VI CONCLUSIONS

A time-line reconstruction of events at Big Spring Run clearly reveals a sequential collapse of the wild brook trout population in relation to development of two hatcheries A commercial hatchery was developed on Big Spring (Green Spring Trout Co., owner Colin Thomas), 0.6 mile below the source around 1954. In the mid-to-late-'50s, after the Thomas hatchery reached a production of around 300,000 trout, the wild brook trout population failed from only that section downstream of the hatchery. This initial failure of the wild trout population below the Thomas hatchery was revealed by a 1958 electrofishing survey (PF&BC, unpublished data). Following closure of the Thomas hatchery in 1968, the brook trout population made a partial recovery. But in 1972, the PF&BC's Big Spring Fish Cultural Station was built and began discharging effluent immediately below the spring source. Between 1973, the first production year, and 1975, the remaining wild population collapsed. This was confirmed by electrofishing in 1977 (PF&BC, unpublished data). The close correspondence in space and time between development of hatcheries and collapse of the wild brook trout populations below these operations, is strong evidence that pollution by fish hatcheries caused the collapse.

Hatcheries are useful in fisheries management, but the high protein diets fed in hatcheries have significant potential to pollute. Solbe (1988) has equated the daily production of solids resulting from 1000 kg (2,200 lbs). of fish, to a discharge of properly treated sewage from a town of 300,000 people. On the other hand, it seems unlikely that hatchery discharges per se will harm trout populations in every case. Effects will likely vary depending both upon the amounts of pollutants released and nature of the receiving stream. In some relatively nutrient poor streams, hatchery wastes may actually benefit trout. Fertile streams such as limestone spring creeks are probably most vulnerable to damaging effects of hatchery effluent.

The Big Spring Fish Cultural Station removes more than 90% of settlable solids from its effluent using a conical clarifier, but this removes only about half of the BOD, COD, suspended solids and total phosphorous (Mudrak, 1981). Nitrogenous wastes would tend to have much higher passage rates. Based on these removal efficiencies and a known annual production of

900,000 fish, the amounts of these pollutants would roughly equal the quantities released in untreated effluent from 400,000 fish. It is interesting that this production exceeds that of the Thomas commercial hatchery (1953-1968) which caused the initial brook trout population collapse documented in 1958.

When considered in toto, the current truncated trout population distribution, the presence of a benthic invertebrate community dominated by aquatic sow-bugs and lacking in species diversity, the overgrowths of aquatic vegetation, and the changes in water quality, are all consistent with known effects of organic pollution by fish hatchery wastes. Our chemical measurements are in the range known to be associated with the kinds of ecological damage in Big Spring Run. Furthermore, hydrogen sulfide in stream-bed gravels below the Big Spring Fish Cultural Station indicates anoxic conditions exist in the gravel interstitial water (hydrogen sulfide can only form in the absence of oxygen). We therefore conclude that infiltration and decomposition of hatchery wastes within the gravel reduces oxygen concentrations and has caused brook trout reproduction to fail. Our conclusions are supported by many published scientific investigations.

There has been a world-wide explosion in the scientific literature relative to pollution effects of aquaculture. The Institute of Marine Biology has compiled a data base containing in excess of 4800 references dealing with environmental impacts of aquaculture (Owen, 1996). The design and construction of the Big Spring fish cultural station occurred prior to 1972. As very few studies concerning polluting effects of hatcheries had been conducted as of the early 1970's (Liao, 1970), it seems likely that the PF&BC expected their effluent clarifier would adequately protect the wild brook trout population. This expectation has not been borne out.

With respect to any fishery agencies' program priorities, perpetuation of a policy of producing large numbers of catchable sized trout in hatcheries to provide temporary fisheries in marginal trout streams is a questionable policy at best (White, Karr, Nehlsen, 1995). Regardless of how rigidly entrenched this policy is, and regardless of the extent to which it has created its own angler demand, when this practice is carried out at the expense of high quality trout water, it

is our contention that this policy is misguided. With respect to the future of Big Spring Run, no quantity of hatchery production, however efficient, is worth sacrificing what was one of America's best trout streams. The Pennsylvania Fish Commission can restore a wild brook trout fishery at Big Spring Run, by eliminating hatcheries from the stream, otherwise, the PF&BC must forever bear the responsibility for the loss of this unique wild brook trout fishery. Wise fisheries management will place a premium on a nationally known, high quality brook trout stream, like Big Spring Run. Wild brook trout fisheries are uncommon natural resources. They have a special, almost unique value when they occur in a near-urban environment, such as in the case of Big Spring Run.

VII RECOMMENDATIONS

The PF&BC has indicated a need for improved waste treatment at Big Spring Fish Cultural Station. A cost of $200,000 to $600,000 has been mentioned. It appears that these funds would be used to construct a "polishing pond". Efforts made to produce a cleaner effluent are at face value, a step in the right direction, however, our greatest concern is that these expensive efforts may not be adequate. For example at Big Spring there are high densities of trout only in the vicinity of the discharge. The precise reasons for this abnormal population distribution have not been unambiguously identified. It is tempting to make a leap-of-faith and assume that there are simple explanations involving organic pollution water chemistry ie. high nocturnal carbon dioxide concentrations coupled with low dissolved oxygens, etc. This unfortunately is speculation. Our studies relative to this phenomenon could at best be described as suggestive. Complex biological factors such as odors or pheramones (chemical attractants) released by the fish could be involved here.

Although a number of options could be employed to deal with the Big Spring hatchery, probably the most cost-effective would be to simply close the hatchery. Based on PF&BC's cost/benefit analysis (data for fiscal year 1994/1995), annual cost saving realized from hatchery closure would be $702,479. In the same commission report a figure of $90,500 per annum is mentioned as the cost associated with a partial closure, ie. rearing of fingerlings, a base level of security, maintenance, etc.

Although closing a large hatchery has a negative economic impact upon the hatchery's employees, a restored brook trout fishery in Big Spring Run would attract thousands of anglers from the Eastern and Mid-Atlantic U.S. Under catch and release regulations it is likely that brook trout exceeding 12 inches would be common and some brook trout exceeding 18 inches would be present throughout the stream. Such a fishery is a powerful attraction to flyfishermen. An out-of-state flyfisherman commonly spends more than $100 per day, not including travel costs. Were a year round brook trout fishery restored only to the upper 1.5 miles portion (source to Keck's Dam) this part of the stream alone could generate 7,900 to more than 15,000 angler-days of

fishing opportunity. At a conservative daily expenditure of $30 per angler, this would generate revenues in the range of $237,000 to $474,000 per year. If a quality fishery were restored to the level of the stone arch bridge (a 3.5mile reach), angling opportunity and revenues would be even greater. Favorable publicity from a restored fishery throughout this upper 3.5 mile reach, could result in economic benefits exceeding the costs of closing the hatchery.

Thus it is our primary recommendation that within a two year period, the production of fish at the existing Big Spring Fish Cultural Station should be terminated. During a subsequent three year moratorium on fish production, PF&BC should undertake studies of the stream's recovery. Documentation of the chemical and biological changes, especially changes in trout reproductive success, will be of value to other fisheries agencies.

There are of course numerous predictable arguments for maintaining the status quo. A shift in priorities away from stocking catchable size trout based on political or purely recreational considerations will be required. A change to a more environmentally based, resource-first policy will require integrity and strong leadership.

Some compromise solutions might also allow restoration of a wild brook trout fishery. Cost savings from hatchery closure could finance a new, more environmentally friendly hatchery which uses recycled water, as opposed to the current "single-pass" system. This hatchery should be relocated to a downstream site. The move will protect headwaters spawning sites and yet facillitate a normal distribution of trout throughout the stream.

Recirculation systems are no longer laboratory curiosities. Use of recirculation methods can offer significant benefits. Recirculation aquaculture involving removal of solids, biofiltration, and hydroponic plant production reduces water use and effluent production and the operator has more control of water quality. Advanced effluent "clean-up" by hydroponic vegetable production is already in use by some operators. Use of expanded energy-dense and low phosphate diets have been shown to reduce polluting effects of hatcheries (Roberts, 1990; Ketola, et.al., 1991). If recirculation were combined with reduced hatchery production, all needs might be satisfied.

Cost savings from hatchery closure could also be used to "rescue" other high quality limestone streams. We especially recommend purchase of the commercial hatcheries on Green Spring and Falling Spring Run as they are obvious sources of pollution to these streams. No new permits should be issued for hatcheries on limestone streams unless it can be shown that these developments will not impair the biotic integrity of the resource. Acquisition is a powerful tool for fisheries management. In addition to providing permanent fishing access, strategic acquisitions can afford a significant degree of environmental protection.

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APPENDIX

TABLE 1
HISTORICAL WATER CHEMISTRY
BUREAU OF WATER QUALITY MANAGEMENT
BIG SPRING CREEK BASIN, CUMBERLAND COUNTY

PARAMETER[1]	RANGE					
	11/71	3/72	2/73	1/74	10/79	6/84
# of stations	6	4	3	3	2	2
temperature (°C)	-	-	-	10-11.5	10-10	12.5-15.0
dissolved oxygen	-	-	-	9.3-11.6	10.6-10.8	11.6-13.6
sp cond (us/cm)	-	-	-	250-265	-	250-300
pH (field)	-	-	-	-	7.9-7.9	7.5-7.8
pH (lab)	6.9-7.4	6.9-8.0	7.4-7.6	7.5-7.8	7.9-8.3	-
alkalinity	148-160	155-165	155-170	160-170	198-202	164-166
hardness	172-184	120-200	160-200	145-175	179-194	196-196
Turbidity (J.C.U.)	0-5.00	-	-	-	-	-
TDS	-	220-260	220-290	200-220	308-318	260-266
TSS	-	0-20	-	55-50	8-10	-
BOD	0.6-2.8	0-1.4	1.2-1.6	0.6-1.0	<0.4	-
SO4	-	-	-	-	-	26.0-37.0
NH3-N	-	0.3-1.8	0-0.6	0.04-0.13	0.04-0.05	0.15-0.16
NO2-N	-	-	0.05-0.06	0.02-0.04	0.03-0.03	0.014-0.022
NO3-N	26.5-28.0	3.4-4.0	3.7-4.1	5.3-6.2	4.0-4.2	4.61-5.22
phosphorus	0-0.07	0.06-0.08	0.12-0.16	0.06-0.26	0.05-0.08	-
chloride	-	9-18	14-15	7-8	-	-
Cr-total	-	-	-	-	-	<0.07
Cu	-	-	-	-	-	<0.08
Fe	-	-	-	-	-	<0.1
Pb	-	-	-	-	-	<0.0175
Mn	-	-	-	-	-	<0.05
NI	-	-	-	-	-	<0.14
Zn	-	-	-	-	-	0.01
Al	-	-	-	-	-	<0.10
fecal coliform (#/100ml)	-	-	-	-	30-70	25-180

[1]mg/l except as noted.

PENNSYLVANIA FISH COMMISSION — Stream Examination Report

Stream Name Spring Ck., Bg. Sec. No. 03 Mgmt. Area 707B Cnty CUMB

COMMENTS AND RECOMMENDATIONS (Punch written comments, each line to a card. Col. 80 will be marked with a < where indicated.)

Card Format: [1][0] (1) Dup. col. 3-18 Yr. [7][8] (19)

	Data Group (21)	Card No. (23-24)		Col.80
Dup. col. 1-20	02	01	Section Limits: From Strohm Dam downstream to the	<
Dup. col. 1-20	02	02	stone arch bridge.	<
Dup. col. 1-20	02	03	Examiners: Jackson, Baker, Kaufmann.	
Dup. col. 1-20	02	04	Present Mgmt.: Along with Section 04, receiving	
Dup. col. 1-20	02	05	1600 ST-BT preseason and 1600 ST-BT.	
Dup. col. 1-20	03	01	Two Commission owned and maintained parking lots	
Dup. col. 1-20	03	02	available to section users.	
Dup. col. 1-20	04	01	Downstream Station Limits: At the stone arch bridge.	
Dup. col. 1-20	05	01	Station confined to deep, narrow channel with good	
Dup. col. 1-20	05	02	cover. Light to moderate growths of Elodea, P. crispus	
Dup. col. 1-20	05	03	and Nasturtium.	
Dup. col. 1-20	06	01	D. O. meter inoperative.	
Dup. col. 1-20	09	01	Gear: T&J DC generator. Too few trout taken to	
Dup. col. 1-20	09	02	justify a recapture run for population estimate. !	
Dup. col. 1-20				
Dup. col. 1-20				
Dup. col. 1-20				
Dup. col. 1-20				
Dup. col. 1-20				
Dup. col. 1-20				
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Dup. col. 1-20				
Dup. col. 1-20				
Dup. col. 1-20				

ST = Speckled (Brook) Trout

COMMENTS AND RECOMMENDATIONS

79-87 QH301.P67

WATER: Big Spring Creek (707B) Cumberland County

EXAMINED: 1988

BY: R. T. Greene and M. T. Marcinko

Bureau Director Action: Norm. Delaw R. Dorr Date: 6-5-89

Division Chief Action: Richard A. Snyder Date: 6-6-89

WW Unit Leader Action: _____ Date: _____

CW Unit Leader Action: Martin Marcinko Date: 5/8/89

CW UNIT COMMENTS

Significant changes have occurred in the Big Spring Creek fishery since the annual assessments were initiated. The present management plan was developed when the trout populations were vastly different from those observed in 1988. New plan elements and strategies need to be developed, and I therefore propose the following framework for management action.

A. Maintain the brook trout management area. Despite arguments about the genetic integrity of the population or the need to continually remove other trout species, this population is unique. No other fishery in the Commonwealth provides the number and size distribution of brook trout found in Big Spring.

   Alternative actions:

   1. Develop long range plans to improve instream habitat. All effort would be devoted to Section 01.

   2. Initiate planning to reconstruct the deteriorating barrier.

   3. Conduct annual assessments to include the removal of brown, rainbow and palomino trout.

   4. Investigate alternatives to minimize or prevent the escape of trout from the Big Spring Fish Culture Station.

B. Develop a new management strategy for Section 02. Habitat will support little more than an insignificant wild trout fishery. Fingerling stockings are not practical since high mortalities are expected to occur.

Alternative actions:

1. Initiate a catchable trout stocking program under conventional statewide regulations.

2. Stock only brook trout.

C. Evaluate the management of downstream sections to determine if present practice reflects the capabilities/opportunities of the resource.

Alternative actions:

1. Update the inventory of Big Spring Creek.

2. Evaluate present sectioning strategy and management objectives to determine whether other options will improve or enhance angling opportunities.

DIVISION CHIEF COMMENTS

Discussions on future management options on much of Big Spring Creek could be endless until such time as efforts regarding habitat restoration and enhancement bear fruit. In one sense, Big Spring Creek in light of habitat deterioration could be viewed as an embarrassment to the Pennsylvania Fish Commission. It is my sincere opinion that this agency is not at fault for the loss of habitat nor the decline in trout population. However, for a stream of national prominence to literally "fall apart" except for a couple of hundred feet of the special reg area, this agency, as the owner, bears responsibility especially in light of the "Resource First" theme. Presently, most of the section managed in the Limestone Springs Wild Trout program has one of the sparsest trout populations of all special regulation areas in the state and was once well qualified as wild trout water in general. There should be no illusion that the brook trout in the very upstream reaches are all wild trout. Based on the annual fall removal of some 1600 brown and rainbow trout (1987 & 1988), doesn't that seem to indicate a high probability of considerable numbers of brook trout also coming into the stream from the hatchery? I tend to agree with the Coldwater Unit Leader that regardless of origin or genetic make-up the Big Spring Creek brook trout fishery is unique and should merit such management. It is also a unique opportunity to manage "super-size" rainbow and brown trout. However, the extremely artificial nature of the situation particularly when overshadowed with the dismal population in the remaining one mile or so of special reg area makes one wonder.

A review of the habitat with appropriate Engineering personnel is anticipated for mid-summer. I am optimistic that a major initiative will come forth from that work. After all, how can this agency justify working with sportsmen often on marginal, seasonal trout water where work may not make any difference

from one year to the next, when a major Fish Commission holding lies virtually fishless during much of the angling season. During the annual assessment work in Section 02 a typical sampling crew could realistically carry all the trout in the one mile section as the population is that sparse. I will not be surprised if the section managed under conventional regulations when resurveyed supports more trout than a comparable length in the special reg area. The real irony may come if the conventional reg area is found to harbor a Class A (biomass) trout population and stocking is terminated with there being no real value in stocking the lower mile of the special reg area as the habitat will not support many trout!

It is also somewhat ironic that for one of the most fitting stream habitats where many of the proven improvement techniques can make a difference, Big Spring Creek is virtually ignored by the very agency heading up a relatively large habitat improvement program, albeit it volunteer oriented. In the early to late 1970s the management of this stream (when it undoubtedly was at its peak in modern times) came under fire by sincere and well-meaning anglers. The Commission worked through all of that because we had good data, a good plan and good habitat. If those same critics came around today, this agency doesn't have a leg to stand on. Except for the annual removal operation (electrofishing) and efforts to improve the quality of the hatchery effluent, we are not paying much attention to the stream.

Following the summer meeting regarding habitat improvement and perhaps a reinventory of Big Spring Creek this fall, I expect the Coldwater Unit and the AFM to work out a long-term plan for this stream.