Southern Environmental Law Center

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VIA ELECTRONIC MAIL Tisha.Calabrese@tn.gov

Ms. Tisha Calabrese Benton
Director, Division of Water Resources
Tennessee Department of Environment and Conservation
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue,
Nashville, Tennessee 37243

Re: Proposed General Aquatic Resources Alteration Permit and § 401 Water Quality Certification for "Recreational Prospecting"

Dear Ms. Calabrese Benton,

The Southern Environmental Law Center is pleased to submit these comments on behalf of Tennessee Scenic Rivers Association, Center for Biological Diversity, Tennessee Environmental Council, Tennessee Conservation Voters, Conservation Fisheries, Inc., Tennessee Chapter of the Sierra Club, United Mountain Defense, Harpeth River Watershed Association, and Statewide Organizing for Community eMpowerment (collectively, "Commenters") in response to the revised General Aquatic Resource Alteration Permit and § 401 Water Quality Certification ("ARAP") proposed by the Division of Water Resources of the Tennessee Department of Environment and Conservation ("TDEC" or "the State") for recreational prospecting for gold and other precious and semi-precious ores, metals, and minerals in the waters of Tennessee ("Proposed Permit"). We appreciate this opportunity to share our concerns about this permitting decision; these groups represent a broad cross section of Tennesseans who care about protecting Tennessee's public lands, wildlife, and waters from the damage that prospecting activities can cause to those resources.

General permits, by their very nature, authorize degradation of Tennessee's waters without site-specific analysis or mitigation. According to TDEC's rules, general permits may only be issued for categories of activities that result in no more than a *de minimis* degradation of water quality.[1] As such, the State cannot issue the Proposed Permit. Here, the State has specific information that mechanized and non-mechanized prospecting activities (individually and their cumulative impact) cause degradation and that this degradation is more than *de minimis*. As documented by the U.S. Forest Service and the Tennessee Wildlife Resources Agency, the prospecting activities described in the Proposed Permit are highly disruptive to aquatic species and their habitat. This disruption damages spawning habitat, displaces important food organisms, smothers habitat for food chain organisms and creates an unhealthy stream. Moving vast amounts of substrate, in other words, causes a negative reaction throughout the food chain.

[1] Tenn. Comp. R. & Regs. 0400-40-07-.04(2) (*i.e.*, "consistent with T.C.A. § 69-3-108 of the Tennessee Water Quality Control Act of 1977").

In addition, the State has already concluded that mechanized prospecting will result in more than *de minimis* degradation: in December 2014, the Gold Prospectors Association of America applied for an individual ARAP ("GPAA Individual ARAP") for its members to operate in some of East Tennessee's Exceptional Tennessee Waters, Naturally Reproducing Trout Streams, Designated Wilderness Areas, and the Cherokee National Forest. According to the Public Notice for the GPAA's Individual Permit—and directly contrary to this permit—the State concluded that mechanized prospecting will result in degradation.[2]

In addition, the State has recently concluded that degradation from mechanized and non-mechanized prospecting may be *de minimis* only when it is significantly restricted. In June 2015, the State issued a permit that closely circumscribes the locations where GPAA members can operate, acknowledging the documented impacts and impairments caused by recreational gold prospecting.[3] The State justified its *de minimis* finding for that individual permit, in part, by pointing to the limited amount of private property and limited number of persons who could operate under the GPAA Individual ARAP. This general permit, by contrast, would ***expand*** the degradation caused this activity to the entire State of Tennessee, without any meaningful state oversight or public involvement.

Therefore, as described below, we respectfully request that the State rescind the Proposed Permit from consideration and decline to issue it in its current form because (1) the proposed activity is incompatible with state and federal anti-degradation regulations, (2) the activity has the potential to cause impermissible loss of habitat, diminishment of biological diversity, and the "take" of protected species, and (3) the use of a general permit denies public participation and state oversight.

We conclude this letter by offering comments on the specific terms of the Proposed Permit.

I. BACKGROUND

Nearly two hundred years ago, gold was discovered near Coker Creek in East Tennessee.[4] However, despite having the benefit of being able to use highly toxic mercury to more efficiently extract the gold,[5] "The Coker Creek gold rush was short-lived—no mother lode was discovered, and the gravels never yielded enough gold to make anyone rich—but the fever never was completely cured."[6] For many years, Tennessee gold prospectors continued to operate in the area; those operating near Coker Creek did

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[2] ARAP NRS14.431 "Pubic Notice" at p.1 ("mechanized prospecting with dredges will result in degradation to water quality, whereas the non-mechanized prospecting with pans and hand tools will result in *de minimis* degradation").

[3] *See* ARAP No. NRS14.431 "Notice of Determination," at p. 5 (June 3, 2015) ("[B]ecause of rare species and public lands concerns, the permit was limited to short segments of Coker Creek which will by nature limit the scale of impact.").

[4] A.H. Koschman and M.H. Bergendahl, *Principal Gold-Producing Districts of the United States* at 240 (U.S. Geological Survey, 1968) *available at* http://pubs.usgs.gov/pp/0610/report.pdf.

[5] http://news.nationalgeographic.com/news/2010/12/101221-next-water-pollution-disasters-/. *See also* Comments of U.S. Forest Service on NRS14.341 ("[E]lemental mercury is present in the substrate of Coker Creek . . . . [T]his mercury is probably a remnant from the exploitation dredging that went on in the late 1800's.").

[6] Morgan Simmons, *Impact of prospecting weighed; state to regulate gold hunting at Coker Creek,* Knoxville News Sentinel, *available at* http://www.knoxnews.com/news/local-news/theres-gold-in-them-thar-hills-but-environmental.

so pursuant to a U.S. Forest Service permit.[7] And yet today, Coker Creek is impaired by sediment/siltation as a direct result of prospecting activities.[8]

By 2012, as the activity gained renewed popularity, state officials began receiving complaints.[9] State and federal resource agencies then took actions to address the harm from small-scale gold prospecting, and the Division of Water Resources of the Tennessee Department of Environment and Conservation ("the Division") developed a general permit for Class 1 ("non-mechanized forms of prospecting") and Class 2 ("mechanized forms of prospecting") "recreational" prospecting. The Division placed fewer limits on Class 1 activities, for which no fee or prior notice is required.

The Proposed Permit impermissibly relaxes the standards for Class 1 and Class 2 prospecting, standards that have only been in effect since late 2014. Moreover, since late 2014, the State has been presented with evidence that demands stricter standards.

Specifically, earlier this year, TDEC concluded that "mechanized prospecting with dredges will result in degradation to water quality . . . . ."[10] Shortly thereafter, the Tennessee Wildlife Resources Agency ("TWRA"), U.S. Fish & Wildlife Service ("FWS"), and the U.S. Forest Service ("USFS") submitted comments that objected to the issuance of a permit for recreational prospecting, which was very similar to the Proposed Permit. TWRA stated that, "It is our opinion that the Gold Prospector's Association of America continually misrepresents Class 2 mechanized dredging as 'beneficial' to stream ecological function. To be clear, in high quality, biologically diverse streams, mechanical dredging is ***straight-forward destruction of habitat for fish and aquatic life***." FWS likewise "refute[d]" the GPAA's claims that prospecting activities improve fish habitats and was "very concerned that these activities could result in ***direct mortality*** to mussels, fish eggs, and larvae and indirectly have impacts on substrate stability, fish and mussel food sources, and reproductive success of fish and mussels." FWS was also concerned about the cumulative effects of these activities on the ecological integrity of the main stem and tributaries listed in the application. In addition, USFS cited surveys of the Coker Creek area beginning in the 1970's that demonstrate that recreational gold prospecting has significantly and negatively affected the structure of the macroinvertibrate community; the Forest Service noted that "[***s***]***erious damage*** to all aquatic resources is likely to occur. Other recreational activities (fishing) will be adversely affected and public health could be at risk." Commenters respectfully suggest that these concerns are applicable to the Proposed Permit, and the Proposed Permit should not be issued.

II. THE PROPOSED ACTIVITY IS INCOMPATIBLE WITH STATE AND FEDERAL ANTI-DEGRADATION REGULATIONS

The activity described in the Proposed Permit will unlawfully degrade Tennessee's waters, because the Proposed Permit does not comply with Tennessee's antidegradation regulations or those

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[7] Draft General ARAP Comments of Tennessee State Director of GPAA, at pp. 2-3 (Jan. 20, 2015). ("[W]e discussed the existing Forest service permit that we helped to formulate for the Tellico Ranger District. It had worked well for both parties.").

[8] TDEC *Year 2012 303(d) List*. January 2014.

[9] *TWRA Responds to Gold Mining Concerns in Tennessee Streams and Rivers*, *available at* https://news.tn.gov/node/9342.

[10] *Public Notice*, NRS14.431.

promulgated by the U.S. Environmental Protection Agency ("EPA").[11] Antidegradation review is based on the fundamental goal of the Clean Water Act ("CWA") to eliminate the discharge of pollutants to our nation's waters by 1985. With this overarching goal in mind, new or increased discharges of pollutants should be exceedingly rare, and should be authorized only if there are no reasonable alternatives to the discharge and if there is a strong economic and social justification.

EPA established an antidegradation policy for water quality standards.[12] Each state must adopt and implement an antidegradation policy that is, at a minimum, consistent with the federal regulation.[13] EPA creates three tiers of water quality.[14] The first tier creates a minimum floor of protection for all waters.[15] Waters that "exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water" fall into the higher quality second tier.[16] The quality of these waters may not be lowered without meeting several criteria.[17] One of the criteria is that "allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located."[18] Waters that fall under the third tier are considered "Outstanding National Resource Waters" and they may not be degraded for any reason.[19] Tennessee's antidegradation statement classifies waters into four categories: waters with unavailable parameters (Tier 1), waters with available parameters (Tier 2), Exceptional Tennessee Waters (Tier 2 ½), and Outstanding National Resource Waters (Tier 3).[20] Effective as of December 2013, degradation of waters with available parameters and Exceptional Tennessee Waters "will only be authorized if the applicant has demonstrated to the [Tennessee Department of Environment and Conservation] that reasonable alternatives to degradation are not feasible and the degradation is necessary to accommodate important economic or social development in the area . . . ."[21]

Antidegradation review for Tier 2 waters requires consideration of these factors by the proponent and the regulator, and—critically—the opportunity for public participation in the determination of whether the available assimilative capacity of our unpolluted waters should be taken out of the public domain and given to an individual entity for its private economic benefit. Application of the *de minimis* exception allows new or increased discharges to skip this critical analysis, and proceed straight to the permitting process with the *de facto* presumption that a permit will be issued. There is nothing in the text

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[11] This section re-submits some of the Tennessee Clean Water Network comments concerning anti-degradation review previously provided to TDEC/EPA Region 4 in June 2014.

[12] *See* 40 CFR § 131.12

[13] *See id.*

[14] *See id.*

[15] *See* 40 CFR § 131.12(a)(1).

[16] *See* 40 CFR §131.12(a)(2).

[17] *See id.*

[18] *Id.*

[19] *See* 40 CFR § 131.12(a)(3).

[20] Tenn. Comp. R. & Regs. 0400-40-03-.06 (2015).

[21] *Id.*

or structure of the Clean Water Act or EPA's implementing regulations to support this approach. Here, the Division's Public Notice states that the proposed activity will "result in no more than an insignificant or *de-minimis* degradation of water quality"[22] but provides no analysis to support this assertion; as such, the permit skips over even the minimal requirements provided to come within the antidegradation exception upon which it relies. The State has provided no information to suggest that mining with mechanized equipment causes a similar level of degradation as non-mechanized mining, why multiple miners at a single site cause no more harm than one miner (even using hand tools), why multiple miners within a single stream segment cause no more harm than one miner, or why the use of both mechanized and non-mechanized equipment by unknown numbers of miners within watersheds across Tennessee causes only *de minimis* degradation.

Any application of the *de minimis* exception to avoid antidegradation review is harmful to Tennessee streams and in conflict with the Clean Water Act and applicable EPA regulations. Tennessee's antidegradation standards must be at least consistent with federal standards established in 40 C.F.R. § 131.12(a). This regulation provides that Tier 2 water quality "shall be maintained and protected" unless the state finds an economic and social necessity for degradation. Automatic *de minimis* findings are not appropriate because they do not provide the opportunity to evaluate site-specific impacts. Such consideration is particularly important where, as here, threatened or endangered aquatic species are present and bioaccumulative pollutants like mercury may be released.

Degradation to Tennessee's waters is prohibited, except degradation of a short duration. The general permit would allow repeated degradation of an unknown duration during the 5-year permit term, and there is no such exception to the Antidegradation Statement.[23]

a. <u>TDEC cannot issue a General Permit that causes more than *de minimis* harm, and Tennessee-specific studies confirm that recreational prospecting adversely affects aquatic habitats and species</u>

Years of small-scale prospecting in Tennessee have created deteriorating conditions in the sites where the activity is most practiced. Because evidence of the cumulative impact of this practice in East Tennessee is already known, the practice should not be permitted to propagate across the entire State of Tennessee. Specifically, we attach the following materials already in TDEC's possession to make them part of this record:

- Comments of the U.S. Department of Interior, Fish & Wildlife Service (March 12, 2015) regarding TDEC Public Notice File Number NRS14.431 [**ATTACHED**]
- Comments of the U.S. Department of Agriculture, Forest Service (March 6, 2015) regarding NRS14.431 [**ATTACHED**]
- Comments of the Tennessee Wildlife Resources Agency (March 6, 2015) regarding ARAP Public Notice File Number NRS14.431 [**ATTACHED**]

[22] Public Notice, https://www.tn.gov/assets/entities/environment/attachments/ppo_noph15-005_general-permit.pdf.

[23] Tenn. Comp. R. & Regs. 0400-40-04-.03.

The Proposed Permit is incompatible with the fact that "the majority [of suction dredging studies] . . . show[] that suction dredging can adversely affect aquatic habitats and biota."[24] A federal court recently confirmed the proposition that small-scale recreational mining/dredging may affect the critical habitats of aquatic species that are sensitive to sediment, affecting them directly and indirectly (in foraging and reproductive activities).[25] Additional scientific studies confirm these findings:

- Gary G. Williams & John R. Thurman, *Gold Dredge Monitoring – Coker Creek Tellico Ranger District*, U.S. Department of Agriculture – Forest Service (August 2011) [**ATTACHED**]

- R.D. Bivens and C.E. Williams, Fisheries Report, *Annual Stream Fishery Data Collection Report Region IV 1990*, Tennessee Wildlife Resources Agency (Nashville, Tennessee).

- Gary G. Williams & John R. Thurman, *Gold Dredge Monitoring – Select Streams Tellico Ranger District*, U.S. Department of Agriculture – Forest Service (2010).

- Bret C. Harvey & Thomas E. Lisle, *Effects of Suction Dredging on Streams: A Review and an Evaluation Strategy*, 23 Fisheries Habitat 8 (1998) (collecting research and references) [**ATTACHED**]

These studies show that the use of "Class 1" equipment will cause unjustifiable degradation, and no grounds for degradation have been supplied by the State. "Class 1" equipment is described as "*includ[ing]* non-mechanized forms of prospecting including, but not limited to: pans, hand-powered sucker tubs, portable hand sluices and rocker boxes." The State does not define or describe these pieces of equipment, such that their size and meaning could be interpreted beyond what the permit writer countenanced. Similarly, Class 2 equipment will cause unjustifiable degradation. "Class 2" recreational prospecting is described to "*include* mechanized forms of prospecting including, but not limited to: dredges, highbankers, powered sluices and trommels." Significantly, the Proposed Permit does not define certain key terms, though they have been described elsewhere as follows:

- High-bankers ["small-scale version of larger gold mining production machinery that is used throughout the goldfields of the world"][26]

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[24] *Karuk Tribe of California v. U.S. Forest Service*, 681 F.3d 1006, 1029 (9th Cir. 2012) (holding that U.S. Forest Service must consult with appropriate federal wildlife agencies under Section 7 of the Endangered Species Act before allowing mining activities to proceed in critical habitat of a listed species).

[25] "**First**, '[e]ntrainment by suction dredge can directly kill and indirectly increase mortality of fish—particularly un-eyed salmonid eggs and early developmental stages.' **Second**, disturbance from suction dredging can kill the small invertebrates that larger fish feed on, or alter the invertebrates' environment so that they become scarce. **Third**, destabilized streambeds can 'induc[e] fish to spawn on unstable material,' and fish eggs and larvae can be 'smothered or buried.' **Fourth**, because the streams the salmon occupy are already at 'near lethal temperatures,' even 'minor' disturbances in the summer can harm the salmon. **Fifth**, juvenile salmon could be 'displaced to a less optimal location where overall fitness and survival odds are also less.' **Finally**, a long list of other factors—disturbance, turbidity, pollution, decrease in food base, and loss of cover associated with suction dredging— could combine to harm the salmon." *Id.*

[26] GPAA Individual ARAP Application NRS14.431 (Section 8).

- Trommels ["Their purpose is to process gold bearing material by separating out the larger rocks and boulders, allowing the smaller material that contains the gold to be run through a sluice box. . . . . [T]he ultimate goal is to completely break apart any clays and mud that could retain placer gold and prevent it from being caught in the sluice."][27]

- High-banker dredges ["combines a traditional highbanker . . . with excavating capabilities of a suction dredge"][28]

b. <u>The anti-degradation rules have specific requirements regarding Exceptional Tennessee Waters.</u>

The Proposed Permit does not exclude mining in Exceptional Tennessee Waters, only Outstanding Natural Resource Waters. Rules governing impacts to Exceptional Tennessee Waters ("ETWs") mandate that alternatives and economic and social justifications be analyzed.

> Part of the responsibility the policy places on the Division of Water Pollution Control is identification of exceptional Tennessee Waters (previously known as Tier 2) and Outstanding National Resource Waters (Tier 3). In exceptional waters, degradation cannot be authorized unless (1) there is no reasonable alternative to the proposed activity that would render it non-degrading and (2) the activity is in the economic or social interest of the public. In Outstanding National Resource Waters, no new discharges, expansions of existing discharges, or mixing zones will be permitted unless such activity will not result in measurable degradation of the water quality.[29]

Because this general permit would apply state-wide, it is not possible or practicable to list each of the ETWs that might be affected.[30] According to the database kept by TDEC, it appears that there are currently **3,153** waters that meet the characteristics of Exceptional Tennessee Waters and Outstanding National Resource Waters. Many more may rightly be included, but the list only includes waterbodies that the Division has already evaluated. The Division cannot authorize degradation of waters merely because they have not yet been assessed; the Division cannot authorize degradation of waters that have been assessed as ETWs or ONRWs without complying with the antidegradation regulations.

c. <u>The benefits of the existing uses exceed those of the activities described in the permit.</u>

The economic and social benefits of fishing and other natural resource values in the State of Tennessee exceed any benefit from permitting the streambed destruction that would result from prospecting these small streams. For example, trout fishing is a significant tourism attraction, particularly in East Tennessee. The U.S. Fish and Wildlife Service reported that 2.8 million residents

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[27] GPAA Individual ARAP Application NRS14.431 (Section 8).

[28] GPAA Individual ARAP Application NRS14.431 (Section 8).

[29] http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=9034:34304:16575260034583:::::

[30] When the GPAA applied for a permit, commenters—including the Tennessee Wildlife Resource Agency—were able to determine that the application encompassed ETWs such as Coker Creek and unnamed tributaries; Tellico River and unnamed tributaries; John's Creek; Basin Creek; Wildcat Creek; Natty Creek; Sixmile Creek; Tobe Creek; and Lyons Creek and its East Fork.

and nonresidents spent $2.3 billion on wildlife-related recreation in Tennessee in 2006, including $600 million on fishing-related expenditures alone.[31] In 2011, freshwater fishing resulted in over $1.2 million in retail sales statewide providing over 17,000 jobs and $111,000 in state and local tax revenue.[32] Many of the prospecting practices proposed in this ARAP would negatively impact key species and result in a decline of sport fishing, and therefore, revenue to these areas so dependent on the sport fishing industry. The social and economic benefits of the current use clearly outweigh any social or economic benefit of prospecting.

- Increased revenues from recreation and tourism (for instance, associated with fishing, swimming, boating, hunting, bird/wildlife watching, hiking, camping, etc.);[33]

- Increased human health benefits (for instance, reduced illness from ingesting contaminated fish and polluted water, reduced exposure to infectious diseases while recreating, and resulting decreased expenditures on health care);[34]

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[31] U.S. Dept. of Interior, 2007.

[32] American Sport Fishing Association. *Sport Fishing in America: An Economic Force for Conservation*. January 2013.

[33] U.S. Department of the Interior, Fish & Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau, *2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. This report quantifies the amount of money spent by visitors to Tennessee and by Tennesseans on several forms of wildlife-related recreation. For instance, in 2011, Tennessee residents spent $2,137,741 on fishing and hunting expenditures in the United States. In 2011, people spent $942,572 and $1,925,532 respectively on wildlife-watching expenditures and fishing and hunting in Tennessee. These numbers do not include money spent on other river-related and water-related recreation activities. *See* http://www.census.gov/prod/2012pubs/fhw11-nat.pdf.
U.S. Department of the Interior, Fish & Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau,

- *2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Tennessee*. This report quantifies the amount of money spent by visitors to Tennessee and by Tennesseans on several forms of water-based, wildlife-related recreation. It also found that 2.6 million Tennessee residents and nonresidents 16 years old and older fished, hunted, or wildlife watched in Tennessee. *See* http://www.census.gov/prod/2013pubs/fhw11-tn.pdf.
- Whitehead, J.C., Haab, T.C., & Huang, J.C., *Measuring recreation benefits of quality improvements with revealed and stated behavior data*, Resource & Energy Economics, 22:339-354 (2000). This article uses several methods to value the economic benefits of improving water quality (such as reducing pollution and restoring wildlife habitat) in North Carolina's Pamlico and Albemarle Sounds in terms of increased recreational use for boating, fishing, hunting, swimming, skiing, bird-watching, windsurfing, and camping. The authors estimated that a change in aggregate consumer surplus of $56 million would result from the hypothetical water-quality improvement for the residents of the 41 counties surveyed, for recreation in the Pamlico and Albemarle Sounds. This research could be extrapolated to water recreation sites in Tennessee.
- Phaneuf, D.J., *A random utility model for total maximum daily loads: Estimating the benefits of watershed-based ambient water quality improvement,* Water Resources Research, 38 (11):1254-1264 (2001). This study uses a random utility-maximization model to estimate the economic benefits of implementing TMDLs in North Carolina, and shows a significant relationship between watershed-level water quality and recreational trip-taking behavior. For instance, the authors estimate that statewide nutrient reduction could lead to benefits of $100,840,000 to $342,950,000, and $86,730,000 in benefits associated with statewide improvements in the Index of Watershed Indicators. The data is also broken down by individual watershed.
- Cordell, H. K., Bergstrom, J. C., Ashley, G. A. and Karish, J., *Economic Effects of River Recreation on Local Economies*, Journal of the American Water Resources Association, 26:53–60 (1990). This article quantifies monetary expenditures associated with recreation on several rivers, and it shows that river water quality and instream flow that are sufficient to support river recreation in turn significantly stimulate local economies, through direct expenditures (boat rentals, restaurant visits, equipment purchases, jobs for river and fishing guides, etc.) as well as indirect or secondary effects to support those businesses directly affected.

- Enhanced property values;[35] and,

- Economic benefits associated with cleaner water supplies for municipalities, industry, and agriculture, and with reduction in necessary pre-use treatment.[36]

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34 Van Houtven, G., Powers, J., Pattanayak, S.K., *Valuing water quality improvements in the United States using meta-analysis: Is the glass half-full or half-empty for national policy analysis?,* Resource and Energy Economics 29:2006-228 (2007).

- U.S. Environmental Protection Agency, *Liquid Assets: America's Water Resources at a Turning Point (2000)*. This report includes a section on the health costs of contaminated water, high levels of nutrients in water

35 Epp, D.J., & Al-Ani, K.S., *The Effect of Water Quality on Rural Nonfarm Residential Property Values*, American Journal of Agriculture & Economics 61(3), 529-534 (1979). This paper examines the increases to property values in Pennsylvania associated with improved water quality, including concentrations of nitrogen, phosphate, dissolved oxygen, minerals, and even the mere perception of cleanliness. It finds that "water quality significantly affects the value of adjacent residential properties."

- Leefers, L. and Jones, D. M., *Assessing Changes in Private Property Values Along Designated Natural Rivers in Michigan*, submitted to Forest Management Division, Michigan Department of Natural Resources (1996). This study finds that property values and selling prices in Michigan are higher along areas with "Natural River" designation. Presumably, there would be a similar premium associated with private property values near streams that are protected with Tennessee's protective designations and that the premium would increase with increased water quality.
- Clean Water Fund, *Economic Benefits of Restoring America's Everglades*. This brochure lists economic benefits expected to result from improvement in water quality in Florida's Everglades, including a 35% increase in property values for the 16 counties in the area and 273,000 new construction jobs.

36 National Park Service, *Economic Benefits of Conserved Rivers: An Annotated Bibliography* (2001). This report lists numerous other articles that document the economic benefits of conserved rivers, including articles regarding each of the various categories of benefits described in more detail above.

- Dumas, C.F., Schuhmann, P.W., & Whitehead, J.C., *Measuring the Economic Benefits of Water Quality Improvement with Benefit Transfer: An Introduction for Noneconomists*, American Fisheries Society Symposium (2005). This paper provides an introduction to economic valuation of water quality improvements.
- Van Houtven, G., Powers, J., & Pattanayak, S.K., *Valuing water quality improvements in the United States using meta-analysis: Is the glass half-full or half-empty for national policy analysis?,* Resource and Energy Economics 29:2006-228 (2007). This article uses regression analysis to examine data from 131 willingness-to-pay estimates from 18 other studies and develop methods for estimating the value of incremental water quality improvements for eight designated uses (primary contact such as swimming, secondary contact such as boating, agriculture, industrial water supply, public water supply, aesthetics, fish consumption, and aquatic life habitat).
- Benson, M.C., *An Economic Valuation of Improved Water Quality in Opequon Watershed*, Master's Thesis, West Virginia University, Morgantown, W. Va. (2006). This paper uses willingness-to-pay methods to value incremental water quality improvements. For instance, it calculates that willingness to pay for in-state water quality improvements is $48 annually for Virginia households and $32 for West Virginia households for improving water quality in the Opequon Watershed, which is listed as impaired for bacteria and benthic habitat. Total benefits of improved water quality were estimated at up to $8.8 million for the watershed, depending on various assumptions.
- Viscusi, W.K., Huber, J., & Bell, J., *The Economic Value of Water Quality,* Vanderbilt University Law School, Law and Economics, Working Paper No. 08-02 (2007). This paper used survey results to assess the benefit of water quality. The survey estimated an average valuation of $32 for each percent increase in lakes and rivers in the region for which water quality is rated "Good." The paper concluded that the annual economic value of the decline in inland U.S. water quality from 1994 to 2000 is over $20 billion.
- Viscusi, W.K., Huber, J., & Bell, J., *The Value of Regional Water Quality Improvements*, Harvard Law School, John M. Olin Center for Law, Economics and Business, Discussion Paper No. 477 (2004). This paper uses willingness-to-pay methods to value incremental water quality improvements. For instance, it calculates that willingness to pay for a one percentage point improvement in water quality has a mean value of $23.17 per person and a median value of $15, and increases with family income, age, education, and other such variables.

Beyond the various economic impacts of recreational users of Tennessee's waters lies the value of the water itself. The economic benefits (direct and indirect) of preserving and improving water quality cannot be overstated. Those who have tried to value it confirm that the benefits of protecting water quality are significant and weighty.[37] Tennessee is privileged to be a water rich state, and it must weigh the degradation of this resource before issuing the Proposed Permit.

d. The State cannot authorize degradation to impaired waters and should not authorize degradation to non-impaired waters.

It is illogical and impermissible that Tennessee waters that are not already "impaired" may become impaired by activities described in the Proposed Permit while waters that are "impaired" are protected.[38] Tennessee has too many impaired waters as it is. We should protect our high quality waters that have either managed to avoid impairment or have been restored from a state of impairment.

III. THE PROPOSED ACTIVITY THREATENS PROTECTED SPECIES AND COULD LEAD TO "TAKES"

Neither the special nor general conditions of the Proposed Permit will prevent impermissible impacts on protected species or their critical habitat, in violation of the Endangered Species Act[39] and the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974.[40]

When the GPAA applied for its individual permit, the Tennessee Wildlife Resources Agency, the U.S. Fish & Wildlife Service and the U.S. Forest Service pointed out that protected species are found in and depend upon the waterbodies listed in the permit application and Public Notice.[41] When TDEC

- Kramer, R.A., Duke University Nicholas School of the Environment and Earth Sciences, *Economic Tools for Valuing Freshwater and Estuarine Ecosystem Services* (2005). This paper reviews different methods of determining the value of water quality and water ecosystems. It also presents several case studies that illustrate the methods and tools in use.
- Whittington, D., et al., *The Economic Value of Improving the Environmental Quality of Galveston Bay*, University of North Carolina at Chapel Hill Department of Environmental Sciences and Engineering (1994) (available at: http://repositories.tdl.org/tamug-ir/handle/1969.3/10190/search). This report uses contingent valuation to value improvements to water quality in Galveston Bay, Texas, at about $100 million to $150 million.
- Clean Water Fund, *Economic Benefits of Restoring America's Everglades*. This brochure lists economic benefits expected to result from improvement in water quality in Florida's Everglades, including a reduction in water purification cost.
- Canadian Council of Ministers of the Environment, *Cost-Benefit Analysis for Cleaner Source Water* (2007). This report describes an analytical approach for quantifying, among other things, economic benefits of total loading of BOD, total suspended solids, ammonia, phosphorous, temperature, toxic chemicals, and pathogens, including benefits to recreation, human health, property values, and commercial fishing.

[37] *E.g.,* https://www.nwf.org/News-and-Magazines/National-Wildlife/News-and-Views/Archives/2005/How-Much-Is-Clean-Water-Worth.aspx; http://www4.ncsu.edu/~amdomans/waterquality/viscusi_and_huber_forthcoming_ERE.pdf; http://www.fws.gov/daphne/shu/2012economic_benefits_factsheet2%5B1%5D.pdf.

[38] Tenn. Comp. R. & Regs. 0400-40-03-.06(2)(c) prohibits further degradation to waters with unavailable conditions when such condition is a parameter compromising the habitat criterion.

[39] 16 U.S.C. § 1531 *et seq*.

[40] Tenn. Code Ann. § 70-8-101 *et seq.*

[41] TWRA Comments NRS14.341.

issued the permit, it concluded that a "take" of these species could occur even when the degradation allowed by the permit was *de minimis*:

> [T]he permit that was issued did not include the Exceptional Tennessee Waters within the Cherokee National Forest in which the protected species are found. The Division has determined that the impact of the activity under the conditions of the permit would result in de minimis impact, however, we also have determined that ***take of protected species could still occur under those conditions***, and therefore did not include the Tellico watershed in the permit.[42]

The same standard should apply here, and Commenters urge TDEC to apply a conservative analysis as it examines the Proposed Permit. The fundamental purpose of the Endangered Species Act ("ESA") is to conserve endangered and threatened species and the ecosystems upon which they depend for survival and recovery.[43] This conservation mandate is incorporated into Section 9 of the ESA. Under Section 9, it is "unlawful for any person" to "take [any] endangered species within the United States."[44] This prohibition generally applies to threatened species as well.[45]

The term "take" is defined broadly as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct."[46] Under the statute, "harm" means "an act which actually kills or injures wildlife . . . by significantly impairing essential behavioral patterns, including breeding . . . "[47] "Harass" means "an intentional or negligent act or omission which creates the likelihood of injury . . . by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering."[48] The activities proposed in this permit are likely to cause take through direct mortality and indirectly by the adverse modification of habitat needed for feeding, sheltering, and breeding.

In addition to prohibiting direct take, it is also unlawful for "any person" to "cause to be committed" a taking of any endangered species within the United States.[49] The term "person" includes "any officer, employee, agent, department, or instrumentality . . . of any State, municipality, or political subdivision of a State . . ." and thus appears to include TDEC.[50] Accordingly, under Section 9, "a governmental third party pursuant to whose authority an actor directly exacts a taking . . . may be

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[42] NRS14.341 Notice of Determination, at p. 5 (June 3, 2015).

[43] 16 U.S.C. § 1531(b).

[44] 16 U.S.C. § 1538(a)(1)(B).

[45] 50 C.F.R. § 17.31(a).

[46] *Id.* § 1532(19); *Defenders of Wildlife v. EPA*, 882 F.2d 1294, 1300 (8th Cir. 1989) ("Take is defined in the broadest possible manner to include every conceivable way in which a person can 'take' or attempt to 'take' any fish or wildlife.").

[47] 50 C.F.R. § 17.3.

[48] *Id.*

[49] 16 U.S.C. § 1538(g).

[50] *Id.* § 1532(13).

deemed to have violated the provisions of the ESA."[51] Further, an agency's failure to regulate in a way that avoids take of a listed species can constitute prohibited Section 9 take.[52] "[I]n keeping with its commitment to species conservation, the ESA states that a state law may be more restrictive than the provisions of the Act, but not less."[53]

If the State issues this Proposed Permit, we are concerned that it will be authorizing the take of protected species. "General condition 14," which attempts to prohibit the adverse impacts on "formally listed state or federal threatened or endangered species or their critical habitat" is insufficient. It is an untenable fiction to assume that a person seeking coverage under the Proposed Permit will know which streams contain protected species, contain critical habitat, or are listed as impaired. The State does not have this information for all streams in Tennessee, waterbodies are not marked, and impacts in upstream segments may nonetheless impact downstream waterbodies and species. These assessments should be done when an individual applicant proposes mining activities in specific locations. At minimum, an individual permit application or Notice of Coverage should document potential impacts to rare species based on site-specific surveys *before* operations may commence.

IV. THE PERMIT SHOULD SPECIFY THE ADDITIONAL PERMITS NEEDED

"General Condition 12" notes that applicants are responsible for obtaining any additional authorizations, but it should be more specific to ensure compliance. For example, Commenters question whether this activity also needs a discharge permit pursuant to § 402 of the CWA, not just a § 401 water quality certification.[54] For decades, sediment from recreational prospecting activities has entered streams in violation of the Tennessee Water Quality Control Act ("WQCA") and the CWA.[55] The CWA requires a permit for the addition of sediment to waters from a point source.[56] Similarly, the WQCA requires a

[51] *Strahan v. Coxe*, 127 F.3d 155, 163 (1st Cir. 1997) (holding Massachusetts official liable under Section 9 for licensing and permitting fishing practices that injured endangered whales); *Sierra Club v. Yeutter*, 926 F.2d 429, 438-39 (5th Cir. 1991) (finding Forest Service caused take of endangered red-cockaded woodpecker by permitting logging practices near nesting colonies); *Defenders of Wildlife*, 882 F.2d at 1301 (holding EPA caused take of endangered species through its registration of pesticides for use by others); *Pac. Rivers Council v. Oregon Forest Indus. Council*, No. 02-243-BR, 2002 U.S. Dist. LEXIS 28121, *31-33 (D. Or. Dec. 23, 2002) (finding state forester's authorization of logging operations that are likely to result in a take is itself a cause of a take).

[52] *See Loggerhead Turtle v. Cnty. Council of Volusia Co.*, 896 F. Supp. 1170, 1180-81 (M.D. Fla. 1995), *rev'd on other grounds*, 148 F.3d 1231 (11th Cir. 1998) (holding county government caused take of endangered sea turtles through its authorization of vehicular beach access during turtle mating season); *Animal Protection Inst. v. Holsten*, 541 F. Supp. 2d 1073, 1078-1080 (D. Minn. 2008) (holding state natural resources agency liable for causing risk of take of lynx through its licensure of trapping and its regulations of trap uses).

[53] *Gibbs v. Babbitt*, 214 F.3d 483, 487 (4th Cir. 2000) (citing 16 U.S.C. § 1535(f)).

[54] *Nw. Envtl. Def. Ctr. V. Envtl. Quality Comm'n*, 223 P.3d 1071, 1083 (Or. Ct. Ap. 2009) ("Although [Ninth Circuit] did not expressly address the interplay between sections 402 and 404—in fact, section 404 is never mentioned in the court's opinion—the EPA subsequently relied on the case as authority for the proposition that mining wastewater is, in fact, regulated as a pollutant under section 402. And, relying in part on [that decision], the EPA, since 1997, has expressly regulated small suction dredge mining under the NPDES permitting scheme, though general permits not unlike the . . . permit at issue here.").

[55] *See* Comments from U.S. Forest Service.

[56] CWA §§ 301(a); 402(a); 502(6), (12).

permit for any activity or facility that adds sediment to waters or a location from which it is likely that the sediment will move into waters.[57]

Under the CWA, permits are required for discharges from a "point source" to a protected water.[58] A point source is broadly defined as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, [or] rolling stock . . . from which pollutants are or may be discharged."[59] In contrast, the WQCA requires a permit for discharges from a "source" to a "location from which it is likely that the discharged substance will move into waters."[60] A "source" includes "any activity, operation, construction, building, structure, facility, or installation"; there is no requirement that the discharge flow through a confined or discrete conveyance.[61] Owners, however, are not the only responsible parties under the CWA.[62] "When a facility is owned by one person but is operated by another person, it is the operator's duty to obtain a permit."[63] The "operator" responsible for a discharge is the entity with control over that discharge—*i.e.*, the ability to discover and abate the pollution.[64] An operator is strictly liable for any discharge without regard to "the intent of the operators or the reasonableness of the existing collection system."[65] The sediment discharged from gold prospecting activities requires a permit under either standard.

For "Exceptional Tennessee Waters"— a regulatory determination that includes waterbodies that have been reviewed, but which does not necessarily include all waterbodies that might actually provide critical habitat and contain exceptional biological diversity or naturally reproducing trout—the bar is even higher to allow degradation.[66]

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[57] Tenn. Code Ann. §§ 69-3-108; -103(10), (22), (26), (35).

[58] While no permit is required for discharges to "wet weather conveyances," this exemption applies only if "sediment [is] prevented from entering other waters of the state" by use of "erosion and sediment controls … to detain runoff and trap sediment." Tenn. Code Ann. § 69-3-108(q).

[59] CWA § 301; 502(12), (14).

[60] Tenn. Code Ann. §§ 69-3-103(10); -108.

[61] Tenn. Code Ann. 69-3-103(35).

[62] *Comm. to Save the Mokelumne River v. East Bay Mun. Util. Dist.*, 37 ERC (BNA) 1159, 1170 (E.D. Cal. 1993) (stating that ownership "is not a prerequisite to liability" under the CWA).

[63] 40 C.F.R. § 122.21(b). This provision is applicable to both federal and state administered programs. *See also Newton County Wildlife Ass'n v. Rogers*, 141 F.3d 803, 810 (8th Cir. 1998) (holding that a logging operator, not the Forest Service, would bear any permitting obligation under the CWA); *Sierra Club v. Martin*, 71 F. Supp. 2d 1268, 1304 n.5 (N.D. Ga. 1996) (same).

[64] *Resurrection Bay Conservation Alliance v. City of Seward, Alaska*, 2008 U.S. Dist. LEXIS 13667, at *16-17 (D. Alaska 2008); *Beartooth Alliance v. Crown Butte Mines*, 904 F. Supp. 1168, 1175 (D. Mont. 1995). *See also* Tenn. Code Ann. § 69-3-103(24) ("'Owner or operator' means any person who owns, leases, operates, controls, or supervises a source"); Tennessee Construction General Stormwater Permit (defining "operator" as one who meets either or both of two "operational control components" of the definition—"design control" and "day-to-day operational control.").

[65] *O'Leary v. Moyer's Landfill*, 523 F. Supp. 642, 655 (E.D. Pa. 1981). *See also Mokelumne River*, 37 ERC (BNA) at 1170 (defendant is the "cause" of a discharge if it has control of discharge or status as operator).

[66] Tenn. Comp. R. & Regs. 0400-40-03-.05(1)(c).

The State may not authorize an activity unless "any lost resource value associated with the proposed impact is offset by mitigation sufficient to result in no overall net loss of resource value."[67] In making the determination, the State must consider among other factors: (1) direct loss of in-stream, waters, or wetlands habitat due to the proposed activity, (2) impairment of stream channel stability due to the proposed activity, (3) diminishment in species composition in any stream, wetland, or state waters due to the proposed activity, (4) whether the proposed activity is reasonably likely to have cumulative or secondary impacts to the water sources, (5) the quality of stream or wetland proposed to be impacted, and (6) whether the state waters is listed on the § 303(d) list, (7) whether the proposed activity is located in a component of the National Wild and Scenic River System, a State Scenic River, waters designated as Outstanding National Resources Waters, or waters identified as high quality waters, (8) whether the activity is located in a waterway which has been identified by the Department as having contaminated sediments; and (9) whether the activity will adversely affect species formally listed in State and Federal lists of threatened or endangered species.

V. SPECIFIC COMMENTS ON THE PROPOSED PERMIT

As stated above, Commenters believe the permit violates the Tennessee Water Quality Control Act, the Clean Water Act, the Endangered Species Act, and the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act. We offer the following comments on the terms of the Proposed Permit (1) to reduce the degradation caused by the Proposed Permit as currently conceived and (2) to increase the amount of information available to the State so it may more fully evaluate the scope of degradation caused by recreational prospecting:

Class 1

1. Require a "Notice of Intent" to be submitted to the State when a person seeks coverage for Class 1 prospecting activities so the State may track and evaluate where the activity is taking place and require written confirmation that the waterbody in which the person seeks to operate is eligible.
2. Limit the number of pans, sluices, and operators at a given site.
3. Prohibit prospecting in any stream on the Division of Water Resource's 303(d) impaired waters list for channel, physical substrate, or habitat alteration (as is true for Class 2 activities).
4. Remove the exemption from the wetted width minimum for private landowners and their immediate family. Whether a land is privately owned is irrelevant to the impacts on a public resource.
5. Exclude the use of #2 shovels and other large tools.
6. Increase the distance between sites from 75 feet to prevent a daisy-chain effect of impacts, given that the plume limit is 300 feet.

[67] Tenn. Comp. R. & Regs. 0400-40-07-.04(6)(c).

Class 2

7. Require that mechanical equipment be checked for leaks, and all leaks repaired, prior to the start of operations each day. Spills of petroleum products must be reported to TDEC.
8. At minimum, reinstate the requirement that operations shall not be conducted within 5 feet of the water's edge.
9. At minimum, reinstate the requirement that the minimum wetted width for 2-inch dredges is 15 feet, for 3 inch dredges is 50 feet, and at least 100 feet for larger dredges.
10. Remove the exemption for "periodic, special events" as it is inconsistent with the Tennessee Water Quality Control Act.

Class 1 & Class 2

11. Require the submission of an annual report, to include information about location (waterbody where prospecting occurred and the geographic location of the operation), duration (dates of operation and the length of operation each day), and minerals recovered. This report shall be signed and certified as accurate.
12. Shorten the term of the permit from 5 years to 1 year to use the information from the annual reports, spot-inspections, and other analysis to more fully analyze the degradation of the activity.
13. Limit the number of days a site can be used in a given period, add a temporal limit on how much material can be moved in a day.
14. Prohibit Class 1 and Class 2 activities taking place at the same site.
15. Limit the times of years certain waters can be used to exclude seasonal spawning. Prohibit operations when fish are spawning or when fish eggs or yolk-sac larvae are known to exist at the time the dredging occurs. Likewise, prohibit operation in gravel bar areas at the tail of pools or where operations result in fine sediments discharging onto gravel bars.
16. Establish a shorter permit term than 5 years to confirm, based on additional data and observation, whether the State can defend its *de minimis* determination.
17. Require protective minimum flow levels, not just wetted width.
18. Require the permittee to ensure that there is adequate passage for fish around and through the mining area at all times.
19. Define key terms, including "site" and "wetted width."
20. Require that, if mercury is found during the operation (*i.e.*, if mercury is collected in the sluice box or other apparatus), keep mercury collected, do not remobilize the collected mercury, dispose pursuant to hazardous waste laws
21. Specify the additional permit(s) required to operate.
22. Prohibit recreational prospecting in Exceptional Tennessee Waters.
23. Prohibit adverse impacts to state or federal aquatic species proposed for listing as endangered and threatened, candidate species, partial status species, non-essential

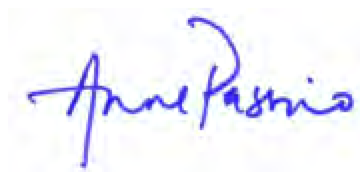
experimental population, as well as aquatic species of special concern and the critical habitat of all such species.[68]

24. Extend the prohibition and limitations established for all Tennessee Wildlife Resources Agency properties [*i.e.*, Supplemental Requirements] to all waters that flow through federal, state, and local public lands.[69]

VI. CONCLUSION

For the numerous reasons outlined above, we request that the Proposed Permit be rescinded and the State decline to issue it in its current form. Thank you for the opportunity to provide these comments.

Sincerely,



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[68] http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=9014:3:34519223876674:::::

[69] We note that because most of the federal land in the eastern United States was acquired for public use after the General Mining law of 1972, mining activities in the East are largely governed by the Acquired Lands Act of 1947, which specifically acknowledges the application of state add location regulations to mining activity on acquired lands. 30 U.S.C. § 357 (2015).

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Tennessee Conservation Voters

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Dorene Bolze
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Encl.

cc:

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Effects of Suction Dredging on Streams: a Review and an Evaluation Strategy

By Bret C. Harvey and Thomas E. Lisle

ABSTRACT

Suction dredging for gold in river channels is a small-scale mining practice whereby streambed material is sucked up a pipe, passed over a sluice box to sort out the gold, and discarded as tailings over another area of bed. Natural resource managers should be concerned about suction dredging because it is common in streams in western North America that contain populations of sensitive aquatic species. It also is subject to both state and federal regulations, and has provided the basis for litigation. The scientific literature contains few peer-reviewed studies of the effects of dredging, but knowledge of dredging practices, and the biology and physics of streams suggests a variety of mechanisms linking dredging to aquatic resources. Effects of dredging commonly appear to be minor and local, but natural resource professionals should expect effects to vary widely among stream systems and reaches within systems. Fishery managers should be especially concerned when dredging coincides with the incubation of embryos in stream gravels or precedes spawning runs soon followed by high flows. We recommend that managers carefully analyze each watershed so regulations can be tailored to particular issues and effects. Such analyses are part of a strategy to (1) evaluate interactions between suction dredging and other activities and resources; (2) use this information to regulate dredging and other activities; (3) monitor implementation of regulations and on- and off-site effects of dredging; and (4) adapt management strategies and regulations according to new information. Given the current level of uncertainty about the effects of dredging, where threatened or endangered aquatic species inhabit dredged areas, fisheries managers would be prudent to suspect that dredging is harmful to aquatic resources.

Suction dredging for gold is a small-scale mining practice whereby streambed material is excavated from a wetted portion of a river channel and discarded elsewhere. Suction dredges use high-pressure water pumps driven by gasoline-powered motors to create suction in a flexible intake pipe [commonly 75-300 cm (3 in-12 in) in diameter]. The intake pipe sucks streambed material and water and passes them over a sluice box that is usually mounted on a floating barge. Dense particles (including gold) are trapped in the sluice box. The remainder of the material is discharged into the stream and can form piles of tailings or spoils. Large boulders, stumps, and rootwads may be moved before excavating a site, and rocks too large to enter the intake pipe are piled nearby. Dredging can vary in area from a few small excavations to the entire wetted area in a reach and can exceed several meters in depth. Material is commonly dredged from pools and cast over downstream riffle crests.

Suction dredging is common during the summer in many river systems in western North America. It can affect aquatic and riparian organisms (Griffith and Andrews 1981; Thomas 1985; Harvey 1986), channel stability (T. E. Lisle and B. C. Harvey, personal observation), and the use of river ecosystems for other human activities.

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Suction dredging is regulated by both state and federal agencies, based in part on the U.S. General Mining Law of 1872, Organic Administration Act of 1897, and Clean Water Act of 1972. Suction dredging is an important issue to fisheries professionals because many dredged streams contain threatened or endangered species, and the adequacy of agency management of suction dredging has been legally challenged. Surprisingly, the effects of suction dredging on river ecosystems have not been studied extensively. A literature search yielded only five journal articles that specifically address the effects of suction dredging (Griffith and Andrews 1981; Thomas 1985; Harvey 1986; Hall 1988; Somer and Hassler 1992). However, some impacts of dredging can be predicted from general knowledge of physical and biological processes in streams.

Our goals in this paper are to summarize potential effects of suction dredging on stream biota and physical channel characteristics and to propose a basin-scale strategy for evaluating the effects of suction dredging. We also identify several research areas critical to improving management of suction dredging in streams.

On-site effects of dredging

Entrainment of organisms by suction dredges

State regulations generally limit dredging to summer months, but dredging can still overlap with fish spawning and incubation of embryos. In some streams salmonids do not emerge from the substrate until summer, and many nonsalmonids have protracted spawning periods extending into summer (Moyle 1976).

Griffith and Andrews (1981) observed a range of mortality rates for aquatic organisms entrained into a suction dredge. Mortality among benthic invertebrates in four Idaho streams was generally low (<1% of more than 3,600 individuals) but was highest among an emerging mayfly species. In contrast, entrainment increased mortality of the early life history stages of trout. Mortality was 100% among un-eyed eggs of cutthroat trout (*Oncorhynchus clarki*) from natural redds but decreased to 29%-62% among eyed eggs. Similar tests at a commercial hatchery with eyed eggs of rainbow trout (*O. mykiss*) revealed little difference in mortality after 10 d between a control group (18% mortality) and a group that passed through a dredge along with gravel (19% mortality). Sac fry of hatchery rainbow trout suffered >80%o mortality following entrainment, compared to 9% mortality for a control group. Entrainment in a dredge also would likely kill larvae of other fishes. Sculpins (Cottidae), suckers (Catostomidae), and minnows (Cyprinidae) all produce small larvae (commonly 5 mm-7 mm at hatching) easily damaged by mechanical disturbance. Eggs of nonsalmonid fishes, which often adhere to rocks in the substrate, also are unlikely to survive entrainment. Fish eggs, larvae, and fry removed from the streambed by entrainment that survived passage through a dredge would probably suffer high mortality from subsequent predation and unfavorable physicochemical conditions.

> Surprisingly, the effects of suction dredging on river ecosystems have not been studied extensively.

Most juvenile and adult fishes are likely to avoid or survive passage through a suction dredge. All 36 juvenile and adult rainbow and brook trout (*Salvelinus fontinalis*) entrained intentionally by Griffith and Andrews (1981) survived. Adult sculpin also can survive entrainment (B. Harvey, personal observation).

Effects of excavation on habitat

Direct disturbance of streambeds, including dredging, tends to destabilize natural processes that mold stream channels. Channel topography, bed particle size, and hydraulic forces in undisturbed natural channels mutually adjust so variations in stream flow and sediment supply usually create only modest changes from year to year (Dietrich and Smith 1984; Nelson and Smith 1989). These adjustments allow a channel to transport its load of sediment. Excavation by dredging directly causes significant local changes in channel topography and substrate conditions, particularly in small streams. The resulting destabilization may increase local scour or fill in parts of the streambed that were not directly disturbed. Because hydraulic forces and sediment transport rates vary widely among and within channels from year to year, the persistence of dredging-related alterations also can vary widely. For example, dredged channels would be less likely to be remolded annually if they were downstream of impoundments or diversions that decrease peak flows and trap bedload.

Dredging that excavates streambanks may have long-lasting effects because streambanks are commonly slow to rebuild naturally (Wolman and Gerson 1978). Erosion of streambanks is likely to be greater where (1) streambanks and riparian vegetation are directly disturbed by suction dredging and related activities; (2) streambanks are composed of erodible materials such as alluvium; (3) dredging artificially deepens the channel along streambanks; and (4) the roughness of streambanks and the adjacent bed is reduced. Bank roughness in the form of large rocks, roots, and bank projections tends to reduce hydraulic forces on streambanks (Thome and Furbish 1995).

Dredging near riffle crests (the transition between pools and riffles) also can pose special problems for channel stability. If dredging causes riffle crests to erode, spawning sites may be destabilized, and upstream pools may become shallower. Disturbance of riffle crests also can destabilize the reach immediately downstream. Riffle crests are commonly flat, so any imposed topography would tend to deflect the flow to one side of the channel downstream, promoting bank erosion, and scour and fill of the bed (Figure 2). Dredge tailings placed in different locations from year to year would exacerbate these impacts.

In some locations excavations may temporarily improve fish habitat. Pools can be temporarily formed or deepened by dredging. Deep scour may intersect subsurface flow and create pockets of cool water during summer, which can provide important habitat for fish (Nielsen et al. 1994). At low flows, increased water depth can provide a refuge from predation by birds and mammals (Harvey and Stewart 1991). Harvey (1986) observed that all eight fish occupying a riffle during late summer in Butte Creek, California, moved into a dredged excavation nearby. However, dredged excavations are usually short-lived because they tend to be filled with sediment during high flows.

Piling of cobbles

Miners commonly pile rocks too large to pass through their dredges. These piles can persist during high flows and, as imposed topographic high points, may destabilize channels during high flows, as previously described. Piles of cobbles probably have only minor, local effects on the abundance of aquatic organisms. Taxa that strongly select large, unembedded substrate [e.g., speckled dace (*Rhinichthyes osculus*)] might become more abundant where cobbles are piled.

Deposition of tailings

Sediment mobility

Gravel and coarse sand cast downstream during dredging tend to remain as loose tailings because there is insufficient power to transport them downstream. Fine sediment (clay, silt, and fine sand) will be carried further downstream in suspension, but minor proportions of this material are usually present in gravel streambeds (Lisle 1989). Moreover, a single dredging operation cannot mobilize significant volumes of fine sediment compared with the volume mobilized during high seasonal discharge, when erosional sources deliver fine sediment from the watershed and widespread areas of the streambed are entrained.

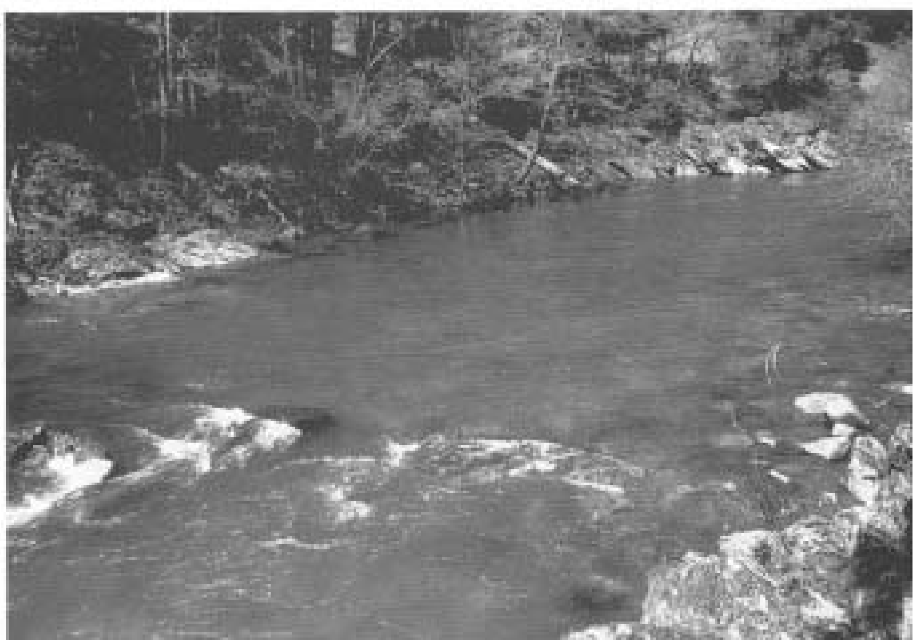
Benthic invertebrates

Exposure of new substrate and deposition of tailings locally reduce the abundance of benthic invertebrates. Both Thomas (1985) and Harvey (1986) measured significant reductions in some benthic invertebrate taxa within 10 m of dredges that disturbed the substrate. Harvey (1986) found that large-bodied insect taxa that avoid sand (e.g., hydropsychid caddisflies and perlid stoneflies) were most affected. These results are consistent with reduced benthic invertebrate abundance and species richness after complete embedding of larger substrate by fine sediment (e.g., Brusven and Prather 1974; Bjornn et al. 1977; McClelland and Brusven 1980). Somer and Hassler (1992) measured colonization of artificial substrates upstream and downstream of active dredges and found differences in assemblage composition but not in overall abundance. However, their artificial substrates were initially silt-free, while the surrounding substrate was not.

Bret Harvey

A miner works upstream of these dredges in Butte Creek, California, at a depth of greater than 2 meters.

Bret Harvey



This is the same site in spring of the following year. The log at water's edge in the upper, center-right of this photograph is visible in the upper center of the photo above.

In general, benthic invertebrates (Mackay 1992), hyporheic invertebrates (Boulton et al. 1991), and periphyton (e.g., Stevenson 1991; Stevenson and Peterson 1991) all rapidly recolonize small patches of new or disturbed substrate in streams. Abundance and general taxonomic composition of benthic invertebrates can be restored on dredge tailings four to six weeks after dredging (Griffith and Andrews 1981; Thomas 1985; Harvey 1986). In the three studies cited above, dredging disturbed only a minor proportion of available habitat for benthic invertebrates. Recolonization on tailings would probably be slower if dredging were more extensive because potential colonizers would be less abundant and more remote. However, recovery of benthic invertebrate communities after even large-scale disturbances (e.g., Minshall et al. 1983) suggests that both the total number of individuals and species diversity could recover even in areas of widespread dredging.

However, not all benthic inver-tebrates can be expected to rapidly recolonize disturbed areas. For example, many mollusks have low dispersal rates (Gallardo et al. 1994) and limited distributions in river systems (Green and Young 1993). Many aquatic insects also have limited geographic ranges (e.g., Erman and Nagano 1992). Populations of such species may be influenced strongly by local events such as suction dredging. Unfortunately, only about one-quarter of the freshwater mussels in the United States and Canada have stable abundances (Williams et al. 1993), and little is known about mussels in states where suction dredging is common (California, Idaho, Oregon, Washington). The challenge of evaluating the effects of dredging on aquatic invertebrates is often exacerbated by a lack of taxonomic information.

Stability of spawning gravels

Deposition of dredge tailings also may affect fish reproduction by inducing fish to spawn on unstable material (T. E. Lisle and B. C. Harvey, personal observation). Substrate stability is critical to spawning success of fall-spawning species because the weeks or months of embryo development in the gravel commonly coincide with the season of high flows that mobilize streambeds (Holtby and Healey 1986; Lisle and Lewis 1992). The coarseness of natural armor layers indicates the power of flows to move bed material (Parker and Klingeman 1982; Dietrich et al. 1989), so dredge tailings of fine gravel and sand that are cast over much coarser bed material (cobbles and boulders) have a high potential for scouring. State regulations in Idaho and Washington require dredge operators to backfill holes and level tailings, thereby increasing their stability.

Dredge tailings may be attractive to salmonids as sites for redd (nest) construction because tailings are often located near riffle crests where fish frequently spawn, and they provide relatively loose, appropriately sized substrate. However, dredge tailings may reduce embryo survival because they tend to be less stable than natural spawning gravels. Embryos in tailings may suffer high mortality if high flows scour the tailings, thereby destroying the redds.

The risk depends in part on the timing of spawning and high flows. Tailings are likely to be remolded or removed by high flows, providing greater stability afterwards. For example, fall spawners [chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*)] in northwestern California spawned on fresh tailings that were later completely scoured by seasonal high flows (T. Lisle and B. Harvey, personal observation). In contrast, unstable tailings are likely to be gone or remolded before reproduction by later-spawning species such as steelhead (*O. mykiss*).

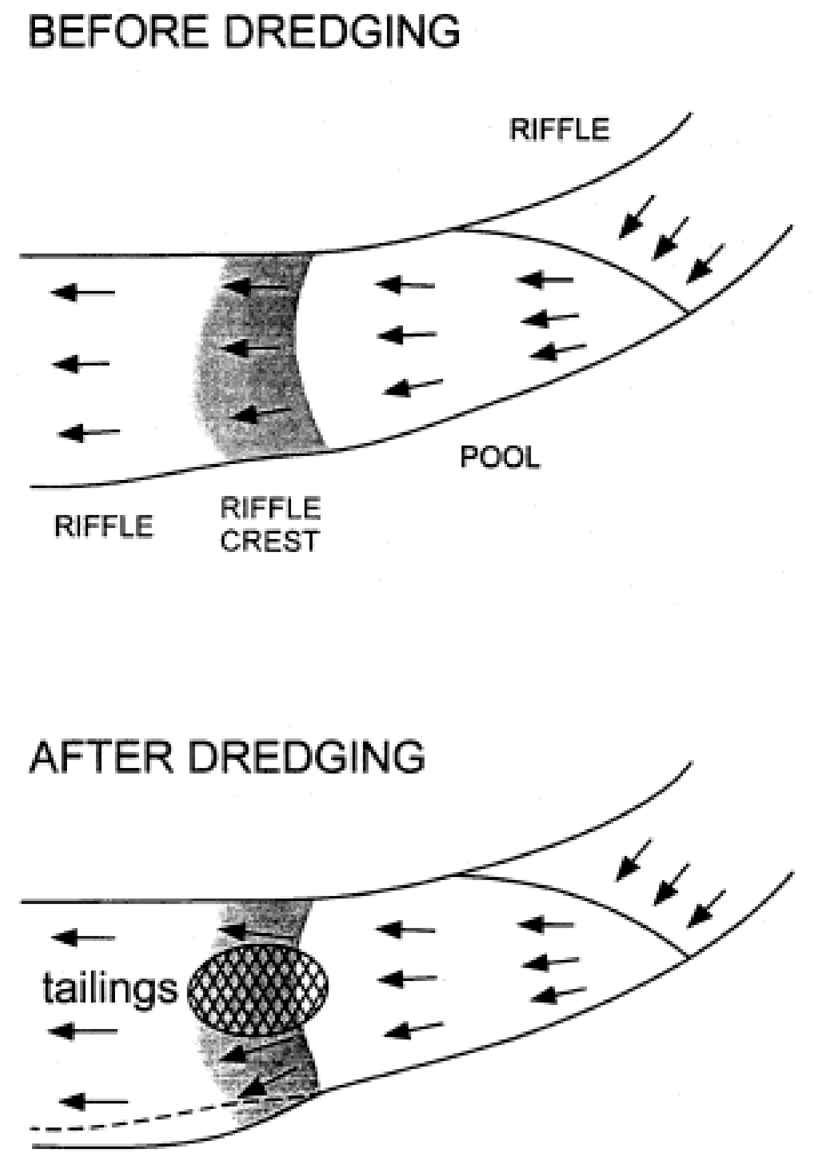


Figure 2. A conceptual planimetric view of a channel before and after dredging shows that diversion of flow around tailings on the riffle crest concentrates flow along the left bank and causes the bank to erode.

Little information exists on the selection of tailings by spawning fish. Hassler et al. (1986) noted that chinook salmon, coho salmon, and steelhead all spawned on dredge tailings in Canyon Creek in northwestern California. Three of eight spring chinook salmon redds, one of one coho redd, and one of eleven steelhead redds were located on dredge tailings. Selection of dredge tailings for spawning cannot be evaluated without knowing the overall availability of spawning gravels. However, spawning gravel was not in short supply in Canyon Creek, suggesting that tailings were not avoided by spawning fish (Hassler et al. 1986).

Tailings may significantly increase the availability of spawning sites for salmonids in channels lacking spawning gravel such as those that are armored with cobbles and boulders too large to be moved by spawning fish (Kondolf et al. 1991). However if such tailings are unstable, the population-level consequences of dredging could be negative. Considering the decline of populations Chinook salmon and coho salmon in western North America (Nehlsen et al. 1991), we think information on the relative stability of tailings and their use for spawning by these species is needed.

The relationship between suction dredging and spawning may require special consideration in regulated rivers. Impoundments commonly reduce sediment supply and peak flows downstream. Dredging may loosen and locally flush fine sediment from static streambeds, with little danger of redds being disturbed during egg incubation. However, we suspect that long-term improvement of spawning habitat by dredging downstream of dams is rare. Annual dredge mining (and renewal of spawning gravels) may not be sustainable because gold-bearing pockets would tend to be mined out without replenishment by new sediments. At the same time, dredge holes and tailings may be more persistent below impoundments, perhaps leaving these areas less suitable for recreation.

Fish habitat

Tailings also may influence juvenile and adult fishes, particularly if habitat depth and volume are altered substantially. Habitat depth is positively related to the abundance and/or size of salmonids (Everest and Chapman 1972) and other stream fishes (Harvey and Stewart 1991). The number of rainbow trout in a small pool in Butte Creek, California, declined by 50% after dredging upstream filled 25% of the pool volume (Harvey 1986). Clearly, small channels are more vulnerable to dredging impacts than large channels. For example, the entire width of small channels may be spanned by dredge tailings, creating shallow riffles that inhibit the longitudinal movement of aquatic organisms.

Some stream fishes can be affected by changes in substrate composition alone. Juveniles and adults of some benthic fish species (e.g., sculpin and dace) often occupy microhabitats beneath unembedded cobbles and boulders (Baltz et al. 1982; Harvey 1986). Harvey (1986) observed significantly reduced densities of juvenile and adult riffle sculpin (*Cottus gulosus*) downstream of a dredge on the North Fork of the American River, California, and attributed the decline in part to burial of cobbles by dredge tailings.

Movement of large roughness elements

Dredge operators may remove coarse woody debris (CWD) and large boulders from stream channels or reduce the stability of these elements by removing surrounding material. (Removing these elements from the stream is prohibited in some states.) Many pools are formed by scour around large roughness elements (Keller and Swanson 1979; Lisle 1986a; Montgomery et al. 1995). Large pieces and conglomerations of CWD are especially important because they cause scour of larger pools and can be more stable than smaller pieces (Bilby 1984). Furthermore, large roughness elements such as CWD can govern the location of scour and deposition at the scale of pools and riffles (Lisle 1986b; Montgomery et al. 1995).

Many studies provide evidence that CWD and other large elements affect various ecological processes and conditions in streams, including the microbial uptake and transfer of organic matter (Tank and Winterbourn 1996), the species composition and productivity of benthic invertebrates (Benke et al. 1984), and the density of fish (e.g., Fausch and Northcote 1992; Crispin et al. 1993). While fish may not always be associated with large substrate elements, these features may be limiting during critical events such as concealment by salmonids in winter (Heggenes et al. 1993; Smith and Griffith 1994) or reproduction by sculpins (Mason and Machidori 1976; Moyle 1976).

Suction dredging is likely to affect large roughness elements only locally, but because CWD has been depleted in many western streams by other human activities (Bilby and Ward 1991; Ralph et al. 1994), resource managers may still need to consider this issue.

Behavioral responses to dredging

Behavioral responses of stream biota to noises and vibrations generated by dredging have not been quantified. This issue appears insignificant for many taxa. Sculpin close to active dredges appear to behave normally (B. Harvey, personal observation), and juvenile salmonids have been observed feeding on entrained organisms at dredge outfalls (Thomas 1985; Hassler et al. 1986). However, Roelofs (1983) expressed concern that dredging could frighten adult summer-run steelhead, based on their response to divers. Spring-run chinook and summer-run steelhead adults held within 50 m of active dredges in Canyon Creek, California, (Hassler et al. 1986) but dredging may have inhibited upstream movement by the fish. Even minor disturbances during the summer may harm adult anadromous salmonids because their energy supply is limited, and the streams they occupy can be near lethal temperatures (Nielsen et al. 1994).

Off-site effects of fine sediment mobilized by dredging

Suspended sediment

High concentrations of suspended sediment can alter survival, growth, and behavior of stream biota (Newcombe and MacDonald 1991). Impacts of suspended sediment can increase with (1) longer exposure time (Newcombe and MacDonald 1991), (2) smaller sediment particle size (Servizi and Martens 1987), (3) extremes in temperature (Servizi and Martens 1991), and (4) higher organic content of the sediment (McLeay et al. 1987). Extremely high levels of suspended sediment (e.g., >9,000 mg/L) can be lethal to aquatic biota, and lethal thresholds may be lower under natural conditions (Bozek and Young 1994) than in the laboratory (Redding et al. 1987).

Even slightly elevated suspended sediment may reduce reactive distance of salmonids to drifting prey (Barrett et al. 1992) and prey capture success (Berg and Northcote 1985). Growth rates of steelhead and coho salmon in laboratory channels were higher and their emigration rates lower in clear water than in turbid water (22-286 NTU) after 11-21 d (Sigler et al. 1984). In contrast, feeding by sculpin in laboratory channels was not detectably affected by suspended sediment levels of 1,250 mg/L (Brusven and Rose 1981).

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 (Gregory 1993). Similarly, brook trout are more active and spend less time near cover in moderately turbid water than in clear water (Gradall and Swenson 1982). 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).

One of the most obvious off-site effects of dredging is increased suspended sediment because background concentrations where and when dredging occurs are usually low. However, lethal concentrations of suspended sediment are probably rarely produced by suction dredging. Field measurements of changes in turbidity and suspended sediment below suction dredges indicate minor, localized effects. For example, turbidity was 0.5 NTU upstream, 20.5 NTU 4 m downstream, and 3.4 NTU 49 m downstream of an active dredge on Canyon Creek (Hassler et al. 1986). Suspended sediment concentrations at the same three locations were 0, 244 mg/L, and 11.5 mg/L, respectively. On Butte Creek and the North Fork of the American River where ambient turbidities were <1 NTU, maximum turbidity 5 m downstream of active dredges reached 50 NTU but averaged only 5 NTU (Harvey 1986). In Gold Creek, Montana, suspended sediment was 340 mg/L at the dredge outflow and 1.8 mg/L 31 m downstream of an active dredge (Thomas 1985). Extrapolating results from studies exposing biota to chronic suspended sediments may overestimate the impacts of dredging because dredgers commonly operate for <5 h/d.

Unfortunately, the results cited here do not eliminate the possibility that dredging can affect stream biota via increased suspended sediments. Mobilization of suspended sediment by dredging and resulting effects on biota are site-specific. Production of suspended sediment is no doubt linked to the size and frequency of dredging operations, but such cumulative effects have not been evaluated. Dredging in streambeds in which sand is the dominant interstitial fine sediment is unlikely to yield high suspended sediment concentrations, but excavation of streambanks anywhere is likely to substantially increase suspended sediment because banks commonly contain abundant finer sediments.

> ...we suspect that long-term improvement of spawning habitat by dredging downstream of dams is rare.

Deposition of fine bedload

Neither the extent of off-site deposition and transport of dredging-generated fine sediment (clay, silt, and sand) nor the responses of aquatic biota have been investigated in a variety of streams. These issues deserve consideration because fine sediment can alter a variety of stream processes and conditions, including primary production (e.g., Power 1990), density of aquatic insects (e.g., Hogg and Norris 1991), and fish reproduction (e.g., Phillips et al. 1975; Fudge and Bodaly 1984).

While silt and clay entrained by dredging may remain suspended and travel long distances before being deposited, sand and gravel are usually deposited immediately downstream. At low flows pools tend to accumulate sediment transported as bedload (Keller 1971). Thus, pools can be filled by sediments mobilized by upstream dredging (Thomas 1985; Harvey 1986). While deposition of bedload would be most severe close to dredging sites, disruption of the continuity of bedload transport can have unpredictable consequences downstream, including both erosion and deposition (Womack and Schumm 1977). However, unless significant bank erosion occurs, increased sediment transport is limited by the fact that the sediment load delivered to the channel remains the same, and overall effects downstream are probably minor. Furthermore, lower channel stability by itself may not be important to some aquatic ecosystems.

Deposition of fine sediment downstream of active dredges is unlikely to substantially decrease water depth, but it may increase the embeddedness of cobble and boulder substrates used by many organisms. Complete embedding of substrates (particularly by silt and clay) generally will severely harm assemblages of benthic invertebrate (Hogg and Norris 1991). Slight increases are unlikely to significantly reduce the density of benthic invertebrates. In fact, partially embedded substrate may support a more-dense, diverse invertebrate fauna than unembedded substrate (Bjornn et al. 1977). Neither Thomas (1985) nor Harvey (1986) detected differences in the abundances of invertebrates 10 m or more downstream of dredged areas versus abundances at upstream control sites. However, these studies had low probabilities of detecting differences for several reasons: (1) High spatial variability occurred in the abundances of benthic invertebrates (even under natural conditions); (2) slow-water habitats where silt and clay may have been deposited were not sampled in either study; (3) sand dominated the fine sediments of the streams sampled in both studies; and (4) Harvey (1986) could not sample in the deepest parts of the channel where dredging-generated bedload was concentrated because of limitations of the sampling device.

Downstream transport and deposition of fine sediment also can reduce availability of microhabitats used by benthic fish. Density of sculpin was lower downstream of dredge tailings on the North Fork of the American River, in part because of increased deposition of sand (Harvey 1986). Similar to benthic fishes, amphibian larvae and adults might be harmed by reduced habitat beneath cobbles and boulders. For example, Parker (1991) measured a strong positive response by Pacific giant salamader larvae (*Dicamptodon tenebrosus*) to the addition of cobbles to a stream dominated by smaller substrate.

Deposition and transport of fine sediment by dredging is less likely to affect fish that occupy the water column during summer. Repeated visual censuses and observations of tagged fish revealed no short-term response to dredging by rainbow trout in pools in Butte Creek where substrate embeddedness and the percentage of fine sediment were increased, but habitat depth and volume were not changed substantially (Harvey 1986). Similarly, Bjornn et al. (1977) observed only minor differences in salmonid density in artificial channels with unembedded versus half-embedded gravel, cobble, and boulder substrates. However, if extensive dredging reduced invertebrate production, then salmonids could be affected. For example, Crouse et al. (1981) found a negative relationship between coho salmon production and the amount of fine sediment in the substrate of laboratory streams that lacked allochthonous inputs of invertebrates.

Bedload transport *per se* also may need to be considered when examining off-site effects of dredging on benthic invertebrates and fish. Culp et al. (1986) observed short-term reductions in invertebrate abundance from increased transport of fine bedload in a natural riffle where the composition of the substrate was not altered greatly. In addition, dredging-caused increase in transport of fine sediment may have harmed sculpin at the North Fork of the American River (Harvey 1986): relatively few sculpin occupied microhabitats beneath cobbles and boulders that remained unembedded downstream of the dredge.

Reproduction by spring-spawning animals will not be affected by the deposition of fine bedload where high winter discharge entrains these sediments. However, temporal overlap of dredging and reproduction by species of concern may produce significant off-site effects of dredging. For example, fine sediment deposition over more than 4 km below 4 suction dredges in Piru Creek, California, apparently reduced survival of eggs and larvae of the endangered Arroyo toad (*Bufo microscaphuus californicus*) throughout a significant proportion of the known range of the species (Sweet 1992).

Effects of multiple dredges

Off-site effects of individual dredges may be minor, but downstream impacts may be of concern where dredges are closely spaced, and other human activities and natural conditions increase the potential for cumulative effects. A moderate density of dredges in Butte Creek generated minor increasees in sedimentation, and cumulative effects on benthic invertebrates or rainbow trout were not detected (Harvey 1986). However, no research has been dedicated to measuring the cumulative physical or biological effects of many closely spaced dredges. Cumulative effects of dredging and other human activities deserve attention, particularly where reaches are dredged year after year. Experiments will be difficult to conduct because of the length of stream reach that would comprise a reasonable unit of observation and variability among reaches (Carpenter et al. 1995). An experimental approach to management (McAllister and Peterman 1992) that included measurements on streams varying strongly in dredging intensity would help answer questions about cumulative effects.

Activities associated with dredging

Examination of dredging impacts also should include activities commonly associated with dredging such as camping and fishing. Dredge operators often camp in riparian zones that are critical to birds, amphibians, and aquatic insects. Miners' campsites are seldom maintained by resource agencies, so waste disposal and control of site damage is usually left to the miners. Sites are usually occupied for long periods. Some mining claims are used by a series of dredge operators in one season, leading to intense activity in one area. Also, fishing by miners may intensify pressure on local populations.

Analyzing suction dredging in a watershed context

Effects of suction dredging must be analyzed in the context of individual stream systems. The potential for a variety of dredging effects is great, and the distribution of physical and biological attributes and human activities in each stream basin is unique. In many systems, dredging effects may be minor when considered in isolation, yet they may contribute to significant cumulative effects on important resources. A methodology to accurately identify general thresholds of dredging activity leading to unacceptable cumulative effects is not available. A useful strategy is to adapt a watershed-scale approach to identify and evaluate important conflicts between dredging and aquatic organisms. A general strategy for analyzing dredging impacts parallels those outlined in existing management guidelines that include ecosystem analyses at the watershed scale (e.g., FEMAT 1993; Washington Forest Practices Board 1993; Regional Ecosystem Office 1995). Ideally, analysis of suction dredging would be part of a comprehensive examination that addresses all important issues for a particular watershed. The following steps might be included in either a specific analysis of dredging or an overall watershed analysis:

(1) Evaluate interactions between suction dredging and other activities and resources by

A. identifying and prioritizing issues (other activities and resources) that could be affected by dredging and associated activities.

B. identifying and evaluating probable on- and off-site effects of dredging on conditions and processes important to these issues. How strong are these effects? How and when do they occur? How far do they extend? How long do they last? How do they interact with other human disturbances?

C. analyzing how patterns of dredging and disturbances overlay patterns of potentially affected activities and resources.

(2) Use this information to develop guidelines for dredging and other activities. Even an exhaustive analysis is unlikely to reveal an indisputable, definite threshold of acceptable dredging activity. Instead, limits and regulations for each stream system will need to be decided openly in a scientifically informed, political process.

(3) Monitor implementation of regulations, on-site effects of dredging on key physical and biological parameters, and off-site effects of dredging on downstream conditions and processes. Take an experimental approach to monitoring that includes contrasts among different management strategies (McAllister and Peterman 1992).

(4) Alter management strategies and regulations in response to monitoring results, new issues, and changing physical and biological conditions in the watershed.

Examples of the analysis strategy

A. Fish populations

In many western streams where dredging occurs, managers will identify the population viability of one or more fishes as an issue of concern (Step 1.A.). In this case, the following questions might arise (Step 1.B.):

(1) Are fish in early life stages (e.g., eggs, larvae, alevins) present during dredging?

(2) Does dredging increase suspended sediment to levels that could affect fish, and are the likely effects negative or positive?

(3) Do environmental conditions (e.g., high water temperature or fine sediment with high organic content) raise the risk to fish populations of increased suspended sediment?

(4) What is the probability that fish will spawn before dredge spoils are reworked by high flows?

(5) If eggs are deposited in dredge tailings, what is the probability that flows capable of transporting bed material will occur during the incubation period?

(6) What is the stability of dredge spoils relative to natural spawning areas?

(7) To what extent does dredging significantly change the volume of channel geomorphic units or the loss of large substrate elements?

And in analyzing patterns (Step 1.C.):

(1) Does dredging occur in stream reaches that are hotspots of spawning activity?

(2) Are natural spawning gravels in such short supply that a large percentage of spawners might use dredge tailings?

(3) What is the probability that dredging-related mortality will significantly affect fish populations? (Does the area affected comprise a significant or key proportion of a population's range?)

(4) How does the overall impact of dredging on fish populations compare to, or interact with, other possible impacts such as fishing?

Answers to these questions may suggest changes in dredging techniques (Step 2). For example, if dredging occurs where existing fall-spawning chinook salmon are limited by recruitment, then requiring that tailing piles be obliterated could reduce the threat to reproductive success from spawning on unstable tailings.

Issues and impact mechanisms identified in the analysis (Step 1) would logically focus monitoring (Step 3) of the effectiveness of new regulations (Step 2). For example, if destabilization of fall spawning gravels is a problem, managers would want to survey the proportion of redds located on tailings and measure the relative stability of redds on spawning gravels that have and have not undergone post-dredging restoration. This could be done with repeated topographic surveys or scour monitoring devices (Nawa and Frissell 1993).

B. Channel stability

Where channel stability is identified as an issue of concern, a geomorphologist might be enlisted to help answer the following questions (Step 1.B.):

(1) How much will the original bed topography, including the particle size and morphology of pools and riffle crests, be altered by dredging?

(2) Will streambanks be subjected to increased hydraulic forces?

(3) Is the channel likely to reconstruct its original form given typical peak flows?

(4) Will coarse woody debris and other large roughness elements that influence channel morphology be disturbed?

Step 1.C.:

(1) What is the extent of channel morphological effects, and how are dredging sites distributed relative to other disturbances (e.g., fires and roads) and inherently unstable reaches (e.g., those with alluvial streambanks, low gradients, or multiple channels)?

(2) What other factors such as large floods, impoundments, and large sediment inputs affect channel stability, and how does the impact of dredging interact with these factors?

Scoping the problem of channel stability in Step 1 should indicate reaches to monitor because of their inherent instability and proximity to dredging operations. On- and off-site channel changes could be monitored with repeated topographic surveys or aerial photography. At the same time, flood stages and other disturbances (e.g., grazing, landslides, and fires) also would be monitored.

Conclusions

Suction dredging and associated activities have various effects on stream ecosystems, and most are not well undestood. In some situations, the effects of dredging may be local and minor, particularly when compared with the effects of other human activities. In others, dredging may harm the population viability of threatened species. Dredging should be of special concern where it is frequent, persistent, and adds to similar effects caused by other human activities. Fishery managers should be especially concerned when dredging coincides with the incubation of young fish in stream gravels or precedes spawning runs (e.g., fall-run chinook salmon) soon followed by high flows. They also should be concerned about increased fine-sediment deposition in channels that naturally contain abundant fine sediment or receive inputs from other disturbances.

We recommend that basin-scale analyses of dredging and other activities be performed so regulations can be tailored to particular issues and effects in each stream system. Quantitative, uniform guidelines and regulations that are truly applicable and scientifically supportable for a variety of basins probably will never be found. Instead, basin-specific regulations will need to be created in a political but scientifically informed process using information from a basin-scale analysis. Considering the uncertainty surrounding dredging effects, declines in many aquatic animal populations, and increasing public scrutiny of management decisions, the cost of assuming that human activities such as dredging cause no harm deserves strong consideration by decision makers (Mapstone 1995). Where threatened or endangered species exist, managers would be prudent to assume activities such as dredging are harmful unless proven otherwise (Dayton 1998).)

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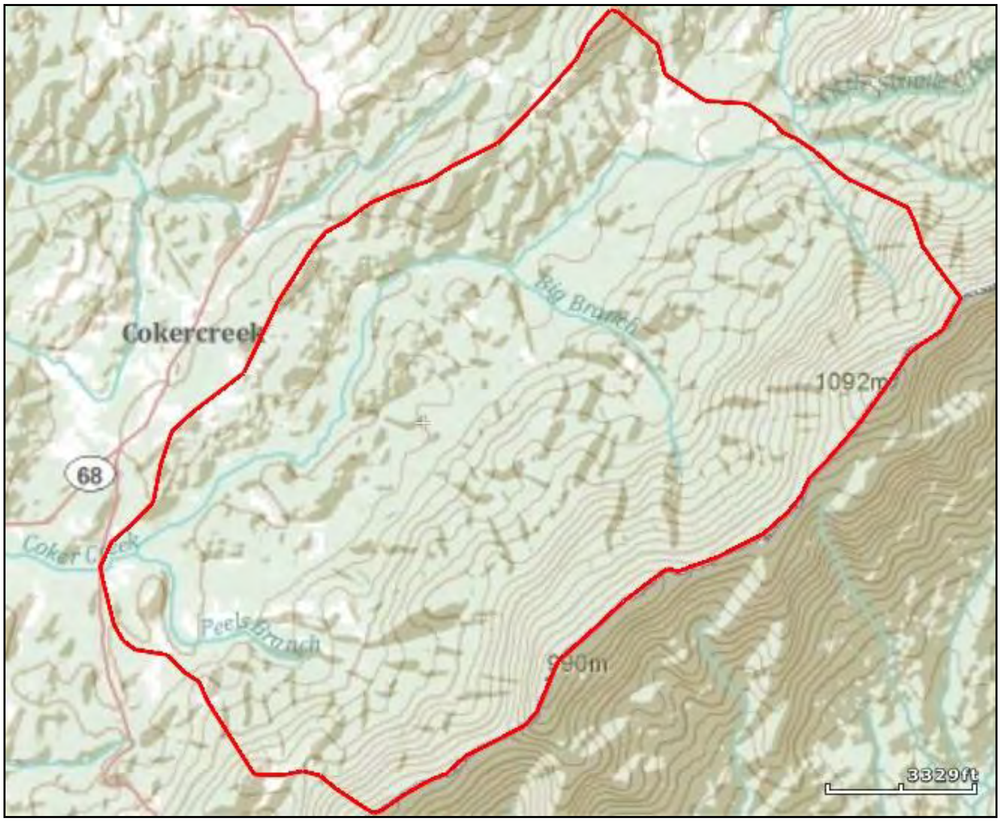
Gold Dredge Monitoring – Coker Creek, Tellico Ranger District

~~Draft~~ Final Report



For: U.S. Department of Agriculture – Forest Service

Cherokee National Forest Tellico Ranger District

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INTRODUCTION

At the request of the United States Department of Agriculture (USDA), United States Forest Service (USFS), Cherokee National Forest (CNF), a stream monitoring project (Williams and Thurman 2010) was conducted from December 2009 through August 2010 to assess impacts from recreational gold suction dredging activities on select aquatic and physical habitat components in Coker Creek, which is located within the Tellico Ranger District, Monroe County, Tennessee. This report represents the results of a December 2010 to August 2011 supplemental monitoring project to further evaluate and assess biological integrity and substrate component conditions in Coker Creek.

Figure 1 Recreational suction gold dredging on Coker Creek at site 1.

In recent years, there has been a significant increase in recreational suction gold dredging on the Cherokee National Forest. As gold market prices have risen, recreational gold dredging activity has increased in Coker Creek. Most dredging activity in the Coker Creek watershed occurs within the Doc Rogers Fields stream reach.

Two sample sites, one-quarter mile apart, were established; one at Doc Rogers Fields and one just upstream from the Joe Day Bridge on Unicoi Lakes Road. Biological assessment data for fish and macroinvertebrates and substrate composition and characterization data were collected.

Objectives of this study were to:

(1) Continue biological monitoring and substrate composition characterization sampling at two established monitoring sites on Coker Creek
(2) Conduct fish sampling utilizing fish community biological and monitoring assessment protocols.
(3) Conduct aquatic invertebrate sampling utilizing benthic macroinvertebrate biological monitoring and assessment protocols.
(4) Conduct stream substrate composition and characterization utilizing pebble count sampling protocols.
(5) Conduct sampling each quarter from December 2010 through August 2011.
(6) Submit final report including recommendations to Cherokee National Forest Aquatic Biologist.

SITE DESCRIPTION

Coker Creek is a tributary watershed that drains into the Hiwassee River watershed. The Hiwassee River watershed is a Tennessee River sub-basin and drains through both the Blue Ridge and Ridge and Valley Ecoregions. Coker Creek watershed is located in both Monroe and Polk counties. Both study sites are located near the town of Tellico Plains Tennessee (Figure 2).

Figure 2 Project Location.

Sample sites were located upstream and downstream of publicly accessible active suction dredging sites. Both sites are located within Cherokee National Forest administrative boundaries. Coker Creek sites (Figure 3) are located within the Doc Rogers Fields area and just upstream the Joe Brown Hwy Bridge on Unicoi Lakes Road. Table 1 shows geographic longitude and latitude coordinates for these sites.

Figure 3 Coker Creek sampling site locations.

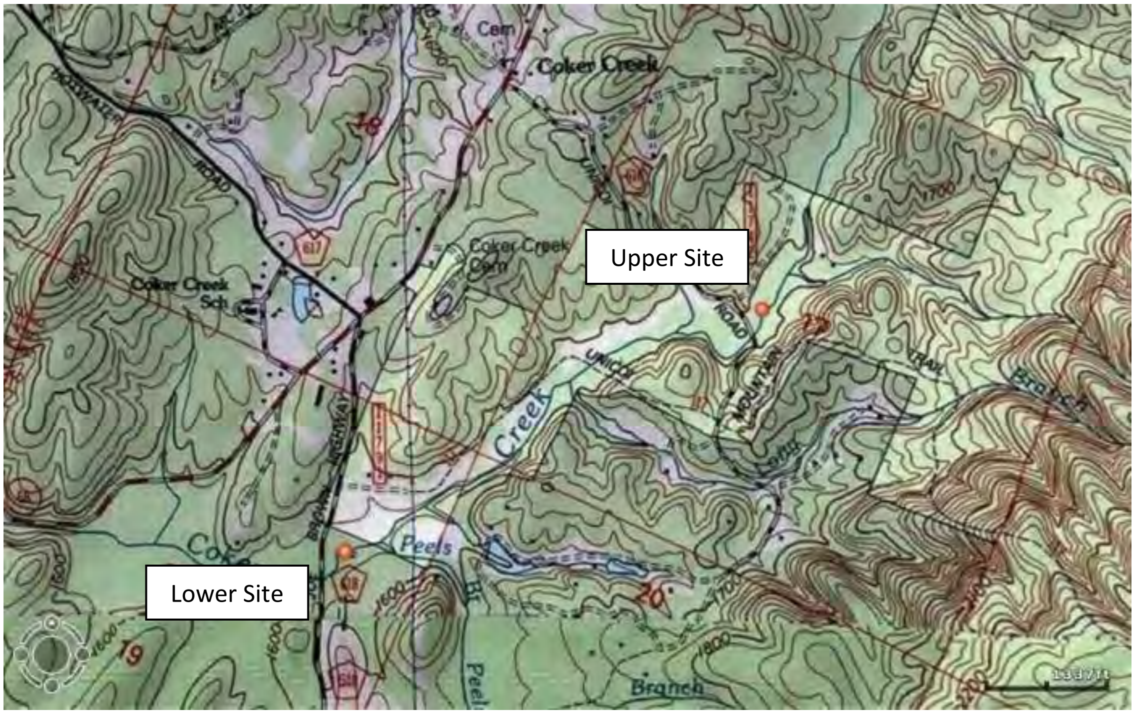


Table 1 Geographic longitude and latitude and elevations for Coker Creek sample sites.

Stream	Site Name	Latitude	Longitude	Elevation
Coker Creek	Lower Coker Creek	35° 15.168’ N	84° 17.278’ W	1570 Feet
Coker Creek	Upper Coker Creek	35° 15.448’ N	84° 16.602’ W	1595 Feet

METHODS

Fish

Fish populations were sampled using North Carolina Division of Water Quality North Carolina Index of Biological Integrity (NCIBI) Sampling Protocols (NCDEHNR 2001). The NCIBI is adapted from the Index of Biotic Integrity as described in Karr (1981) and Karr, JR, et.al. (1986). These protocols were developed to assess stream biological integrity by examining the fish community structure, and health. Most federal, state, non-governmental organizations, and local governments utilize some adaptation of biological index of integrity stream monitoring to carry out resource management objectives.

Fish sampling was conducted during mid-spring in order to avoid collection of young-of-the-year (YOY) individuals. Fish sampling included identification of a 600-foot representative sample site, which included macro- and micro- habitat types expected throughout the target stream reach. Fish were collected using battery-powered backpack electrofishing units - Model AA-24 Backpack Aquatic Sampling Device from Appalachian Aquatics, Inc.

A general formula of one electrofishing unit per three meters of stream width was utilized to determine the number of sampling units required. Fish sampling was conducted upstream through the sample reach with a five minute break at the end to transport and sort collected fish. Sampling was then continued back downstream through the sample area primary riffle utilizing a 15-foot kick seine with a 3/8 mesh net to collect bottom-dwelling species missed during the upstream sampling. The 3/8 mesh size reduces the number of YOY entrainment (Charlie Saylor, personnel communication).

Once the collection process was completed, all individuals were anesthetized with CO^2 to reduce handling stress and expedite identification, measurement and enumeration. Individuals were examined for lesions, diseases, sores, anomalies, and measured to the nearest one mm length.

Fish collection data were recorded on an adaptation of the NCIBI Fish Community Assessment – IBI Data Sheet. Once the first 50 individuals of a species were measured, those remaining were released once they had been counted. Species represented by multiple age classes were identified by recording "Y" in the margin of the data sheet beside the species name. Species that were not readily identifiable or were disputed between biologists were preserved and taken to the laboratory for identification.

NCIBI analysis and scoring is based on cumulative scoring metrics for wadeable streams in the Western North Carolina Mountains of the Little Tennessee and Hiwassee River watersheds ranging from 3.1 to 161 square miles. The ten metrics used in calculating and obtaining an overall NCIBI score are:

1. Number of species collected.
2. Number of fish.
3. Number of darter species.
4. Number of rock bass, smallmouth bass, and trout species.
5. Number of cyprinid species.
6. Number of intolerant species.
7. Percentage of tolerant individuals.
8. Percentage of omnivorous and herbivorous individuals.
9. Percentage of insectivorous individuals.
10. Percentage of species with multiple age groups.

Scores from these ten metrics were summed and assigned an NCIBI score and integrity class based on the following values:

Excellent = 58-60

Good = 48-56

Good to Fair = 42-46

Fair = 34-40

Poor = ≤32

Because ten metrics, rather than 12, are used for the Hiwassee and Little Tennessee basins, and if 60 is to be used as the maximum NCIBI total score, a multiplier of 1.2 must be used. Use of the multiplier gives a decimal number, which must be rounded up or down to the nearest whole even number resulting in the final total NCIBI score. Using ten metrics eliminates scores of 54, 42, and 30 from NCIBI final scores. This minor anomaly should not reduce the effectiveness of this bioassessment tool.

Macroinvertebrates

Aquatic invertebrates were sampled quarterly (November 2009; February, May and August 2010) using techniques similar to those prescribed by the Tennessee Department of Environment and Conservation Protocol F, Biorecon (Reconnaissance/Screening) (Ref.), which is a genus-level protocol. This protocol is based on EPA's Rapid Assessment Protocol (Barbour et al, 1999). Techniques used are also similar to TVA's Benthic Index of Biotic Integrity (BIBI) Rapid Assessment protocol; and the North Carolina Department of Environment and Natural Resources IBI protocol. TVA's BIBI is a family-level protocol, and North Carolina's is species-level.

Seven different habitats were sampled: leaf packs; fine sediment; rooted undercut banks; rooted macrophyte beds; riffles; riffle, run and pool rocks; and woody debris. Five hundred millimeter mesh rectangular kick and sweep nets (D-net) were used to collect invertebrates. The kick net was used to sample riffles, leaf packs and fine sediment; the D-net was used to sample root wads and macrophytes; rocks and wood were sampled by visual search. Habitats were not sampled unless greater than one square meter of that habitat could be sampled within a 50-yard stretch of the GPS-located sample station.

Four half-square meter samples were taken from two different riffles; two kicks were taken from each riffle, one from a high velocity area and one from a lower velocity area. Three half-square meter grabs were taken from rooted undercut banks, macrophyte beds, leaf packs and sediment habitats. Rocks and wood were visually searched. Rocks were sampled in riffle, run and pool habitats and woody debris was searched where found. Kick and grab samples were picked for 15 minutes, and rocks and wood were searched for 15 minutes. Specimens were picked from sampled material, identified to the appropriate taxonomic level, and recorded. At least one specimen for each taxa was stored in 95 per cent ethanol. Taxa not identified in the field were taken to the lab for identification. The number of specimens observed for each taxon was recorded while being picked in the field; collection was stopped for a taxon after ten were recorded.

The following biometrics, used by TDEC in its genus-level biorecons, were calculated: (1) taxa richness (TR) (total number of taxa identified to genus level (chironomids are identified as red midges, non-red midges and tanypodinae (retractile antennae); oligochaetes, isopods, amphipods, leeches, acarina, nematodes and nematomorpha are identified to lowest practical level; (2) total EPT taxa (EPT); caddis, stonefly and mayfly genera; (3) total intolerant taxa (IT) (list developed based on NC tolerance values of 0 – 3); and (4) total EPT families.

Abundance values were not used in metric calculations; however, abundance values were shown for each taxa at each sample station as follows: rare (1 - 2 specimens), common (3 – 9 specimens), abundant (10 + specimens). Genus-level taxonomic keys used to identify invertebrates are shown in References.

Pebble Counts

Substrate component characterization was assessed using an adaptive pebble count method as described in the Pebble Count section of Applied Fluvial Geomorphology (Rosgen 1996). Representative pebble count surveys provide a systematic sampling method for proportionally sampling all bed features within a given sample reach. Profiling of a representative sample reach can provide critical information regarding the quality of substrate components and effects of watershed land use activities on a given stream.

A sample reach is typically measured as 20 to 30 times the bankfull channel width of a stream. Sample reaches generally followed this formula and pools typically represented a rounded up 30% of the sample reach; riffles represented 70% of stream habitat in a sample reach. Ten sample transects were established consisting of three mid pool transects, three end-of-riffle reach transects, three beginning of riffle reach transects, and one mid-riffle transect. This standardized transect formula was applied to all four streams and eight samples sites.

At each transect, ten samples were collected at evenly-spaced intervals from stream bankfull to stream bankfull. For each sample, a particle was selected by looking away and reaching down and selecting the first pebble at the toe of the boot. Since water clarity was very good and pool bottoms could be observed, a particle size visual estimate was utilized in pools deeper than four feet. For measuring particle size, a gravelometer with sizes ranging from two mm to 180mm was used by inserting the B axis of the particle through the appropriate size class opening. Particle sizes less than two mm were visually estimated and recorded, and particle sizes larger than 180 mm were measured across the B axis with the graduated scale on the side of the gravelometer. Particle size samples were recorded using the Pebble Count Field Data sheet as described in Applied Fluvial Geomorphology (Rosgen 2008).

RESULTS

Fish

A total of 8 different fish species and 170 individuals including 40 young-of-year were collected from the two sample sites. A total of eight species were collected at the Lower Coker Creek site and six at the Upper site. No darters, dace, smallmouth bass, trout, or sculpin species were collected from Coker Creek (Table 2). The most abundant species present at both upper and lower sites was creek chubs.

Table 2 Fish species accounts, occurrences and (number) collected from December 2010 and August 2011 Lower and Upper Coker Creek sample sites.

Common Name	Species	Lower Coker Creek	Upper Coker Creek
Bluegill	*Lepomis macrochirus*	X (3)	
Creek Chubb	*Semotilus atromaculatus*	X (52)	X (40)
Green Sunfish	*Lepomis cyanellus*	X (7)	X (3)
Largescale Stoneroller	*Campostoma oligolepis*	X (19)	X (6)

Northern Hogsucker	*Hypentelium nigricans*	X (13)	X (8)
Redbreast Sunfish	*Lepomis auritus*	X (11)	X (2)
Rock Bass	*Ambloplites rupestris*	X (3)	X (2)
Warpaint Shiner	*Luxilus coccogenis*	X (1)	
Total Species	**8**	**8**	**6**

Biological Integrity classification scores show a poor condition for both Lower and Upper Coker Creek sites. Lower biological integrity scores from both sites were primarily influenced by (1) relatively low abundance and diversity of individuals, (2) lack of darters, smallmouth bass, dace, and the presence of only a single individual shiner species, (3) lack of a single apex predator species such as smallmouth and/or rock bass, (4) number of tolerant species present and a high percentage of tolerant individuals, (5) low percentage of species with multiple age groups. These conditions, along with the resulting biological integrity scores and Index of Biotic Integrity classifications, demonstrate an impaired fish community assemblage at both lower and upper Coker Creek sample sites.

Table 3 North Carolina Index of Biotic Integrity analysis metrics, scores, and resulting biological integrity classifications.

	Fall 2010				Spring 2011			
Metric	Lower Coker Creek Values	Scores	Upper Coker Creek Values	Scores	Lower Coker Creek Values	Scores	Upper Coker Creek Values	Scores
Number of Fish Species	6	1	3	1	7	1	6	1
Number of Fish	64	1	40	1	154	1	82	1
Number of Species of Darters	0	1	0	1	0	1	0	1
Number of Species of Rockbass,Smallmouth, and Trout	0	1	0	1	1	3	1	3
Number of Species of Cyprinids	3	1	2	1	2	1	2	1
Number of Intolerant Species	0	1	0	1	1	1	1	1
Percentage of Tolerant Individuals	46.9%	1	50.0%	1	35.7%	1	85.3%	1
Percentage of Omnivorous + Herbivorous Individuals	33.8%	5	20.0%	5	14.3%	5	4.9%	1
Percentage of Insectivorous Individuals	87.5%	1	80.0%	1	77.9%	5	90.2%	1
Percentage of Species with Multiple Age Groups	33.0%	1	66.0%	5	85.7%	5	50.0%	3
Biological Integrity Class Score		16		22		24		14
IBI Integrity Classification		Poor		Poor		Poor		Poor

Note: Number of individual fish represents a multiplier of 2 in order to compute metric values from a 300 foot sample reach.

Macroinvertebrates

Benthic sampling during the first three quarters showed Coker Creek aquatic invertebrate populations to be somewhat depressed. Values for the three primary key biometrics - Total EPT Families, Total EPT Taxa, and Total Intolerant Taxa - were lower than what one would expect to find in non-impaired Blue Ridge Ecoregion streams of this size with little influence from human activity. Significantly lower scores were recorded at both Coker Creek stations during August sampling. Results from 2010/2011 sampling are shown in Table 4.

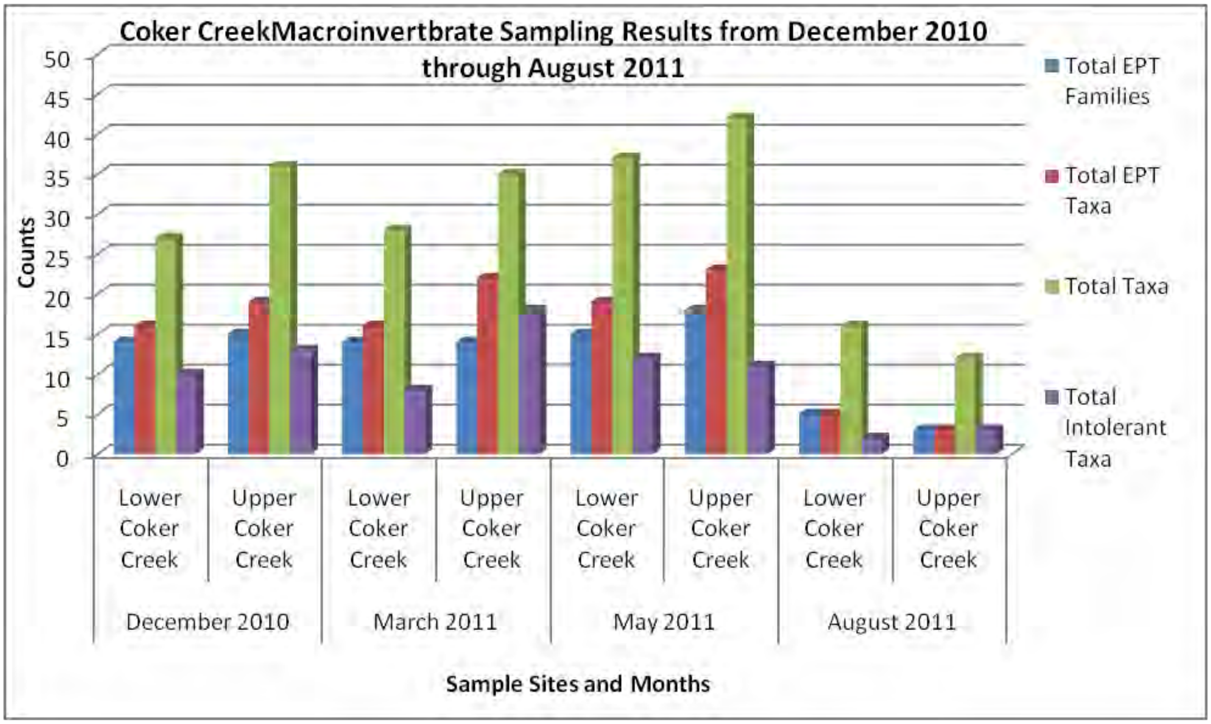
Riffle/run habitat, which is critical habitat for many invertebrate taxa, has been severely impaired by suction gold dredging; riffle/run habitat was non-existent at both stations during August sampling. Complete loss of flow and these two critical habitats is a major factor contributing to the drastic reduction in the EPT Family, Total EPT Taxa, and Total Intolerant Taxa biometrics.

Table 4 Macroinvertebrate bioassessment results and ratings from sampling results conducted from December 2010 through August 2011.

Sample Date	Sites	Total EPT Families	Total EPT Taxa	Total Taxa	Total Intolerant Taxa
December 2010	Lower Coker Creek	14	16	27	10
	Upper Coker Creek	15	19	36	13
March 2011	Lower Coker Creek	14	16	28	8
	Upper Coker Creek	14	22	35	18
May 2011	Lower Coker Creek	15	19	37	12
	Upper Coker Creek	18	23	42	11
August 2011	Lower Coker Creek	5	5	16	2
	Upper Coker Creek	3	3	12	3

An earlier TWRA stream survey report by Bivens and Williams 1990 lends credence to this conclusion. In October 1990, TWRA biologists sampled Coker Creek at the same lower station sampled in this survey (just upstream from the Joe Brown Highway Bridge). At the time of the TWRA sample, apparently little or no suction gold dredging was taking place; the report described the stream as “a high quality Blue Ridge stream” where “There was some siltation evident, but for the most part, this is a nice, clean little stream”. TWRA found a total of 61 total taxa (TR), 29 EPT taxa (EPT), and 19 EPT families. It was not possible to determine a metric for total intolerant taxa (IT). These numbers exceed those found in this survey for all quarters.

Figure 4 Total EPT Taxa collected during December 2010 to August 2011 sampling from Coker Creek.



Pebble Counts

A total of 802 pebble count samples were collected from four quarters at two sampling sites at Coker Creek. 2009/2010 pebble count results from Tellico River, Lyons Creek, and Wildcat Creek suggest that cumulative percentages of fines less than two mm (sand and silt) should represent approximately two to ten % of the total sample depending on the time of year.

During December 2010 Lower Coker Creek and Upper Coker Creek showed cumulative percentages of fines less than two mm to be 29% and 34% respectively.

During March 2011, the percentage of fines less than two mm collected at Lower Coker Creek and Upper Coker Creek showed cumulative percentages of fines less than two mm as 11% and 24%. A significant reduction in cumulative particle size characterization at the lower Coker Creek site was observed during sampling from this period. It is not completely understood what contributed to this since we did not observe a similar occurrence during the 2009/2010 sampling at approximately the same time of year. It is worth noting however that these conditions would have been favorable for increased spawning success since many of the species in Coker Creek spawn in early to mid-Spring.

May 2011 sampling showed cumulative percentages of fines less than two mm increased at Lower Coker Creek and Upper Coker Creek to 29% and 26%, respectively.

August 2011 sampling revealed cumulative percentage of fines less than two mm continued to be 32% and 35% at Lower and Upper Coker Creek stations. As represented in the 2009/2010 sampling, these data collected during sampling at this time of the year would represent the highest values observed during 4 quarters of sampling.

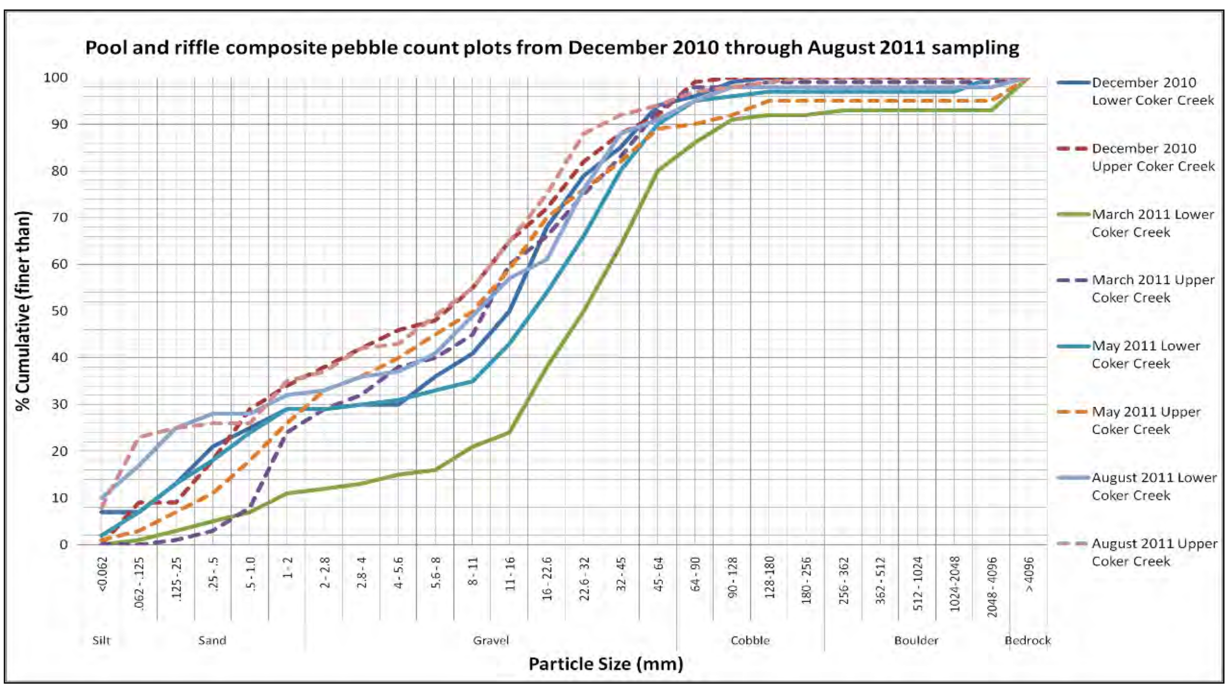
Table 5 Cumulative particle size component percentages finer than collected from Coker Creek December 2010 through August 2011.

Composite		Silt	Sand					Gravel									
Date	Sites	<0.062	.062 - .125	.125 - .25	.25 - .5	.5 - 1.0	1 - 2	2 - 2.8	2.8 - 4	4 - 5.6	5.6 - 8	8 - 11	11 - 16	16 - 22.6	22.6 - 32	32 - 45	45 - 64
December 2010	Lower Coker Creek	7	7	13	21	25	29	29	30	30	36	41	50	68	79	85	94
	Upper Coker Creek	0	9	9	18	29	34	38	42	46	48	55	65	72	82	88	92
March 2011	Lower Coker Creek	0	1	3	5	7	11	12	13	15	16	21	24	38	50	64	80
	Upper Coker Creek	0	0	1	3	8	24	29	32	38	40	45	60	66	75	83	93
May 2011	Lower Coker Creek	2	7	13	18	24	29	29	30	31	33	35	43	54	66	80	90
	Upper Coker Creek	1	3	7	11	18	26	33	36	40	45	50	59	70	76	82	89
August 2011	Lower Coker Creek	10	17	25	28	28	32	33	36	37	41	49	57	61	76	88	91
	Upper Coker Creek	8	23	25	26	26	35	37	42	43	49	55	65	75	88	92	94

(Continued)

Composite		Cobble				Boulder					Bedrock
Date	Sites	64 - 90	90 - 128	128-180	180 - 256	256 - 362	362 - 512	512 - 1024	1024-2048	2048 - 4096	> 4096
December 2010	Lower Coker Creek	96	99	100	100	100	100	100	100	100	100
	Upper Coker Creek	99	100	100	100	100	100	100	100	100	100
March 2011	Lower Coker Creek	86	91	92	92	93	93	93	93	93	100
	Upper Coker Creek	98	98	99	99	99	99	99	99	99	100
May 2011	Lower Coker Creek	95	96	97	97	97	97	97	97	100	100
	Upper Coker Creek	90	92	95	95	95	95	95	95	95	100
August 2011	Lower Coker Creek	95	98	98	98	98	98	98	98	98	100
	Upper Coker Creek	97	98	99	100	100	100	100	100	100	100

Figure 5 Percent Cumulative Finer Than plot of substrate particle sizes collected during December 2010 to August 2011 sampling from Coker Creek.



DISCUSSION

Fish

Fish community biological integrity sampling results demonstrate that fish community assemblage in Coker Creek at both the lower and upper sites has been significantly altered over the last several years. Biological integrity classification scores and Index of Biotic Integrity classifications continue to decline even further from 2009/2010 sampling results. Although fish species diversity between a 1990 TWRA stream sampling survey (Bivens and Williams 1990) and this sampling differed by only two species - 1 rainbow trout and 2 blacknose dace - it is clear that fish community tolerance structures and trophic functions have been negatively altered.

In the 1990 TWRA stream survey report, largescale stonerollers, warpaint shiners, northern hogsuckers, and rock bass represented 50.3%, 14.2%, 10.9%, and 9.7% percent of all fish collected. Our 2009 /2010 sampling showed the primary species in Coker Creek were creek chubs, green sunfish, largescale stoneroller, and bluegill representing 42.4%, 25.4%, 18.0%, and 6.6%, respectively. 2010/2011 sampling found creek chubs, largescale stonerollers, northern hogsuckers and redbreast sunfish representing 54.1%, 20.6%, 12.4%, and 7.6% of the total fish collected,

There appears to be a shift from a balanced herbivorous/insectivorous/piscivourous fish community to a predominately omnivorous/herbivorous /insectivorous fish assemblage and structure. Biological integrity classification scores and results support final integrity classifications. Absence of common cool water species such as warpaint shiners, blacknose dace, and Tennessee darters (*Etheostoma simoterum*) from this section of Coker Creek (insectivores and typically not found in streams with excessive sedimentation and siltation) is cause for concern.

It is important to note that the small stream habitat in Coker Creek also likely contributes to the lower diversity of fish species found in upper Coker Creek; however, previous historical sampling suggests that relative abundance within these assemblages should be higher. Bivens and Williams 1990 collected approximately 80% more individuals in only 100 feet of additional sample length with a single electrofishing unit instead of the two side by side units used in our sampling.

Macroinvertebrates

2010 and 2011 benthic biometric scores continue to support the conclusion from our initial report of October 2010 that suction dredging has significantly altered the structure of the macroinvertebrate community. Results of the August 2011 sample (Figure 4) are particularly graphic showing an extreme drop in scores; this is primarily due to the complete loss of all riffle/run habitat due to lack of stream flow. Lack of flow coupled with excessive embeddedness and entrenchment has resulted in significant adverse impacts to the benthic community.

Coker Creek stations, on the other hand, had lower key metric scores; this is most likely caused by habitat degradation due to suction gold dredging activity within our sample reaches. Pebble count results show a significant amount of embeddedness and entrenchment; and there has been significant physical alteration of much of the riffle and stream bank habitats.

Pebble Counts

As previously shown in Williams and Thurman 2010, the majority of pebble count cumulative particle size percentages finer than 2mm from Lower and Upper Lyons Creek, Wildcat Creek, and Tellico River sample sites were observed to be between 2% and 10% during fall, winter, spring, and summer of 2009-2010. During 2010/2011 survey ranges at Lower and Upper Coker Creek were observed between 11% and 35% as compared to the 2009/2010 ranges of 12% to 58.4% at the same sites. It would be expected that this predominance of sedimentation and siltation would affect the ecological integrity of macroinvertebrates and fish community reproductive success and assemblage structures; and bioassessment classifications and scores from this project support that.

Significant streambed aggradation was observed again during 2010/2011 monitoring at the lower Coker Creek site and to a lesser degree, the upper Coker Creek site as well. Streambed aggradation typically results in a rise in streambed elevation, which causes an increase in width/depth ratio and a decrease in channel capacity. This decrease in channel capacity usually causes heavy flows from storm events to erode and create failing streambanks. These changes usually cause elevated stream temperatures, loss of riparian zone vegetation and adverse effects on biological function, which results in a decline in the quality of fish habitat.

CONCLUSION

It is apparent that the biological and physical integrity at both Coker Creek sites has been adversely impacted by suction gold mine dredging. As mentioned in Williams and Thurman 2010, roads, private in-holdings, and homes exist in Tellico River, Lyons Creek, and Wildcat Creek watersheds, but significant suction gold mine dredging activity appears to exist only in Coker Creek. Based on biological monitoring and substrate physical characterization results from this monitoring project, suction gold mine dredging appears to be a primary influence in lower fish and macroinvertebrate metric scores and the high percent of sediment fines less than two mm.

Suction gold dredge mining activity appears to be increasing in Coker Creek. Several factors may be contributing to this increase such as media promotion, a significant increase in gold prices, tradition and history of gold mining in the stream, and local businesses promoting the activity. Considering the results observed during our monitoring, it is unlikely that at current levels of suction gold mine dredging activity, the stream will be able to recover biological integrity. It is likely that only a cessation of suction gold mine dredging activity in Coker Creek along with stream habitat restoration will restore hydrological processes and biological integrity to this stream.

Figure 6 Standing pool conditions and exposed streambed at Lower Coker Creek sample site.

RECOMMENDATIONS

1. **If increasing biological integrity in Coker Creek is desirable, elimination of suction gold dredging is recommended. Partner with private landowners and TDEC to eliminate suction gold mine dredging activity is recommended as well.**
2. **Continue Coker Creek biological and stream habitat monitoring surveys to monitor changes related to suction gold dredging and effects of low water conditions observed during this project.**
3. **Implement streambank stabilization/stream restoration project to stabilize critically eroding streambanks; that would assist transport of streambed aggradation materials and downstream to expedite recovery of hydrological processes and improve biological integrity.**

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APPENDIX A

Fish Data

FISH COMMUNITY ASSESSMENT _ IBI DATA SHEET

Uniue Stream Identifier	Lower	Sample No.	1
Stream	Coker Creek	Sample Date	12/10/2010
County	Monroe	Time	10:30 AM
River Basin	Hiwassee	No. of Shocking Units	2
SubBasin		Duration	1 hour
Latitude	35° 15.168' N	Sampling Personnel	G. Williams, J. Herrig
Longitude	84° 17.278' W	B. Reynolds, R. Humbert, Chattanooga TDEC	
Drainage Area	3375 acres	Location of Reach	300'
Stream Index No.		Seine Use (Y/N)	Yes 15'
Stream Classification		Sample Identified By	G. Williams
Habitat Score			
Elevation	1570 Feet	Date Sample Identified	12/10/2010
		Date Entered By	G. Williams
		Date of Data Entry	12/12/2010

PHYSICAL DATA

Conductivity	19	Avg. Stream Width	
Dissolved Oxygen	95%	Average Stream Depth	
Temperature	37F	Water Clarity (clear,cloudy,turbid)	clear
pH	6.06	Substrate Types	
Habitat Description			

SPECIES COLLECTED

Species	Total No.	Length	Length	Length	Length	Length
Creek Chub	109	135	115	115	110	105
	110	105	95	80	55	52
	55					
Northern Hogsucker	175	170	197	100	145	110
	110	113				
Largescale Stoneroller	90	85	80	84	78	58
	62	61				
Redbreast Sunfish	121					
Green Sunfish	65					
Warpaint Shiner	110					
Dusky Salamanders	6 count					

FISH COMMUNITY ASSESSMENT _ IBI DATA SHEET

Uniue Stream Identifier	Upper	Sample No.	1
Stream	Coker Creek	Sample Date	12/10/2010
County	Monroe	Time	11:30 AM
River Basin	Hiwassee	No. of Shocking Units	2
SubBasin		Duration	1
Latitude	84° 16.602’ W	Sampling Personnel	G. Williams, J. Herrig
Longitude	35° 15.448’ N	B. Reynolds, R. Humbert, Chattanooga TDEC	
Drainage Area		Location of Reach	300'
Stream Index No.		Seine Use (Y/N)	Y 15'
Stream Classification		Sample Identified By	G. Williams
Habitat Score			
Elevation	1595 Feet	Date Sample Identified	12/10/2010
		Date Entered By	G. Williams
		Date of Data Entry	12/12/2010

PHYSICAL DATA

Conductivity	16	Avg. Stream Width	
Dissolved Oxygen	95.50%	Average Stream Depth	
Temperature	37.6	Water Clarity (clear,cloudy,turbid)	clear
pH	5.74	Substrate Types	
Habitat Description			

SPECIES COLLECTED

Species	Total No.	Length	Length	Length	Length	Length
Largescale Stoneroller	90	70	85	98		
Northern Hogsucker	195	110	184	185	165	120
Creek Chub	119	100	105	110	100	105
	95	65	60	50	50	

FISH COMMUNITY ASSESSMENT _ IBI DATA SHEET

Uniue Stream Identifier	Lower	Sample No.	1
Stream	Coker Creek	Sample Date	5/19/2011
County	Monroe	Time	10:30 AM
River Basin	Hiwassee	No. of Shocking Units	2
SubBasin		Duration	1 hour
Latitude	35° 15.168' N	Sampling Personnel	G. Williams, J. Herrig
Longitude	84° 17.278' W	B. Reynolds, R. Humbert, Chattanooga TDEC	
Drainage Area	3375 acres	Location of Reach	300'
Stream Index No.		Seine Use (Y/N)	Yes 15'
Stream Classification		Sample Identified By	G. Williams
Habitat Score			
Elevation	1570 Feet	Date Sample Identified	5/19/2011
		Date Entered By	G. Williams
		Date of Data Entry	5/30/2011

PHYSICAL DATA

Conductivity	18	Avg. Stream Width	
Dissolved Oxygen	88%	Average Stream Depth	
Temperature	54F	Water Clarity (clear,cloudy,turbid)	clear
pH	7	Substrate Types	
Habitat Description			

SPECIES COLLECTED

Species	Total No.	Length	Length	Length	Length	Length
Creek Chub	110	115	125	97	105	70
	120	117	85	57	75	110
	111	110	72	85	102	90
	80	72	75	100	61	91
	63	71	70	67	73	74
	67	66	59	61	65	61
	55	57	66			
YOY number	7 count					
Northern Hogsucker	187	125	123	125	102	
YOY number	10 count					
Largescale Stoneroller	67	64	85	65	70	90
1individual with severe blackspot	64	63	70	80	63	
YOY number	9 count					
Redbreast Sunfish	160	85	131	143	80	81
	76	79	76	78		
YOY number	3 count					
Green Sunfish	156	115	86	71	53	70
Bluegill	95	123	105			
Rockbass	111	59	55			
Dusky Salamanders	65 count					
Junaluska Salamanders	1 count					

APPENDIX B

Macroinvertebrate Data

Benthic Macroinvertebrate Lab Sheet

Stream: Coker Creek	**County: Monroe**
Station: Lower	**pH/TDS/Cond.:**
Date: December 11, 2010	**Temp/DO**

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptera	**N**	**TV**	**Plecoptera**	**N**	**TV**	**Odonata**	**N**	**TV**
Siphloplecton	C		Isoperla	C	1.50	Macromia	R	
Ephemerella	R	2.04	Allocapnia	C	1.47	Gomphus	R	
Leptophlebia	C							
Hexagenia	R							
McCafferterium	C							
Stenonema	R					**Megaloptera**		
Paraleptophlebia	C	0.94				Sialis	R	
Ameletus	C	2.38	**Misc.Diptera**			Nigronia	R	
			Hexatoma	C				
			Tipula	C		**Oligochaeta**	R	
			Prosimulium	R				
Trichoptera						**Hirudinea**		
Pycnopsyche	R	2.52						
Ptilostomis	R		**Chiros**			**Crustacea**		
Neophylax	C	2.20	Non-red	C				
Lepidostoma	R	0.90	Red	R				
Wormaldia	R	0.65						
Ceratopsyche	R		**Coleoptera**					
			Psphenus	R	2.35	**Gastropoda**		
			Hemiptera					
						Mollusca		

Total Taxa: 27	**Total Intolerant Taxa: 10**
Total EPT Taxa: 16	**Total EPT Families: 14**

Benthic Macroinvertebrate Lab Sheet

Stream: Coker Creek	**County: Monroe**
Station:Upper	**pH/TDS/Cond.:**
Date: Dec. 11, 2010	**Temp/DO**

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptera	**N**	**TV**	**Plecoptera**	**N**	**TV**	**Odonata**	**N**	**TV**
Siphloplecton	C		Pteronarcys	R	1.67	Boyeria	R	
McCafferterium	C		Isoperla	C	1.50	Cordulegaster	R	
Hexagenia	C		Allocapnia	C	2.52	Calopteryx	R	
Paraleptophlebia	C	0.94	Acroneuria	R	1.47	Stylogomphus	R	
Ephemerella	R	2.04						
Ameletus	R	2.38				**Megaloptera**		
						Nigronia	C	
			Misc.Diptera			Sialis	R	
			Tipula	C				
			Antocha	R		**Oligochaeta**	R	
			Prosimulium	R				
			Hexatoma	C				
Trichoptera						**Hirudinea**		
Neophylax	C	2.20						
Ceratopsyche	C		**Chiros**			**Crustacea**		
Pycnopsyche	C	2.52	Non-red	C				
Hydropsychidae	R		Red	R				
Polycentropus	R							
Chimarra	R	**2.76**	**Coleoptera**					
Wormaldia	R	0.65	Optioservus	R	2.36	**Gastropoda**		
Dolophilodes	R	0.81	Helichus	R				
			Ancyronyx	R				
			Stenelmis	R				
			Hemiptera					
						Mollusca		

Total Taxa: 36	**Total Intolerant Taxa: 13**
Total EPT Taxa: 19	**Total EPT Families: 15**

Benthic Macroinvertebrate Lab Sheet

Stream: Coker Creek	**County:** Monoe
Station: Lower	**PH/TDS/Conductivity:** 7.1/8/15
Date: 3/13/11	**Temp/DO:** 52/91.3

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptera	N	TV	**Plecoptera**	N	**TV**	**Odonata**	N	TV
McCafferterium	A		Paraleuctra	R	0.67	Macromia	R	
Ameletus	A	2.38	Eccoptura	C		Cordulegaster	R	
Hexagenia	C		Isoperla	A	1.50	Gomphus	C	
Ephemerella	A	2.04	Acroneuria	C	1.47	Caloperyx	R	
Plauditus	R							
Baetis	R					**Megaloptera**		
						Nigronia	C	
			Misc.Diptera					
			Tipula	C				
			Hexatoma	R		**Oligochaeta**	R	
			Ceratopogonidae	R				
Trichoptera						**Hirudinea**		
Pycnopsyche	C	2.52						
Glossosoma	A	1.55	**Chironomidae**			**Crustacea**		
Neophylax	R	2.20	Chironominae	A				
Phylocentropus	R		Tanypodinae	C				
Ptilostomis	R							
Ceratopsyche	R		**Coleoptera**					
			Stenelmis	R		**Gastropoda**		
			Hemiptera					
						Mollusca		

Total Taxa: 28	**Total Intolerant Taxa: 8**
Total EPT Taxa: 16	**Total EPT Families: 14**

Benthic Macroinvertebrate Lab Sheet

Stream: Coker Creek	**County: Monroe**
Station: Upper	**pH/TDS/Cond.: 7.1/7/15**
Date: March 13, 2011	**Temp/DO: 51.5/84.2**

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptera	**N**	**TV**	**Plecoptera**	**N**	**TV**	**Odonata**	**N**	**TV**
Ameletus	C	2.38	Isoperla	C	1.50	Basiaeshna	R	
Hexagenia	C		Acroneuria	C	1.47	Cordulegaster	R	
Ephemerella	C	2.04	Eccoptura	R				
McCafferterium	C		Paraleuctra	R	0.67			
Paraleptophlebia	R	0.94	Tallaperla	R	1.18			
Epeorus	R	1.27				**Megaloptera**		
						Nigronia	R	
			Misc.Diptera					
			Hexatoma	C				
			Prosimulium	C		**Oligochaeta**	R	
			Tipula	A				
			Pedicia	R	2.00			
Trichoptera			Antocha	R		**Hirudinea**		
Glossosoma	A	1.55						
Rhyacophila	C	0.73	**Chiros**			**Crustacea**		
Ceraclea	R	2.01	Tanytarsinae	R		Cambarus	R	
Dolophilodes	C	0.81						
Polycentropus	R							
Chimarra	C	2.76	**Coleoptera**					
Pycnopsyche	C	2.52	Helichus	R		**Gastropoda**		
Ceratopsyche	C							
Wormaldia	C	0.65						
Neophylax	C	2.20						
Psychomyia	R	2.44						
			Hemiptera					
			Aquarius	R		**Mollusca**		

Total Taxa: 35	**Total Intolerant Taxa: 18**
Total EPT Taxa: 22	**Total EPT Families: 14**

Benthic Macroinvertebrate Lab Sheet

Stream/Station: Coker Creek/Lower	PH/Conductivity:
County: Monroe	Temp/DO:
Date: 5/22/11	TDS:

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)
T = Tolerance Value (for intolerants only)

Ephemeroptea	**N**	**T**	**Plecoptera**	**N**	**T**	**Odonata**	**N**	**T**
Epeorus	R	1.27	Remenus	C	0.20	Neurocordulia	R	
Baetis	A		Eccoptura	C		Gomphus	R	
Plauditus	C		Isoperla	C	1.50	Boyeria	R	
Isonychia	A		Paraleuctra	R	0.67	Calopteryx	R	
Hexagenia	A					Macromia	R	
Ephemerella	A	2.04				Somatochlora	R	
McCafferterium	C					**Megaloptera**		
Paraleptophlebia	C	0.94	**Misc.Diptera**			Nigronia	R	
			Prosimulium	R		Sialis	R	
			Tipula	R		**Oligochaeta**	R	
Trichoptera						**Hirudinea**		
Pycnopsyche	C	2.52						
Dolophilodes	C	0.81	**Chironomidae**			**Crustacea**		
Wormaldia	R	0.65	Orthocladinae	C		Cambarus	R	
Neophylax	A	2.20						
Trianodes	R							
Glossosoma	A	**1.55**	**Coleoptera**					
Nyctiophylax	R		Psphenus	R	**2.35**	**Gastropoda**		
			Ancyronyx	R		Ancylidae	R	
			Hemiptera					
			Aquarius	A		**Mollusca**		
			Rhagovelia	R				

Total Taxa 37 **Total Intolerants** 12 **Total EPT** 19 **Total EPT Families** 15

Benthic Macroinvertebrate Lab Sheet

Stream/Station:Coker/Upper	PH/Conductivity:
County: Monroe	Temp/DO:
Date: 5/22/11	TDS:

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptera	N	T	**Plecoptera**	N	T	**Odonata**	N	T
Hexagenia	R		Pteronarcys	R		Macromia	R	
Ephemerella	C		Acroneuria	R	1.47	Calopteryx	R	
Eurylophella	C		Remenus	C		Boyeria	R	
Plauditus	C		Isoperla	C	1.50	Basiaeshna	R	
Heptagenia	C	2.57	Amphinemura	R		Gomphus	C	
McCafferterium	C					Cordulegaster	R	
Isonychia	C					**Megaloptera**		
			Misc.Diptera			Nigronia	R	
			Tipula	C				
			Probezzia	R		**Oligochaeta**	R	
			Prosimulium	R				
Trichoptera						**Hirudinea**		
Pycnopsyche	C	2.52						
Polycentropus	R		**Chiros**			**Crustacea**		
Dolophilodes	C	0.81	Tanypodinae	C		Cambarus	R	
Glossosoma	A	1.55	Orthocladinae	C				
Neophylax	C	2.20	Chironominae	C				
Agapetes	A	0.00	**Coleoptera**					
Ironoquia	R		Macronychus	R		**Gastropoda**		
Wormaldia	C	0,65	Dystiscidae	R				
Anisocentropus	R	0.85						
Rhyacophila	R	0.73						
Nyctiophylax	R							
			Hemiptera					
			Aquarius	R		**Mollusca**		
			Rhagovelia	R				

Total Taxa 42 **Total Intolerants** 11 **Total EPT** 23 **Total EPT Families** 18

Benthic Macroinvertebrate Lab Sheet

Stream/Station: Lower Coker	PH/Conductivity:
County: Monroe	Temp/DO:
Date: 8/07/11	TDS:

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptea	**N**	**T**	**Plecoptera**	**N**	**T**	**Odonata**	**N**	**T**
Hexagenia	C					Macromia	R	
McCafferterium	R					Hagenius	R	
						Megaloptera		
						Sialis	R	
			Misc.Diptera					
						Oligochaeta		
Trichoptera						**Hirudinea**		
Polycentropus	R							
Phylocentropus	R		**Chironomidae**			**Crustacea**		
Pycnopsyche	R	2.52	Red midge	C		Orconectes	R	2.6
			Tanypodinae	R		Cambarus	R	
			Coleoptera					
			Dytsicadae	R		**Gastropoda**		
			Macronychus	R				
			Hemiptera					
			Aquarius	A		**Mollusca**		
			Rhagovelia	A				

Total taxa -16	Total EPT - 5	Total Intolerants - 2
Total EPT Families - 5		

Benthic Macroinvertebrate Lab Sheet

Stream/Station: Upper Coker Creek	PH/Conductivity:
County: Monroe	Temp/DO:
Date: 8/07/11	TDS:

N = Abundance, A = Abundant (10+) C = Common (3 – 9) R = Rare (1 - 2)

Ephemeroptea	**N**	**T**	**Plecoptera**	**N**	**T**	**Odonata**	**N**	**T**
			Isoperla	R	1.5	Boyeria	R	
						Macromia	R	
						Stylagomphus	R	
						Megaloptera		
						Sialis	R	
			Misc.Diptera					
						Oligochaeta	R	
Trichoptera						**Hirudinea**	R	
Pycnopsyche	C	2.52						
Neophylax	C	2.20	**Chironomidae**			**Crustacea**		
			Red midge	A				
			Coleoptera					
						Gastropoda		
			Hemiptera					
			Aquarius	A		**Mollusca**		
			Rhagovelia	A				

Total taxa - 12	Total EPT - 3	Total intolerants - 3
Total EPT families - 3		

APPENDIX C

Pebble Count Data

Stream: Coker Creek Date: 12/10/10 Reach: Lower

			Pool (%)			Riffle (%)			Total (100%)		
(mm)	Pool	Riffle	Tot #	Item %	% Cum	Tot #	Item %	% Cum	Tot #	Item %	% Cum
<0.062	4	3	4	13.3%	13.3%	3	4.3%	4.3%	7	7.0%	7.0%
.062 - .125	0	0	0	0.0%	13.3%	0	0.0%	4.3%	0	0.0%	7.0%
.125 -.25	2	4	2	6.7%	20.0%	4	5.7%	10.0%	6	6.0%	13.0%
.25 - .5	2	6	2	6.7%	26.7%	6	8.6%	18.6%	8	8.0%	21.0%
.5 - 1.0	3	1	3	10.0%	36.7%	1	1.4%	20.0%	4	4.0%	25.0%
1 - 2	3	1	3	10.0%	46.7%	1	1.4%	21.4%	4	4.0%	29.0%
2 - 2.8	0	0	0	0.0%	46.7%	0	0.0%	21.4%	0	0.0%	29.0%
2.8 - 4	0	1	0	0.0%	46.7%	1	1.4%	22.9%	1	1.0%	30.0%
4 - 5.6	0	0	0	0.0%	46.7%	0	0.0%	22.9%	0	0.0%	30.0%
5.6 - 8	3	3	3	10.0%	56.7%	3	4.3%	27.1%	6	6.0%	36.0%
8 - 11	0	5	0	0.0%	56.7%	5	7.1%	34.3%	5	5.0%	41.0%
11 - 16	3	6	3	10.0%	66.7%	6	8.6%	42.9%	9	9.0%	50.0%
16 - 22.6	2	16	2	6.7%	73.3%	16	22.9%	65.7%	18	18.0%	68.0%
22.6 - 32	0	11	0	0.0%	73.3%	11	15.7%	81.4%	11	11.0%	79.0%
32 - 45	1	5	1	3.3%	76.7%	5	7.1%	88.6%	6	6.0%	85.0%
45 - 64	4	5	4	13.3%	90.0%	5	7.1%	95.7%	9	9.0%	94.0%
64 - 90	1	1	1	3.3%	93.3%	1	1.4%	97.1%	2	2.0%	96.0%
90 - 128	2	1	2	6.7%	100.0%	1	1.4%	98.6%	3	3.0%	99.0%
128-180	0	1	0	0.0%	100.0%	1	1.4%	100.0%	1	1.0%	100.0%
180 - 256	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
256 - 362	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
362 - 512	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
512 - 1024	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
1024-2048	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
2048 - 4096	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
> 4096	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
Total	30	70	30			70			100		

Stream:	Coker Creek			Date:	12/10/10			Reach:	Upper		
			Pool (%)			Riffle (%)			Total (100%)		
(mm)	Pool	Riffle	Tot #	Item %	% Cum	Tot #	Item %	% Cum	Tot #	Item %	% Cum
<0.062	0	0	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
.062 - .125	6	3	6	20.0%	20.0%	3	4.3%	4.3%	9	9.0%	9.0%
.125 -.25	0	0	0	0.0%	20.0%	0	0.0%	4.3%	0	0.0%	9.0%
.25 - .5	5	4	5	16.7%	36.7%	4	5.7%	10.0%	9	9.0%	18.0%
.5 - 1.0	8	3	8	26.7%	63.3%	3	4.3%	14.3%	11	11.0%	29.0%
1 - 2	2	3	2	6.7%	70.0%	3	4.3%	18.6%	5	5.0%	34.0%
2 - 2.8	1	3	1	3.3%	73.3%	3	4.3%	22.9%	4	4.0%	38.0%
2.8 - 4	0	4	0	0.0%	73.3%	4	5.7%	28.6%	4	4.0%	42.0%
4 - 5.6	1	3	1	3.3%	76.7%	3	4.3%	32.9%	4	4.0%	46.0%
5.6 - 8	0	2	0	0.0%	76.7%	2	2.9%	35.7%	2	2.0%	48.0%
8 - 11	1	6	1	3.3%	80.0%	6	8.6%	44.3%	7	7.0%	55.0%
11 - 16	0	10	0	0.0%	80.0%	10	14.3%	58.6%	10	10.0%	65.0%
16 - 22.6	0	7	0	0.0%	80.0%	7	10.0%	68.6%	7	7.0%	72.0%
22.6 - 32	3	7	3	10.0%	90.0%	7	10.0%	78.6%	10	10.0%	82.0%
32 - 45	2	4	2	6.7%	96.7%	4	5.7%	84.3%	6	6.0%	88.0%
45 - 64	1	3	1	3.3%	100.0%	3	4.3%	88.6%	4	4.0%	92.0%
64 - 90	0	7	0	0.0%	100.0%	7	10.0%	98.6%	7	7.0%	99.0%
90 - 128	0	1	0	0.0%	100.0%	1	1.4%	100.0%	1	1.0%	100.0%
128-180	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
180 - 256	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
256 - 362	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
362 - 512	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
512 - 1024	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
1024-2048	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
2048 - 4096	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
> 4096	2	0	2	6.7%	106.7%	0	0.0%	100.0%	2	2.0%	102.0%
Total	32	70	32			70			102		

Stream: Coker Creek			Date: 3/13/11				Reach: Lower			
			Pool (%)			Riffle (%)			Total (100%)		
(mm)	Pool	Riffle	Tot #	Item %	% Cum	Tot #	Item %	% Cum	Tot #	Item %	% Cum
<0.062	0	0	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
.062 - .125	1	0	1	3.3%	3.3%	0	0.0%	0.0%	1	1.0%	1.0%
.125 -.25	1	1	1	3.3%	6.7%	1	1.4%	1.4%	2	2.0%	3.0%
.25 - .5	1	1	1	3.3%	10.0%	1	1.4%	2.9%	2	2.0%	5.0%
.5 - 1.0	1	1	1	3.3%	13.3%	1	1.4%	4.3%	2	2.0%	7.0%
1 - 2	1	3	1	3.3%	16.7%	3	4.3%	8.6%	4	4.0%	11.0%
2 - 2.8	0	1	0	0.0%	16.7%	1	1.4%	10.0%	1	1.0%	12.0%
2.8 - 4	0	1	0	0.0%	16.7%	1	1.4%	11.4%	1	1.0%	13.0%
4 - 5.6	0	2	0	0.0%	16.7%	2	2.9%	14.3%	2	2.0%	15.0%
5.6 - 8	0	1	0	0.0%	16.7%	1	1.4%	15.7%	1	1.0%	16.0%
8 - 11	4	1	4	13.3%	30.0%	1	1.4%	17.1%	5	5.0%	21.0%
11 - 16	2	1	2	6.7%	36.7%	1	1.4%	18.6%	3	3.0%	24.0%
16 - 22.6	3	11	3	10.0%	46.7%	11	15.7%	34.3%	14	14.0%	38.0%
22.6 - 32	2	10	2	6.7%	53.3%	10	14.3%	48.6%	12	12.0%	50.0%
32 - 45	4	10	4	13.3%	66.7%	10	14.3%	62.9%	14	14.0%	64.0%
45 - 64	4	12	4	13.3%	80.0%	12	17.1%	80.0%	16	16.0%	80.0%
64 - 90	0	6	0	0.0%	80.0%	6	8.6%	88.6%	6	6.0%	86.0%
90 - 128	1	4	1	3.3%	83.3%	4	5.7%	94.3%	5	5.0%	91.0%
128-180	0	1	0	0.0%	83.3%	1	1.4%	95.7%	1	1.0%	92.0%
180 - 256	0	0	0	0.0%	83.3%	0	0.0%	95.7%	0	0.0%	92.0%
256 - 362	0	1	0	0.0%	83.3%	1	1.4%	97.1%	1	1.0%	93.0%
362 - 512	0	0	0	0.0%	83.3%	0	0.0%	97.1%	0	0.0%	93.0%
512 - 1024	0	0	0	0.0%	83.3%	0	0.0%	97.1%	0	0.0%	93.0%
1024-2048	0	0	0	0.0%	83.3%	0	0.0%	97.1%	0	0.0%	93.0%
2048 - 4096	0	0	0	0.0%	83.3%	0	0.0%	97.1%	0	0.0%	93.0%
> 4096	5	2	5	16.7%	100.0%	2	2.9%	100.0%	7	7.0%	100.0%
Total	30	70	30			70			100		

Stream: Coker Creek Date: 3/13/11 Reach: Upper

			Pool (%)			Riffle (%)			Total (100%)		
(mm)	Pool	Riffle	Tot #	Item %	% Cum	Tot #	Item %	% Cum	Tot #	Item %	% Cum
<0.062	0	0	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
.062 - .125	0	0	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
.125 -.25	0	1	0	0.0%	0.0%	1	1.4%	1.4%	1	1.0%	1.0%
.25 - .5	0	2	0	0.0%	0.0%	2	2.9%	4.3%	2	2.0%	3.0%
.5 - 1.0	3	2	3	10.0%	10.0%	2	2.9%	7.1%	5	5.0%	8.0%
1 - 2	11	5	11	36.7%	46.7%	5	7.1%	14.3%	16	16.0%	24.0%
2 - 2.8	2	3	2	6.7%	53.3%	3	4.3%	18.6%	5	5.0%	29.0%
2.8 - 4	1	2	1	3.3%	56.7%	2	2.9%	21.4%	3	3.0%	32.0%
4 - 5.6	2	4	2	6.7%	63.3%	4	5.7%	27.1%	6	6.0%	38.0%
5.6 - 8	1	1	1	3.3%	66.7%	1	1.4%	28.6%	2	2.0%	40.0%
8 - 11	1	4	1	3.3%	70.0%	4	5.7%	34.3%	5	5.0%	45.0%
11 - 16	0	15	0	0.0%	70.0%	15	21.4%	55.7%	15	15.0%	60.0%
16 - 22.6	1	5	1	3.3%	73.3%	5	7.1%	62.9%	6	6.0%	66.0%
22.6 - 32	1	8	1	3.3%	76.7%	8	11.4%	74.3%	9	9.0%	75.0%
32 - 45	0	8	0	0.0%	76.7%	8	11.4%	85.7%	8	8.0%	83.0%
45 - 64	3	7	3	10.0%	86.7%	7	10.0%	95.7%	10	10.0%	93.0%
64 - 90	3	2	3	10.0%	96.7%	2	2.9%	98.6%	5	5.0%	98.0%
90 - 128	0	0	0	0.0%	96.7%	0	0.0%	98.6%	0	0.0%	98.0%
128-180	0	1	0	0.0%	96.7%	1	1.4%	100.0%	1	1.0%	99.0%
180 - 256	0	0	0	0.0%	96.7%	0	0.0%	100.0%	0	0.0%	99.0%
256 - 362	0	0	0	0.0%	96.7%	0	0.0%	100.0%	0	0.0%	99.0%
362 - 512	0	0	0	0.0%	96.7%	0	0.0%	100.0%	0	0.0%	99.0%
512 - 1024	0	0	0	0.0%	96.7%	0	0.0%	100.0%	0	0.0%	99.0%
1024-2048	0	0	0	0.0%	96.7%	0	0.0%	100.0%	0	0.0%	99.0%
2048 - 4096	0	0	0	0.0%	96.7%	0	0.0%	100.0%	0	0.0%	99.0%
> 4096	1	0	1	3.3%	100.0%	0	0.0%	100.0%	1	1.0%	100.0%
Total	30	70	30			70			100		

Stream: Coker Creek Date: 5/22/11 Reach: Lower

(mm)	Pool	Riffle	Pool (%) Tot #	Item %	% Cum	Riffle (%) Tot #	Item %	% Cum	Total (100%) Tot #	Item %	% Cum
<0.062	2	0	2	6.7%	6.7%	0	0.0%	0.0%	2	2.0%	2.0%
.062 - .125	4	1	4	13.3%	20.0%	1	1.4%	1.4%	5	5.0%	7.0%
.125 -.25	4	2	4	13.3%	33.3%	2	2.9%	4.3%	6	6.0%	13.0%
.25 - .5	3	2	3	10.0%	43.3%	2	2.9%	7.1%	5	5.0%	18.0%
.5 - 1.0	2	4	2	6.7%	50.0%	4	5.7%	12.9%	6	6.0%	24.0%
1 - 2	1	4	1	3.3%	53.3%	4	5.7%	18.6%	5	5.0%	29.0%
2 - 2.8	0	0	0	0.0%	53.3%	0	0.0%	18.6%	0	0.0%	29.0%
2.8 - 4	0	1	0	0.0%	53.3%	1	1.4%	20.0%	1	1.0%	30.0%
4 - 5.6	0	1	0	0.0%	53.3%	1	1.4%	21.4%	1	1.0%	31.0%
5.6 - 8	0	2	0	0.0%	53.3%	2	2.9%	24.3%	2	2.0%	33.0%
8 - 11	0	2	0	0.0%	53.3%	2	2.9%	27.1%	2	2.0%	35.0%
11 - 16	2	6	2	6.7%	60.0%	6	8.6%	35.7%	8	8.0%	43.0%
16 - 22.6	1	10	1	3.3%	63.3%	10	14.3%	50.0%	11	11.0%	54.0%
22.6 - 32	3	9	3	10.0%	73.3%	9	12.9%	62.9%	12	12.0%	66.0%
32 - 45	2	12	2	6.7%	80.0%	12	17.1%	80.0%	14	14.0%	80.0%
45 - 64	0	10	0	0.0%	80.0%	10	14.3%	94.3%	10	10.0%	90.0%
64 - 90	2	3	2	6.7%	86.7%	3	4.3%	98.6%	5	5.0%	95.0%
90 - 128	1	0	1	3.3%	90.0%	0	0.0%	98.6%	1	1.0%	96.0%
128-180	0	1	0	0.0%	90.0%	1	1.4%	100.0%	1	1.0%	97.0%
180 - 256	0	0	0	0.0%	90.0%	0	0.0%	100.0%	0	0.0%	97.0%
256 - 362	0	0	0	0.0%	90.0%	0	0.0%	100.0%	0	0.0%	97.0%
362 - 512	0	0	0	0.0%	90.0%	0	0.0%	100.0%	0	0.0%	97.0%
512 - 1024	0	0	0	0.0%	90.0%	0	0.0%	100.0%	0	0.0%	97.0%
1024-2048	0	0	0	0.0%	90.0%	0	0.0%	100.0%	0	0.0%	97.0%
2048 - 4096	3	0	3	10.0%	100.0%	0	0.0%	100.0%	3	3.0%	100.0%
> 4096	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
Total	30	70	30			70			100		

Stream: Coker Creek			Date: 5/22/11				Reach: Upper			
			Pool (%)			Riffle (%)			Total (100%)	
(mm)	Pool	Riffle	Tot #	Item %	% Cum	Tot #	Item %	% Cum	Tot #	Item %	% Cum
<0.062	1	0	1	3.3%	3.3%	0	0.0%	0.0%	1	1.0%	1.0%
.062 - .125	1	1	1	3.3%	6.7%	1	1.4%	1.4%	2	2.0%	3.0%
.125 -.25	2	2	2	6.7%	13.3%	2	2.9%	4.3%	4	4.0%	7.0%
.25 - .5	3	1	3	10.0%	23.3%	1	1.4%	5.7%	4	4.0%	11.0%
.5 - 1.0	3	4	3	10.0%	33.3%	4	5.7%	11.4%	7	7.0%	18.0%
1 - 2	4	4	4	13.3%	46.7%	4	5.7%	17.1%	8	8.0%	26.0%
2 - 2.8	2	5	2	6.7%	53.3%	5	7.1%	24.3%	7	7.0%	33.0%
2.8 - 4	3	0	3	10.0%	63.3%	0	0.0%	24.3%	3	3.0%	36.0%
4 - 5.6	0	4	0	0.0%	63.3%	4	5.7%	30.0%	4	4.0%	40.0%
5.6 - 8	2	3	2	6.7%	70.0%	3	4.3%	34.3%	5	5.0%	45.0%
8 - 11	0	5	0	0.0%	70.0%	5	7.1%	41.4%	5	5.0%	50.0%
11 - 16	1	8	1	3.3%	73.3%	8	11.4%	52.9%	9	9.0%	59.0%
16 - 22.6	1	10	1	3.3%	76.7%	10	14.3%	67.1%	11	11.0%	70.0%
22.6 - 32	0	6	0	0.0%	76.7%	6	8.6%	75.7%	6	6.0%	76.0%
32 - 45	1	5	1	3.3%	80.0%	5	7.1%	82.9%	6	6.0%	82.0%
45 - 64	1	6	1	3.3%	83.3%	6	8.6%	91.4%	7	7.0%	89.0%
64 - 90	0	1	0	0.0%	83.3%	1	1.4%	92.9%	1	1.0%	90.0%
90 - 128	0	2	0	0.0%	83.3%	2	2.9%	95.7%	2	2.0%	92.0%
128-180	0	3	0	0.0%	83.3%	3	4.3%	100.0%	3	3.0%	95.0%
180 - 256	0	0	0	0.0%	83.3%	0	0.0%	100.0%	0	0.0%	95.0%
256 - 362	0	0	0	0.0%	83.3%	0	0.0%	100.0%	0	0.0%	95.0%
362 - 512	0	0	0	0.0%	83.3%	0	0.0%	100.0%	0	0.0%	95.0%
512 - 1024	0	0	0	0.0%	83.3%	0	0.0%	100.0%	0	0.0%	95.0%
1024-2048	0	0	0	0.0%	83.3%	0	0.0%	100.0%	0	0.0%	95.0%
2048 - 4096	0	0	0	0.0%	83.3%	0	0.0%	100.0%	0	0.0%	95.0%
> 4096	5	0	5	16.7%	100.0%	0	0.0%	100.0%	5	5.0%	100.0%
Total	30	70	30			70			100		

Stream: Coker Creek   Date: 8/7/11   Reach: Lower

(mm)	Pool	Riffle	Pool (%) Tot #	Pool Item %	Pool % Cum	Riffle (%) Tot #	Riffle Item %	Riffle % Cum	Total (100%) Tot #	Total Item %	Total % Cum
<0.062	7	3	7	23.3%	23.3%	3	4.3%	4.3%	10	10.0%	10.0%
.062 - .125	4	3	4	13.3%	36.7%	3	4.3%	8.6%	7	7.0%	17.0%
.125 -.25	4	4	4	13.3%	50.0%	4	5.7%	14.3%	8	8.0%	25.0%
.25 - .5	1	2	1	3.3%	53.3%	2	2.9%	17.1%	3	3.0%	28.0%
.5 - 1.0	0	0	0	0.0%	53.3%	0	0.0%	17.1%	0	0.0%	28.0%
1 - 2	2	2	2	6.7%	60.0%	2	2.9%	20.0%	4	4.0%	32.0%
2 - 2.8	1	0	1	3.3%	63.3%	0	0.0%	20.0%	1	1.0%	33.0%
2.8 - 4	1	2	1	3.3%	66.7%	2	2.9%	22.9%	3	3.0%	36.0%
4 - 5.6	1	0	1	3.3%	70.0%	0	0.0%	22.9%	1	1.0%	37.0%
5.6 - 8	0	4	0	0.0%	70.0%	4	5.7%	28.6%	4	4.0%	41.0%
8 - 11	2	6	2	6.7%	76.7%	6	8.6%	37.1%	8	8.0%	49.0%
11 - 16	2	6	2	6.7%	83.3%	6	8.6%	45.7%	8	8.0%	57.0%
16 - 22.6	2	2	2	6.7%	90.0%	2	2.9%	48.6%	4	4.0%	61.0%
22.6 - 32	1	14	1	3.3%	93.3%	14	20.0%	68.6%	15	15.0%	76.0%
32 - 45	1	11	1	3.3%	96.7%	11	15.7%	84.3%	12	12.0%	88.0%
45 - 64	1	2	1	3.3%	100.0%	2	2.9%	87.1%	3	3.0%	91.0%
64 - 90	0	4	0	0.0%	100.0%	4	5.7%	92.9%	4	4.0%	95.0%
90 - 128	0	3	0	0.0%	100.0%	3	4.3%	97.1%	3	3.0%	98.0%
128-180	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
180 - 256	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
256 - 362	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
362 - 512	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
512 - 1024	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
1024-2048	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
2048 - 4096	0	0	0	0.0%	100.0%	0	0.0%	97.1%	0	0.0%	98.0%
> 4096	0	2	0	0.0%	100.0%	2	2.9%	100.0%	2	2.0%	100.0%
Total	30	70	30			70			100		

Stream: Coker Creek			Date: 8/7/11				Reach: Upper				
			Pool (%)			Riffle (%)			Total (100%)		
(mm)	Pool	Riffle	Tot #	Item %	% Cum	Tot #	Item %	% Cum	Tot #	Item %	% Cum
<0.062	5	3	5	16.7%	16.7%	3	4.3%	4.3%	8	8.0%	8.0%
.062 - .125	11	4	11	36.7%	53.3%	4	5.7%	10.0%	15	15.0%	23.0%
.125 -.25	1	1	1	3.3%	56.7%	1	1.4%	11.4%	2	2.0%	25.0%
.25 - .5	0	1	0	0.0%	56.7%	1	1.4%	12.9%	1	1.0%	26.0%
.5 - 1.0	0	0	0	0.0%	56.7%	0	0.0%	12.9%	0	0.0%	26.0%
1 - 2	5	4	5	16.7%	73.3%	4	5.7%	18.6%	9	9.0%	35.0%
2 - 2.8	1	1	1	3.3%	76.7%	1	1.4%	20.0%	2	2.0%	37.0%
2.8 - 4	2	3	2	6.7%	83.3%	3	4.3%	24.3%	5	5.0%	42.0%
4 - 5.6	0	1	0	0.0%	83.3%	1	1.4%	25.7%	1	1.0%	43.0%
5.6 - 8	0	6	0	0.0%	83.3%	6	8.6%	34.3%	6	6.0%	49.0%
8 - 11	0	6	0	0.0%	83.3%	6	8.6%	42.9%	6	6.0%	55.0%
11 - 16	0	10	0	0.0%	83.3%	10	14.3%	57.1%	10	10.0%	65.0%
16 - 22.6	0	10	0	0.0%	83.3%	10	14.3%	71.4%	10	10.0%	75.0%
22.6 - 32	2	11	2	6.7%	90.0%	11	15.7%	87.1%	13	13.0%	88.0%
32 - 45	1	3	1	3.3%	93.3%	3	4.3%	91.4%	4	4.0%	92.0%
45 - 64	0	2	0	0.0%	93.3%	2	2.9%	94.3%	2	2.0%	94.0%
64 - 90	2	1	2	6.7%	100.0%	1	1.4%	95.7%	3	3.0%	97.0%
90 - 128	0	1	0	0.0%	100.0%	1	1.4%	97.1%	1	1.0%	98.0%
128-180	0	1	0	0.0%	100.0%	1	1.4%	98.6%	1	1.0%	99.0%
180 - 256	0	1	0	0.0%	100.0%	1	1.4%	100.0%	1	1.0%	100.0%
256 - 362	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
362 - 512	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
512 - 1024	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
1024-2048	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
2048 - 4096	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
> 4096	0	0	0	0.0%	100.0%	0	0.0%	100.0%	0	0.0%	100.0%
Total	30	70	30			70			100		

TENNESSEE WILDLIFE RESOURCES AGENCY

ELLINGTON AGRICULTURAL CENTER
P. O. BOX 40747
NASHVILLE, TENNESSEE 37204

March 9, 2015

Robert Baker
Tennessee Department of Environment and Conservation
Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243

Re: ARAP Public Notice File Number: NRS14.341
Applicant: Gold Prospector's Association of America
Proposed Recreational Prospecting
Coker Creek and Tellico River, Including Tellico River Tributaries: John' Creek, Basin Creek, Wildcat Creek, Natty Creek, Six Mile Creek, Tobe Creek, and Lyons Creek
Monroe, Polk, and Blount Counties, Tennessee

Dear Mr. Baker:

The Tennessee Wildlife Resources Agency appreciates the opportunity to provide comments and recommendations with regard to ARAP NRS14.341 as filed by the Gold Prospector's Association of America. The applicant proposes to conduct recreational prospecting in Coker Creek and the Tellico River and several tributaries.

The southern portion of the Cherokee National Forest, Tellico District is also a Wildlife Management Area (WMA) under a cooperative agreement between the U.S. Forest Service (USFS) and the Tennessee Wildlife Resources Agency (TWRA). The USFS is an important and valued partner with the State of Tennessee in the conservation of terrestrial and aquatic habitat and the diverse assemblage of species occurring in the Cherokee National Forest in Tennessee. TWRA supports the USFS in those actions necessary to protect species and habitat under Cherokee National Forest jurisdiction.

The Tennessee Wildlife Resources Agency has concerns regarding adverse impacts to fish and aquatic life, and their habitat as may result from activities as proposed by the Gold Prospector's Association of America. Most of the Tellico River and its tributaries have been classified as Exceptional Tennessee Waters (ETW). The following Tellico River tributaries proposed for recreational prospecting that we identified from the figures that were provided in the public notice are and their classification is:

- Bullet Branch – Exceptional Tennessee Waters
- Morgan Branch – Exceptional Tennessee Waters

- Caney Branch – Exceptional Tennessee Waters
- Buck Branch
- Lyons Creek – Exceptional Tennessee Waters
- Stillhouse Creek – Exceptional Tennessee Waters
- Murr Branch
- East Fork – Exceptional Tennessee Waters
- Wildcat Creek – Exceptional Tennessee Waters
- Dorsey Branch
- Natty Creek
- Basin Creek – Exceptional Tennessee Waters
- Johns Creek – Exceptional Tennessee Waters
- Laurel Creek – Exceptional Tennessee Waters
- Panther Branch – Exceptional Tennessee Waters
- Unnamed Tributary 1
- Green Cove Branch – Exceptional Tennessee Waters
- Spivey Creek – Exceptional Tennessee Waters
- Pheasant Branch – Exceptional Tennessee Waters
- Davis Creek– Exceptional Tennessee Waters
- Holder Cove Branch– Exceptional Tennessee Waters
- Big Oak Cove Creek – Exceptional Tennessee Waters
- Rough Ridge Creek – Exceptional Tennessee Waters

The Tellico River and its tributaries are inhabited by a highly diverse aquatic fauna which includes several rare stream dwelling species including:

- Smokey Dace (*Clinostomus funduloides ssp. 1*)(1994) – State Deemed in Need of Management
- Tangerine Darter (*Percina aurantiaca*) – State Deemed in Need of Management
- Hellbender (*Cryptobranchus alleganiensi*)(1979, 1987 & 2008) – State Deemed in Need of Management
- Junaluska Salamander (*Eurycea junaluska*)(1978) - State Deemed in Need of Management and Federally of Management Concern
- Seepage Salamander (*Desmognathus aeneus*)(1978) - State Deemed in Need of Management and Federally of Management Concern
- Spotfin Chub (*Erimonax monachus*)(2003) – State and Federally Threatened
- Yellowfin Madtom (*Noturus flavipinnis*)(2003) – State Endangered and Federally Threatened
- Smoky Madtom (*Noturus baileyi*)(2003) - State and Federally Endangered
- Citico Darter (*Etheostoma sitikuense*)(2003) - State and Federally Endangered
- Tennessee Clubshell (*Pleurobema oviforme*)(1998) – State Rank S2S3
- Purple Lilliput (*Toxolasma lividus*) (1998) – State Rank S1S2
- Tennessee Dace (*Phoxinus tennesseensis*) - State Deemed in Need of Management and identified in the State Wildlife Action Plan as a species of Greatest Conservation Need – has been documented to occur in Tellico River tributaries

TWRA has participated in and been supportive of the Department's process to generate a General Permit (GP) to cover in-stream activities by recreational prospectors. Our participation has been in concert with the U.S. Fish and Wildlife Service (USFWS) and the U.S. Forest Service (USFS). We believe the GP which became effective February 1, 2015, is generally protective of Tennessee aquatic resources. We continue to have concerns about Class 1 activities in high gradient streams as small as five (5) feet wetted width. Also, statement 2 under Supplemental Requirements that "Class 2 (mechanized) prospecting is permitted in the South Cherokee National Forest and Wildlife Management Area (WMA)" is inaccurate and incomplete. At no time during the preparation of the GP did the resource agencies anticipate that an ARAP Individual Permit (IP) would be less protective than the GP. The IP application NRS14.341 Public Notice should contain a complete listing of the protective provisions of the GP.

Consideration of this ARAP permit is subject to the provisions of Tennessee's Anti-degradation Statement as found in the 2008 Rule as approved by the U.S. Environmental Protection Agency (EPA). The proposed Class 2 activities would degrade Exceptional Tennessee Waters (ETW) and should require an alternatives analysis and proof of economic necessity. Further we recommend:

- Class 1 activities take place only in streams with a wetted width of twenty (20) feet or greater. Class 1 activities under this IP should be allowed only in those streams and locations as approved by the USFS, Tellico District.
- Class 2 (mechanized) activities under this IP be restricted to those sections of Coker Creek and the Tellico River where the USFS has previously authorized such activity. Class 2 activity should be allowed only in those streams and location as approved by the USFS.

It is our opinion that the Gold Prospector's Association of America continually misrepresents Class 2 mechanized dredging as "beneficial" to stream ecological function. To be clear, in high quality, biologically diverse streams, mechanical dredging is straight-forward destruction of habitat for fish and aquatic life. This degradation of aquatic resources is wholly contrary to both the intent and letter of the Tennessee Water Quality Control Act and the Tennessee Wildlife Code.

In-stream prospecting that utilizes engine powered mechanical pumps and other equipment should be considered Class 2 mechanical activity. Class 1 activity by definition is non-mechanical. Allowing Class 1 activities to become mechanized will render both the GP and IP unenforceable.

Biologically diverse Exceptional Tennessee Waters (ETW) at issue in this ARAP are also outstanding Tennessee trout streams. Trout fishing in Tennessee brings significant recreational dollars to the local economy. Trout fishermen in Tennessee have a long standing and proven tradition at supporting conservation, protection, and restoration of Tennessee Streams. Mechanized dredging of streams as a "recreational" activity is a relatively new business and is being aggressively marketed nationwide by equipment manufactures. Mechanical dredging of streams should not take place at the expense of decades of commitment and millions of dollars invested by trout fishermen in the conservation and protection of Tennessee's world class trout streams.

We have concerns related to management of wild trout and the operations of the Tellico State Fish Hatchery. The Tellico River is well-known for the quality put-and-take rainbow trout fishery that TWRA manages. This trout fishery is important to the local economy and tourism.

The upper part of the Tellico River, upstream of the North River confluence, has natural reproduction of rainbow and brown trout. Natural reproduction provides angling opportunities outside of the put-and-take management of this fishery and is reflective of the current conditions of the Tellico River. With closure of ATV use in the Upper Tellico River watershed in North Carolina, conditions have improved to the point that TWRA is planning brook trout stocking in upper Tellico River in the future.

One of the Tellico tributaries included in the ARAP is Rough Ridge Creek. This is a brook trout stream and should not be open to any mining activities.

The lower reaches of the Tellico River and its tributaries provide a cool water sport fishery with smallmouth bass and rock bass being the target species of fishermen. These fish are intolerant of sediment and poor water quality. The proposed activities will degrade water quality and adversely impact this cool water sport fishery.

We are concerned about the influence of mechanical dredging in the vicinity of the intake for Tellico Hatchery. This intake is located just upstream of the hatchery. TWRA currently maintains an NPDES permit for the outflow from the hatchery. Dredging activity in the vicinity of the hatchery would confuse the results of monitoring associated hatchery permits. Dredging near the intake would present water quality issues within the hatchery system. We are opposed to any Class 2 mining upstream of the North River confluence.

We are aware of House Bill HB0442 and Senate Bill SB0290 currently making its way through the legislative process. ARAP NRS14.341 should be issued based on existing conservation requirements for protection of Tennessee’s aquatic resources.

Thank you for the opportunity to comment on this proposed public notice.

Sincerely,

Robert M. Todd

Robert M. Todd
Fish and Wildlife Environmentalist

cc:

Mary Jennings, U.S. Fish and Wildlife Service
Kelly Laycock, Environmental Protection Agency
Mike Butler, Tennessee Wildlife Federation
D. Jasal Morris, U.S. Forest Service

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Tennessee ES Office
446 Neal Street
Cookeville, Tennessee 38501

March 12, 2015

Technical Secretary of the Tennessee Board of Water Quality, Oil and Gas
Tisha Clabrese Benton
Director, Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243
Attention: Permit Coordinator

Subject: TDEC Public Notice File Number NRS14.341, Gold Prospector's Association of America request for a §401 water quality certification and Aquatic Resource Alteration Permit that would authorize recreational prospecting in Coker Creek and Tellico River, including the following tributaries to the Tellico River: John's Creek, Basin Creek, Wildcat Creek, Natty Creek, Six Mile Creek, Tobe Creek, and Lyons Creek. These streams are found in Monroe, Polk, and Blount counties.

Dear Ms. Benton:

The U.S. Fish and Wildlife Service (Service) would like to submit comments regarding the proposed issuance of an Aquatic Resource Alteration Permit that would authorize recreational prospecting in Coker Creek and Tellico River and tributaries to the Tellico River in Monroe, Polk, and Blount counties, Tennessee.

Coker Creek enters the Hiwassee River in a reach where four endangered mussels are found, and including critical habitat for two of them. These include the Cumberland bean (*Villosa trabalis*), tan riffleshell (*Epioblasma florentina walkeri*), slabside pearlymussel (*Pleuruonia dolabelloides*), and fluted kidneyshell (*Ptychobranchus subtentum*), with critical habitat designation for slabside pearlymussel and fluted kidneyshell. These relatively sedentary mussels are filter feeders, consuming algae, diatoms, detritus, and zooplankton drifting in the water column, and individuals likely spend their entire lives within a small area of the river bottom. Mussels reproduce by attracting specific species of host fishes (often with a lure that resembles a fish or food item of interest to the fish) and releasing their larvae (glochidia) that attach to the fish's gills or fins. The glochidia develop on the fish and metamorphose into juveniles before dropping off to continue development on the stream bottom.

Stable substrates of sand, gravel, and cobble with low to moderate amounts of fine sediment and containing flow refugia with low shear stress are listed in the slabside pearlymussel and fluted kidneyshell critical habitat designations as important components of the Primary Constituent Elements (PCEs) for both mussels. We are concerned about fine sediment that could accumulate from issuance of the proposed

Aquatic Resource Alteration Permit. Flow in this reach of the Hiwassee River where Coker Creek enters is already reduced by a flume which diverts a large proportion of the river's flow from this reach until it re-enters the Hiwassee River downstream at the Appalachia powerhouse. Addition of fine sediment can smother the gills of mussels, reduce the amount of food availability to mussels because of increased turbidity, and also reduce the ability of successful reproduction by limiting the ability of host fishes to see the reproductive lures used to infest host fishes with glochidia.

The Tellico River between the backwaters of the Tellico Reservoir and Tellico River mile 33, near the Tellico Ranger Station was established under the Endangered Species Act (ESA) as an area where four federally listed endangered or threatened fishes can be re-established as nonessential experimental populations (NEPs). These fishes include the endangered duskytail darter (*Etheostoma percnurum*, now known as Citico darter, *E. sitikuense*) and smoky madtom (*Noturus baileyi*), and the threatened yellowfin madtom (*N. flavipinnis*) and spotfin chub (*Eriomonax* (=*Hybopsis*) *monachus*). The NEP designation is designed to allow reintroduced populations of federally listed species to be treated as threatened, regardless of the species' designation elsewhere in its range, which reduces most of the ESA's regulatory restrictions in order to foster the conservation and recovery of these species. While the NEP designation is expected to allow for continued routine use of designated areas by the public, this expectation clearly does not include removing rocks and sediment from the stream bottom and the potential impacts of these activities further discussed below.

The recovery plans for the two endangered fishes (Citico darter and smoky madtom) include criteria that would allow the species to be reclassified to threatened throughout their ranges, and the recovery plans for all four of these fishes provide criteria that would allow for the species to be delisted entirely. Those criteria include protection and enhancement of existing populations and re-establishment of previously extirpated populations so that more distinct and robust populations are viable throughout their ranges. Consequently, since 2002, a cooperative project involving the Service, the Tennessee Wildlife Resources Agency, the U.S. Forest Service (Cherokee National Forest), National Park Service (Great Smoky Mountains National Park), Tennessee Valley Authority, Conservation Fisheries, Inc., and the Tennessee Aquarium Conservation Institute have worked together in a cooperative captive propagation effort that has resulted in approximately 20,000 spotfin chubs, 5,000 Citico darters, 3,000 smoky madtoms, and 2,500 yellowfin madtoms reintroduced into the Tellico River.

The spotfin chub spawns in crevices in bedrock or in cavities beneath rocks on the stream bottom. The smoky and yellowfin madtoms and the Citico darter spawn on the stream bottom in clean cavities beneath flat rocks during spring and summer. Citico darter nests consist of a layer of eggs attached to the underside of nest rocks. Smoky and yellowfin madtom nests consist of clusters of eggs attached to each other, resting in the clean cavity beneath their nest rocks. Males of all three fish species guard and care for their eggs until they hatch, and both madtom species continue to guard the hatchlings for some time. This guardianship is a several week period. Each of the nest-guarding species has very particular requirements for nest rock size and water depth and flow. For successful reproduction, each species must find areas where the appropriate combination of these conditions is present. The number of these areas is limited and often patchy in distribution on the stream bottom.

We understand that the Gold Prospector's Association of America claims that much of the material removed from stream beds during prospecting would be replaced after processing, and that prospecting activities actually improve fish habitats by cleaning out stream gravels and providing cold water refugia for fish in the resulting pits left on the stream bottom by these activities. However, we refute these claims and are very concerned that these activities could result in direct mortality to mussels, fish eggs, and larvae and indirectly have impacts on substrate stability, fish and mussel food sources, and reproductive success of fish and mussels. Spring and summer (May through July), when recreational gold prospecting activities seem more likely, overlaps the spawning season for these four fishes. If rocks containing Citico darter eggs attached on the underside are moved while gold prospecting activities are taking place, entire nests attached on the undersides of those rocks are likely to be crushed, exposed to predators, or dried. If rocks with smoky or yellowfin madtom eggs beneath them are moved, the entire cluster of eggs would be swept downstream in the current and consumed by predators. In all cases, the male guardians would no longer be able to care for their eggs or young. Additionally, prospecting activities in the tributaries to the Tellico River could result in accumulation of fine sediment in the Tellico River mainstem. As the permit includes so many tributaries, we are especially concerned that the cumulative effects of these activities in so many tributaries to the Tellico River would directly affect the ecological integrity of the tributaries as well as the Tellico River. The effects of this could affect not only the ecological integrity of the Tellico River tributaries, but also the ecological integrity of the Tellico River mainstem by reducing the availability of appropriate nest rocks with clean cavities beneath them for successful spawning of the three nest-guarding fishes, by filling in crevices in boulders and bedrock and limiting appropriate spawning sites for spotfin chubs, smothering eggs and larvae of these benthic fishes, and smothering and reduce the aquatic insect food for these fishes.

Surveys to document the success of these reintroductions demonstrate that all four species are successfully reproducing, individuals are consistently observed during annual surveys, and the species are dispersing and expanding their ranges in the Tellico River. These observations support the likelihood that future ESA status downgrades from endangered to threatened and/or delistings might be possible.

Based on the information presented above, the Service is concerned that TDEC's approval of the proposed NRS14.341 Application from the Gold Prospectors Association of America that resulted in recreational prospecting on Coker Creek would adversely affect designated critical habitat on a reach of the Hiwassee River and affect four federally listed mussels that occur there and recreational prospecting in the Tellico River and tributaries to the Tellico River would undermine conservation and recovery efforts for four listed fishes in the Tellico River. For the reasons discussed above, we respectfully request this permit be denied.

Thank you for the opportunity to provide comments on this permit application. Please contact Peggy Shute at peggy_shute@fws.gov and (931) 525-4982 if you have questions about these comments.

Sincerely,

Peggy W. Shute

for Mary E. Jennings

Field Supervisor

USDA United States Department of Agriculture | Forest Service | Cherokee National Forest

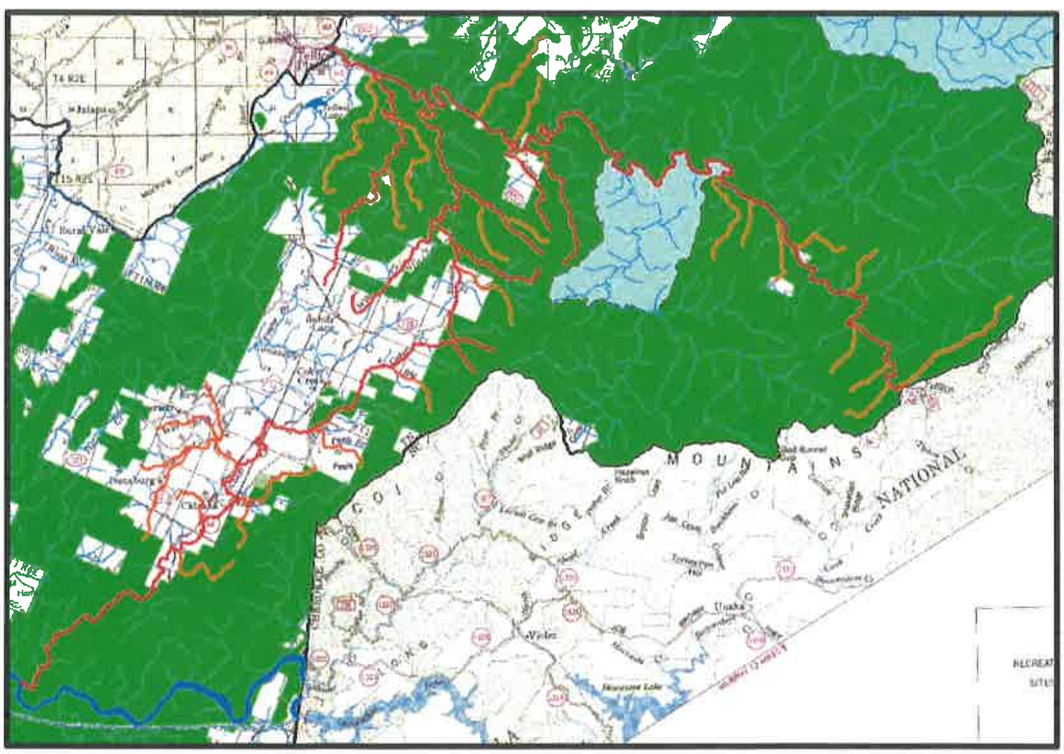
2800 North Ocoee Street North
Cleveland, TN 37312
423-476-9700
FAX: 423-476-9721

File Code: 2800
Date: March 6, 2015

Technical Secretary of the Tennessee Board of Water Quality, Oil and Gas
Tisha Calabrese Benton, Director, Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Ave, 11th Floor
Nashville, TN 37243
Attention: Permit Coordinator

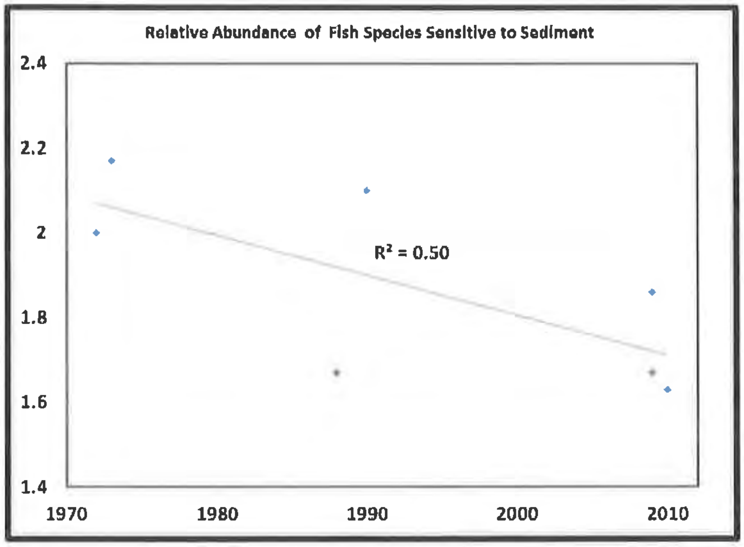
Dear Ms. Benton:

The Cherokee National Forest welcomes the opportunity to present comments on NRS14.341 from the Gold Prospector's Association of America for recreational prospecting in the following waters all of which are partially or entirely within the proclamation boundary of this Forest: Coker Creek and Tellico River, including the following tributaries to the Tellico River: John's Creek, Basin Creek, Wildcat Creek, Natty Creek, Six Mile Creek, Tobe Creek, and Lyons Creek (see map below). On the map the black border is the Forest proclamation boundary; green represents National Forest lands; light blue is wilderness areas; and white (within the proclamation boundary) is private lands.



Beginning in December 2009 and continuing through August 2011, monitoring of stream conditions associated with recreational prospecting activities was conducted on Coker Creek. This monitoring was designed to determine if mechanical recreational prospecting was detrimental to aquatic ecosystems, their associated communities, and the level of that detriment.

Fish monitoring at Coker Creek began in the 1970's and has continued through 2012. Surveys were done at irregular intervals but consistently at the same site. The fish community has changed over the years; fish species intolerant to sediment have declined while fish species tolerant to sediment have increased (see table below). All three fish most intolerant to sediment (rainbow trout, rockbass and smallmouth bass) have been extirpated from this section of Coker Creek; most of the fish species with intermediate tolerance to sediment have also been extirpated. Green sunfish and yellow bullheads, species not only tolerant of sediment but often indicators of degraded aquatic environments, are now present in this section of stream having first appeared in 2009 and 2010, respectively. Fish Biological Integrity scores rated poor in 2010 and 2011 (Williams and Thurman 2011).



Monitoring has shown that recreational prospecting "...has significantly altered the structure of the macroinvertebrate community... (Williams and Thurman 2011) " in this section of Coker Creek. The most important macroinvertebrate taxa: mayflies, stoneflies and caddisflies , have been significantly reduced (Williams and Thurman 2011).

Stream bottom (benthic) analysis was also conducted. This monitoring looks at the makeup of the substrate in the stream channel. Most stream bottoms on this Forest are composed of less than 10% fine sediments (sand and silt less than 2 mm diameter). Coker Creek within the prospecting section had fine sediment from 26% to 35% (Williams and Thurman 2011). These values are well outside the normal range for mountain streams and indicate a serious disturbance within the watershed.

Benthic samples collected by TDEC on August 13, 2010 showed similar results. Benthic scores decreased as samples were taken from moderate to heavy prospecting areas. The overall habitat assessment score at the lowest end was given an impaired status (Burr and Everett 2010).

Finally, and this discussion may be unique to Coker Creek, elemental mercury is present in the substrate of Coker Creek and is often collected by prospectors in their sluices (Jim Herrig personal observation). This mercury is probably a remnant from the exploitation dredging that went on in late 1800's. Mercury is a very toxic metal that should not be disturbed from the sediments because it will eventually show up in the drinking water taken from the Hiwassee River.

Based on the information provided above, I would strongly recommend not approve the NRS14.341 Application from the Gold Prospector's Association of America for recreational prospecting on federal lands. Serious damage to all aquatic resources is likely to occur. Other recreational activities (fishing) will be adversely affected and public health could be at risk.

Sincerely,

D. JASAL MORRIS
Forest Supervisor

cc: Jim Herrig, Allison Reddington, Mark Healey, Michael Wright,