

**DAMAGE ASSESSMENT STUDY PLAN: PRYOR OIL WELL FIRE AND SPILL,
OBED WILD AND SCENIC RIVER**

Submitted to:

National Pollution Fund Center
Arlington, VA

TRUSTEE REVIEW DRAFT

Submitted by:

Department of the Interior
Lead Administrative Trustee on behalf of:

State of Tennessee
National Park Service
U.S. Fish and Wildlife Service

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DAMAGE ASSESSMENT STUDY PLAN: PRYOR OIL WELL FIRE AND SPILL, OBED WILD AND SCENIC RIVER

INTRODUCTION

On 19 July 2002, the Howard/White Unit No. 1 oil well in Morgan County, Tennessee started to spill oil. Clear Creek, White Creek, and the surrounding vegetation in the Obed Wild and Scenic River (Obed WSR) system were affected during this spill event. The Department of Interior and the State of Tennessee are co-Trustees for the damage assessment of this river system. The agencies assisting the Trustees include the National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), the Tennessee Wildlife Resources Agency (TWRA) and the Tennessee Department of Environment and Conservation (TDEC). The Trustees have completed the Preassessment Phase, collecting ephemeral data that were necessary for determining the fate and effects of the spilled oil, reviewing the results and analyzing the data, compiling the Administrative Record, and making a determination that there is injury or potential injury to Trust resources or services potentially affected. They have prepared a Preassessment Phase report dated April 2003 and issued the Notice of Intent to Conduct Restoration Planning, pursuant to 15 C.F.R. § 990.44 (61 Fed. Reg. 440, January 5, 1996). For the reasons discussed in these two documents the Trustees have made the determination required by 15 C.F.R. § 990.42 (a) and are proceeding with injury quantification and restoration planning to develop alternatives that will restore, replace, or acquire the equivalent of natural resources injured and/or natural resources (including natural resource services) lost as a result of this incident. This document outlines the Damage Assessment Study Plan to collect the data necessary to conduct an injury assessment in accordance with the Oil Pollution Act (33 U.S.C. 2701, *et seq.*) and guidance provided at 15 CFR Part 990 and to determine appropriate restoration measures.

POTENTIALLY AFFECTED RESOURCES

Based on the Preassessment Phase report, the potentially injured resources include:

- Air quality
- Benthic algae
- Benthic invertebrates
- Fish
- Forest vegetation and soils
- Ground water/geologic sources
- Riparian wetlands and habitat
- Sediment quality
- Surface water quality
- Vertebrates (Terrestrial and aquatic)
- Visitor use

It is important to note that there have been continuing releases of oil from seeps into Clear Creek at the base of the burned slope. Personnel with the TWRA reported that sheens were released during the macroinvertebrate sampling activities on 10 October 2003. Personnel from USEPA reported and photographed sheens during visits to the spill site on 16 July 2004. Because

of the continued oil releases from the bank at the spill site, USEPA determined that it was necessary to maintain the boom at the spill site in Clear Creek. On 17 August 2004, staff from NPS and TWRA surveyed the impact area from Barnett Bridge to the spill site on both Clear Creek and White Creek. They reported sheens extending to just above Barnett Bridge and active oil releases from the base of the slope at the spill site. The boom was filled with liquid oil and paraffin. Refer to the Site Visit Report in Appendix A.

The Trustees have reviewed all available data and identified the following additional studies that are need to quantify injury to affected resources and to determine appropriate restoration options to restore injured resources. The proposed studies are outlined below.

Air Quality

The oil release and fire resulted in the release of volatile organic compounds, combustion gases, and particulates. The U.S. Environmental Protection Agency (USEPA) conducted air quality monitoring at the site, primarily to determine whether there were potential impacts to human health and safety. Although the Trustees acknowledge that the spill and fire had short-term impacts to air quality, no further studies are proposed for injury quantification or restoration planning.

Benthic Algae

Impacts to benthic algae were assessed during the Preassessment Phase through the sampling of natural substrates and short-term deployment of artificial tiles at control and impacted locations in Clear Creek. The results indicated that the natural substrate sampled in October appeared to be similar among all three stations sampled. The December samples analyzed from the artificial substrates indicated a change in the number of species between locations, with the highest number of species found at the upstream location in Clear Creek. These data suggest a change in the algal community as a possible response to the water quality impacts in Clear Creek after the oil spill. Therefore, the Trustees propose to use these data to quantify the injury to benthic algae in terms of changes in primary production, which is the lowest trophic level in the stream ecosystem. The proposed study will consider the spatial extent and temporal duration of the impacts to generate a measure of lost primary production as one component of the injury to benthic and aquatic resources that will be quantified using an overall stream Habitat Equivalency Analysis (HEA) model. These losses in primary production will be considered in the scaling of restoration options using HEA. Costs for these efforts are part of the aquatic HEA study included in Appendix B.

Benthic Macroinvertebrates

Impacts to benthic macroinvertebrates were assessed during the Preassessment Phase by three types of studies: 1) mussels sampling in August and October 2002 for chemical analysis of tissues to measure the bioavailability of the oil; 2) underwater video surveys; and 3) benthic monitoring conducted to compare benthic species abundance and diversity between oiled and unoiled areas of Clear Creek. Crayfish were also sampled in May 2003 but not analyzed; they have been properly preserved and maintained under chain of custody.

All mussels collected in 2002 showed low or no detectable polynuclear aromatic hydrocarbons (PAH). Because of the continued oil releases to Clear Creek, the Trustees have determined that it is appropriate to analyze the crayfish collected in May 2003 and water samples collected in August 2004, and to collect additional mussel samples at two upstream and two downstream sites in September 2004. These samples are needed to determine whether the continued oil releases are bioavailable and a continuing source of injury to aquatic resources in Clear Creek.

The benthic macroinvertebrate community data collected in October 2002 showed impacts to the benthic macroinvertebrate communities in Clear Creek for the area above Barnett Bridge but not as far downstream as Jett Access. The degradation of benthic community health in Clear Creek dropped to “partially-supporting,” whereas it previously was fully supporting and considered to be a reference stream. The Trustees determined that additional studies were needed to determine the spatial extent and duration of these impacts. Benthic macroinvertebrate sampling was conducted at four sites on 10 October 2003. Samples were collected in accordance with TDEC’s accepted protocols for Semi-Quantitative Riffle Kicks (Arnwine, 2002). The preserved samples were sent to the Tennessee Department of Health Aquatic Biology Section for processing, benthic identification, and scoring. The results of the 2003 sampling indicated that the benthic community in the area above Barnett Bridge had returned to “fully supporting.” A new site 0.4 miles downstream of Barnett Bridge was sampled in October 2003 to determine the downstream extent of impact, and this site was also “fully supporting” in terms of its benthic community. However, sheens were released from both sites above and below Barnett Bridge during the October 2003 sampling efforts.

Once all of the benthic community data are collected and analyzed, the results will be used to quantify injury to benthic aquatic resources. Injury will be measured as the degree and duration of reductions in benthic community health and services as indicated by a benthic index score which is based on taxa richness, percent Ephemeroptera, Plecoptera, and Trichoptera (EPT), EPT richness, North Carolina Biotic Index (NCBI), percent Oligochaetes and Chironomids (OC), percent of dominant taxa, and percent of clinger taxa. Scores are recorded based on values developed for each category (i.e., taxa richness, EPT richness) under Bioregion 68a, where Clear Creek is located (Arnwine, 2002). These impacts to benthic community services will be one component of the inputs to the stream HEA model. Restoration planning will evaluate potential restoration measures that will improve water and habitat quality to restore the benthic macroinvertebrate community and its associated services. Costs for these efforts are part of the stream HEA study included in Appendix B.

Fish Community Health

Fish samples were collected at two reference sites and two oiled sites (Barnett and Jett Bridges) in 2002. For a portion of the 2002 samples, some preliminary analysis were conducted which indicated injury at various levels of biological organization to the health of both rock bass and redbreast sunfish (sentinel indicator species) collected from the oil spill site. Samples have been collected in 2002, 2003, and 2004 are being held in storage at ORNL until funding is available for analysis.

Because of the on-going seepage of oil into Clear Creek, the Trustees have determined that analysis of the fish collected at the two reference and two oiled sites in 2002 and 2003 are needed to quantify the degree and duration of impacts to the health of fish populations as a result of the spill and continuing releases. These data will be used to quantify impacts to the fish population in Clear Creek in terms of reduced ability to survive, grow, or reproduce. The injury will be quantified as reduced fish biomass. Restoration options will be identified and scaled based on the production of the lost fish biomass.

Costs for fish injury quantification and restoration planning are included in Appendix C.

Forest Vegetation And Soils

The Trustees conducted an initial study to document impacts to the forest structure by sampling vegetation within the burned site and a nearby reference site in January and February 2003. The study results showed high mortality of the vegetation in the footprint of the two slope areas (on both Clear Creek and White Creek) affected by the oil spill and fire. The soil was severely impacted by the oil spill and fire. The oil saturation and fire probably caused the loss of the fine roots, the seed bank, and the sources of vegetative reproduction, which will slow recovery of the burned area.

To further quantify the injury to forest vegetation and soils, the Trustees propose to repeat the field data collection in August 2004. These data will be used to quantify the reduction in forest services. A model that describes woody biomass accumulation will be used to estimate the time required for woody biomass in the oiled/burned area to recover to the conditions at the reference area. Habitat Equivalency Analysis (HEA) will be used to scale both the injury and restoration options. Costs for vegetation injury quantification and restoration planning are included in Appendix D.

Ground Water/Geologic Sources

There have been no studies of the extent and duration of groundwater contamination as a result of the oil spill, although the continued release of oil at the base of the slope indicates that there are potentially large amounts of oil in the subsurface. The Trustees believe that this residual oil poses a significant risk of on-going exposure to aquatic resources in the form of continuous or episodic release of seeps at the creek edge. Staff from the U.S. Geological Survey measured high levels of volatile organics (benzene, toluene, ethylbenzene, and xylene, or BTEX) in samples of water seeping from springs below the well site on 30 October 2003. In water samples collected at the edge of the bank below the spill site, benzene was 870 micrograms per liter (ug/L), toluene was 210 ug/L, and o-xylene was 400 ug/L. They also collected samples on 17 August 2004. Analytical results and photographs from these two site visits are available at: http://tn.water.usgs.gov/Clear_Creek/

The Trustees propose to conduct an assessment of the extent and degree of oil contamination of the shallow subsurface at the spill site. Costs for assessment of groundwater impacts are included in Appendix E.

Riparian Wetlands And Habitat

During the Preassessment Phase, surveys were conducted of riparian habitat adjacent to and in Clear Creek, from the spill site to Barnett Bridge. Dead and stressed vegetation was observed ____ Heidi: can you dig up this reference? I don't have it.

The Trustees do not propose to collect additional field data for injury determination of riparian wetlands and habitats. However, they do propose to assess the impacts to these habitats as a component of the aquatic HEA model and develop appropriate restoration options as part of their overall restoration planning effort. Costs for these efforts are part of the aquatic HEA study included in Appendix B.

Sediment Quality

Based on sediment sampling conducted in 2002, sediments in Clear Creek showed evidence of contamination from the oil spill, with elevated total petroleum hydrocarbon (TPH) concentrations in sediments from the point of entry site to Barnett Bridge. Although there is potential for continued sediment contamination from continued oil releases, the Trustees propose to assess sediment injury in terms of impacts to the benthic community, as reflected in contamination of mussels and crayfish and the health of the benthic macroinvertebrate community. Therefore, no additional injury assessment studies are proposed.

Surface Water Quality

Water samples collected in July, August, and October 2002 showed evidence of contamination by oil that was fingerprinted as matching the source oil from the oil well. Additional water samples collected on 1-2 October 2003 also showed contamination with PAHs that were a match with the source oil. Water samples are evidence of on-going exposure of aquatic resources to the oil releases. Costs for water sample analyses and for injury quantification and restoration scaling of impacts to water quality are part of the stream HEA study included in Appendix B.

Vertebrates (Terrestrial And Aquatic)

One oiled duck recovered from the spill site died. No other oiled wildlife were reported. No further studies are proposed.

Visitor Use

Clear Creek was closed from Double Drop Falls to Jett Bridge for the period 23 July 2002 to 6 February 2003, when the stream between Barnett Bridge and Jett Bridge was opened. Clear Creek from Double Drop Falls to Barnett Bridge remained closed until 25 May 2004. During the Preassessment Phase, ephemeral data on the potential impacts of the spill event on park visitors and baseline visitation levels of the affected areas were documented. These data will be used to quantify the economic losses using the benefits transfer methodology to value this

lost and diminished visitor use and to scale the associated compensatory restoration. Costs for visitor use impact quantification and restoration planning are included in Appendix F.

OTHER INJURY QUANTIFICATION AND RESTORATION PLANNING COSTS

Trustee Council Activities

Since the completion of the Preassessment Phase, the Trustees have held ___ meetings as of ___ as part of their injury assessment activities. They will continue to meet ___ (how often) from ___ through the end of 2005 to review damage assessment study plans and reports, conduct restoration planning, prepare the draft Damage Assessment and Restoration Plan, respond to public comments on the Plan, and prepare the final Damage Assessment and Restoration Plan. Agency costs for Trustee Council activities are included in Appendix G.

Technical Support to the Trustee Council

The Trustees hired a contractor (Research Planning, Inc.) in August 2004 to assist them in preparing the Damage Assessment Study Plan. They will also hire a contractor to assist in preparation of the draft Damage Assessment and Restoration Plan, compilation of public comments, and preparation of the final Damage Assessment and Restoration Plan. Costs for these contractor services are included in Appendix H.

The USFWS will also provide data management support to the Trustee Council by creating a spatial database of all the sampling locations linked to attribute data on the sample results. The data will be managed in a Geographical Information System (GIS) that has already been developed during the Preassessment Phase. This database will facilitate the use of data among study programs. Costs for the GIS data management system are included in Appendix I.

SUMMARY OF COSTS FOR INJURY QUANTIFICATION AND RESTORATION PLANNING

REFERENCES CITED

Arnwine, D. 2002. Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys. Division of Water Pollution Control, Department of Environment and Conservation, State of Tennessee.

APPENDIX A
AUGUST 2004 CLEAR CREEK SITE SURVEY
HOWARD/WHITE UNIT NO. 1 OIL SPILL

INTRODUCTION

Part of the Research Planning Inc. (RPI) Statement of Work included conducting a site visit to the location of the oil spill. The site visit was conducted on 17 August 2004 by Nancy Keohane (NPS), Jonathon Burr (TDEC-WPC), Mike Bradley (USGS), and Jacqui Michel and Heidi Hinkeldey (RPI). This site survey was essential in determining the studies that are necessary to quantify the injury to the aquatic and terrestrial resources.

The specific objectives of the site visit was to:

1. Make visual observations on the condition (residual oil, physical disturbance, general condition of plants) of the impacted area;
2. Observe the extent of the oil by disturbing the bottom sediments in Clear Creek, downstream of the spill;
3. Observe whether oil was still seeping from the rocky slope;
4. Collect water samples along Clear Creek between Barnett Bridge and the location of the spill for temporal comparison with samples collected in 2002 and 2003.
5. Collect sediment samples downstream of the oil spill.

METHODOLOGY

The survey extended from Clear Creek at Barnett Bridge upstream to the location of the oil spill. While traveling upstream, sediments in the water and soil along the banks were disturbed, and sheen on the water surface was noted to determine the fate and extent of the oil. Sediment and surface water samples were taken at certain sites along Clear Creek and the Trustees recorded data on their observations of the impacted area.

RESULTS

Small amounts of sheen were observed at Barnett Bridge, downstream of the spill, when sediments were disturbed in Clear Creek. It was noted that the sheens that surfaced were not biogenic, as determined by trying to "break up" the oil with a stick or finger. The oil instead remained together making ribbon-like spirals on the surface of the water. Many fish (darters, minnows, etc.) were seen at this location along the creek. A sediment sample was taken downstream of the island at the confluence of Clear and White Creek, and a surface water sample was taken under Barnett Bridge.

There was an accumulation of oil at the first riffle that was encountered upstream of Barnett Bridge (Fig. 1). From this point on, the sheen on the surface of the water became more visible and widespread closer to the site of the spill (Fig. 2). An oil odor was also detected. Two more surface water samples were taken between Barnett Bridge and the spill site.



Figure 1. Oil (hazy blue-green color) accumulating at the first riffle upstream of Barnett Bridge in Clear Creek on 17 August 2004.

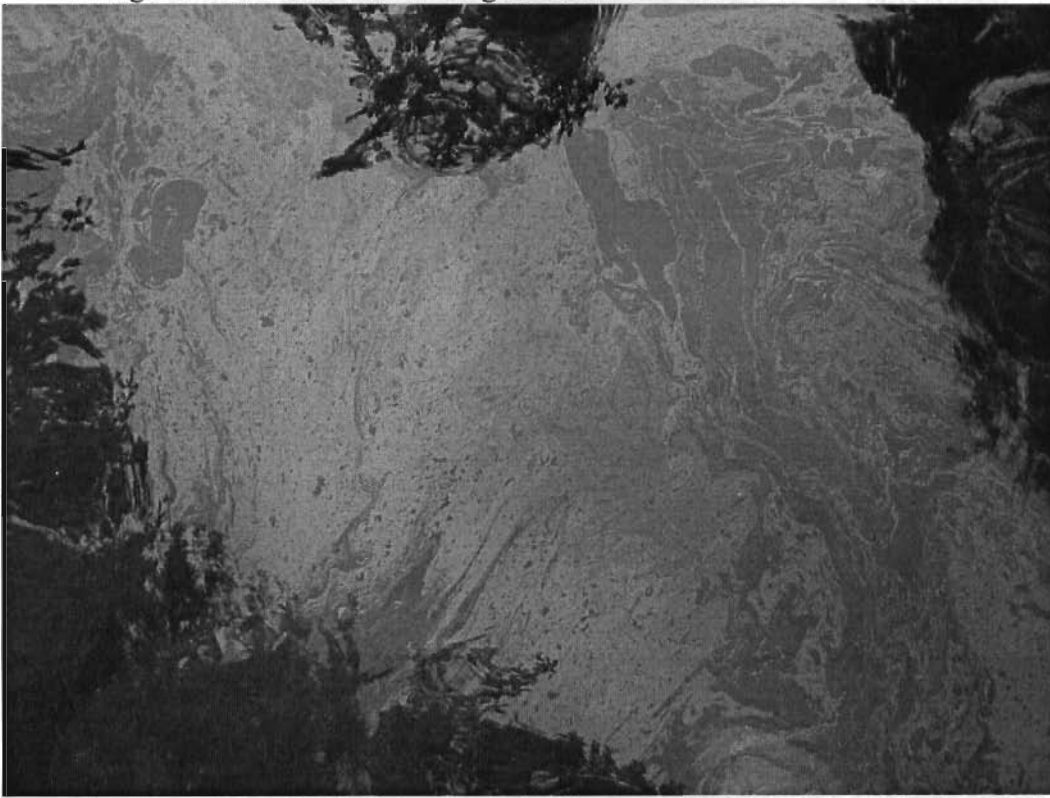


Figure 2. Sheen on the surface of the water in close proximity to the spill site, outside of the booms on Clear Creek, on 17 August 2004.

Thick oil and paraffin accumulations were seen inside the boom at the spill site, seeping out of the rocky slope (Figs. 3 and 4). The orange- and yellow-colored material is the coagulated paraffin, whereas the hazy bluish liquid is the fresh oil. There were noticeably less fish in this portion of the creek. A sample was taken of the bluish, liquid oil at the edge of the bank, for fingerprinting and weathering analysis.

There were oil stains on the rocks above the water line near the spill site. Surface water samples were taken approximately 30 ft upstream of the spill site. Sheens were visible approximately 30 feet upstream of the spill site. Beyond this point (further upstream of the spill site), no more sheening was evident.

The burned slope was inspected to observe the recovery of the vegetation that had been oiled and burned during the spill event. After two years, there has been little recovery of the vegetation in the area. Much of the area was bare with no vegetation (Figs. 5 and 6). There were some areas with blackened, hard crusts on the surface. It appeared that the soils were still unable to support any vegetation.

SUMMARY

The Trustees observed that, two years after the spill event, oil is still seeping from the rocky slope at the spill site into Clear Creek. The flow in Clear Creek was about 22 cubic feet per second, which is significantly lower than times of other site visits in 2004. During high water levels, the water levels were above the seeps, making it difficult to observe them.

Oil was found in sediments as far downstream as Barnett Bridge. One sediment sample was taken at Barnett Bridge and five surface water samples were taken between Barnett Bridge and the spill site. Selected samples will be sent to LSU for PAH analysis. The USGS will measure BTEX in the water and sediment samples. Additional studies are needed to determine the amount of oil remaining as a source of seepage into the river.

The vegetation on the burned slope has not recovered in much of the area. Additional studies will be necessary to determine how long it will take for the soils and vegetation to recover.



Figure 3. Oil accumulated within the boom at the spill site in Clear Creek. Photograph taken 17 August 2004.



Figure 4. Oil accumulated within the boom at the spill site in Clear Creek. Photograph taken 17 August 2004.

APPENDIX B

QUANTIFICATION OF INJURY TO STREAM SERVICES

Study Description

Injury to the habitats and associated ecological services of Clear and White Creeks will be quantified using the Habitat Equivalency Analysis (HEA) approach. The injury will include impacts to benthic algae, benthic macroinvertebrates, mussels, riparian habitat, and water and sediment quality. The field data will be analyzed to develop both the temporal and spatial extent of the impacts to these resources resulting from the spill and fire.

Injury will be measured, in part, as the degree and duration of reductions in benthic community health and services as indicated by a benthic index score which is based on taxa richness, percent Ephemeroptera, Plecoptera, and Trichoptera (EPT), EPT richness, North Carolina Biotic Index (NCBI), percent Oligochaetes and Chironomids (OC), percent of dominant taxa, and percent of clinger taxa. Scores are recorded based on values developed for each category (i.e., taxa richness, EPT richness) under Bioregion 68a, where Clear Creek is located (Arnwine, 2002). The benthic macroinvertebrate field data will also be analyzed to determine whether there were any significant changes in species composition and relative abundance, looking in particular at the more pollution-sensitive species. The degree and duration of oil exposure will be indicated by chemical analysis of water, sediment, and biota samples and field observations on the duration and extent of sheening. The life histories of the different species of benthic communities (e.g., algae, macroinvertebrates, mussels) will be considered in estimating the time of return to baseline conditions once oil exposure is terminated.

There are several on-going studies funded by the USFWS to determine the impacts of land-based disturbances in the Emory River watershed (of which Clear and White Creeks are tributaries) on stream water-quality and benthic and fish community health. Trustees will use these and other data to evaluate restoration options that will improve aquatic habitat in the affected watershed.

Inputs to the HEA model will include:

- Areal extent of the affected habitat
- Time path of percent lost services representing the overall diminishment of ecological services relative to the baseline conditions of the injured habitat
- Initial percent lost services at the time of the incident
- Time periods of each phase of recovery to baseline given the selected primary restoration measures
- Time path of percent replacement services to be provided by compensatory restoration relative to the baseline conditions of the injured habitat
- Time periods of each phase of maturation (or full functioning) of selected compensatory restoration measures
- Percent replacement services provided at project maturity, and whether that level would continue into perpetuity

The injury assessment and quantification studies will be conducted by Dr. Brad Cook of Tennessee Tech University, who is currently conducting studies of fish and benthic communities in the Emory River Watershed as part of a study on A Comparative Study of the Historical and Present Ecological State of the Emory River Watershed.

Study Costs

Salaries

Dr. Brad Cook – 15 days @ \$___/day

Technician – 30 days @ \$___/day

Other Direct Costs

Analysis of crayfish collected in May 2003 – 3 @ \$750 each \$2250.00

Total Costs

APPENDIX C

INJURY AND RESTORATION SCALING OF IMPACTS TO FISHERY RESOURCES

Study Description

Injury and restoration scaling of impacts to fish from the Pryor Oil spill and fire will be assessed through two related studies:

1. Assessment of the Short- and Long-term Damages to Fishery Resources Using Bioindicator and Reproductive Analyses – to be conducted by researchers at the Environmental Sciences Division of Oak Ridge National Laboratory
2. Quantification of Population-Level Impacts to Fishery Resources – to be conducted by researchers at Tennessee Tech University

Study 1 - Assessment of the Short- and Long-term Damages to Fishery Resources Using Bioindicator and Reproductive Analyses

The main purpose of this study is to assess the short- and long-term damages to fishery resources due to oil releases into Clear Creek through the following specific activities:

- Determine if there are causal relationships between oil exposure and measured biological effects.
- Determine the spatial (downstream) extent of fish injuries in Clear Creek.
- Determine if there are long-term reproductive and population-level impairments in fish.

Even though no acute toxicity or observable mortalities of aquatic organisms were immediately apparent, sublethal or latent effects could be manifested in the future as injury to individuals, populations, and communities. However, measuring such injury can be difficult using conventional biological monitoring approaches. The bioindicator approach, which involves measuring a suite of organism responses over several different levels of biological organization, can be used to establish causal relationships between the specific stressor agent (e.g., PAH compounds) and injury or damage to biological resources.

Reproduction is widely considered to be the most critical life function affected by contaminants. Furthermore, certain reproductive processes, including egg production and embryonic development, are among the most sensitive life stages to environmental toxicants. Reproduction (propagation) of aquatic life is a classified use of Clear Creek as determined by the State of Tennessee. The ability to successfully reproduce is essential for the establishment and continued maintenance of viable fish populations in Clear Creek.

Preliminary results of an investigation into fish reproductive health conducted three weeks after the oil spill suggest that fish reproductive tissues may have been adversely affected in the aftermath of the spill. The objective of the reproductive studies is the characterization of the reproductive condition of fish populations in Clear Creek downstream of the spill site in 2003, the first complete breeding season occurring after the spill. Fish from the impacted site

will be compared with fish from an unimpacted upstream reference site on Clear Creek (and/or Whites Creek). For each site, the reproductive condition of adult fish collected just prior to the onset of their spring/summer breeding seasons will be examined.

The following analyses will be conducted for approximately 160 fish (redbreast sunfish, rock bass, hogsuckers) previously collected in 2002 and 2003 from Clear Creek upstream (Hwy 127 reference site) and downstream (Barnett Bridge) of the oil spill site:

1. Bioindicator analyses.

- Health Assessment Index (HAI)
- Age and growth determinations
- 7-Ethoxyresorufin-O-deethylase (EROD) activity in liver tissue as a measure of cytochrome P4501A induction
- Somatic indices (visceral, liver, spleen)
- Body condition (condition factor, gross lesions and parasites, fat levels)
- Hematology (hematocrit, leukocrit)
- Blood chemistry (cholesterol, triglycerides, creatinine, blood urea nitrogen, total protein, albumin, aspartate aminotransferase)
- Histopathology (liver and gill tissue)
- Data analysis, interpretation, and reporting

2. Reproductive analyses

- Reproductive steroids in fish plasma (estradiol and testosterone in females, testosterone and 11-ketotestosterone in males; depends on sufficient plasma remaining after blood chemistry)
- Female fish reproductive status (gonadal somatic index (GSI) batch fecundity, abundance of vitellogenic oocytes, incidences of oocyte atresia and ovarian parasites)
- Male reproductive condition (GSI, histological condition of testes)
- Data analysis, interpretation, and reporting

Quantitative and statistical analysis of the data will involve primarily comparison of the various measured parameters between oil-impacted and reference sites using a variety of statistical and graphical procedures including Analysis of Variance (ANOVA) and canonical discriminant analysis. The multivariate discriminant analysis procedure considers all the individual biomarker responses together in one integrated analysis and provides a multi-dimensional color illustration of the overall health or injury status of each species at a particular site.

A written report will be provided to the Trustee Council consisting of an integrative analysis of fish health and reproductive condition at the two study sites over the two years within the context of regional conditions. After receipt of comments, a final report will be submitted. The study will be contracted to the Environmental Sciences Division, Oak Ridge National Laboratory, under the direction of Dr. Marshall Adams. He has over 25 years experience related to assessing the effects of various environmental stressors on the health of fish populations and

communities. A significant percentage of his publication record of 90 scientific articles (scientific journals and book chapters) and three books reflects studies conducted on a variety of freshwater and marine systems that have investigated the effects of different types of environmental stressors on the health of various fish species

Study 2 - Quantification of Population-Level Impacts to Fishery Resources

The results of Study 1 will be used, in combination with field data on numbers of fish and length-weight (by species) and life-history data on affected species, to calculate the extent and duration of any reproduction or population-level impacts to fisheries resources in the affected reaches of Clear and White Creeks, compared to reference sites. The normal survival rates per year and length-weight by age relationships will be used to construct a life table of numbers and kilograms for each annual age class, by species group. The results from Study 1 will be used to estimate reductions in survival and reproduction as a result of the oil spill. Injuries to fish with reduced survival will be quantified as the net growth normally expected if they would have survived, summed over their normal life span (termed lifetime production). Reproductive injuries to fish will be quantified as lost future reproduction which would otherwise recruit to the next generation. The services provided by the injured fish will be measured in terms of production (i.e., biomass in kilograms wet weight) not produced each year, discounted at 3 percent annually.

The quantification of fish injury will be conducted by Dr. Bard Cook of Tennessee Tech University.

Study Costs

Fish Study 1

Labor	\$ 70,000
Materials and Supplies	5,000
Subcontracts	<u>8,500</u>
Subtotal	\$ 83,500
FAC*	<u>2,500</u>
Study 1 Total	\$ 86,000

Included in the above totals are the following estimated LDRD costs:

ORNL LDRD**	\$1670
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* FAC is the Federal Administrative Charge that is mandated by Section 3137 of the Strom Thurmond National Defense Authorization Act of 1999 (Public Law 105-261).

** LDRD is the DOE Laboratory Directed Research and Development charge. The LDRD is a normal component of DOE overhead charges to both DOE programs and reimbursable work performed for other federal agencies. It is shown above as a component of the overall subtotal charge to the project. The FY 2002 Energy and Water Development Appropriations Conference Report (HR 107-258) requires DOE to notify federal sponsors that the Department charges LDRD.

Fish Study 2

Salaries

Dr. Brad Cook – 15 days @ \$___/day

Technician – 30 days @\$___/day

Other Direct Costs

Total Costs

APPENDIX D

INJURY SCALING OF IMPACTS TO FORESTRY RESOURCES

Study Description

Injury to the habitats and associated ecological services of forestry resources impacted by the oil spill and fire will be scaled using the Habitat Equivalency Analysis (HEA) approach. Impacts to the HEA model will be developed using a model that describes woody biomass accumulation on both the burned site and the reference area. This model will be used to estimate the time required for woody biomass in the oiled/burned area to recover. Additional review of scientific literature will be conducted to estimate the “lag time” in recovery resulting from conditions that are difficult to predict (i.e., soil formation and recovery, loss of native seed banks, and vegetative reproduction). The model will utilize species-specific biomass equations and predict standing biomass accumulation through time based on tree growth measured as change in tree diameter.

During late September 2004, the oiled/burned and reference sites will be resampled to assess overstory mortality and herbaceous species composition. The condition of all overstory trees and the percent cover of all identifiable herbaceous species will be determined. In addition, understory trees and shrubs at the burned site will be resampled to determine if woody species have reestablished since the fire. All sampling will be done within the 10 m X 50 m permanent plots established at both the burned and reference sites. Soil samples will be collected at the same locations within the burned site using the same methods as in 2003, and they will be sent to the same laboratory (LSU) for chemical analysis of the PAHs. The chemical results will be used to characterize the degree of oil weathering in the soils and the potential for on-going impacts to vegetative recovery.

Growth data will be obtained from increment cores collected at both sites from a representative sample of trees of each species present. Ring widths will be measured to the nearest 0.01 using an electronic transducer and binocular microscope fixed over a moving stage. Prior to model development, published biomass equations for the southeastern United States will be reviewed to select those that best represent conditions at the impacted site. After initial runs, the model will be calibrated to refine model predictions. This step will require several iterations of the model and consultation with NPS personnel. The researcher will work closely with NPS personnel on the writing of the draft and final reports to generate the inputs into the HEA model to calculate the injury. The scaling of restoration options will be conducted by the Trustees once they have compiled an initial list of restoration options.

Inputs to the HEA model will include:

- Areal extent of the affected habitat
- Time path of percent lost services representing the overall diminishment of ecological services relative to the baseline conditions of the injured habitat
- Initial percent lost services at the time of the incident
- Time periods of each phase of recovery to baseline given the selected primary restoration measures

- Time path of percent replacement services to be provided by compensatory restoration relative to the baseline conditions of the injured habitat
- Time periods of each phase of maturation (or full functioning) of selected compensatory restoration measures
- Percent replacement services provided at project maturity, and whether that level would continue into perpetuity

The fieldwork will be conducted by Dr. Mike Jenkins, a forestry ecologist at the Smokey Mountains National Park who conducted the initial post-burn surveys. Dr. Christopher R. Webster, Assistant Professor of Quantitative Ecology and Forest Management at Michigan Technological University, will be responsible for the modeling study, working closely with Dr. Jenkins.

Study Costs

Salaries

Dr. Mike Jenkins – 80 hours @\$41.66/hour	\$ 3,332.80
Dr. Chris Webster – 80 hours @ \$63.08/hour	5,046.40

Other Direct Costs

Travel for fieldwork by Jenkins	300.00
Field supplies/shipping to lab	200.00
Chemical analysis of 8 soil samples @\$500/each	<u>4,000.00</u>

Total costs	\$ 12,879.20
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"Field Trip"

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Subject: "Field Trip"

From: Candace Norris <CNorris@tntech.edu>

Date: Mon, 21 Nov 2005 10:23:19 -0600

To: Dgeorge@tntech.edu

Good morning – As we mentioned when you and Pam were up for the “picnic,” the Meadow Creek Conservation Coalition encompasses nearly 2,000 acres that our property adjoins (among 8 property owners). I am trying to coordinate a small-group visit to some of the land—in particular, the Stone Box formation and to see what the mine drainage damage has done and partial “healing” to Meadow Creek. Bob Lee, who worked to secure this land and got the conservation easement set up. This would be David and I (although I’ll stay at the cabin, stirring the soup), Wally (who works with FWS) and Sharon, and perhaps you and Pam and if Vance can.. This could actually qualify as educational. Hey maybe we can write it off as a business expense!

In trying to schedule a Saturday for this, Bob is off from his Nursery in Gallatin only during January and February. Wally can come Saturdays Jan. 21 and 28; February 4 and 25. Can you and Pam come any of those four Saturdays? Let us know.

Have good Thanksgiving – Travel well and have a wonderful time. Candy