The Decline of the Spring Run Fishery

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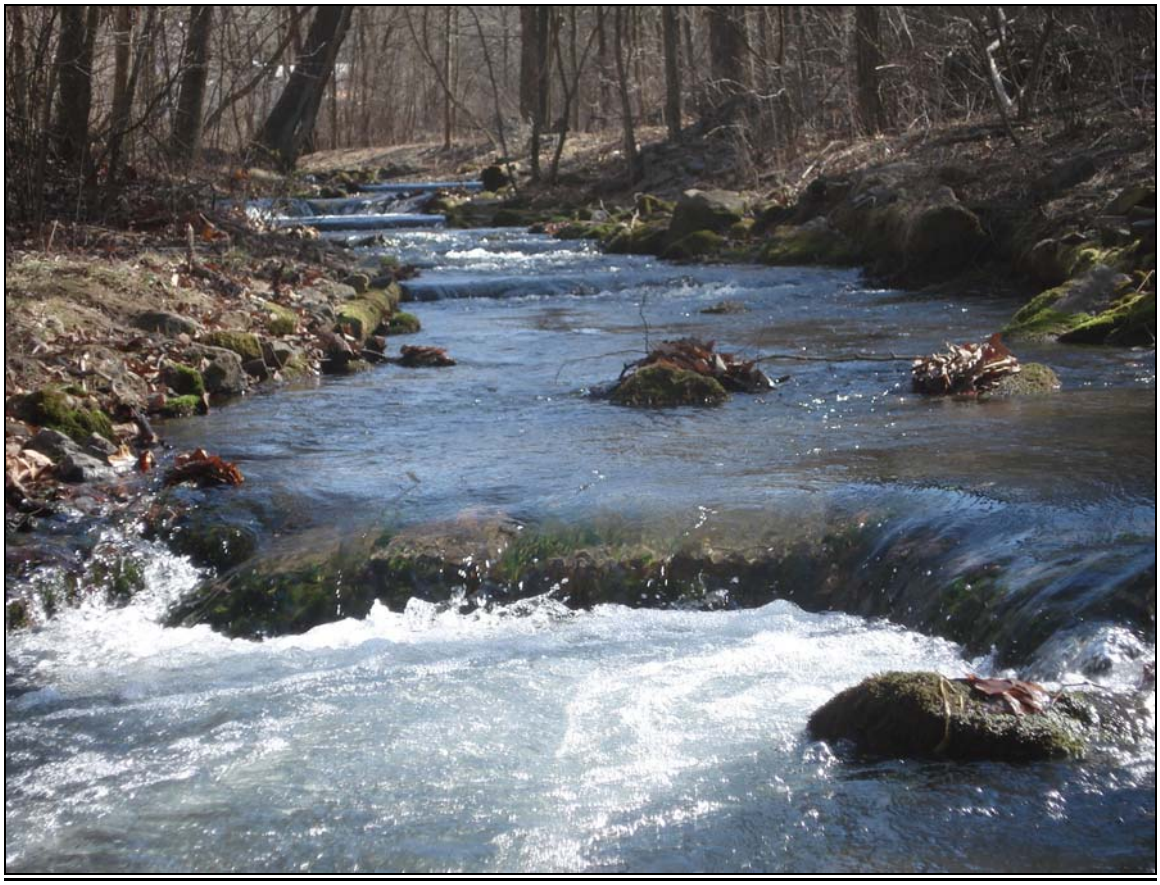


Synopsis

Summary and Conclusion:

The writer understands the value of time, so he has tried to be as succinct as possible in the discussion section of this paper, while still presenting sufficient information and data which will allow the reader to follow his reasoning and draw their own conclusions. Those interested in following the writer's reasoning and drawing their own conclusion should read the full text. Others may just read the following, which summarizes the discussion and ends with the writer's conclusions:

For a list of references such as "*the paper and the book"* which are discussed below, the reader's attention is directed to the *Appendix:* of this document.

Dissolved Oxygen: Dissolved Oxygen levels in the *water column* are adequate for the growth and survival of rainbow trout. The unanswered question is, whether or not this holds true for the stream bottom and substrata where the benthic community lives and trout eggs are spawned and incubated.

Acidity (pH), Chemical Characteristics, Parasites, Diseases and Toxins: Median pH levels are slightly on the alkaline side and are considered to be excellent for egg incubation, growth and survival of rainbow trout.

The paper does not describe other reported, currently existing chemical characteristics, such as phosphorus, nitrogen and BOD5 as being detrimental to the health of the Spring Run benthic or rainbow trout environment.

It does not appear that there are, or that there has been, any parasites, diseases or toxins which are, or might have been detrimental to the incubation and/or growth and survival of the rainbow trout population in Spring Run.

Water Temperature: Recorded values of Spring Run water temperatures are well within the optimum range for spawning, incubation, and/or growth and survival of rainbow trout.

Rainfall, Stream Flows and Sedimentation: Spring Run base flows are adequate for the growth and survival of rainbow trout. However, these base flows might not produce the flow velocities needed to keep suspended solids in suspension or to scour sediments from the stream bed and/or substrata.

In recent years the amount of rainfall occurring during the spawning and subsequent incubation periods has been below average. Therefore, there has probably not been any appreciable scouring of sediments resulting from settlement of suspended solids during the base flow periods.

Offsite and onsite erosion and sediment control measures have been employed which have helped to reduce the amount of runoff laden sediments reaching Spring Run.

It has been suggested that a wetlands be constructed in the natural depression located on the west side of Spring Run in the upper reach of the catch and release section, and that the effluent from the hatchery's treatment facility be piped directly into this wetlands. The wetlands would serve as a forebay or filter, which would further reduce the volume of suspended solids being deposited into Spring Run. The writer sees considerable merit in this proposal and suggests that it be pursued.

If not already being employed, it is suggested that a flocculent be used in the hatchery's clarifiers to increase the settlement rate of suspended solids, which would in turn allow for a shorter detention period, resulting in a less offensive purtriseptic effluent.

The writer believes that sediments resulting from the Spring Run Trout Hatchery's *"cleanout plumes",* combined with the lack of sediment flushing flows, have greatly impacted the benthic community, reducing the food source readily available to the rainbow trout population, and that these sediments have effectively reduced the number of young trout in Spring Run due to suffocation of the embryos during incubation and escape of fry from their redds.

Predation: Predation by nature's creatures and man has and probably always will occurred in the catch and release section of Spring Run.

While this is true, the writer believes that such predation has and will continue to play only a minor role in the decline of the fishery.

Stocking of Rainbow Trout: The *inadvertent stocking,* by the escape of rainbow trout from the hatchery played only a minor role in the number of rainbow trout previously found in the catch and release section of Spring Run. Furthermore, the end of this *inadvertent stocking* in June of 2007, when the hatchery's effluent treatment facility came on line, will not have a serious detrimental impact on the recovery of this fishery.

The writer is certain that others will challenge his opinion with respect to the role that this *inadvertent stocking* of rainbow trout, had or will have on the number of fish and/or the number of large fish to be found in the catch and release section of Spring Run. He suggests however, that it be proved or disproved by a study to be performed utilizing the stocking of various age group *tagged* Spring Run Hatchery rainbow trout. This would provide a means by which the *tagged* rainbows can be studied so that their survival rates, growth rates, migratory habits and spawning habits can be better understood or established.

Spawning, Incubation, Survival and Mortality: Spring Run rainbow trout spawn each year during the fall and early winter months. In recent years, stream flows have been low during the spawning and incubation periods. These low flows allow harmful sediments to settle out. The amount of organic and inorganic sediments in the streambed and substrata has a significant impact on both the benthic community and the successful spawning of rainbow trout.

A total of 66 redds were observed in the catch and release section of Spring Run from September to December of 2008. For the conditions assumed in the analysis, if sediments reduce the number of viable redds by 25 percent, there is the possibility that of the 64,800 eggs laid in the 64 rainbow trout redds, only 0.13 percent or 87 fish will live beyond 3 years of age. A 50 percent reduction in viable redds results in only 58 fish living beyond 3 years in age.

The writer believes that the large amounts of suspended solids in the hatchery *"cleanout plumes",* prior to June, 2007, combined with low flows during the spawning and incubation periods, have resulted in:

1. A reduction in the number of viable rainbow trout redds, which in turn results in a reduction in the number of surviving fry available to live to the age of 3 years or beyond.

2. A reduction in the number and species of benthic community organisms available as food, both of which are necessary for the growth and survival of the rainbow trout population.

Trout Density: In general trout density in Spring Run appears to be and has always been cyclic in nature. Since 2000 there has been a decline in the number of rainbow trout 14 inches or longer in length. Loss of age classes is detrimental to the availability of larger fish.

Food Sources: Even though scuds are the dominate species of macroinvertebrate to be found in Spring Run, they are not the primary food source available to the Spring Run rainbow trout population. At the present time, the second most dominate species, namely midges are.

Mayflies, stoneflies and caddis were once found in abundance in the catch and release section of Spring Run; this is no longer the case. Being larger, these organisms provide more protein than midges do, so their return is critical to the growth and survival of the rainbow trout population.

The writer believes that the loss or the significant reduction in the number of mayflies, stoneflies, caddis and other pollution sensitive macroinvertebrates, is probably responsible for the reduction in the number of larger rainbow trout to be found in the catch and release section of Spring Run, and furthermore believes that with their return the number of larger rainbows trout will increase.

Habitat: Stream improvements made over the years within the catch and release section of Spring Run, have produced some of the finest and trout friendly habitat to be found on any of the small trout streams in the eastern United States.

The numerous drop and lateral cover structures provide both dissolved oxygen and protection for the resident trout population.

As can be witnessed by past reproduction rates, the tailouts of the numerous pools created by these drop structures are ideal areas for spawning and the successful incubation of rainbow trout eggs.

Conclusion: There is no question that the number of larger fish in the catch and release section of Spring Run has declined since 2000.

By a process of elimination, the writer believes that he has shown that the *"cleanout plumes",* or effluent from the Spring Run Trout Hatchery, in combination with the low flow rates during the recent spawning and incubations periods, are probably the cause for the decline in this fishery.

Sediments from these *"cleanout plumes",* impact the fishery in two ways: first, they reduce the number of pollution intolerant organisms in the benthic community, which are necessary for the growth and survival of the rainbow trout population, and second they smother the eggs and fry in the spawning redds.

The need for the Spring Run trout rearing facility is not being questioned. However, it must be operated and maintained in the most neighborly and environmentally friendly manner possible.

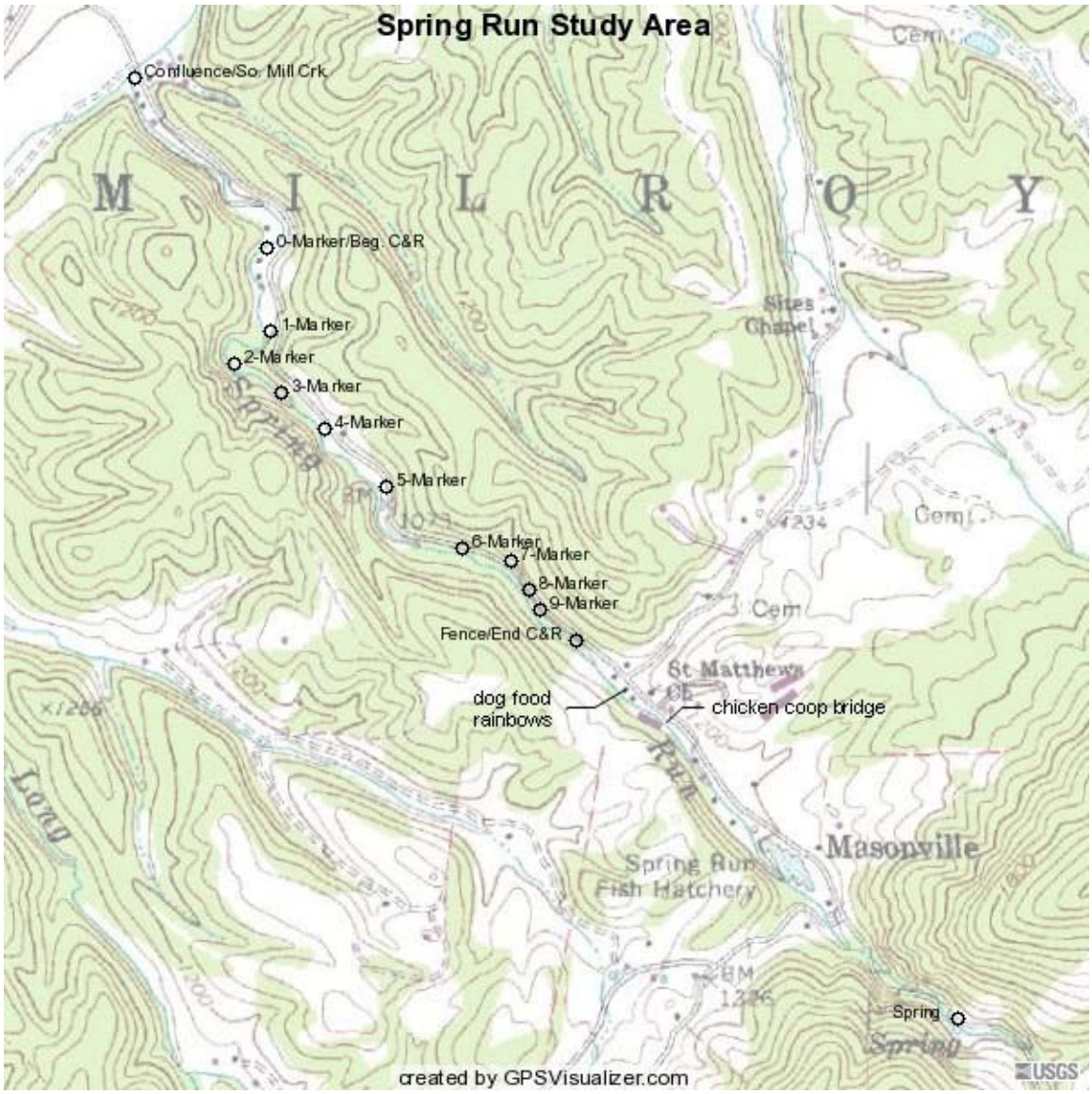
The writer does, or at least chooses to believe that the hatchery's new effluent treatment facility, made operational in June of 2007, will reduce the amount of solids in the *"cleanout plumes".* It is hoped that this reduction in sediments will result in a healthier environment for both the benthic community and the rainbow trout population.

Will this prove to be true, only time and the continuation of the macroinvertebrates and chemical analysis studies for a few more years will tell!

Special thanks to those that have contributed to this document.

c.a.r.

Location Map



The Catch and Release Fly Fishing Only Section of Spring Run begins at the riparian landowners' northerly property line and ends at the fence line marking the southerly limits of their holdings. It contains 9 reaches of various lengths, numbered 0 to 9 which encompass a total distance of approximately one mile.

The Decline of the Spring Run Fishery

Introduction:

A newcomer to fly fishing the catch and release section of Spring Run might ask, what decline, what are you talking about, this is the best wild rainbow trout fishery that I've ever seen or fished. While this may be true to the newcomer, those of us who were privileged to have fished Spring Run in 2000 know better. Imagine if you would, starting out at the cabin pool which is located at the beginning of section 4 and seeing two or more rainbows in the 14 to 16 inch class, then just a few yards upstream in the willow pool you see two more fish just as large. At the bend in the stream, just upstream from the number 5 marker lie three or four more rainbows even larger than those you saw downstream. About 50 yards upstream in the Mongold pool are two or three more rainbows in the 14 to 18 inch class. Continuing up through section 5 there are two more good pools with large trout in them. At the number 6 marker is a deep pool containing two more very large rainbows. Wading up through section 6 you see several more fish in the 14 to 16 inch class. The pine log hole in section 7 has always been home to three or four fish in the 16 to 18 inch class and above that is the sugar shack hole with its great pool holding at least two more large fish. From there to the fence line in section 9, marking the end of the catch and release area you find another half dozen fish in the 14 to 24 inch range.

It should be noted that when we speak of large or larger fish, we are referring to any fish 14 inches or larger, and not just the behemoths above 20 inches in length. That's as it was, but regrettably not as it is, for it was their presence that made Spring Run one of the finest small stream rainbow trout fishery in the eastern United States.

Discussion:

The following expressed opinions and conclusions are those of *the writer*, admittedly a layman who has fished Spring Run more than 120 times in the past eight years, and who has spent numerous hours on stream restoration and erosion and sediment control projects. These observations are offered in the hopes that they might stimulate thought as to what has happened at Spring Run to cause the apparent decline in its fishery.

For the sake of brevity, Spring Run sample and/or testing locations as noted in this paper follow the convention used in the benthic studies and are as follows:

Sample site 0.4 is located at the beginning of the catch and release section of Spring Run.

Sample site 1.6 is located at the end of the catch and release section of Spring Run.

Sample site 2.3 is located at the Spring Run spring.

For a list of references such as *the paper and the book* which are discussed in the following sections, the reader's attention is directed to the Appendix: of this document.

Dissolved Oxygen:

High levels of dissolved oxygen are necessary for both egg incubation and the growth and survival of trout. Samples taken and reported in *the paper*; at sites 2.3, 1.6 and 0.4 in 2005, 2006 and 2007, indicate relatively high median levels of dissolved oxygen ranging from 10.1 to 10.7 mg/L, with the lowest levels being at site 2.3 and the highest level being at site 0.4. At 55°F (12.8°C) and 70°F (22.2°C), the saturation point of water is approximately 11.9 mg/L and 8.8 mg/L of oxygen, respectively. These numbers represent the temperature ranges for the best growth and survival of rainbow trout, as reported in *the book*.

On the subject of dissolved oxygen requirements during incubation of trout eggs, Roger A. Barnhart reports the following in *the book*:

"The amount of dissolved oxygen available to incubating eggs can drop if too much fine organic or inorganic material is present in the gravel. Oxygen levels may appear satisfactory, but the amount of oxygen actually reaching the embryos can be inadequate because fine sediments block the intragravel flow and because the breakdown of organic material uses up the oxygen."

From the foregoing, with such high recorded levels of dissolved oxygen one might conclude that at the given temperature ranges recorded for Spring Run, *(Ref. 2 & 3),* there are adequate levels of dissolved oxygen for the *growth and survival* of rainbow trout and other aquatic life. *While this may be true for the water column, the question begs to be asked, is this also true for the stream bed and substrata where eggs incubate and the benthic community lives.*

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Acidity (pH), Chemical Characteristics, Parasites, Diseases and Toxins:

As reported, in *the paper*, median pH levels in Spring Run range from a high of 7.9 to a low of 7.5, putting them slightly on the alkaline side. Data compiled by various experts in *the book*, indicates pH levels from 7 to 8 to be optimum for the growth and survival of rainbow trout.

Other chemical characteristics such as phosphorus, nitrogen and BOD5 are reported in *the paper,* but were not cited as being detrimental to the incubation, growth and survival of rainbow, brook or brown trout. These other chemical characteristics are not discussed in *the book,* so further comment cannot be made about them by the writer. The reader is directed however, to *Molony, Brett. 2001. Environmental requirements and tolerances of Rainbow trout (Oncorhynchus mykiss) and Brown trout (Salmo trutta) with special reference to Western Australia: A review. Fisheries Research Report of Western Australia 130:1-28*. Available at the following website: http://www.fish.wa.gov.au/docs/frr/frr130/frr130.pdf . Although this paper was written with respect to Western Australia it contains many general references applicable to other parts of the world and is a good source of data related to the subject matter.

Trout are subject to a number of parasites and diseases. These parasites and diseases are described in *the book*. While the possibility does exist that these parasites and diseases are or have been present in Spring Run, to the writer's knowledge the Hatchery has never been closed down due to their presence and given the absence of sightings of sick fish within the catch and release section, one might conclude that they are not, or at least have not been a recent problem.

It has been speculated that perhaps the poultry industry within the Spring Run drainage might be responsible for the release of toxins detrimental to the Spring Run fishery. While this may be possible, the writer discounts this theory for the following reasons:

Toxins normally associated with the poultry industry, have been reported to be primarily carried by runoff occurring over the areas inhabited by poultry or used for the storage of litter, the latter being the principal source. There are three possible sources of poultry pollution located above the catch and release section and below the hatchery. The first is a chicken coop located immediately adjacent to the southwesterly bank of the stream about half way between the top of the catch and release section and the hatchery, and the second and third sites are well off stream to the northeast. Runoff from the second and third sites reaches Spring Run via three intermittent drainage ditches. One ditch is located above the first mentioned chicken coop and two below it. Within this stream reach, and more particularly that portion of the reach extending from the second house above the end of the catch and release section (approximately 150 to 200 yards) and the bridge (approximately 600 yards) leading to the first mentioned chicken coop, lives the vestige of what was commonplace to the catch and release section, a population of large rainbow trout from 16 to 24 inches or more in length. During the placement of the 2007 erosion and

sediment control measures, the writer stood on the bridge behind the subject second house and counted eighteen rainbow trout in the 16 to 24 inch plus range. The section of stream extending from the second house to the chicken coop bridge also contains a high number of large trout. A conversation with the owner of the house revealed that he feeds the trout dog food each day as he crosses the bridge to feed his dog

Now, given the fact that these trout *(the miner's canary)* grow and survive in this reach, the first area subject to possible toxins which might emanate from the poultry farms, one might conclude that poultry toxins are not, or at least do not appear to be the cause of the decline of the Spring Run fishery.

In summary, it might be concluded that neither *existing* acidity values, other chemical characteristics, parasites, diseases or toxins appear to be detrimental to the incubation and/or growth and survival of rainbow trout in Spring Run, nor do they appear to be the cause of the decline of the fishery.

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Water Temperature:

Spring Run water temperatures have been documented by two sources; the first by continuous gage readings for the period extending from June 01, 2007 to September 13, 2007 with the gage readings having been recorded on the same day at both sites 1.6 and 0.4, and the second having been recorded by the writer for the period extending from January 01, 2006 to the December 31, 2008 with the readings having been taken early in the day, approximately half way between the top and bottom of the catch and release section at the number 4 marker.

The resultant data has been compiled and charted in two separate spreadsheets; the first being Spring Run Water Temperatures (Gage Data Jun-07 to Sept-07) *(Ref. 2),* and the second being Spring Run Air and Water Temperatures 2006-2008 *(Ref. 3).* The continuous gage readings from the first source indicate a daily differential of approximately 1 to 1.5 degrees between the top and bottom sections of the catch and release area (sites 1.6 and 0.4 respectively), with temperatures ranging from a high of 64.3°F to a low of 53.1°F. These temperatures representing daily extremes recorded during the summer months of 2007. The second source indicates an *early day* minimum seasonal temperature of 44°F and a maximum of 58°F for the period extending from January 01, 2006 to December 31, 2008. The 44°F reading having been recorded when the air temperature was 14°F and the 58°F reading having been recorded when the air temperature was 68°F.

Water temperatures were only briefly referred to in *the paper*, probably because recorded values are well within acceptable ranges for spawning, incubation and/or growth and survival of rainbow trout. *The book* indicates temperature levels from 5°C (41°F) to 15°C (59°F) and 13°C (55°F) to 21°C (70°F) to be optimum for spawning, incubation, growth and survival of rainbow trout.

From this one might conclude that Spring Run's water temperatures are well within the optimum range for spawning, incubation, growth and survival of the rainbow trout population.

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Rainfall, Stream Flows and Sedimentation:

Spring Runs *base flows* are provided by the spring located above the Spring Run Trout Hatchery. Almost all of the spring flows are captured at the source by a control structure and diverted through a pipe system to and through the hatchery. By-pass flows, which are nominal at best, are allowed to flow down the original stream bed, by-passing the hatchery.

The writer believes that due to the existing topography and geology, *direct runoff* resulting from either rainfall or snowmelt is a short term contributor to the flows in Spring Run. Therefore, it can be concluded that in the absence of any long term tributary flows entering the catch and release section of Spring Run, all or most of the flows from the spring pass through the hatchery.

Rainfall records for the period extending from January 1998 to January 2009, as charted in *Reference 4,* were obtained from the following two sources:

1. The Petersburg Airport, Weather Station KW99.

2. The Mathis Weather Station.

The Petersburg Airport Weather Station KW99 is located approximately 5.5 miles west, northwest of the Spring Run catch and release fishery. Unfortunately, rainfall data for this weather station is not available on line for those years preceding 2004.

The Mathis Weather Station is located approximately 12.5 miles east, southeast of the fishery. This weather station although relatively close to Spring Run is three mountain ranges east of the fishery so the total rainfall could vary from that recorded at the Petersburg airport. However, the general precipitation patterns appear to be similar in nature.

Rainfall data obtained from the Petersburg Weather Station indicates that September of 2004 produced a total of 6.34 inches of rainfall with 2.17 inches falling on the 8th and 2.64 inches falling on the 28th. August 2005, produced a total of 3.74 inches of rainfall with 1.02 inches falling on the 9th. October 2005, produced a total of 3.75 inches of rainfall with 1.01 inches falling on the 7th and 0.97 inches falling on the 21st. October 2006, produced a total of 3.78 inches of rainfall with 1.66 inches falling on the 6th and 0.92 inches falling on the 17th.

Spring Run flows, recorded at site 0.4 are reported in *the paper* for the period extending from April 2005 to September 2007. These flows vary from a low of approximately 8 or 9 cubic feet per second (c.f.s.) to a high of approximately 41 or 42 c.f.s. If these high flows occurred on or near the 9th of August 2005, one might conclude that *1 inch of high intensity short duration rainfall* could produce runoff, which in turn will provide higher flows with resultant scouring velocities. The operative words being "*high intensity short duration rainfall"*, for 1 inch of rainfall over two or three hours is unlikely to produce runoff. Assuming this to be true it would appear that scouring velocities might have occurred on the 8th and 28th of September, 2004, the 9th of August, 2005 and the 6th of October, 2006, if the 1 inch or more of recorded rainfall was in fact of *high intensity and short duration.*

Further review of the charted rainfall data for Petersburg, extending from 2004 thru 2008, indicates that rainfall from September thru March of these years probably produced little or no runoff events. Unfortunately, this time period coincides with the spawning and incubation periods for the Spring Run rainbow trout population. So, in the absence of snowfall data, it might be concluded that there were no high flow, sediment scouring velocities during this period.

The writer having been present on Spring Run, periodically since 2000, can attest to the fact that base flows have always appeared to be adequate for the growth and survival of rainbow trout, but questions if the 8 or 9 c.f.s. flows are sufficient to keep suspended solids emanating from the hatchery's *"cleanout plumes"*, in suspension. Given the absence of sediment flushing flows resulting from *direct runoff* during the spawning and incubation period of from September to April, one might wonder if the settling out of these suspended solids is not diminishing the amount of dissolved oxygen available to incubating eggs, thereby suffocating the embryo. Even if the embryo do hatch, the fry must still be able to escape through the sediment laden gravel in the redd, to the surface where they begin their lives in the water column.

In order to help minimize sedimentation resulting from *direct runoff* into Spring Run, an Erosion and Sediment Control Plan was prepared in August of 2006 by the Friends of Spring Run's Wild Trout. The plan, which entailed the use of rock check dams, log/brush/filter fabric check dams, rock culvert inlet protection, rock plunge pools, stone rip rap, sediment basins, seeding and planting of tree seedlings was implemented by the Friends of Spring Run's Wild Trout in August of 2006 with work continuing through August of 2007. These measures were employed in all drainage ditches discharging into Spring Run, extending from just below the middle of the catch and release section to the last ditch entering Spring Run from the northeast just below the hatchery. Approximately 110 tons of quarried rock, 150 man-hours, and 35 hours of tractor/bull dozer time were expended in this effort. Prior to this effort, erosion and sediment control measures were employed in the stream bed just above the spring. These measures included laying back the eroded stream banks, rip rapping of the banks, log check dams, tree planting and seeding.

In 2008, in a continuing effort to control offsite erosion and sedimentation attributed to roadside ditches, Friends of Spring Run's Wild Trout were instrumental in soliciting the cooperation of the West Virginia Department of Highways. This effort involved placement of rock culvert inlet protection, rock outlet plunge pools and stone rip rap.

While not totally eliminating sedimentation, all of the above described measures have been successful in helping to minimize the amount of water borne sediments entering Spring Run as a result of direct runoff. This can be witnessed by the large amount of sediments trapped behind the check dams, culvert inlet protection and in the culvert outlet plunge pools.

Another offsite source of sediments is the stream section immediately above and adjacent to the upper end of the catch and release fishery. Prior to 2008, approximately 100 yards or so of stream bank were constantly being torn up by cattle entering the stream to cool down and water. In 2008, a new owner took possession of this farm, removed the cattle and indicated his desires to improve the habitat in this section. These improvements, which might include armoring of the stream banks to prevent crumbling and further erosion of the soft banks, are critical. They must be made however, discriminately and with care so as to avoid a hard edge along the entire stream bank which would preclude the growth of desirable watercress plants. Although no physical manmade improvements were made in 2008, this section of the stream has started to heal itself as can be witnessed by the healthy crop of watercress.

There is a serious need for additional erosion and sediment control measures at the point where the old channel extends from the spring head diversion structure down to and along the roadway leading to the hatchery. It is hoped that this work will be considered for completion by the owners and operators of the Spring Run Hatchery.

The paper speaks of recorded values of suspended solids, but points out that sampling was avoided on hatchery clean out days in order to avoid the *"cleanout plume"*. While this may result in the collection of better normal water column characteristics, the writer wonders if it adequately addresses the issue of deposition of sediments resulting from this *"cleanout plume"*. Flows, in these *"cleanout plumes"*, prior to June of 2007 when the hatchery's filtration clarifiers came on line were laden with suspended solids. Sludge and other pollutants lying in the bottom of the hatchery's trout rearing pens were swept, washed and discharged directly into Spring Run. Under normal flow conditions the writer can attest to the fact that the water in Spring Run appeared to be crystal clear. However, having been there on several clean out days, he can also attest to the fact the water in these *"cleanout plumes"*, was dark gray and so laden with suspended solids that visibility was reduced to zero. This effluent however, was relatively fresh *sewage* and did not have a particularly offensive order. After June of 2007 when the hatchery clarifiers came on line, the *"cleanout plumes"*, became a lighter gray, probably from a reduction in suspended solids, but visibility was still limited to 12 to 18 inches and the smell was very offensive, an indication of *purtriseptic sewage,* resulting from extended detention of the effluent in the clarifiers' holding tanks.

It has been suggested that a wetlands be constructed in the natural depression located on the west side of Spring Run in the upper reach of the catch and release section, and that the effluent from the hatchery's treatment facility be piped directly into this wetlands. These wetlands would serve as a secondary level of treatment for the effluent from the hatchery's treatment facility. This secondary treatment facility could all but eliminate the discharge plume as a direct source of pollution of both the water column and the benthics. The feasibility of constructing such a facility should be carefully studied, and associated cost established. If determined to be viable, funding for the project should be provided. The writer sees considerable merit in this proposal and suggests that it be pursued.

If not already being employed, it is suggested that a flocculent be used in the hatchery's clarifiers to increase the settlement rate of suspended solids, which would in turn allow for a shorter detention period, resulting in a less offensive purtriseptic effluent.

That said, the writer, can't help but believe that sediments resulting from the *"cleanout plumes"*, coupled with low stream flows, have greatly impacted the benthic community, reducing the available food source and effectively reducing the number of young trout in Spring Run due to suffocation of the embryos during incubation and escape of the fry from their redds.

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Predation:

Predation by birds, mammals and man has always occurred on Spring Run. The writer has on occasion seen great blue herons, kingfishers, mink and raccoons in the catch and release sections of Spring Run, all known to be fish eaters to one extent or the other. While great blue herons, kingfishers and mink are effective fishermen, raccoons are not. Poaching by man has happened in the past, as it does to some extent today. *None of these forms of predation however, had a significant impact on the rainbow trout fishery prior to 2000.*

In the eight years that the writer has been privileged to fish Spring Run, he has seen or caught approximately a dozen or so wounded or dead trout. Two of these dead trout had large hooks in them, indicating poaching, the rest contained punctures attributed to either great blue herons or kingfishers.

While it is true that these observations are occasional in nature, one might still speculate that predation has and continues to play only a minor role in the decline of the fishery.

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Stocking of Rainbow Trout:

Over the years, Spring Run and South Mill Creek have been stocked with brown, brook and rainbow trout. *The 2005 report* advises that *"the stocking of catchable-sized trout was discontinued in 1987." The 2008 report* alludes to, but gives no specific dates, for "*the stocking and subsequent immigration, of age-1 rainbow trout from South Mill Creek into Spring Run*. For a history of these stocking events one is directed to *"Spring Run 1966-2008, Jerry Burke's Recollections" (Ref. 8).* However, in the more recent past (since 2000) the writer does not know of any *direct* rainbow trout stocking events in the catch and release section that would affect the number of fish to be found there.

Prior to June 2007, *inadvertent* stocking of rainbow trout by the escape of fish from the Spring Run Hatchery has been known to occur. The best evidence of this *inadvertent* stocking was the occasional sighting and catching of golden trout, a hybrid rainbow species, in the catch and release sections. Since June, 2007 when the hatchery's treatment facilities came on line, this *inadvertent* stocking appears to have stopped, as can be witnessed by the fact that no golden

trout were observed or caught in the catch and release section of Spring Run in 2008. (See *Ref. 5* for a summary of Golden trout caught between 2005 and 2008 inclusive.)
It has been postulated, that the cessation of this *inadvertent* stocking by the escape of trout from the hatchery, will have a *significant impact* on the rainbow trout population in the catch and release section of Spring Run. While this may be true to a lesser degree, the writer does not believe that it will have a *significant impact* for the following reasons:

1. The number of large rainbow trout has steadily declined since 2000, even before the new hatchery treatment facility effectively stopped the *inadvertent* stocking.

2. It is not believed that the trout that did escape from the hatchery were able to survive for long periods of time, given the absence of daily feedings, as may be witnessed by the short duration of sightings and catching of the golden trout that did escape from the hatchery.

Other fin worn trout, a result of having been reared in the hatchery, have been caught, but again these fish were not caught repeatedly or for long periods of time. *The book* speaks of these hatchery trout as *"hand-fed innocents"* and goes on to say*" Shetter in 1944, Flick and Webster in 1964, and Bachman in 1984 have reported that fish from populations maintained in hatcheries for a long time had poor survival rates when introduced into the wild. Behavioral differences often are believed to partly responsible for this phenomenon."*

The Spring Run Hatchery is a trout rearing facility, and as such does not have large brooder stock. Therefore, the fish that have escaped in the past, are probably small to stockable size fish, mostly fingerlings to 12 inch in length and not the 14 to 24 inch fish that were once so common to the catch and release section.

In conclusion, it is the writer's belief that in the past, the *inadvertent stocking,* by the escape of rainbow trout from the hatchery, played only a minor role in the number of trout and/or the number of large rainbow trout to be found in the catch and release section of Spring Run. Furthermore, the end of this *inadvertent stocking* in June of 2007 when the hatchery's effluent treatment facility came on line will not have a significant impact on the recovery of this fishery.

The writer is certain that others will challenge his opinion with respect to the role that this *inadvertent stocking* of rainbow trout, had or will have on the number of fish and/or the number of large fish to be found in the catch and release section of Spring Run. He suggests however, that it be proved or disproved by a study to be performed utilizing the stocking of various age group *tagged* Spring Run Hatchery rainbow trout. This would provide a means by which the *tagged* rainbows can be studied so that their survival rates, growth rates, migratory habits and spawning habits can be better understood or established.

On the subject of other studies which might be performed to better comprehend this fishery, Charles M. Heartwell the then Supervisor of Hatcheries for the West Virginia Department of Natural Resources wrote the following in a letter to Jerry Burke dated November 15, 1984:

"There are undoubtedly a number of projects that warrant research at the masters or doctoral levels as you mentioned. A number of projects which come quickly to mind would include benthos of a limestone stream, trout growth in a rich environment - is a clear annulus even formed under the conditions in Spring Run, spawning duration and success of the trout in Spring Run, strain differences in resident fish - could be probably achieved by acrylamids of starch gel analysis of the trout enzyme systems. You probably have additional ideas which would be equally valid and interesting."

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Spawning, Incubation, Survival and Mortality:

In their natural habitat, rainbow trout are spring spawners. However, the forerunners of the Spring Run species of rainbow trout were hybridized and manipulated by hatchery operators, such that they are now predominately fall spawners. Over the years Spring Run has had a large self sustaining population of rainbow trout which can be attributed to spawning and natural reproduction. Since 2000, the writer has personally witnessed the steady decline in the number of larger rainbow trout in the catch and release sections of Spring Run.

As noted in *the book, "Female rainbow usually are larger than males because females typically grow faster and often reach maturity a year later than males. Adults can be from about 13 centimeters (5 to 6 inches) long, weighing a few ounces, to well over a meter (40 inches) in length, weighing 24 kilograms (52 pounds)! "Trout that are genetically programmed for maturity at seven or eight years of age have a much greater opportunity to reach a larger size than do those programmed to mature at two or three years of age."* The writer has seen spawning rainbows varying in size from approximately 12 inches to over 24 inches, but has no knowledge of the age of such fish or how long it takes Spring Run rainbows to reach sexual maturity.

The book further advises that *"The number of eggs deposited by the female varies directly with her size. A fish about 13 centimeters (5 to 6 inches) long will have fewer than 200 eggs, while the larger females are capable of producing 2,000 eggs per kilogram (900 eggs per pound of body weight)." "Salmonids have spawned when water temperatures were as low as 1°C (34°F) and as high as 20°C (68°F), but usually the temperatures range from 6°C (43°F) to 15°C (59°F) when they spawn."* As can be seen in the spreadsheet entitled, *Spring Run Air and Water Temperatures 2006-2008 (Ref. 3),* Spring Run water temperatures during the fall and early winter are ideal for spawning.

It is said in *the book* that "*brook trout"* are the most studied of all the salmonids and that *"more than 80 percent of the eggs in a brook trout redd will hatch unless siltation smothers them." "Brash showed that only 1 to 2 percent of the fry in streams survived to become nine-month-old fingerlings. But with an increase in size and age, it is common for the survival rate to improve. Brash found that 39 percent of the fingerlings lived to ages 1 to 2, and 73 percent of those lived to ages 2 to 3. In many populations, however, brook trout are short lived, and Brash noted a decrease in survival to 39 percent at ages 3 to 4.*

This type of detailed data does not appear to be available for rainbow trout, but in *the book*, Barnhart speaks of steelhead in this manner*,"Under normal stream conditions, perhaps 80 percent of the fertilized eggs survive to at least the emerged-fry stage, a long-term study of steelhead in a small California costal stream by Shapovalov and Taft showed a mean survival rate of only 3 percent overall from egg to eventual downstream migration."* Steelhead trout, *Oncorhynchus mykiss* are described in the book as *"simply a migratory strain of rainbow trout."* The age of downstream migrating steelhead varies from 1 to 4 years.

Spring Run rainbows, like most other salmonids, spawn in the transitional areas between pools and riffles where the water velocity is accelerating, water is forced through the substrate by the convex slope of the streambed and gravel is relatively easy to excavate and free of silt and debris. *The book* advises *"The spawning act of depositing eggs and milt in egg pockets may be repeated several times until all the eggs have been deposited. In streams with ample areas of suitable gravel, all the egg pockets are often made in a single redd, but in streams with smaller patches of gravel, the female may construct and spawn in more that one redd."*

During the period extending from September through December of 2008, sixty-six redds were observed in the catch and release section of Spring Run. The majority of these redds were observed in the upper reaches (sections five through nine) of the catch and release section. The writer has personally observed as many as six redds in the tailout of one pool located just below the fence line marking the end of section nine and the catch and release section. Brook trout

have been observed to spawn during this same period, though the number of spawning pairs, observed by the writer never exceeded two. Brown trout also spawn during this same period; however, the writer has never seen spawning brown trout in Spring Run. The question as to how many of the sixty-six redds counted during the 2008 spawning season, were made by the same spawning female is unknown.

With this in mind one can see a parallel between the survival rate of brook and rainbow trout, so it would be interesting to assume that the survival data for brook trout applies to rainbows and see what the survival rate would be from the 66 redds previously mentioned.

For the sake of this analysis let's assume the following:

Of the 66 redds, 2 were made by brook trout, leaving 64 rainbow redds.

Of these 64 redds only 75% were viable (capable of producing fry), resulting in 48 viable redds

The average spawning female was approximately 14 to 15 inches in length and weighed 1.5 lbs, with each 1.5 lb. female being capable of producing 900 eggs per pound of body weight.

This results in a total of 48 x (1.5 x 900) = 64,800 eggs

Of this number of eggs 80% hatched, resulting in 64,800 x 0.80 = 51,840 fry.

Of this 51,840 fry only 1.5% live to 9 months of age, leaving 51,840 x 0.015 = 778 fry

Of this number only 39% live to ages 1 to 2, leaving 778 x 0.39 = 303 fingerlings

Of this number only 73% live to ages 2 to 3, resulting in 303 x 0.73 = 221 adult fish.

Of this number only 39% live to over 3 years in age, leaving a grand total of 221 x 0.39 = 87 adults over 3 years in age.

If the percentage of viable redds falls to 50, there will only be 58 adult fish over 3 years of age.

So the mortality rate would be approximately 100 – ((86/64,800) x 100) or 99.87%. How would you like to be a trout egg??

Growth rate is such a food dependent variable that little has been written on the subject. On this subject *the book* notes the following; *"Moyle reports that in typical small California streams, rainbow will reach 11 to 17 centimeters (4 to 7 inches) total length in their first year, 14 to 21 centimeters (6 to 8 inches) in their second, and 20 to 23 centimeters (8 to 9 inches) in their third year, at which time most will be sexually mature."*

The book further advises, *"Redds that remain intact during incubation may become less suitable for embryos if inorganic fine sediments and organic materials are deposited in the interstitial spaces between the larger particles. The fine particles impede the movement of water and alevins in the redd and organic material consumes oxygen during decomposition. Survival of embryos will decrease as apparent velocities, an indication of the amount of dissolved oxygen reaching the embryos decreases. Organic matter that gets deposited in the redd and decomposes, is probably the most important factor causing reduced levels of oxygen. Relatively small amounts of organic material can cause a reduction in levels of dissolved oxygen if water velocities in the redd are low."* The quality of the gravel in the redd during incubation and emergence of the fry is therefore super critical.

As previously noted, Spring Run flows, recorded at site 0.4 are reported in *the paper* for the period extending from April 2005 to September 2007. As recorded, September flows at this site

are approximately 8 or 9 cubic feet per second (c.f.s.). In the absence of other additional tributary flows resulting from *direct runoff,* it would appear logical that these flows occur through out the catch and release sections. A review of the precipitation data recorded in *Reference 4* indicates that recent year rainfall levels during the spawning and incubation periods extending from September through April are nominal at best. These low rainfall levels have the following impact on the flows in Spring Run. First, they do not significantly increase the flows emanating from the spring and second, they do not produce enough direct runoff to create higher water levels with resulting flushing or scouring velocities, so critical to the redds during the incubation period.

So once again, the question begs to be asked, is or was the large amounts of suspended solids in the hatchery *"cleanout plumes",* prior to June, 2007, combined with low flows during the spawning and incubation periods, the prime cause for the reduction of life in the benthic community and the number of rainbow trout to be found in Spring Run. The writer believes this to be true, but suggest that this hypothesis can be better qualified and/or quantified with at least two more years of water chemistry, macroinvertebrate sampling, electro-fishing surveys and anglers catch records.

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Trout Density:

Spring Run is home to three species of salomids. Listed in their order of dominance they are: Rainbow Trout *(Oncorhynchus mykiss),* Brook Trout *(Salvelinus fontinalis)* and Brown Trout *(Salmo trutta).* Spring Run rainbow trout, subject of this paper, are not indigenous to the eastern United States but rather were stocked in these waters sometime in the past.

The best recognized measure of fish density is determined by triple pass electro-fishing techniques. This technique was performed by the West Virginia Division of Natural Resources on Spring Run in May, 2005, September, 2005 and April, 2008.

The *2005 report* contains data related to an unpublished 1978 electro-fishing survey performed near the confluence of Spring Run with South Mill Creek. Table 3, as contained in the *2005 report* is a tabulation of the results of the 1978 and 2005 electro-fishing surveys. Of particular interest, is the fall 2005 survey which was conducted near the same site as the 1978 survey. This study shows that in 1978 a total of 11 different species of fish where found at the test site, with this number diminishing to 6 species in the fall of 2005, an apparent loss of 5 species. In this report, the number of fish per 100 meters was determined to be 3,010 in 1978 and 955 in the fall of 2005, a loss of 2,055 specimens. The *2005 report* furthermore indicates the 1978 biomass to be 311 lbs/acre and the fall 2005 biomass to be 148.7 lbs/acre a reduction in biomass of approximately 162 lbs /acre. The environmental causes of these drastic reductions in numbers, are not discussed in the *2005 report*, but are possibly a general indication of a change in health of the eco-system.

The *2008 report* provides a comparison of the May 2005 and April 2008 electro-fishing surveys. The sampling site in both surveys being a 107 meter long section beginning at the lower end of the 4th reach of the catch and release section.

Within this report, the following comparisons are to be found*:*

"Upon reviewing sample data collected from the sample site nested in beat 4 on May 2005 and April 2008, some substantial differences were observed. The observed number of rainbow trout declined over the period between the two samples from 112 to 38 individuals per 100m (Tables 1 & 2). Additionally, the mean length (mm) of rainbow trout in this stretch declined from 156 – 133 (Tables 1 & 2).

There were also rather negligible declines in the observed abundances of Blue Ridge sculpin (4 to 1), brown trout, and brook trout - neither of which was collected during the April 2008 effort – between the May 2005 and April 2008 samples (Tables 1 & 2). Nevertheless, two more species were collected and abundances of all species were higher in the May 2005 than in the April 2008 sample (Tables 1 & 2).

Upon inspection of the length-frequency histograms for rainbow trout collected during May 2005 and April 2008 (Figures 2 &3 respectively), one can see a shift from an abundance of 120 – 190mm fish in May 2005 to smaller (50 – 90mm) fish in April 2008."

The significance of this shift is that it indicates an apparent loss of rainbow trout within the 120 mm to 190 mm range, assumed to be the 7 to 18 month old age group. The apparent loss of this age group will surely impact the future of the fishery.

Without question, the comparisons found in the *2008 report* indicate a significant decline in the number and size of rainbow trout to be found in the catch and release section of Spring Run.

The following statement was made in *the 2005 report*

"Anglers in Spring Run are interested in increasing the number of large fish in the catch. Due to the high density of rainbow trout in Spring Run, angler may want to selectively harvest some of the small trout especially in the 8 and 9 inch categories. The reduction of fishes in this size group would increase food availability and result in more fish reaching larger size classes. In addition, anglers throughout the region know Spring Run is a world class fishery and landings on large trout are common. Therefore, the removal of large fish by unauthorized angler harvest is a consideration and would cause long term reduction in the number of large trout throughout the stream. The WVDNR is committed to conducting additional surveys to characterize the Spring Run trout population and spatial distribution of the size frequency."

Although this may be true to some extent, this statement might be challenged by the following:

1. Spring Run rainbow trout are not being *stunted* by the lack of food such as the Seneca Creek rainbows above the waterfall are.

2. The reduction in the number of rainbow trout found in the control section in April, 2008, would indicate a natural culling of smaller fish.

3. The fact that poaching has always occurred in the catch and release section of Spring Run and that historically it has not appreciably affected the number of larger fish.

4. The book speaks to the issue of increased food availability as follows:

"Can trout in streams reduce the numbers of their invertebrate prey enough to limit their growth and survival? Because trout feed primarily on drifting organisms, at least a portion of which are likely to be surplus individuals emigrating from the population, it seems unlikely that their feeding could markedly affect benthic invertebrate abundance in streams."

5. For the sake of argument, lets assume that 25 percent of the trout 8 or 9 inches in length (2 to 3 years in age) are removed as suggested above, and see what impact it has in the mortality analysis made in *Spawning, Incubation, Survival and Mortality* section of this paper.

Picking up at the following:

Of this number only 39% live to over 3 years in age, leaving a grand total of 221 x 0.39 = 87adults over 3 years in age.

Removal of 25% of these adult fish results in, 87 x 0.75 = 65 fish remaining to continue the natural reproduction cycles. So as suggested, these fish might grow larger, but the question remaining to be answered is, is this number sufficient to continue the natural reproduction cycles and the re-population of rainbow trout in the catch and release section.

Two sources of Spring Run fishermen's catch and release data, extending from 1966 to December 31, 2008 have been summarized and charted in *Reference 5.* These sources are:

1. Detailed catch and release card data recorded by Spring Run fisherman for each reach within the catch and release section extending from April, 2005 to December 31, 2008.

2. Jerry Burke's journal entries extending from 1966 to December 31, 2008.

Because the same fish may have been caught a number of times, one should not consider the number of rainbow trout caught during any particular period to be an indication of the actual density of rainbow trout, but rather a general indication of their density. As an example, Jerry Burke's journal entries speaks of catching the 25" pig , as she was affectionately referred to, seven times and #46 tagged fish a total of eight times.

Burke's journal entries are of particular interest, inasmuch as they extend for the longest period of time. The data appears to indicate cyclic occurrences of larger rainbow trout in the catch and release sections. These observations may be summarized as follows:

	1966-1988	1989-1993	1994-1999	2000-2005	2205-2008
Avg. % <14":	81.8	52.5	78.5	71.4	86.2
Avg. % >14":	18.2	47.5	21.5	28.6	13.8
Avg. % >18":	3.2	2.1	0.7	2.1	0.70

A review of the chart entitled "*Percentage of 0 to 7 inch Rainbow Trout per Section",* as contained in *Reference 5,* indicates that prior to 2008, the percentages per section were more or less uniform, ascending from Section 0 to Section 5, and then descending to Section 9. In 2008, there was an overall increase in the percentage of 0 to 7 inch rainbow trout reported (from a prior year average of approximately 33% to 47%). The distribution still increased from Section 0 to Section 5 and descended to Section 9, however, there was a population shift with the distribution percentages increasing from Section 5 to Section 9. This shift can probably be attributed to the decrease in the percentage of larger fish and the hierarchy principal.

From these observations one might conclude the following:

1. In general, there has always been a dominance of rainbow trout less than 14 inches in length.

2. As the percentage of fish less than 14 inches in length decreases, the percentage of fish larger than 14 inches increases.

3. As the percentage of fish larger than 14 inches decreases, the percentage of fish in the 0 to 7 inch range migrate towards the upper reaches extending from Section 5 to Section 9.

From the foregoing, it is apparent that size occurrences are and have been cyclic in nature and that the number of fish 14 inches and greater in length has declined since 2000. The removal of rainbow trout in the 8 or 9 inch age class as suggested in *the 2005 report* is questioned. If this age class is reduced in number, will there be a sufficient number of spawning size fish remaining to carry on the natural reproduction cycle?

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Food Sources:

In September of 1995, Steve Hiner, a Virginia Tech entomologist, sampled the macro-invertebrate population in Section 6, and reported a diverse and heavy population of stoneflies (yellow sallies), mayflies, caddis flies, scud, aquatic worms and more. Subsequent to his sampling, Hiner reported that during his time at Spring Run he witnessed a great hatch of Ephemerella, more commonly known as sulfurs.

In August of 2004, Hiner returned to Spring Run to perform another macro-invertebrate study, at which time he sampled Section 1 and re-sampled Sections 6. In his findings Hiner stated, “the genus Ephemerella was common when I visited in 1995. Where are the Ephemerella now?”

The following observations were made by those that were fortunate enough to have fished Spring Run prior to the apparent decline in the macro-invertebrate population:

1. Prior to 2000, there was a mid-May to early June "sulfur" hatch, this is no longer the case. Also disappearing around the same time was the "hatch" of yellowish flies which hovered above the plunge pools near dusk on late spring-summer evenings; gradually diminishing in numbers during the summer. These were probably yellow sally stoneflies.

2. In year's past it was not unusual for a vehicle's windshield to become bug spattered when driving along Spring Run Road at dusk during late spring, and early summer. This was particularly true when the road was wet from rain. More recently, no less than 3 non-fishermen, individuals who travel Spring Run Road regularly, mentioned that they had not had bugs on their windshields for a long time.

3. During the stream restoration years following the 1985 flood, a large number of macroinvertebrates were observed as rocks were moved. This is no longer the case.

4. In the early years, fishermen were so focused on imitating the ever abundant mayflies, caddis flies and stoneflies that scuds imitations were only used on an occasional basis.

5. In the early years, the abundance of mayflies, caddis flies and stoneflies was reflected in the weight of the trout as determined by their length to girth ratio. In those early years rainbows were a lot heavier, with some of the recorded weights being as follows:

Length	Weight
18.00 inches	3 lbs
18.00 inches	2 lbs. 14 oz
19.00 inches	3 lbs. 8 oz.
21.25 inches	4 lbs. 6 oz.

These were summer caught fish and not those taken during the spawning period when the fish were laden with eggs. This is no longer the case for most fish caught these days do not have the full girths previously observed.

It is unfortunate, that additional detailed benthic study data is not available for prior years. Such data might better serve to document the decline in the number of mayflies and stoneflies to be found in the catch and release sections of Spring Run. For a general discussion of the past

abundance of mayflies and stone flies one is directed to Jerry Burke's 1966 to 2008 Recollections *(Ref. 8).*

Reference 6 is a spreadsheet of all the benthic studies performed by Tim Craddock, et al for the period extending from May, 2005 to October, 2008. Also included in this spreadsheet, is the results of an isolated study by Tim Craddock dated July, 2003.

The following data summaries the results of these studies for those sampling sites (0.4 and 1.6 respectively) located within the catch and release section of Spring Run:

CLASS/Order (Common Name)	2003 Percentages	2005 to 2008 Percentage
CRUSTACEA/Amphipoda (Scuds)	34.29	33.55
INSECTA/Diptera (True flies) (Midges)	28.13	29.47
INSECTA/Ephemeroptrea (Mayflies)	27.47	16.90
INSECTA/Trichoptera (Caddisflies)	7.91	12.41
INSECTA/Coleoptera (Beetles)	0.88	5.72
(Aquatic Worms and Leeches)	0.00	0.93
INSECTA/Plecoptera (Stoneflies)	1.32	0.88
CRUSTACEA/Decapoda (Crayfish)	0.00	0.05
Gastropoda/ (Snails & Limpets)	0.00	0.05
BIVALVIA/ (Clams)	0.00	0.02
INSECTA/Megaloptera (Alderfly/Fishfly)	0.00	0.02
INSECTA/Odonata	0.00	0.00

As can be seen from this summary data, scuds and midges have been and still are the dominate species. There appears to be a decrease in mayflies and stone flies and an increase in caddis, these differences, may however be attributed to the fact that the 2003 data resulted from one survey while the 2005 to 2008 data is a compilation of studies completed within that time period.

Reference 7 is a spreadsheet summarizing reach by reach gastric aspirate studies performed by Curtis Winter, on March 10, 2006 and May 18, 2006. The study does not include data related to the number, or size of the fish from which the gastric aspirates were obtained. The results of these combined studies are as follows:

CLASS/Order (Common Name)	Percentages
CRUSTACEA/Amphipoda (Scuds)	11.35
INSECTA/Diptera (True flies) (Midges)	48.03
INSECTA/Ephemeroptrea (Mayflies)	34.93
INSECTA/Trichoptera (Caddisflies)	4.80

TERRESTRIALS 0.87

Tim Craddock has speculated that even though scuds are the most dominate species they are not free swimmers, so they are not readily available as a food source to the Spring Run rainbow trout population. Curt Winter's gastric aspirate studies appear to substantiate this speculation.

The book characterizes a rainbow trout's diet as being primarily insectivorous, and from the gastric aspirate surveys performed by Curtis Winter in March and May of 2006 *(Ref. 7*) the writer would have to agree with this statement.

Item 5, page 4 of *the paper* posses the following questions about preferences of the Spring Run trout population:

1. "Why do trout, especially larger fish, favor the upper part of the fly-fishing section?" The answer to this question would appear to be partially answered by Winter's gastric aspirate study *(Ref. 7)* and the benthic studies contained in *Reference 6*. A review of this data indicates that the upper reaches, sections 8 and 9 in particular have the largest food source *available* to the Spring Run rainbow trout population. Also the upper reaches, extending from section 6 through 9 have the highest density of drop and lateral structures, offering better cover and spawning water.

2. "Is there a relationship between distribution of benthic invertebrates in the stream and trout distribution?" With respect to this issue *the book* advises as follows:

"Trout cannot afford to expand energy in continual agonistic "showdowns" throughout the growing season, so they rely on social structure. A short period of testing in the spring determines who is first, second, third and so on down the pecking order at the various foraging sites and a social "force field" surrounding each trout indicates its position in the hierarchy."

"Natural selection dictates that only those trout that maintain a positive balance in the "economics of feeding can survive to reproduce. Therefore, if these fish are to grow sufficiently to reproduce, they must minimize the cost of capturing food and at the same time maximize their energy gain from the food available."

From this discussion and a review of the data to be found in *Reference 6 and 7* one might conclude that in order to survive and grow, trout must go where the most available food source exists and that their natural hierarchy would position the larger fish in the areas where food is most abundant. So there appears to be a direct relationship between the distribution of *available* benthic invertebrates in the stream and trout distribution.

3. "If the Ephemerellidae mayflies and other pollution sensitive macroinvertebrates rebound after the hatchery effluent is treated, will the trout population improve also?" The book describes trout as being opportunistic in their feeding habits and the need for conservation of energy dictates that they get the biggest bang for their buck. Given the fact that midges, although smaller, are presently more abundant and readily available than mayflies and other pollution sensitive macroinvertebrates, the trout population keys in on them. Being larger, mayflies provide more protein than do midges. So one might conclude that should the mayfly population rebound so will the number and distribution of larger fish.

4. "In particular, are trout avoiding areas they used to frequent that are now dominated by midge larvae?" Again from a review of the data contained in *References 6 and 7* indicating midges to be one of the most available and consumed food source in the upper reaches, one might conclude that they are not avoiding areas dominated by midge larvae, but are in fact drawn to these areas by the abundance of midges.

Given the above, one might conclude that although scuds are the dominate species of macroinvertebrate to be found in Spring Run, they are not the primary food source available to the Spring Run rainbow trout population. At the present time, the second most dominate species, namely midges, being more readily available in the water column are. Mayflies, stoneflies and caddis were once found in abundance in the catch and release section of Spring Run; this is no longer the case. Food rules, as can be witnessed by the number of large trout to be found in the area of the second house above the catch and release section where they are feed dog food each day.

So the writer believes that the loss of mayflies and other pollution sensitive macroinvertebrates, is directly responsible for the reduction in larger rainbow trout to be found in the catch and release section of Spring Run, and furthermore believes that with their return the number of larger rainbows trout will increase throughout the catch and release section of Spring Run.

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Habitat:

The catch and release section of Spring Run is approximately 0.99 of a mile long, and is divided into nine reaches numbered 0 to 9. Each reach is of varying length with the longest being reach 5 (995 feet long) and the shortest being reach 8 (200 feet long). (See appended *Ref. 9* and *Location Map* for stream length survey data.)

Over the years a number of measures have been employed to improve the habitat available to the rainbow trout population in the catch and release section of Spring Run. These measures include numerous drop structures, such as inverted vee and straight log dams which create plunge pools, which in turn add oxygen to the water column and provide cover for the resident rainbows. These dams were not placed or constructed in a haphazard manner, but were rather constructed and placed so as to minimize upstream ponding, which causes drowning of the riffles so critical to the benthic community. Careful placement of these structures, also allows for the free movement of the rainbows throughout the catch and release section, which is critical during spawning periods.

Another measure successfully employed, is the use of lateral cover which provides both erosion protection of the stream banks and a place for the rainbow trout to hide from predators and to ambush prey. These lateral covers have been constructed from logs laid along the banks and parallel to the flow in the stream. The logs are slightly elevated from the stream bottom and covered by boards and stones which provides cover for the trout, but does not restrict high flows to the stream channel, but rather allows these high flows to inundate the floodplain, thereby reducing high flow velocities in the main channel and stream bank erosion.

The use of stone rip rap, which is not necessarily good as a means of providing protection for trout, has been limited. For the most part stone rip rap has only been used as groins in places where it is necessary to divert flows from the stream banks or for bank protection. In a lot of cases a single large rock has been carefully placed for the same purpose. This large rock not only serves this purpose, but also serves to break up the current in the flow stream, providing both protection and holding water for the trout.

Although numerous structures have been placed along the ninety-nine hundredths of a mile catch and release section of Spring Run, care has always been exercised to insure that there are sufficient quiescent zones, so important to the survival and growth of emerging rainbow trout fry.

These stream restoration and improvement efforts have been guided by several habitat improvement texts, including; the Stream Habitat Improvement Handbook, by Monte Seehorn; Trout Stream Therapy, by Robert Hunt; Better Trout Habitat, by Christopher Hunter; WI and PA State brochures, and consultation with Donald Phares, WVDNR.

The above described habitat improvements have not come over night, but are instead the results of years of dedicated work by many individuals and organizations, with such efforts dating back to the early 60's when the fly fishing catch and release section of Spring Run was first established.

These dedicated efforts by the likes of Harrison Shobe, the first landowner; LaVerne Kamps, Ronald Laski, Janet and Jerry Burke the current land owners; Friends of Spring Run's Wild Trout and various fisherman account for numerous man-hours of time in the construction and maintenance of these stream improvements. For example, in the period extending from 1981 to 2008, Burke and other fisherman have accrued over 5,300 man-hours of time towards these efforts.

The 1996 flood wreaked grave havoc in the catch and release sections of Spring Run requiring a large expenditure of time, effort and money by the riparian landowners, Friends of Spring Run's Wild Trout and various fisherman, with support from the WV Stream Partners and Canaan Valley Institute grants.

The best spawning areas are at the tailout of the pools located in the upper reaches of the catch and release section. The gravel or stone varies in size and is for the most part not embedded. The sandstone geology in the watershed does create some problems with respect to fines, but not to the point where it prohibit successful spawning.

The results of all this work and effort are evident, in that Spring Run is considered to contain one of the finest small trout stream habitats in the eastern United States.

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Appendix:

References:

The preceding document makes reference to the following four sources:

1. The Effects Of Pollution Reduction On A Wild Trout Stream Progress Report: 2007, by Neil Gillies, et al, herein after referred to as *the paper.*

2. Evaluation of Fisheries Resources in Spring Run, Grant County, West Virginia, by Jim Hedrick, District Fisheries Biologist and Carla Hardy, Watershed Specialist, dated September 2005, herein after referred to as *the 2005 report.*

3. Spring Run Sampling Report April 21, 2008 by Jim Hedrick, District Fisheries Biologist and Carla Hardy, Watershed Specialist, herein after referred to as *the 2008 report.*

4. Trout The Wildlife Series" copyright 1991, a Stakepole publication, herein after referred to as *the book.*

In support of the data presented in this paper, the following documents are to be considered as appended:

Ref. 1: General Data for Trout Survival, a spreadsheet summarizing research by various experts as contained in *the book*.

Ref. 2: Spring Run Air and Water Temperatures 2006-2008, a spreadsheet summarizing Spring Run air and water temperatures for the period extending from January 01, 2006 to December 31, 2008, as recorded by the writer.

Ref. 3: Spring Run Water Temperatures (Gage Data Jun-07 to Sept 07), a spreadsheet summarizing continuous water temperatures recorded by gages placed at the upper and lower limits of the catch and release section of Spring Run for the period extending from June 01, 2007 to September 13, 2007.

Ref. 4: Rainfall Data, a spreadsheet summarizing monthly rainfall recorded at the Petersburg Airport and Mathis weather stations.

Ref. 5: Spring Run Catch Records 1966 to 2008**,** a spreadsheet summarizing the catch records of various fishermen at Spring Run for the period extending from 1966 to December 31, 2008.

Ref. 6: Modified Spring Run Benthic Studies, a spreadsheet summarizing benthic studies by Tim Craddock, et al, for the period extending from May, 2005 to October, 2008. Also included are the results of an isolated study by Tim Craddock dated July, 2003.

Ref. 7: Spring Run Gastric Aspirates, a spreadsheet with photos summarizing a reach by reach gastric aspirates study performed by Curtis Winter, a fellow fly fisherman and long time Friend of Spring Run.

Ref. 8: J.A.B Spring Run Recollections, a chronological history of Spring Run as a fishery. This document contains forty-two years of Jerry Burke's personal observations which will further help to describe the rise and fall of the Spring Run fishery.

Ref. 9: Spring Run Stream Alignment Study, a spread sheet summarizing GPS coordinate data obtained by Jerry Burke for Spring Run extending from its confluence with South Mill Creek to its source at the spring.

Oncorhynchus mykiss mykiss, the Rainbow Trout

Testimonials and Observations by Others:

1. September 1996 Spring Run Questionnaire:

The following are comments from fishermen who fished Spring Run eight months after the 1996 flood really beat up the fishery. The comments were garnered in response to a questionnaire used in part to fulfill the requirements of a WV Stream Partners grant to do "outreach".

Quality Recreation: The Spring Run FFCR section provided many hours and days of quality fly fishing for wild rainbow trout. Fishing was done every month of 1996. 107 permits were issued. We documented at least 64 permittees fished. Five states, plus WV were represented. A questionnaire given to 78 permittees produced 68 replies. Given the opportunity to comment on their Spring Run experience, the theme of respondents' comments was;

--- recognition of Spring Run as providing a high quality fly fishing experience.
--- support for fly fishing, catch-and-release rules.
--- support for "mans" intervention to restore and enhance trout habitat and stabilize stream banks.
--- appreciation of landowners for making available this opportunity for fly fishing.

The following excerpts from respondents' comments (there are many more) are strong commentary on the value of the Spring Run fishery and the importance of restoring and maintaining it.

--- probably my most enjoyable fishing experience ever.
--- one of the best experiences fishing I ever had.
--- most enjoyable trout fishing experience I've had in years.
--- Spring Run provides the finest small stream fishing experience that I know of.
--- a model for managing a small stream.
--- Spring Run provides an excellent experience for both the novice and the expert.
--- a pleasure just to have a place to walk the banks and watch how wild trout feed on aquatic life in their environment.
--- greatest award to me is to be able to construct habitat for the fish today and return later to catch those wild rainbows in these areas.
--- one of the best streams I have ever fished, holds the most beautiful trout in the area.
--- amazing small stream. I don't believe it would be able to remain the great fishery it is without the efforts of the people maintaining it.
--- fish very healthy and size of most is quite good.
--- first summer I was able to go along with my father, numerous times. I thoroughly enjoyed Spring Run and the peacefulness and enjoyment it offers.
--- my biggest trout was caught in Spring Run in 1994, 24 inches.
--- it was a high quality fishing experience.
--- apparent that a lot of hard work and care had gone into stream maintenance and habitat improvement.

--- Spring Run is the best experience I've had this side of Montana.
--- work put into habitat protection and improvement shows great effort and thorough knowledge. These goals should definitely be pursued and expanded.
--- first fish I ever caught on a fly rod was at Spring Run.
--- a joy to fish, biggest asset is the fact that you can lose yourself from the rest of the world, and there's always the chance of catching a big rainbow. My personal best is a 26' rainbow in May 1993.
--- a one-of-a-kind naturally producing rainbow trout stream in our state. Its quality and character should be preserved for future generations.
--- (from a 12 year old) I enjoyed it and want to come back. It has a lot of huge natives, I have never seen any as big as that.
--- the chance to fish for wild trout is so unusual, especially in the numbers and size now living in Spring Run.
--- a unique example of how understanding fishing can result from proper management; some of absolute best fishing I have seen in VA & WVA.
--- fishing was fantastic, a wonderful experience.
--- in just a few hours of complete freedom I was able to catch 8-10 rainbows, all on a dry fly. This experience and habitat must be preserved.
--- stopped by with two of my fishing partners to ask for permission to fish what we thought was a private fishing club, but to our surprise, after a short conversation, we were handed written permission to fish for the remainder of that year.

2. Insights Into How It Use to Be:

The following excerpts are from letters or journal entries made by various Spring Run Fly Fishermen and are offered here in support of "*how it use to be":*

● A fly fisherman from south of Elkins, WV wrote the following in a letter dated April 5, 1989 relating to his June 1988 experience: *"saw lots of sulphurs".*

● Relating to his experiences, a forester from near Waynesboro, VA wrote the following in his February 10, 1989 letter:

7/13/88: *"3-5 pm, 20 on elk hair caddis one 19", 7 were 14" and larger."*
8/2/88: *"2-4pm , 14, largest, 19" on elk hair caddis."*
8/26/88: "*caught 18, largest 17" on elk hair caddis*."
10/22/88: *"didn't know fish were fall spawners; caught 2, 12" males. Saw plenty of fish but no interest in feeding.* '

● A former President of the Virginia Council of Trout Unlimited, in a November 15, 1985 letter wrote the following about his experiences: "I've enjoyed fishing Spring Run more than I can tell you. Nowhere else in the East have I found such high-quality rainbow trout fishing. I caught my largest Eastern rainbow at a pool right across from the house, and have had great days fishing the upper sections. The riffle-pool, riffle-pool series you built there provide more trout cover than I've seen on a stream that size. Any doubter need only see your section of Spring Run to know that trophy-quality trout can indeed thrive in a small stream with proper structures."

● The following observations were made by Tim Aspy, a fellow fisherman who has one of the longest histories relating to the Spring Run fishery: "Spring Run is the best fishery east of the Mississippi", this statement was made by Jack McAllister back before the decline in the fishery, and it has been verified by a number of fisherman like himself who fish all over this country. It was a fishery that would produce 20" plus fish throughout the entire 0.96 mile long catch and release section, and one which would accommodate up to seven fishermen, all with the same satisfying results. Along this relatively short distance one would see an abundance of aquatic life not seen in any other stream in the state. I could go on and on about this fishery and it's early history, and

what it meant to me and many other fishermen, but let me submit my theory on what went on to start this decline.

In my opinion, the decline began near the lower end of the catch and release fishery, not long after the WV Department of Highways completed their Spring Run Road widening project. The road widening project started close to the end of the upper meadow near the beginning of section 5, and ran approximately 650 yards upstream. The results of this roadway project were a high, near vertical wall which ran the entire length of this engineered debacle. This unprotected near vertical embankment eroded, resulting in floods of sediments being discharged into Spring Run during high precipitation events. This sediment ultimately reached and settled out in the lower sections of the catch and release area. This sedimentation was intensified by the transporting of spoils from this road work to the stream side, where it was used as fill to help stabilize the areas of stream that were devastated in the past by floods. This material was stock piled and used along with "store bought rocks" to stabilize stream banks as far up stream as section nine. And yes we all loved this endless supply of material, a commodity that was in short supply prior to this road project.

The Spring Run Hatchery has been there since 1952 and had what I thought to be somewhat of a positive effect on the Run in the early days. Then prior to the decline, we witnessed heavy flows of suspended solids on hatchery clean out days that we hadn't seen before. Upon further investigation, we believe that the acceleration of waste was due to the apparent over population of fish in the hatchery. In conclusion, I believe that erosion and sedimentation from the highway project along with the increase in pollution from the hatchery, all happening at the same time was just too much for this delicate stream to withstand and resulted in the loss of the once abundant pollution intolerant macroinvertebrates and the decline in this fishery.

Do I think the Spring Run fishery will rebound? Yes, and to accelerate this recovery the WVDOH should return and finish their project and shotcrete the high wall they left exposed. As far as the leaching of sediment from the material used as fill to stabilize the stream banks, I think this went on in the early part of the game and has stabilized since then."

Layman Aspy --03/01/09

3. Offered for Consideration:

On the subject of the continuation of studies and new research into the decline of the macroinvertebrate population and the Spring Run fishery, the following comments and suggestions have been offered for consideration by other long time fishermen and Friends of Spring Run's Wild Trout.

● Upon reading the contents of this paper, Pat Docherty suggested the following:

1. Take this report to local colleges and universities and try to generate some interest using Spring Run as a potential site for graduate research projects. The type of tagged fish study as outlined on page 12 of this paper would be particularly beneficial.

2. Continue the electro-fishing survey work currently being performed by the West Virginia Department of Natural Resources. This in conjunction with the catch reports from fishermen is the best way to track important fish population trends.

3. If possible continue ongoing benthic studies work by Tim Craddock, Curtis Winter and others to document trends over time. As indicated in page two of the synopsis it would also be extremely important to try and document the overall DO of the stream bottom and substrata where the benthic communities live.

4. Try to gain support from the various regulatory and natural resource management agencies to take a more active role in helping to understand and actually commit some resources to resolving the problems that we are currently experiencing at Spring Run. If Spring Run is to be restored to it's former glory days we absolutely need the help of these agencies. I will do everything I can to work the contacts I have developed over the years to help with this effort.

Pat Docherty 03/29/09