operations. My exposure to mining techniques have occurred in Southwest Oregon, California and in the Ratanakiri Province of Cambodia. While there I was asked to write the environmental rules for operating gold suction dredges for the country of Cambodia.

I feel it is unnecessary for a moratorium to further study suction dredge mining. There have been a number of important empirical studies involving small-scale gold suction dredging that have concluded already that these operations have a less than significant impact on the environment.

In 1994 the California Department of Fish and Game, in an Environmental Impact Report, reached the conclusion that this form of mining had **less than significant** impact on the environment.

In 1999 the U.S. Environmental Protection Agency reported the results of a cumulative field study evaluating the performance of 10- 8- and 4-inch gold dredges and concluded environmental impacts from these operations were **less than significant.**

In 2004 the Clearwater National Forest completed the draft Environmental Impact Statement for Small-Scale Suction Dredging in Lolo Creek and Moose Creek Clearwater and Idaho Counties. The report stated that "EPA generally supports the terms and conditions for dredging and we believe they are designed to protect fish habitat and seem to minimize the potential to damage stream channels and banks." Which once again supports **less-than-significant** outcome.

Then again, in 2012 the California Department of Fish and Wildlife, forced by environmental groups in a court order completed another Environmental Impact Report on small-scale gold suction dredging, at a cost to the state of $1.2 million dollars. Again the overall conclusion was that the environmental impact from operation of these dredges was **less-than-significant.**

I must implore you to re-think Senate Bills 838 and 401 given the effect of scale. With two thousand, or less, suction dredge miners operating on thousands of miles of Oregon's rivers the impact would only be minor at best.

Consider a calculation by the Siskiyou National Forest concluding that the amount of sediment moved by suction dredges was equal to only about **0.7-**

percent of the natural winter movement of sediments.

Joseph Greene, conducted a study on measurements of suction dredge impacts in the Salmon River, CA provided by the USFS and calculated the linear impact to the river covered much less than **0.26-percent** of the water way.

Data from the Oregon Watershed Enhancement Board and an assumption that there were 2000 suction dredge miners operating in Oregon waters, during the in-water-work-period, resulted in an estimated **<0.0064-percent** of Oregon waterways being impacted by small-scale gold suction dredging. To further refine these data it was assumed that all 2000 small-scale gold suction dredge miners moved into the upper Rogue River Basin to work. This calculation estimated that **<0.67-percent** of the linear area of waterway would be impacted by small-scale gold suction dredging. This is a clear example of the effect of scale that is always ignored by these "not-in-my-backyard" opponents to anything not within their own personal interests.

In closing I ask you to think about this. The small-scale gold suction dredge has been describes as a vacuum cleaner that sucks material from the stream bottom. What has not been clearly stated is that this machine is a highly efficient filtration system that removes valuable minerals along with environmental waste contaminants thereby increasing the quality of the environment in which it is operating.

There are no scientific conclusions that support the level of interference with mining activities that are described in Senate Bill 838 or SB 401, a misuse of the Oregon Scenic Waters Act is being used only to put suction dredgers out of business.

Small-scale gold suction dredge miners expect the right to be regulated fairly when operating on the public domain. Federal law reinforces that expectation.

SB 838 Page 2 SECTION 3d proposes a revised regulatory framework for "*Operating conditions and restrictions, based on the best available science and pre-cautionary principles, designed to protect and recover in-stream and riparian habitat important to achieve water quality standards and the conservation and recovery of indigenous anadromous salmonid, as defined in ORS 196.810, and naturally reproducing populations of bull trout*". Am I then to believe that the $1.2 million dollars that the California Department of Fish and Game just spent for the 2012 Final Environmental Impact Report on Small-Scale Gold Suction Dredging is inadequate for the Oregon legislators to not comprehend the conclusions that the effects of this industry on the environment

are overall, **Less-than-significant**? Must the citizens of Oregon spend more scarce funds to re-study this issue?

These bill adds nothing to the fair and reasonable oversight of this process by State Agencies.

Thank you for listening,

Claudia J. Wise

Physical Scientist
U.S. EPA (Retired)

Breakdown of effects listed

Finalized 2012, Recently Completed CDFG Environmental Impact Report –

Of the **60 areas identified** in the report

56 were less-than-significant

4 were significant and unavoidable

Less-than-significant areas

Hydrology/Geomorphology -

Water Quality/Toxicology

Biological Resources

Hazardous Materials

Cultural Resources

Aesthetics

Noise

Recreational Users

Transportation/Traffic

Cumulative Effects – Less than Significant in all categories

Significant and Unavoidable

Mercury/Trace Metal Re-suspension – Not as significant as EIR suggests

- Suction dredges contained 98% of Mercury
- Compared to 80-90% contained in Combie reservoir remediation project by NID is supported by Environmental Groups including Sierra Fund, Regional Water Quality Board, Ca Dept. Fish and Game.
- Fleck/Alpers study suggested Mercury in particulate form would float indefinitely, no measurements taken. A USEPA commissioned study on fortymile river and resurrection creek in 1999 disagrees. Both Zn, Cu with densities of 7.14 g cm^3 and 8.94 g cm^3 respectively sunk to the river bottom within the length of the dredge plume (80m). I would expect

Mercury at a density of 13.54 g cm3 even in particulate form to fall out even sooner.

- USEPA study Peterson and Ralston concluded 98% of fish and wildlife are protected from Hg toxicity by Selenium, a trace metal and antioxidant, that binds irreversible with mercury. The Study included 12 Western States, Oregon and California included.
- USEPA website Ralston 6 studies showing no harm to human health including children.

- Less than a handful of Mercury Toxicity Cases – only a few were fish consumption related.
  - Minamata Japan – Tons of industrial waste dumped into bay
  - Faroe Islands – Children developed health problems
    Diet was fish and Pilot Whales
    Solution limit consumption of Pilot Whale.. eat more fish

  - Seychelles Islands –Measured Child development from Pregnancy through 9 years. No health problems associated with dietary mercury.
    Diet fish with similar mercury levels to that in the US. However they eat 12 fish meals/week compared to 1-2 fish meals/week for the US.

  - Recent Conclusions indicate improved health effects possibly related to antioxidants.

Birds Associated with Riparian Habitat

- Suction dredges would have Less effect than rafters and fisherman moving up or down the waterway and through the riparian area. Is the intent to block all activities from riparian zones.

Archaeological/Historic Artifacts

- Recent opinion was that artifacts that were found in waterways had no significant value

Noise-

- Local jurisdiction -

(1). Bullets Regarding the Beneficial Environmental Effects of Small-scale Gold Suction Dredging

I. **Beneficial factors of Turbidity**
Experts agree that **fish survival improves under turbid conditions.** Stan Gregory (1993) reported similar situations noting that any reduction in feeding efficiency of fish may be offset by **reduced risk of predation at moderate levels of suspended sediment.**

Elevated TSS conditions, similar to **turbidity plumes created from dredging activity, have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates,** and improve survival (CH2MHill 2000).

II. **Suction Dredge Holes Create Safe Habitat for Fish**
Dredge holes 3 feet or deeper are considered adequate refugia for fish. *Excavations from dredging operations can result in temporarily formed pools or deepen existing pools improve fish habitat.* ***Pools created by abandoned dredger sites can provide holding and resting areas for juvenile and adult salmonids.*** *Stern, G. R. 1988.*

III. **Tailing Piles from Small-Scale Suction Dredging may be Included in excellent Spawning Gravels**
Suction dredging breaks up compacted steam beds. The gravels are dispersed by the high stream flows, which included **dredge tailings, compose a portion of the suitable spawning gravels each year.**

IV. **Small-Scale Gold Suction Dredge Tailings Protect Established Redds by Offering Additional Spawning Substrate in Areas of Limited Natural Substrate.**
Salmonids show **no preference for dredge tailings,** for spawning, if natural substrate is available. If none is available redds built in cleaned dredge tailings that doesn't scour are a net benefit to increased salmonid numbers.

V. ***One year after dredging at both sites...the study found that there was an increase in macroinvertibrate density in mined area....***
Forty Mile River...Final Report (1999), paid for by EPA: studied the 8 and 10 inch suction dredge:

VI. **Miner's, On Their Own Claims Remove Waste Left Behind by Others**
Small-scale gold suction **dredge operators improve water quality by removing massive amounts of lead weights, used water bottles, car debris, nails, bolts etc.** The list goes on and on. Also remove waste left by other users of camping areas.

VII. **Small-Scale Gold Suction Dredging Tourist Dollars Support Local Business.**
Small-scale gold suction **dredgers contribute an average $13,797 per miner into Oregon's economy.** As well as, collectively paying $16,600 in permit fees to the state DEQ. These figures are based on calculations made from figures in the CDFG 2012 EIR and 2010 data received from the DEQ.

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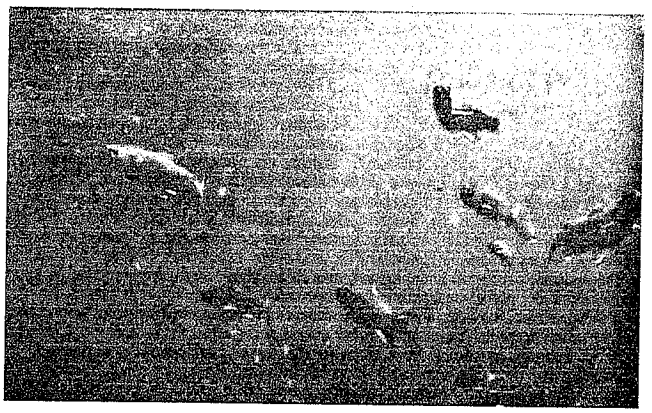
(2). The Beneficial Environmental Effects of Small-scale Gold Suction Dredging

I. Beneficial Factors of Turbidity

"Turbidities greater than 25 NTU can decrease the visual acuity of predatory fish" (McLeay et al. 1984, 1987; Redding et al. 1987; Reynolds et al. 1989). While Sigler (1984) and Lloyd (1987) reported avoidance of turbid water may begin as turbidities approach 30 NTU and then reach a threshold at 37 NTU (Servizi and Martens 1992).

From a personal note when suction dredges are in operation small fish are seen feeding near the nozzle safely away from the larger fish feeding behind the dredge. A kind of a pecking order is created. The larger fish are in the more turbid water potentially packed with tidbits of food loosened from the streambed and flowing over the dredge along with the other dredge materials. I would be interesting to measure the turbidity of the water near this group of fish and see if they are located just to the side of the more moderate turbidities in the 30-37 NTU range as noted in the research above maybe tucked just within the 25 NTU portion of the dredge plume.



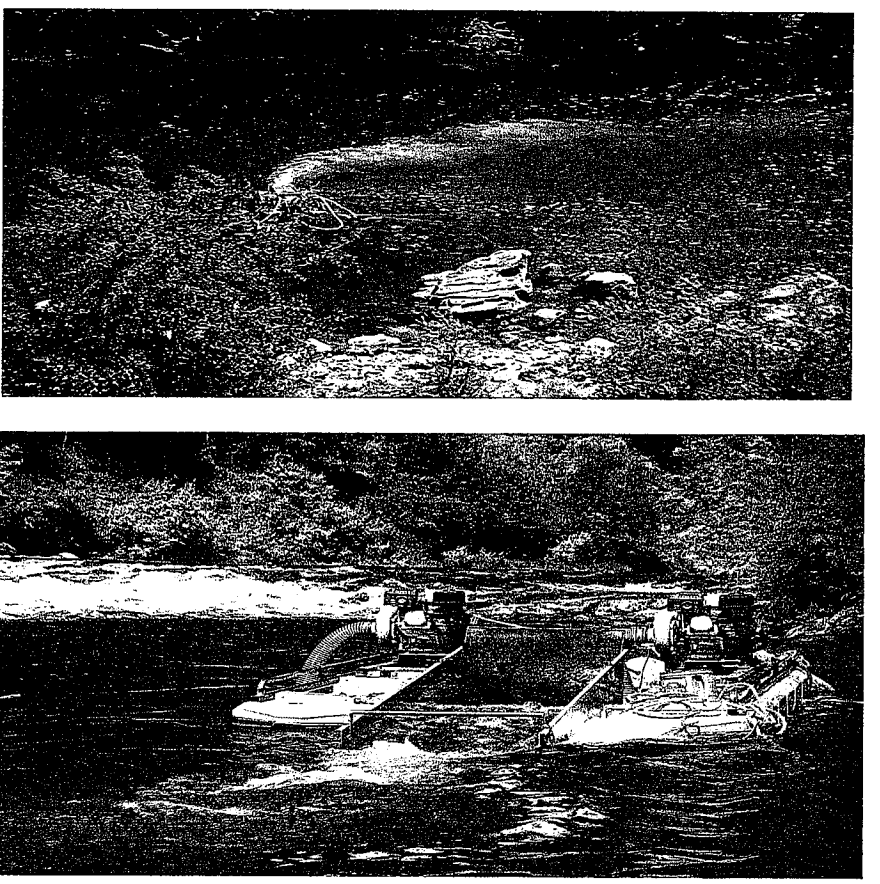
Fish feeding off the back of a dredge

Perch feeding from tailings falling off the back of a suction dredge

Gregory (1993) reported similar situations noting that any reduction in feeding efficiency of fish may be offset by reduced risk of predation at moderate levels of suspended sediment. Juvenile Chinook salmon spend more time foraging in water of moderate turbidity (20-25 NTU) than in clearer water. Similarly, brook trout are more active and spend less time near cover in moderately turbid water than in clear water (Gradall and Swenson 1982) and juvenile estuarine fishes in laboratory channels actively seek moderate turbidity (Cyrus and Blaber 1987). Coho salmon do not avoid turbidities as high as 70 NTU but move into turbid water when frightened (Bisson and Bilby 1982). Elevated TSS conditions, similar to turbidity plumes created from dredging activity, have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival (CH2MHill 2000).

Fish have been observed feeding in turbid plumes created by suction dredging. Stern (1988) observed young steelhead feeding on dislodged invertebrates in turbid dredge plumes, even though clear water was available nearby. Cutthroat and rainbow trout have also been observed feeding.

The effects of suction dredging on the feeding of fish appears to be less than significant. Although invertebrate populations are negatively affected by suction dredging, the impacts are localized and short-term. Stern, G. R. 1988. Effects of Suction Dredge Mining on Anadromous Salmonid Habitat in Canyon Creek, Trinity County, California. Masters Degree Thesis, Humbolt State University, 80p.



Klamath River Suction Dredge

II. Small-Scale Gold Suction Dredge Holes Create Safe Habitat for Fish

1) It is generally accepted that most of the pools made by small-scale suction dredges last only until the following winter high water flows arrive. In the meantime they serve the fish as resting areas and safe locations from predation. The pools may or may not intersect cold ground water or hyporheic subsurface flows. This fact does not negate or makes the pools less beneficial to the survival of salmonids. The pools still serve as resting and protective locations between thermal refugia, that are generally located at the mouths of confluent streams that could be located some miles away (California Final Subsequent Environmental Impact Report, March 2012).

Salmon Circling a Dredge Hole on the Klamath River
Avery Rathburn, September 28, 2009

2) Dredge holes 3 feet or deeper are considered excellent refugia for fish. Excavating pools could substantially increase their depth and increase cool groundwater inflow. This could reduce pool temperature (Harvey and Lisle 1998). If pools were excavated to a depth greater than three feet, salmonid pool habitat could be improved. In addition, if excavated pools reduce pool temperatures, they could provide important coldwater habitats for salmonids living in streams with elevated temperatures (SNF, 2001).

3) *Excavations from dredging operations can result in temporarily formed pools or deepen existing pools which may improve fish habitat. Deep scour may intersect subsurface flow creating pockets of cool water during summer which can provide important habitat for fish. Nielsen, J. L., T. E. Lisle, and V Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. Trans. Am. Fish. Soc. 123:613-626.*

4) *During times of low flow in a river or stream, increased water depth can provide a refuge from predation by birds and mammals. Harvey, B. C., and A. J. Stewart. 1991. Fish size and habitat depth relationships in headwater streams. Oecologia. 87:336□342.*

5) *Pools created by abandoned dredger sites can provide holding and resting areas for juvenile and adult salmonids. Stern, G. R. 1988. Effects of suction dredge mining on anadromous salmonid habitat in Canyon Creek, Trinity County, California. M.S. Thesis, Humboldt State University, Arcata, California, 80 pp.*

6) *Eight fish occupying a riffle during late summer in Butte Creek, California, moved into a dredged excavation nearby. Harvey, B. C. 1986. Effects of suction gold dredging on fish and invertebrates in two California streams. N. Am. J. Fish. Manage. 6:401□409.*

III. Dispersed Tailings from Small-Scale Suction Dredging are Included in Suitable Spawning Gravels

1) Gravels are dispersed by the high stream flows, which included dredge tailings, compose a portion of the suitable spawning gravels each year.

2) In the name of remediation of spawning beds augmenting with gravels from outside the waterway is considered an insignificant and obviously beneficial addition. I came across large project that includes 7 locations along the American River that includes augmenting waterways with 75,000 yards of gravels.

3) "Reclamation will add spawning gravel to the lower American River at seven sites from Nimbus Dam to Upper Sunrise Park and from Jed Smith Bridge to Arden Rapids. Three side-channel habitats would also be established. The purpose of the action is to replenish spawning gravel at the seven restoration sites and to establish side-channel habitat to increase and improve Chinook salmon and steelhead spawning and rearing habitat." (The Final Environmental Assessment/Finding Of No Significant Impact is available at http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=3202 .)

IV. Small-Scale Gold Suction Dredge Tailings Protect Redds by Protecting the Destruction of Redds in Areas of Limited Natural Substrate.

1) Salmonids show no preference for dredge tailings, for spawning, if natural substrate is available. If insufficient substrate is available Salmonids are left with the choice of spawning over, and destroying, previously built redds or using cleaned dredge tailings.

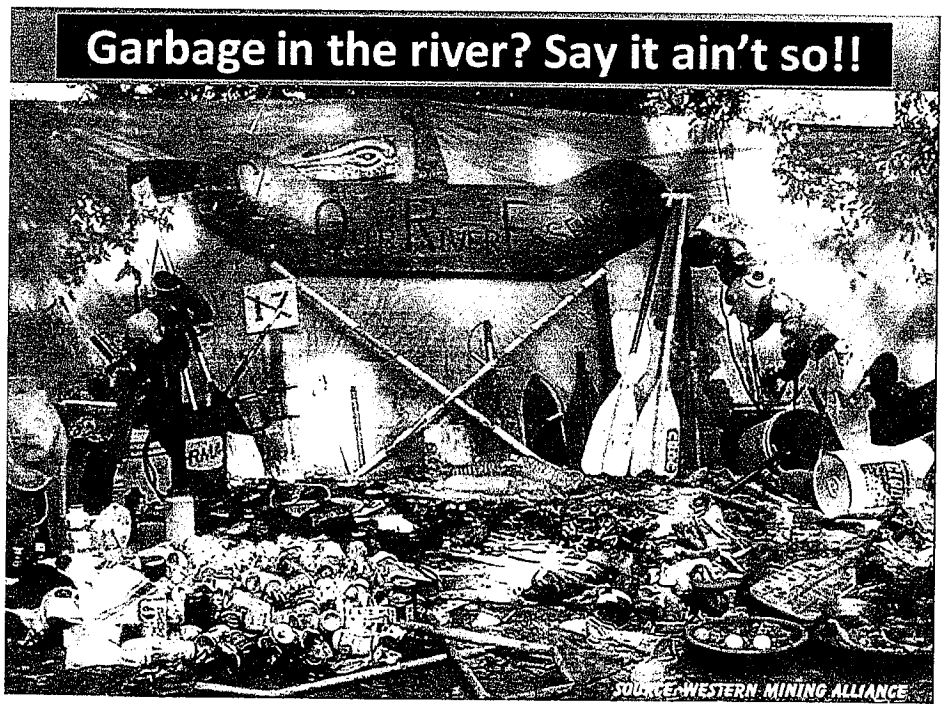
2) In areas where inadequate quantity of natural gravels exist dredge tailings provide a net benefit by saving previously built redds from destruction by later arriving salmonids and at the same time provide excellent future spawning gravels from dredge tailings. This creates, an overall, net positive effect.

V. Miner's, on Their Own Claims Remove Waste Left Behind by Others

A service that **small-scale gold suction dredge operators improve water quality by removing waste** in the waterways left behind by other water users. Not only do many dredgers pickup trash around their camps and along the water banks but because of the nature of a dredge they are able to capture heavy waste found in the water such as lead fishing weights, fishing line and lures long forgotten, old car parts, iron nails, bolts and the like. No only heavy wastes but sunken discarded and/or lost items.

From the Lewis River, WA (Scott Atkinson)

All this garbage was taken from ONE dredge hole during a summer season on the S Fork of the American River, CA.



VI. Small-Scale Gold Suction Dredging Tourist Dollars Support Local Business.

The state DEQ, for 2010, collected $16,600 ($25 x 664 permits) from permit fees according to data received from Oregon DEQ (2010). In the California EIR (2012), CA calculated, on average, each small-scale gold suction dredge miner will spend about $15,424 per year on food, fuel, travel, and equipment. A huge benefit to the state's lagging economy.

(3). Comprehensive List of Scientific Publications that Support Information in the Bullets

Review of Beneficial Effects of Gold Suction Dredging

Compiled by: Claudia J. Wise, Research Physical Scientist

U.S. EPA – Retired

July 2006

wnrc@ymail.com

I. The Beneficial Factors of Turbidity

1) **McLeay, D.J., G.L. Ennis, I.K. Birtwell, and G.F. Hartman. 1984.** Effects On Arctic Grayling (Thymallus arcticus) of Prolonged Exposure to Yukon Placer Mining Sediment: A Laboratory Study. Canadian Technical Report of Fisheries and Aquatic Sciences 1241.

2) **McLeay, D.J., I.K. Birtwell, G.F. Hartman, and G.L. Ennis. 1987.** Responses of Arctic Grayling (Thymallus arcticus) to Acute and Prolonged Exposure to Yukon Placer Mining Sediment. Canadian Journal of Fisheries and Aquatic Sciences 44: 658-673

3) **Redding, J.M., C.B. Schreck, and F.H. Everest. 1987.** Physiological Effects on Coho Salmon and Steelhead of Exposure to Suspended Solids. Transactions of the American Fisheries Society 116:

4) **Reynolds, J.B., R.C. Simmons, and A.R. Burkholder. 1989.** Effects of Placer Mining Discharge on Health and Food of Arctic Grayling. Water Resources Bulletin 25: 625-635.

5) **Sigler, J.W., T.C. Bjornn, and F.H. Everest. 1984.** Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society 113: 142-150.

6) **Lloyd, D.S. 1987.** Turbidity as a Water Quality standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management. 7: 34-45.

7) **Servize, J.A., and D.W. Martens. 1992.** Sublethal Responses of Coho Salmon (Oncorhynchus kisutch) to Suspended Sediments. Canadian Journal of Fisheries and Aquatic Sciences 49: 1389-1395.

8) **Gregory, R.S. 1993.** Effect of Turbidity on the Predator Avoidance Behavior of Juvenile Chinook Salmon (Oncorhynchus tshawytscha). Canadian Journal of Fisheries and Aquatic Sciences 50: 241-246.

9) **Gradall, K.S., and W.A. Swenson. 1982.** Responses of Brook Trout and Creek Chubs to Turbidity. Transactions of the American Fisheries Society 111: 392-395.

10) **Cyrus, D. P, and S. J. M. Blaber. 1987.** The influence of turbidity on juvenile marine fishes in estuaries. Part 2. Laboratory studies, comparisons with field data and conclusions. J. Exp. Mar. Biol. Ecol. 109:71-91.

11) **Bisson, P.A., and R.E. Bilby. 1982.** "Avoidance of Suspended Sediment by Juvenile Coho Salmon. North American Journal of Fisheries Management 4: 371-374.

12) **CH2MHILL. 2000.** Suspended Sediment Effects on Fish: A Literature Review.

13) **Stern, G.R., 1988.** Fish in Canyon Creek sought out dredge plumes to feed on exposed invertebrates.

14) **Stern, G. R. 1988.** Effects of Suction Dredge Mining on Anadromous Salmonid Habitat in Canyon Creek, Trinity County, California. Masters Degree Thesis, Humbolt State University, 80p.

II. Small-Scale Gold Suction Dredge Holes Create Safe Habitat for Fish

1) **California Final Subsequent Environmental Impact Report**, March 2012.
2) **Siskiyou National Forest, 2001**
3) ***Nielsen, J. L., T. E. Lisle, and V Ozaki. 1994.*** *Thermally stratified pools and their use by steelhead in northern California streams. Trans. Am. Fish. Soc. 123:613-626.*
4) ***Harvey, B. C., and A. J. Stewart. 1991.*** *Fish size and habitat depth relationships in headwater streams. Oecologia. 87:336□342.*
5) ***Stern, G. R. 1988.*** *Effects of suction dredge mining on anadromous salmonid habitat in Canyon Creek, Trinity County, California. M.S. Thesis, Humboldt State University, Arcata, California, 80 pp.*
6) ***Harvey, B. C. 1986.*** *Effects of suction gold dredging on fish and invertebrates in two California streams. N. Am. J. Fish. Manage. 6:401□409.*

III. Dispersed Tailings from Small-Scale Suction

The Final Environmental Assessment/Finding of No Significant Impact is available at **http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=3202**

IV. Dredging are Included in Suitable Spawning Gravels

Hassler, T.J., W.L. Somer and G.R. Stern, 1986

V. Small-Scale Gold Suction Dredge Tailings Protect Redds by Protecting the Destruction of Redds in Areas of Limited Natural Substrate

California Final Subsequent Environmental Impact Report, March 2012.

VI. Miner's, on Their Own Claims Remove Waste Left Behind by Others

Reports and pictures of waste collected in small-scale Gold Suction Dredge Holes. **Miner's report.**

VII. Small-Scale Gold Suction Dredging Tourist Dollars Support Local Business

Calculated from California EIR (2012) using permit numbers received from ODEQ (2010).

VIII. Small-Scale Dredging Efficiency and Rates

1) Studies to date have not shown any actual effect on the environment by suction dredging, except for those that are short-term and localized in nature (USACE, 1994);
2) This is an official recognition, by the U. S. Army Corps of Engineers, that below a certain size, the effects of suction dredging are so small and so short-term as to not warrant the regulations being imposed in many cases (USACE, 1994);
3) The U. S. Environmental Protection Agency, has ignored this concept, although numerous studies, including the EPA's own 1999 study of suction dredging, repeatedly and consistently support the Corps finding de minimus effects (USACE, 1994);
4) Four-inch and smaller dredges have inconsequential effects on aquatic resources (USACE, 1994);

5) Reports consistently find no actual impact of consequence on the environment, and so almost always fall back to the position that the ***potential*** for impact exists (USACE, 1994);T

6) he majority of dredge operations studied did not work long periods or disturb large areas of the streambed (Hassler, T.J., W.L. Somer and G.R. Stern, 1986);

7) Dredging improved permeability and velocity of water in gravel (Lewis, R., 1962);

8) The unmodified dredge moved about 2% of the manufacturer's maximum rating (Griffith, J.S. and D.A. Andrews, 1981);

9) Two hundred of the miners interview, only 57 spent more than 500 hours dredging per season (McCleneghan, K., and R.E. Johnson, 1983);

10) The average time spent dredging was 235 hours per season (McCleneghan, K., and R.E. Johnson, 1983);

11) No cumulative effects were indicated by the water sample data (Huber, C. and D. Blanchet, 1992);

12) Suction dredging and hand tool operations in the active stream channel caused no noticeable impact to water quality (Huber, C. and D. Blanchet, 1992);

13) There were no detectable water quality changes from numerous suction dredge operations located on the same creek (Huber, C. and D. Blanchet, 1992);

14) A 6-inch dredge is appropriate where substrate gravel size is large, but a large aperture may be disruptive in a small channel (Lewis, R., 1962);

15) Dredge holes and piles in the center of the stream are usually gone in one year (Stern, G.R., 1988);

16) Dredge piles along the bank of the creek may linger. This is similar to piles left by historic miners (Stern, G.R., 1988); and,

17) When done properly, legal dredging must be allowed by law and effects are acceptable (USDA, 1997).

List of Citations

Anonymous. 1997. Draft Environmental Impact Report Adoption of Amended Regulations for Suction Dredge Mining 1997. California Dept. Fish and Game. Sacramento, CA.

Badali, P.J., 1988. ***Effects of Suction Dredging on Fish and Benthic Invertebrates.*** Recreational Dredging Seminar. Western Mining Council and State of Idaho Dept. of Water Resources.

Bayley, P.B., 2004. ***Response of fish to cumulative effects of suction dredge and hydraulic mining in the Illinois sub-basin, Siskiyou National Forest, Oregon.*** Draft Manuscript. Dept Fisheries and Wildlife, Oregon State University, Corvallis, OR.

Griffith, J.S. and D.A. Andrews. 1981. ***The effects of small a suction dredge on the fishes and aquatic invertebrates in Idaho streams.*** North American Journal of Fisheries Management 1:21-28.

Harvey, B.C. 1980. ***Effects of suction dredge mining on fish and invertebrates in California foothill streams.*** Masters Thesis. University of California Davis.

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