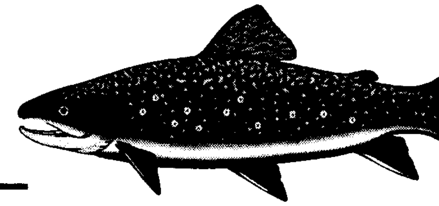
ECOSUMMARY



Bioassessment Report

From: An Ecological Survey of Big Spring Creek with Emphasis on the Effects of Fish Hatchery Effluent

Big Spring Run

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Purpose: This study is an ecological survey of Big Spring Creek with emphasis on the effects of fish hatchery effluent. The following is an ecosummary of that study.

Location: From the source of Big Spring to below the town of Newville.

Date: The study started in 1995 and is ongoing.

History: Big Spring Creek was among the most productive wild brook trout stream fisheries in the eastern half of the United States. This high quality limestone spring creek maintained a continuously productive, blue ribbon quality fishery, until the early 1950's. It has a documented history exceeding 125 years. After a commercial hatchery began operations about 0.6 mile below the source, (Colin Thomas' Green Spring Trout Company, circa 1953-1954), at the point where this hatchery reached a substantial production (-300,000 fish), the wild brook trout population failed downstream of this hatchery. At the same time, the remaining wild population upstream from this hatchery continued to be successful through 1971.

The Pennsylvania Fish Commission established the Big Spring Fish Cultural Station at the stream's spring source in 1972 with an initial crop production in 1973. Various reports indicate the remaining wild population failed shortly thereafter. Thus, the collapse of the remaining wild brook trout fishery was complete, circa 1975. Presently, 98% of the stream is without a fishery. Only the short 150 yard section of stream immediately below the hatchery contains a viable fishery. Currently, the entire stream's population has been estimated at only 2490 trout, less than 10% of historic population numbers. This small population is easily accounted for by stocked trout and hatchery escapism. It is likely that the original strain of wild brook trout, no longer exists.

Water Chemistry: Contemporary water quality measurements of the Big Spring hatchery effluent have indicated elevated levels of nutrients (nitrogen and phosphorous) as well as elevated levels of suspended solids. The effluent was also high in oxygen consuming substances (biochemical oxygen demand) and exhibited a putrid odor. The values of pollutants were within the range associated with altered fish and benthic invertebrate community structure. Actual dissolved oxygen measurements showed levels as low as 4.0 ppm in spawning redds. Reports in the scientific literature show nearly complete redd failure occurs if dissolved oxygen falls below 5 ppm. Continuous exposure to low dissolved oxygen concentration reduces growth and survival of trout. Dissolved oxygen of 5.5 ppm would be considered "safe", but 4.5 ppm is considered to be in the "acutely stressful" range, especially if accompanied by elevated concentrations of carbon dioxide (CO_2). High daytime CO_2 values (10-13 ppm) occur in the vicinity of the spring and hatchery outfall. The CO_2 concentrations decrease with increasing distance from the spring source, probably as a result of utilization of CO_2 by aquatic plants for photosynthesis. At night, in the absence of photosynthesis, plant respiration consumes dissolved oxygen and produces CO_2. This could lead to even higher CO_2 concentrations (15-20 ppm) and result in even more damaging conditions, especially in flat sections of the stream with areas of dense aquatic plant growths.

During examination of compacted gravel below the hatchery, a strong odor, best described as hydrogen sulfide (rotten eggs) combined with an odor of putrifacation. Hydrogen sulfide formation indicates a lack of oxygen and its presence is consistent with decomposition of hatchery wastes within the gravel. Although a role of H_2S to trout reproduction failure at Big Spring is unknown, H_2S is highly toxic, its effect on hemoglobin similar to that of carbon monoxide.

Benthic Community: The benthic (bottom dwelling) invertebrate community of a stream tells a story that few other parameters of stream biology can. The composition of the invertebrate community reflects the long term health of the aquatic ecosystem. Indicators species by their presence or absence can give clues to the type of the pollution and the extent of the perturbation. Healthy streams will have a diverse assemblage of different kinds of organisms (taxa richness). This measurement expressed as the percent of total organisms, is commonly referred to as EPT Taxa for Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies). Healthy streams have large numbers of these insects. Their absence or presence in small numbers is generally taken to indicate a disturbed ecosystem.

Prior to the construction of the hatchery by PF&BC the stream had a fairly diverse invertebrate community dominated by the sulfur mayfy, *Ephemerella rotunda* and the caddisfly, *Glossossoma sp.* Quantitative and qualitative samplings of invertebrates in Big Spring since the early 1970's show a classic trend of polluted zones with recovery zones far downstream. Qualitative sampling of the invertebrate populations in 1979 at four separate stations along the stream indicated fair populations of mayfly nymphs (*Ephemerella rotunda and Baetis sp.*) as the dominant mayfly at the various locations. Several genera of caddisflies were present (*Hydropsyche, Glossossoma, Pycnopsyche, and Neophylax*). *Hydropsyche sp.* was the dominant caddisfly. Scuds and cress-bugs made up an estimated 45% to 50% of the invertebrate population. Mayflies plus caddisflies together made up approximately 20% to 25% of the invertebrate community. Diptera (midge and blackfly larvae), snails, leeches, and aquatic earthworms made up the rest.

Subsequent qualitative and semiquantitative samplings at Big Spring at the same sites in 1985, 1988, 1993, 1995, 1996, and 1997 analyzed using EPA rapid protocols show a stream lacking in diversity (5 to 8 taxa) and dominated by pollution tolerant organisms, especially *Asellus*-the cress-bug. These results were essentially confirmed by a 1990 survey by the Pennsylvania Department of Environmental Resources (DER). Mayflies are totally lacking from most of the stream.

Cress-bugs (*Asellus*) and scuds (*Gammarus*) make up 85% to 97% of the invertebrate community in the upper 4 miles of Big Spring. Both of these organisms are considered pollution tolerant. Their presence as the dominant invertebrates indicates which areas of the stream are most seriously affected. In Big Spring, microhabitat considerations aside, there are no major differences among the substrates, current, and temperature in over 4 miles of stream that would limit the overall distribution of invertebrates to one major area but not another. Furthermore, some species of invertebrates can utilize a variety of substrates and current speeds. The sulfur dun mayfly, *Ephemerella rotunda*, is a good example of a mayfly which can utilize a variety of habitats. The nymph of this insect is found on everything from rock and gravel and plants, and plant debris. However, the scientific literature is clear in reporting that *Ephemerella rotunda* cannot survive when oxygen concentrations are low. This mayfly has some of highest oxygen requirements of any invertebrate. Of the sites sampled, it is found only below the town of Newville four miles from the pollution source, below a mill dam where the recovery occurs due to the oxygenation of the water.

The benthic analysis is clear. Only large populations of pollution tolerant invertebrates are present in almost all of Big Spring Run.

Fishery: The PF&BC contends that major problem in Big Spring is one of habitat. That is, the fish do not occupy 98% of the stream because of poor habitat. We take specific issue with these ideas and state without reservation, that the stream's physical habitat from the site of the old spillway just upstream of the Spring Road Bridge downstream to Keck's Dam has changed very little from the time when brook trout were abundant throughout this reach in the early 1950's.

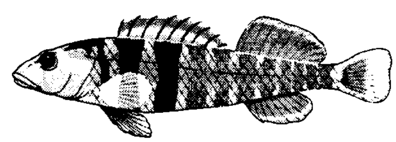
The "ditch" on the other hand, is essentially the native stream channel in what remains of the sediment filled bottom of an old mill pond. The resulting stream channel, unlike most natural streams, is relatively deep and uniform in cross section. It seems bizarre to advance the idea that this deep and unnatural appearing channel (hence the nick-name "The Ditch") constitutes the only good quality habitat in the entire stream. Before the fish hatcheries large numbers of brook trout of all sizes were always visible in all of the easily waded, shallow water habitats, from below the spillway of the first mill dam downstream to the area just uupstream of Keck's Dam. Although most brook trout spawning is believed to have occurred in the upper portion of the stream, some successful spawning probably took place throughout the upper 1.5 miles of the stream.

These proposed stream improvements are at best costly window dressing that will divert resources and attention away from the real problem and could further delay restoration of the wild brook trout population. Although installation of stream improvement structures as advocated by PF&BC may do no harm, these efforts do not address the root cause of the problem, ie. they will not improve water quality; and we predict the brook trout population will not benefit greatly. It appears that the habitat alteration plan has been advanced as a solution with out due consideration of other factors.

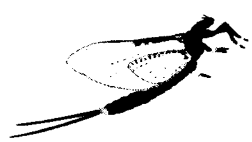
Removing several old mill dams 30 odd years ago, changed the physical habitat in the lower and middle portions of the stream, however it is not clear that these changes have hurt the stream. Their removal should have been beneficial, resulting in faster current velocities, more exposed gravel, and lower water temperatures. Unfortunately, degraded water quality is preventing the expression of any benefits to the fishery.

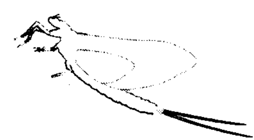
A PF&BC memorandum (unpublished) concluded that "recent habitat improvement efforts in 1991 and 1992 coupled with removal of the fish barrier in 1994 should enhance in-stream habitat downstream of the ditch." We agree that removal of this dam will (in fact has) enhanced the in-stream habitat by exposing potential spawing areas that were previously silted in, by the backwater created by the dam. **It is now 1997 and the brook trout population has not responded to these habitat improvements for the simple reason that a lack of spawning sites or suitable habitat per se is not the cause of the problem.**

Recommendations: The most cost effective way to deal with the pollution problems at Big Spring would be to simply close the hatchery. This approach validates the "Resources First" ideal of the PF&BC. If closed, annual cost-savings would exceed $702.000. However, the report's primary recommendation is to institute a moratorium on fish production by gradually lowering fish production to the lowest possible level. Once the lowest biomass attainable has been reached, the moratorium should be held in place for a period of at least three years. During this time, the effects of reduced amounts of pollution upon the stream and its trout population should be measured. This approach carries several advantages. The moratorium period will permit considerable cost-savings to be achieved and it will also permit careful analysis of choices open to PF&BC, including evaluation of "effluent clean up" technology. If at the end of the proposed 3 year moratorium period, PF&BC has a need for renewed trout production, it is recommended that a new "more environmentally friendly" hatchery using water recirculation technology be built at a downstream location.



We have included two illustrations as an aid in this bioassesment summary.





For further info please check out the website flyfisher.com or flyfisher.net at the end of April (it will be online by then) and a complete copy of the report will be available as well as updates on the status of the stream. You may also contact us:

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Printed copies of the 77 page report are available from Macri International for $10.00 plus $1.00 for shipping.

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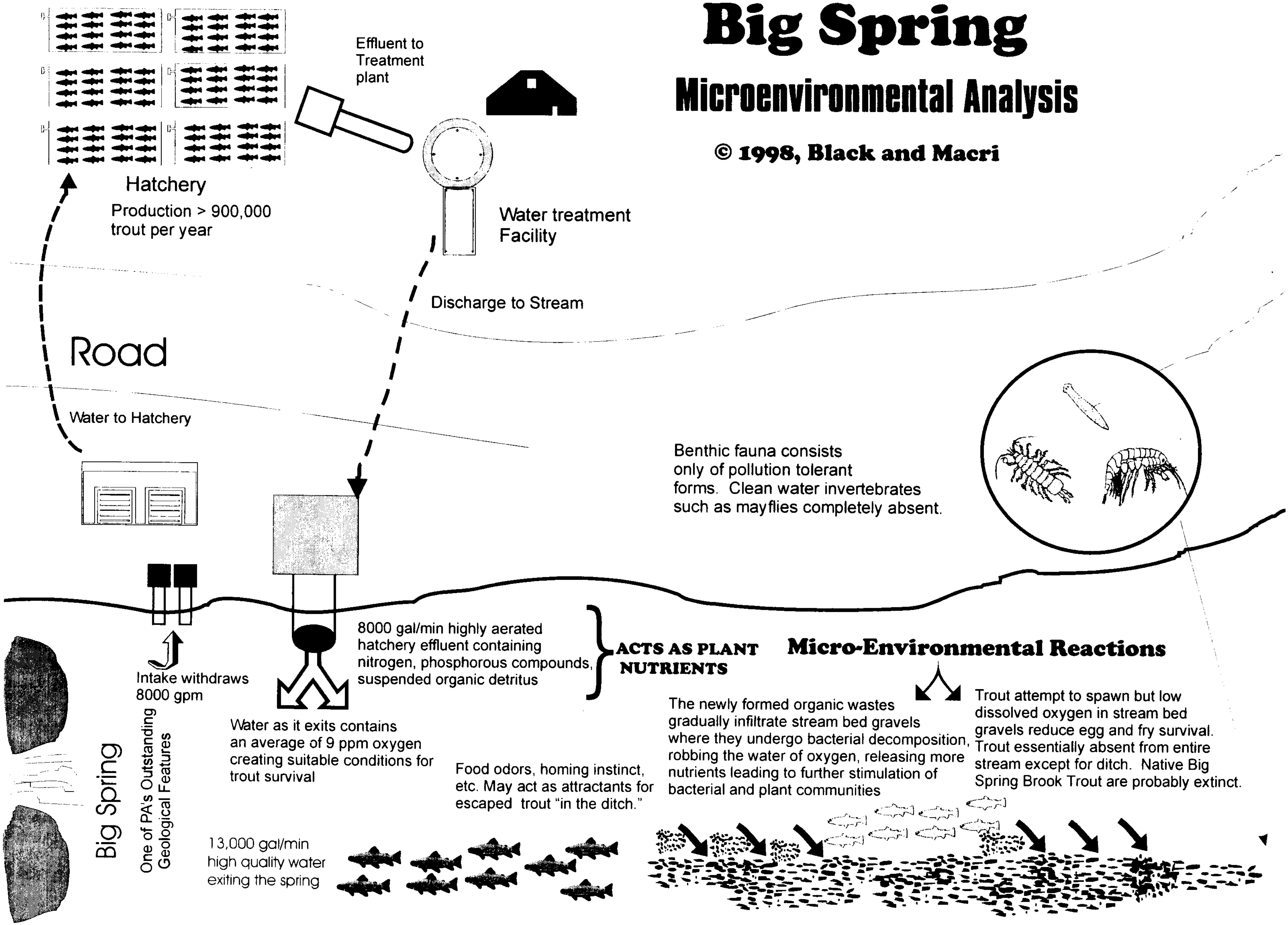
Microenvironmental Analysis



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Microenvironmental Analysis