Lehigh River Fisheries Management Plan

May 1, 2007

Prepared by:

David A. Arnold and Daryl J. Pierce
Fisheries Management Area 5

Division of Fisheries Management
Bureau of Fisheries
Pennsylvania Fish and Boat Commission

Table of Contents

Table of Contents

Table of Contents

List of Tables

List of Figures

List of Appendices

This work made possible by the Sport Fish Restoration Act Project F-57-R Fisheries Management.

1.0 Introduction

The Lehigh River is a major watershed in the northeast region of Pennsylvania supporting a diverse array of outdoor activities. The river attracts many local residents as well as drawing numerous outdoor enthusiasts from considerable distances beyond the Lehigh River watershed specifically for its recreational opportunities. On April 5, 1981 Governor Richard Thornburg signed the Lehigh River Scenic River Act (Act No. 71) into law, thereby declaring this waterway a scenic river and the Secretary of the Department of Conservation and Natural Resources (DCNR) named the Lehigh River Pennsylvania's 2007 "River of the Year". Furthermore its entire length has been declared a navigable waterway **(**Lehigh Falls Fishing Club v. Andrejewski, 2000).

Angling and whitewater rafting represent two major recreational activities that occur on the Lehigh River waters. The Pennsylvania Fish and Boat Commission (PFBC), is responsible for the management of the state's game and non-game fishes and for the protection of the aquatic resources. The Division of Fisheries Management assesses the status of game fish populations and stocks cool and coldwater game fish throughout most of the Lehigh River for the promotion of recreational angling.

In 2003, the Wildlands Conservancy completed a management plan for the Lehigh River Watershed. The Conservancy's plan is a comprehensive review of the status of the Lehigh River that identifies historical, cultural, biological (aquatic and terrestrial), and recreational resources and addresses the watershed's environmental problems; however, fishery management issues, including management practices and assessments, were not specifically addressed.

Fisheries management plans provide an organized approach to identifying opportunities and solving problems. They provide a mechanism for public involvement, allowing citizens to learn, participate, and influence management decisions. They also provide an organized reference for PFBC personnel, other agencies, and citizens who need information about a particular aspect of the river system. The nucleus of the following fisheries management plan is a description of the river and its watershed using a range of topics. These include: geographical description, riverine habitats, water quality, fisheries management, restoration programs, and accessibility. Proposed management actions for addressing maintenance and rehabilitation of riverine resources are listed within each topic in the following plan.

This fisheries management plan is a "living document" designed to guide future fisheries management actions, including environmental protection efforts, of the PFBC, based on biological, environmental, and social data. The goal of this fisheries management plan is to protect, conserve, and where possible, enhance the fishery of the Lehigh River.

The report is organized in a manner that describes the Lehigh River's aquatic resources in an increasingly detailed fashion. First, the geographic setting (Section 2.0) is described. This is followed by discussions of riverine fish habitat types (Section 3.0), water quality (Section 4.0), fisheries management (Section 5.0), and recreational access (Section 6.0). Anticipated public interaction (Section 7.0) and a summary of the proposed actions (Section 8.0) complete the report.

2.0 Geography

The Lehigh River is a 169.6 km (105.7 mi) long navigable and scenic waterway that drains an area of 3,546 km^2 (1,368 mi^2; Figure1). It originates at Pocono Peak Lake in Lehigh Township in the Pocono Plateau, Wayne County, flows in a southwesterly direction to the town of White Haven, and then begins a slow southeasterly trek through the Ridge and Valley province and the Great Valley where it enters the Delaware River at River Mile (RM) 183.60 at the City of Easton, Northampton County. The Lehigh River drops approximately 570 m (1880 ft) in elevation from Pocono Peak Lake (elevation 2040 ft) to its confluence with the Delaware River (elevation 160 ft). The Lehigh River confluence is located 50.3 miles from the head of tide in the Delaware River at Trenton, NJ (RM 133.3).

Descriptions of major land cover types have been addressed by the Wildlands Conservancy Lehigh River Management Plan (Wildlands Conservancy, 2003). Briefly, most of the land cover type in the Lehigh River watershed is forested (63%) as either state game lands (n = 14 totaling 110,00 acres), state park lands (n = 5 totaling 28,488 acres), state forests (n = 2 totaling 27,600 acres), federal lands (n = 2 totaling 656acres), or private holdings, particularly in the mid to upper reaches of the Lehigh River upstream of Jim Thorpe Borough. Agriculture, representing 24% of the land cover in the Lehigh River watershed, combined with rural development, characterizes the mid reaches of the Lehigh River. Developed urban and industrial land cover accounting for 7% of the total land use of the Lehigh River watershed, dominate the downstream reach of the Lehigh River from the Boroughs of Northampton to Easton, PA where the Lehigh River confluences with the Delaware River. Wetlands represent only 4% of the Lehigh River watershed, primarily in the headwaters of the Lehigh River.

2.1 Townships

The course of the river flows through Clifton and Thrunhurst (formally Lehigh) Townships in Lackawanna County; Coolbaugh and Tobyhanna Townships in Monroe County; Buck, Bear Creek, Dennison and Foster Townships in Luzerne County; Kidder, Lehigh, East Penn, Pen Forest, and Lower Towamensing Townships in Carbon County; Washington, North Whitehall, Whitehall, Hanover, Townships in Lehigh County; and Lehigh, Allen, East Allen, Salisbury, Lower Saucon, Bethlehem, Palmer, and Williams Townships in Northampton County.

2.2 Municipalities

Boroughs, towns, and cities that the river flows through or along from its origin to its confluence with the Delaware River are: Gouldsboro, Wayne County; Thrunhurst, Lackawanna County; Port Jenkins, Middleburg, White Haven and Tannery, Luzerne County; Bridgeport, Rockport, Jim Thorpe, Packerton, Lehighton, North Weissport, Weissport, West Bowmans, Bowmanstown, and Palmerton in Carbon County; Lehigh Gap, Slatington, Laurys Station, Cementon, Coplay, Hokendauqua, Catasauqua, Whitehall, City of Allentown, and the City of Bethlehem in Lehigh County; and Walnutport, Treichlers, Northampton, North Catasauqua, City of Bethlehem, Freemansburg, Highland Park, West Easton, South Easton, and the City of Easton in Northampton County.

2.3 River Basin characteristics

Physical and biological characteristics of the Lehigh River change considerably from its headwaters to its mouth as it receives tributaries draining independent catchments, flows through lakes and impoundments, and passes across different landforms having distinctive geologic characteristics. The Blue Mountain ridgeline geographically separates the Lehigh River into two general regions (upper and lower) that reflect dramatic changes in the river. Impoundments can also have a dramatic effect on segment characteristics, often limiting the dispersal of aquatic organisms (e.g., fishes). These major river segments have been further divided into smaller sections by the PFBC for the purposes of fishery management.

2.31 Headwaters to Francis E. Walter Dam (RM 105.69 – 82.51)

2.31a Description of mainstem

The headwaters of the Lehigh River emerge from glacial bogs and swamps located in the Pocono Mountains (Pocono Peak Lake). The river flows 29.2 miles from the headwaters to the Francis E. Walter Dam, and has a water quality designation of High Quality – Cold Water Fishes (HQ-CWF) in 25 PA Code Chapter 93 in this section. This segment encompasses five fishery management sections (1-5; Figure 2). The impounded waters creating the Francis E. Walter Reservoir are not included in these sections. The reservoir is managed separately as a cool water lake with seasonally dependent elevations and inundated acreage resulting from its primary function as a flood control reservoir. River flows are not impeded by any anthropogenic structures above the Francis E. Walter Dam. Water flows are typically swift, with the riverine habitat being dominated by long deep runs, riffles, and rapids. Fishes are representative of typical cool- and coldwater communities in fast flowing conditions.

2.31b Description of impoundments

The Francis E. Walter Dam (dam height: 234 ft; Permit No. 13-105) just downstream of Bear Creek confluence notably impounds the mainstem waters of the Lehigh River. Impoundment volumes are seasonally dependent based on flood and drought storage and recreational releases for whitewater rafting. Summertime pool elevations at 1,365 ft inundate 2.63 mi (4.23 km) of Bear Creek and 2.51 mi (4.04 km) of the Lehigh River. Smaller portions of Bear Creek (1.73 mi; 2.79 km) and Lehigh River (1.86 mi; 3.00 km) are inundated during the lower wintertime pool elevations (1,300 ft). Four other impoundments up stream of Francis E. Walter Reservoir located on the mainstem of the river are: Pocono Peak Lake (10 ft, Permit No. 64-6), Lower Klondike Pond (14 ft, Permit No. 64-175), Larsen Lake (8 ft, Permit No. 35-30), and Lake Natalie (12 ft, Permit No. 64-51). The height of these dams can potentially impede movement of biological communities, especially upstream migrations.

2.31c Description of tributaries

There are 21 tributaries on the western bank and 17 tributaries along the eastern bank of this section of the river. All have a water quality designation of HQ-CWF. Tributary drainage area sizes range from 41 km^2 (0.93 mi^2) to 132.87 km^2 (151.30 mi^2) and 3.03 km^2 (1.17 mi^2) to 331.52 km^2 (128.00 mi^2), respectively (Tables 1 and 2). The first major tributary (>20 m in

width) is Tobyhanna Creek, which joins the mainstem at river mile (RM) 83.50 upstream from its confluence with the Delaware at an elevation of 431 m (1,413 ft) above sea level. Bear Creek now joins the Lehigh by mixing with its waters within the confines of the Francis E Walter Reservoir. Other notable tributaries include Choke Creek, Kendall Creek, Trout Creek, Spruce Run, Wolf Run, Ash Creek, Silver Creek, Rucks Run, and Buckley Run. Most of these waters are small (<10 m in width) coldwater streams. Cold water fish communities are typically representative of these tributaries which all have the potential for exchange with the Lehigh River fish community. The flushing of eggs, fry, and fingerlings during high flow events is typical during spring months. This input of young-of-the-year fish can be a source of replenishment to adult populations in mainstem waters depending on their recruitment success.

2.32 Francis E. Walter Dam to Former Relic Dam at Palmerton (RM 76.51 – 37.70)

2.32a Description of mainstem

From the dam outflow down river 62.46 km (38.81 mi) to the former relic dam at Palmerton (which was removed in 2006 through a PFBC sponsored initiative) the Lehigh River is fast flowing. It has a water quality designation of HQ-CWF above the SR 903 Bridge and a TSF designation from the SR 903 Bridge to the former relic dam in Palmerton. Large runs and rapids ranging from class 1 to 3, dependent on daily flow rates, dominate this reach of river. Pools are relatively few and fast flowing, and can be deep. Fishes are representative of typical cool- and coldwater communities in fast flowing conditions. This segment has two fishery management sections (Sections 6 and 7; Figure 2) with the dividing line at the confluence of Sandy Run (RM 66.77).

2.32b Description of impoundments

The Lehigh River mainstem waters are free flowing within this segment.

2.32c Description of tributaries

There are 20 tributaries on the west bank and 26 tributaries along the east bank of this section of the river. Tributary drainage area sizes range from 6.53 km^2 (2.52 mi^2) to 156.44 km^2 (60.40 mi^2) on the west, and 1.22 km^2 (0.47 mi^2) to 287.49 km^2 (111.00 mi^2) east bank, respectively (Tables 1and 2). In this segment of river, the tributary water quality designations are as follows: Exceptional Value (EV) (one stream), HQ-CWF (31 streams), Cold Water Fishes (CWF) (13 streams), and Trout Stocked Fishes (TSF, one stream; Tables 1 and 2). There are four streams along the western riverbank that are impaired by acid mine drainage: Sandy Run, Buck Mountain Run, Black Creek, and Nesquehoning Creek. The Pohopoco Creek represents a significant input of cold water into the Lehigh River principally from the impounded waters behind Beltzville Dam, an ACOE flood control reservoir, which is located 8.0 km (5.0 mi) on the Pohopoco Creek. During releases of water from the Beltzville Dam, it is possible for live release of fishes from the Reservoir into the Pohopoco Creek and thus into the Lehigh River. Other notable creeks include Mud Run, Mahoning Creek, and Lizard Creek that empty into the Lehigh River below Lehighton, PA. Tributaries draining into the Lehigh River above the Borough of Lehighton are generally of smaller drainage size. Fish communities within these tributaries are typically representative of cold-water communities that have the potential for exchange with the Lehigh

River fish community. The flushing of eggs, fry, and fingerlings during high flow events is typical during spring months. This input of young-of-the-year fish can be a source of replenishment to adult populations in mainstem waters depending on their recruitment success.

2.33 Former Relic Dam at Palmerton to Northampton Dam (RM 37.70 – 24.00)

2.33a Description of mainstem

Just south of the municipality of Palmerton the Lehigh River traverses the Lehigh Gap cutting through the Blue Mountain. After this point the river flows tend to slow as the river broadens. Pools start to become more prevalent but are still widely separated by long runs and riffles/rapids. Fish communities in this section are typical of large transitional cool waters. The Chapter 93 water quality designation of this area is TSF. Water quality begins to decline in this section due to impacts from several large municipalities that have discharges to the drainage and historic inputs from a former metal smelting operation. Currently this segment comprises a single fishery management section (Section 8; Figure 2).

2.33b Description of impoundments

The lower limit of the segment is a low-head dam in the municipality of Northampton that forms the largest pool for this segment, typically extending 1.21 km (0.75 mi) upstream of the dam. The dam, which is 8 ft in height (Permit No.39-060), is one of the few impediments on the Lehigh River that block the upstream movement of fish due to the lack of a passage device.

2.33c Description of tributaries

There are 10 tributaries on the west bank and five tributaries along the east bank of the river in this section. Tributary drainage area sizes range from 4.74 km^2 (1.83 mi^2) to 8.21 km^2 (3.17 mi^2) on the west bank and 25.17 km^2 (9.72 mi^2) to 203.32 km^2 (78.50 mi^2) on the east bank (Tables 1and 2). The water quality designations of the tributaries in this section are all either CWF (14 streams) or TSF (one stream). The Aquashicola Creek, which confluences with the Lehigh River at the Borough of Palmerton, PA represents a significant input of cool water into the Lehigh River (the lower reach of the creek is classified as Chapter 93 TSF waters). Waters for this creek are also a significant source of metal pollution from the Palmerton Zinc Superfund site (Palmerton Natural Resource Trustee Council, 2007).

2.34 Northampton Dam to Confluence with Delaware River at Easton (RM 24.00 –0.00)

2.34a Description of mainstem

Below the low-head dam at Northampton, the Lehigh River flow continues to slow with the development of larger pools. The pools are still well separated by shallow riffles and runs that tend to limit motorized boat travel between them. The water now generally supports a warm water biological community with the associated increase in water temperatures, but there are some localized coldwater seeps that can provide thermal refuges for coldwater species. As a result of the recent installation of fishways, this section is also inhabited by diadromous and catadromous fishes like American shad *Alosa sapidissima*, striped bass *Morone saxitalis*, and sea

lamprey *Petromyzon marinus*, and American eel *Anguilla rostrata*. The mainstem water quality designation of this area is TSF in the upper seven miles of river (Northampton Dam tailrace to Hamilton Street Dam), and Warm Water Fishes (WWF) in the lower 17.0 miles (Hamilton Street Dam to confluence). The water quality continues to decline in this region of the river due to the impoundment of water from three major dams which helps to further warm water temperatures and from municipal and industrial discharges from several large municipalities. This segment represents a single fishery management section 9 (Figure 2).

2.34b Description of impoundments

The Lehigh River is impounded at three locations, Hamilton Street (dam height: 13 ft, Permit No. 39-9), Chain (20 ft, Permit No. 48-013), and Easton Dam (30 ft, Permit No. 48-12), within its lower reach at RM 17.0, 3.0, and 0.0, respectively. These dams create substantial pools extending, on average, 1.5 miles upstream dependent on river flow. Each of the three dams in this section has fish passage facilities.

2.34c Description of tributaries

There are five tributaries on the west bank and six tributaries on the east bank of this section of the river. Tributary drainage area sizes range from 4.92 km^2 (1.67 mi^2) to 492.10 km^2 (190.00 mi^2) on the west bank and 6.37 km^2 (2.46 mi^2) to 126.39 km^2 (48.80 mi^2) on the east bank (Tables 1 and 2). The tributary water quality designations in this segment of river are HQ-CWF (three streams) and CWF (eight streams; Tables 1 and 2). Notable tributaries include the Hokendauqua Creek, Little Lehigh Creek, Monocacy Creek, and Saucon Creek. These tributaries generally support cold water fish communities that can exchange with the Lehigh River fish community. The flushing of eggs, fry, and fingerlings during high flow events is typical during spring months. This input of young-of-the-year fish can be a source of replenishment to adult populations in mainstem waters depending on their recruitment success.

3.0 Riverine Fish Habitat Types

Healthy riverine systems offer an array of habitats capable of supporting diverse biological communities. Riverine habitats are a complex interaction between the physical characteristics of the riverbed, water chemistry, flow characteristics, riparian and instream vegetation, and surrounding floodplains. Riparian vegetation offers a variety of benefits to riverine habitat including a food source, cover, shade, and bank stabilization. Water chemistries such as temperature and dissolved oxygen can limit distributions of some organisms in the river. For example brook trout *Salvelinus fontinalis* are highly dependent on cold well-oxygenated waters.

The Pennsylvania Department of Environmental Protection (PADEP) conducted a comprehensive assessment of the available habitat within the Lehigh River watershed from 1995 to 2000 (Wildlands Conservancy 2003). This survey examined instream and riparian habitat at 230 locations following Rapid Bioassessment Protocols (RBP; Barbour et al. 1999). The findings suggested overall that major parameters of concern were the lack of riparian vegetation and sediment deposition, particularly in the lower reaches of the Lehigh mainstem below Lehigh Gap, PA. Sediment deposition was evident throughout the mainstem with the worst conditions in the lower reaches (i.e., below Palmerton, PA) of the river. Additionally, riparian vegetative

cover, which dominated shorelines in the upper reaches of the Lehigh River, dramatically decreased in the lower reaches where the riparian lands are dominated by urban development.

Although the Wildlands Conservancy (2003) Lehigh River Management Plan provides a comprehensive review of the aquatic and terrestrial habitat and land usage of the Lehigh River Watershed, no information is currently available on the occurrence and extent of aquatic submerged vegetation and structure within the Lehigh River. The RBP assessments conducted by the PADEP include generalized quantifications of epifaunal instream habitat for fish colonization with regards to aquatic communities as a whole. Specific quantification of instream submerged aquatic vegetative and structural habitats in relation to the ecological needs of popular gamefishes are required for their proper management within the Lehigh River. This information is critical for assessing available habitat for those forage and gamefishes that utilize aquatic plants for cover, feeding, and spawning, particularly in the warmer waters of the lower reaches. Assessment of submerged aquatic habitats should not be limited to aquatic vegetation. Other submerged habitats such as rock formations and deadfalls often provide cover and forage grounds for fishes.

3.1 Headwaters to Francis E. Walters Reservoir (RM 105.69 –82.51)

The uppermost reaches of the Lehigh River generally have optimal habitat conditions according to the previously mentioned PADEP study. Most of the sites surveyed were classified as having optimal conditions for the variables included in the RBP analysis. Sediment deposition was not an issue in these sections but approximately 10 percent (%) of the riparian cover was marginal. Additionally, epifaunal substrate, a measure of the available habitat to allow for potential biological utilization, was classified as optimal for 70% of the surveyed sites. Young (2002) also noted that the RBP habitat characteristics just downstream of the confluence of Tobyhanna creek were optimal.

Much of the surrounding landscape in the headwaters is under private ownership. The many wetlands, ponds, and lakes in this section impede the movement of aquatic organisms due to numerous impoundments. The associated shallow pools generally have limited overhead cover resulting in higher water temperatures than would normally occur (Wildlands Conservancy 2003). The river is confined in this section by the Lehigh Canal, a railroad line, and an adjacent highway.

The river substrate is comprised chiefly of gravel, rubble and cobble. Some siltation occurs in the reach as waters begin to slow due to the widening of the river basin before entering into the Francis E. Walter Reservoir. The bottom substrate of the Francis E. Walter Reservoir is typically a mixture of gravel, cobble, boulder, and bare bedrock near the base of the Dam. Some siltation occurs as water velocities slow and is unable to keep larger particles in suspension. Farther upstream from the Dam base, bottom substrate can also include woody debris (e.g., stumps, and logs), and inundated terrestrial vegetation dependent on the seasonal status of water storage.

3.2 Francis E. Walter Dam to Northampton Dam (RM 76.51 – 24.00)

Habitat conditions start to deteriorate in the middle section of the Lehigh River. The PADEP study documented that sedimentation increased in this section with 40% of the sites scoring sub-

optimal with the remainder scoring as optimal. Riparian cover was generally excellent in this section with just 20% of the surveyed sites classified as sub-optimal. Only 60% of the surveyed sites had optimal epifaunal substrate with 20% classified as sub-optimal and the remaining 20% as marginal (Wildlands Conservancy, 2003).

Young (2002) noted RBP habitat scores were optimal at two stations just downstream of the Francis E. Walter Dam but the site approximately 0.5 mile downstream from the dam had a sub-optimal embeddedness score due to heavy iron flocculent caused by anoxic conditions associated with an elevated pool (February to September at elevation 1,392 ft) behind Francis E. Walter Dam. Prior to 2005, the pool was held at 1300 ft during this time of year, but it was held at 1,392 ft in 2002 from February through November as part of a drought study.

According to Jirka (1990), in a study conducted for Whitewater Challengers, Inc., a whitewater rafting company, the habitat for fishes immediately downstream of Francis E. Walter Dam was minimally impacted due to scheduled whitewater releases. Disturbances to habitat, specifically in the form of rapid velocity and depth changes were within the range of discharge fluctuations that naturally occur given run-of-river operation of Francis E. Walter Dam. The author also noted that no evidence of increased erosion, destruction or degradation of fish habitat, or physical displacement of fish resulted relative to increased outflow from the Francs E. Walter Dam for whitewater events. The dominant river substrate observed was cobble and boulders with little sand or silt, so it t was not conducive to shifting or rapid erosion. The Palmerton Natural Resource Trustee Council (2007) made a similar observation in the lower portion of this section. However, no instream flow studies, such as the Instream Flow Incremental Methodology (Bovee 1982) which have been done in some waters elsewhere in Pennsylvania, have ever been done downstream of Francis E. Walter Dam. Such studies are used to quantify incremental changes in the habitat of aquatic species as it relates to changes in flow.

Dominant riverine bottom substrates are cobble and boulders above the Blue Mountain Ridge line (i.e., above the Palmerton-Lehigh Gap, PA region). Below the Blue Mountain Ridge line, as the river flow begins to slow and pools start to become more prevalent, sands, gravel and sedimentation begin to form minor bars. The low-head dam at the Northampton Borough forms the most notable pool within this reach of the Lehigh River. Bottom substrates of this pool have increased sediment loading, as river flows are inadequate to keep course materials in suspension.

Several of the larger tributary inputs (e.g., Pohopoco Creek, Mahoning Creek, Nesquehoning Creek, Mauch Chunk Creek, etc.) into the Lehigh River mainstem can potentially provide colder water than mainstem waters, particularly during summertime months. This input possibly provides temporary thermal refuges for cold and cool water fishes during late summertime months when mainstem water warm to the upper tolerance limits of these fishes. The smaller tributaries can also provide this temporary thermal refuge, but the size and duration of the potential thermal refuge will be relatively smaller than a thermal refuge of a tributary with a larger drainage basin. Additionally, fishes from mainstem waters can also emigrate into the tributary waters, usually for short durations, for more suitable habitat during periods of less than optimal habitat in mainstem waters. Cold water seeps may also provide thermal refuges in mainstem waters. The occurrence, duration, and extent of any thermal refuge have not been documented to date.

3.3 Northampton Dam to Confluence with the Delaware River at Easton (RM 24.00 – 0.00)

In the lower sections of the Lehigh River, habitat conditions continue to decline. The 1995-2000 PADEP study documented that only 50% of the surveyed sites had optimal sedimentation conditions and several sites exhibited poor sedimentation conditions. Less than 10% of the surveyed sites had optimal riparian cover conditions and only 50% of the sites had optimal epifaunal substrate. The reduction of habitat in the lower sections of the Lehigh River is strongly related to the urbanization of the region, its industrial history, and the effects of the impoundments, which has slowed the river as compared to upstream conditions. Much of the river's riparian land has been developed for residential or industrial use.

Dominant riverine bottom substrates are mostly sands, gravel, and cobble. Moderate bar formations and sedimentation are prevalent in the lower reach of the river as riverine flows continue to decelerate and pools become more common. Woody debris becomes common, particularly below Bethlehem, PA in the Chain and Easton Dam pools.

Cold water tributaries such as the Hokendauqua Creek, Little Lehigh Creek, Monocacy Creek, and Saucon Creek, have the potential for providing temporary cooler water thermal refuges during the summertime months. Scattered cold water seeps may also provide some form of thermal refuges for fishes in the lower reaches. The occurrence, distribution and duration of any thermal refuge have not been quantified to date.

3.4 Proposed Actions

1. Identify and quantify the available instream habitat (vegetative and structural) in the portion of the Lehigh River from Northampton Dam downstream to its confluence with the Delaware River. A synoptic survey should be conducted every ten years to provide a time series of habitat quality. Preliminary surveys should be initiated as soon as possible given the fishery management practices of stocking fry and fingerlings of various game fish species that utilize this type of habitat, particularly muskellunge. Funding should be sought through various grant sources. Patterns of occurrence and quality of described instream habitat should be spatially and temporally evaluated for correlation to fish community usage.

2. Describe the occurrence, extent, and duration of cold-water thermal seeps and coldwater tributaries within the mid to lower reaches of the Lehigh River to further quantify the amount of habitat thermally suitable for cold and coolwater fishes. Assessment of available instream thermal habitat from the seeps should be based on a synoptic survey potentially which could be contracted, funded in part from grant sources; however, once seep locations have been identified, quantification of the extent and duration of the habitat will need to be addressed on a site-specific basis. The projected timeframe for the initiation of pilot surveys should be within the next five years (prior to 2011). This data will give PFBC fishery managers a more comprehensive understanding of the ability of these sections of the river to support cold and coolwater fish species.

3. Review the current status of riverine habitat as outlined by the 1995-2000 PADEP RBP habitat study on a ten-year basis to provide a time series of generalized habitat quality.

Based on standard RBP protocols quantification of habitat within the Lehigh Watershed should be comparable to other similar sized streams for evaluation of habitat degradation. Findings will be used to assess habitat changes compared to the initial PA DEP study. Further actions will be based upon these findings (e.g., further degradation should accelerate efforts to address habitat impacts). Funding for both the habitat assessment and potential restoration efforts should be sought from various grant sources.

4.0 Water Quality

One of the most important issues in the Lehigh River Basin is the water quality of the mainstem and its tributaries and the management of the numerous sources of pollution (Wildlands Conservancy 2003). To this day the Lehigh River suffers from a multitude of perturbations including abandoned mine drainage, industrial pollution, urban sprawl, storm water run off, sewage treatment plant discharges, and agricultural runoff.

The Wildlands Conservancy (2003) Lehigh River Management Plan provides a comprehensive review of water quality and current active management practices for addressing pollutant sources within the Lehigh River Watershed.

4.1 25 Pennsylvania Code Chapter 93 Designations

The PADEP is responsible for regulating water quality within the state. Chapter 93 of the Pennsylvania Code Title 25 (http://www.pacode.com/secure/data/025/chapter93/chap93toc.html) sets forth water quality standards based on water uses that are to be protected. Classifications for protected uses fall into the categories of aquatic life, water supply, recreation, and special protection. Chapter 93 classifications are particularly useful for protecting water quality for fishery uses. There are three Chapter 93 designations for the mainstem of the Lehigh River. The upper reach, from the headwaters to the SR 903 Bridge in Jim Thorpe, has been designated for protection of High Quality - Cold Water Fish (HQ-CWF). PADEP defines CWF as "*maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna that are indigenous to a coldwater habitat*". The High Quality designation is added if a water is represented by exceptional water chemistry and biological conditions as defined at 25 PA Code Chapter 93.4b(a). Further downstream, from the SR 903 Bridge in Jim Thorpe to the Hamilton St. Dam in Allentown, the mainstem is classified as TSF, which is defined as: "*maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat*". By the time the Lehigh River reaches its terminus, the river is designated for protection of Warm Water Fish (WWF, Hamilton Street Dam to terminus RM 17.00 – 0.00). WWF is defined is defined as "*Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat*". Figure 3 illustrates water temperature maximums for each of these Chapter 93 designations. Chapter 93 criteria for pH for all three thermal designations are 6.0 – 9.0. Chapter 93 dissolved oxygen criteria are dependent on thermal designations and time of year. The criteria are as follows: HQ-CWF - minimum of 7.0 mg/l; TSF - for the period February 15th to July 31st minimum daily average 6.0 mg/l; minimum 5.0mg/l; for the remainder of the year, minimum daily average 5.0 mg/l; minimum 4.0 mg/l; WWF waters – minimum daily average 5.0 mg/l; minimum 4.0 mg/l.

4.2 303(d) List of Waters Impaired under the Clean Water Act

Section 303(d) of the Clean Water Act requires states to further evaluate any impaired waters, as defined by not meeting identified standards. The PADEP has ongoing investigations to determine which waters remain impaired even after required water pollution control and Best Management Practices have been applied. In the Lehigh River watershed, there are 30 tributaries that have been listed on Section 303(d). Fourteen of these tributaries discharge directly into mainstem waters (Table 1 and 2; http://www.depweb.state.pa.us/watersupply/cwp/view.asp?a=1261&q=480056).

4.3 Non-point Source Pollution

Due to the large size of the Lehigh watershed, non-point source pollution is a serious concern. The majority of the landuse in the watershed is forested but approximately 24% of the land use is agriculture (Wildlands Conservancy, 2003). Common sources of agricultural pollution include sediment runoff where the riparian vegetation is not well established or by way of direct access to the water by livestock; excessive nutrient inputs (nitrogen and phosphorus) through ground and surface runoff from inorganic fertilizers, manure applications, and feed lots; and bacterial pathogens from livestock and soil.

Metropolitan areas account for 7% of the total land use in the Lehigh watershed. Stormwater runoff is considered a significant non-point source of pollution from these areas (Wildlands Conservancy, 2003). Urban areas often have stormwater gathering mechanisms that transport runoff directly into streams. This prevents stormwater from infiltrating the soil. These systems concentrate sediment, debris, and contaminant materials from roofs, roads, and parking lots for direct discharge to tributaries or the mainstem. To address this issue, the Pennsylvanian legislature enacted the Stormwater Management Act (No. 167) (http://www.depweb.state.pa.us/watershedmgmt/cwp/view .asp?a=1437&Q=518682&PM=1) in 1978 to authorize a program of comprehensive watershed stormwater management that retains local implementation and enforcement; however, siltation from urban runoff is still cited as a source of impairment as listed by PADEP on the 303(d) compilation (refer to above subsection in this document). Antiquated combined sewers that handle both sewage and stormwaters are being overtaxed as population growth continues in municipalities along the lower reaches of the Lehigh River watershed. PADEP maintains a current listing of municipalities that have completed Act 167 plans (http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1437&q=519879). The eastern drainage of the Lehigh River is also experiencing dramatic urban development, particularly in the lower reaches of the watershed. This development is impacting the rivers water quality by increasing surface run-off from impervious surfaces (parking lots, roads, etc.) and reducing riparian buffer zones. In urbanized areas surface water run-off is more efficiently collected by gutters and pipelines, thereby increasing the volume and velocity of water that is discharged into the riverine drainage.

4.4 Dirt and Gravel Road Maintenance Program

The Dirt and Gravel Road Maintenance Program was enacted into law as Section 9106 of the PA Vehicle Code in 1997. This law provides dedicated and earmarked funding to eliminate stream pollution caused by dust and sediment from unpaved roads

http://www.mri.psu.edu/centers/cdgrs/resources/dgrp_documents/dgrp_documents.html. All counties of the Lehigh River watershed are participants in this program. Each year $4 million in non-lapsing funding is disbursed among Pennsylvania's 65 County Conservation Districts. Priority consideration is given to roads impacting streams with a Chapter 93 water quality designation of Exceptional Value (EV) or High Quality. This program has aided in the abatement of stream pollution through the stabilization of eroded stream banks; construction of drainage outlets, ditches/culverts, cross pipes; vegetation plantings; and approved road base coverings. To date, most work of this type that in the Lehigh River drainage has occurred in areas from the headwaters downstream to the Francis E Walter Reservoir.

4.5 Point Source Pollution

Most point source pollution originates from municipal and industrial sources (Wildlands Conservancy, 2003). In past years, urbanization and industrialization, particularly in the lower reaches of the Lehigh River, have dramatically impacted the Lehigh River water quality and related biotic communities. Point source pollution is regulated through the National Pollutant Discharge Elimination System (NPDES) Permit program, which is administered by the PADEP. This program was established as the result of the Federal Clean Water Act. Permitting is designed to prevent exceedances of instream water quality criteria that have been established under 25 PA Code Chapter 93. Monitoring and reporting of discharge water quality is a requirement of NPDES permits. There were approximately 1,400 NPDES permitted point source discharges to the Lehigh River watershed as of 2003 (Wildlands Conservancy, 2003).

4.6 Superfund Sites

Pennsylvania has the second largest number of Superfund sites on the National Priority List under the Comprehensive Environmental Response Compensation and Liability Act. Twelve of these sites are located within the Lehigh River watershed as listed by the U. S. Environmental Protection Agency Region III (Wildlands Conservancy, 2003; Table 3). The majority of these superfund sites impact the mainstem of the Lehigh River indirectly via discharge of the tributary waters; however, the Palmerton Zinc Pile Site is located at the confluence of the Aquashicola Creek and the Lehigh River.

Over a period of nearly 70 years the New Jersey Zinc Company deposited 33 million tons of slag on the southern bank of the Aquashicola Creek, creating a cinder bank that extends for 2.6 miles. In addition, smelting operations emitted huge quantities of metals throughout the valley causing defoliation of approximately 2,000 acres on Blue Mountain and contamination of surrounding soils. Leachate from the cinder bank and surface water runoff and erosion of soils has carried contaminants including zinc, copper and cadmium into the Aquashicola Creek and Lehigh River (http://epa.gov/reg3hwmd/npl/ PAD002395887.htm; Palmerton Natural Resource Trustee Council 2007).

The occurrence and concentrations of metals in the Lehigh River has been documented by various entities (PADEP 1988, Pennsylvania Cooperative Fish and Wildlife Research Unit 1989, Versar 2002, Wildlands Conservancy 2003, and Palmerton Natural Resource Trustee Council 2007). The Pennsylvania Cooperative Fish and Wildlife Research Unit (1989) reported that the high concentration of metals downstream of the smelting plant on Aquashicola Creek reduced

the diversity of fish in that stream. PADEP (1988) also reported that discharges from Aquashicola Creek contributed substantial quantities of metals and sedimentation to the Lehigh River. In 2001, concentrations of aluminum (0.02-4.74 mg/l), iron (0.008-0.435 mg/l) and manganese (0.008-1.0 mg/l) were higher during May and June than in August and September (Versar 2002). Levels of cadmium were not detectable (0.005 mg/l detection limit) in any of the grab samples from mainstem waters of the Lehigh River (Versar 2002). Total zinc concentrations did not vary seasonally, averaging about 0.05 mg/l at all sampling stations. This included four sites upstream of the Aquashicola confluence, one site in Aquashicola Creek, and one site upstream of the Northampton treatment plant intake. The highest concentrations of aluminum during May (0.11-0.25 mg/l) and June (0.14-1.26 mg/l) were above DRBC chronic criteria (0.087mg/l; Versar 2002) at all stations on the Lehigh River. Analysis of dissolved metals (Al, Cd, Fe, Mn, and Zn) from the June 2001 samples had concentrations generally below detection limits (0.005mg/l) for cadmium and iron, but dissolved aluminum concentrations (0.21 mg/l) exceeded DRBC criteria (0.087 mg/l) in two tributaries (Buck Mountain and Black Creek). This is due to acid mine drainage rather than contamination from the Palmerton Zinc Pile Superfund site (Versar 2002). Dissolved zinc concentrations (0.629 mg/l) exceeded DRBC Chronic criteria (0.082mg/l) in Aquashicola Creek (Versar 2002) but did not exceed the criteria at Northampton (038 mg/l). Dissolved zinc concentrations were below detection limits (0.005 mg/l) at all other sites upstream of the Aquashicola Creek/Lehigh river confluence. Sediment concentrations of metals, particularly zinc and cadmium, were described by the Palmerton Natural Resource Trustee Council (2007) as having a high potential for aquatic toxicity in the lower Aquashicola Creek and the Lehigh River from Palmerton downstream approximately 15 miles.

Currently, the PFBC Division of Environmental Services (DES) is working with other regulatory agencies in seeking settlement for environmental contamination associated with the Palmerton Zinc Pile. As part of the remediation settlement, DES is negotiating the development and improvement of angler access on the Lehigh River (Hartle 2006). This is justified by the loss of angler trips and fishing opportunities caused by the pollution. Development and improvement of access points are to be limited to the mid and lower reaches of the Lehigh River since anglers, sportsmen's clubs, legislators, and PFBC staff, have indicated that there is limited access to the Lehigh River in these reaches. Additionally, access improvements near the Palmerton Zinc Site would be more likely to benefit those anglers whom have been impacted by the lack of stocking in Aquashicola Creek (Hartle 2006). By improving angler access to the Lehigh River, fishing opportunities can be promoted.

4.7 Abandoned Mine Drainage

The Lehigh River is impacted by abandoned mine drainage (Wildlands Conservancy 2003). Mine drainage waters are typically highly acidic (pH <6.0), infertile waters with elevated levels of metals. The Lehigh River watershed is most impacted by mine drainage in the area between the Francis E. Walter and Northampton Dams. Mine drainage discharges affect the following tributaries that are located in this section: Sandy Run, Buck Mountain Creek, Black Creek, and Nesquehoning Creek. PFBC stream assessments in the late 1970s found that these streams were devoid of fish. Surveys in the vicinities of the confluences of these streams in 2006 showed the continued influence of acid mine drainage, and fish were again absent in three of the four impacted steams (Sandy Run, Buck Mountain Run, and Black Creek; Arnold and Pierce (2007). Arnold's (2007) 2005 survey of Nesquehoning Creek documented the presence of 20 fish

species, and natural reproduction of brook trout and brown trout *Salmo trutta* in this water. This is largely related to Superfund work at the Tonolli Corporation site in the area of the stream north of Nesquehoning Borough, which consisted of culm bank stabilization and drastically reduced the acidic loading into the stream and its tributaries.

4.8 Review of Water Quality Monitoring Studies on the Lehigh River

The water quality of the Lehigh River is constantly monitored at various locations. In addition, a multitude of governmental agencies, consulting companies, and private organizations have gathered water quality data at various times from the Lehigh River. Many of these studies represent a significant time-series but others were intended for more of a synoptic overview of specific regions and periods.

The United States Geological Survey (USGS; http://pa.water.usgs.gov/) operates seventeen gaging stations within the Lehigh River watershed. Seven of these gages (Stoddartsville 01447500, Francis E. Walter 01447800, Lehighton 01449000, Walnutport 01451000, Bethlehem 01453000, Glendon 01454700, and Easton 01454720) are on the mainstem. They are distributed from the headwaters to near the mouth. These stations are primarily designed for monitoring flow (cfs) and surface water elevation, but other water quality parameters have been quantified for various time periods (Table 4; Figure 4).

The PADEP maintains a fixed water quality network (WQN) for monitoring water quality statewide. Currently, there are three active sites in the Lehigh River drainage (WQN0123, WQN0125, and WQN0126) from which sample collections are gathered (every other month since 2002; July 1962 - present year), and one inactive site (WQN0124) (July 1962 - December 1987). Three of these WQN sites are located on the mainstem of the Lehigh River in the general vicinity of the USGS gaging stations at Stoddartsville (WQN0126), Bethlehem (WQN0124), and Glendon (WQN0123; Figure 4). The remaining WQN site (WQN0125) is located at the Treichlers Bridge (SR 145) in Northampton County. The data gathered from this sampling network is stored on the United States Environmental Protection Agency (EPA) STORET (http://www.epa.gov/storet/) interactive website.

Over the years PADEP has also conducted other synoptic surveys in the Lehigh River Watershed. During the late 1980's, PADEP (1989) conducted a study in the mid-to-lower Lehigh River (Francis E. Walter Dam to the confluence with the Delaware River) for toxics modeling to estimate instream decay rates of toxic priority pollutants based on chemical and flow data gathered during the late 1980's. The study's findings illustrated that the poorly buffered mainstem waters are negatively impacted by abandoned mine drainage from tributaries from White Haven downstream to below Lehighton. In addition, other tributaries, including Aquashicola Creek, Hokendauqua Creek, and Little Lehigh Creek, contributed substantial quantities of metals and sedimentation to the mainstem. In 1995, PADEP (1995) investigated a report by a private organization of a fish kill of non-PFBC stocked adult in the Lehigh River between Aquashicola Creek and Walnutport. This occurred following a late spring stocking event. In response, PADEP extensively sampled the benthic community and water quality. They found a significant decrease in the benthic community compared to an upstream control site and fluctuating levels of metal contamination. However, these observations were as expected in streams affected by abandoned mine drainage. PADEP also noted an extensive presence of adult

warm and coolwater fishes in the mainstem during the study period. They concluded that the fish kill was most likely related to naturally warm water temperatures at the time of stocking rather than from poor water quality.

The United States Army Corps of Engineers (ACOE) owns and operates the Francis E. Walter Dam, which is located at the confluence of Bear Creek with the Lehigh River on the Luzerne and Carbon County border (http://www.nap.usace.army.mil/Projects/_FEWalter/index.htm). Since 1975, either the ACOE or its contractor (Versar Inc. 1995 – 2004) has measured various water quality parameters on an annual basis. This has included sites upstream of the reservoir in Bear and Tobyhanna Creeks, various sites within the reservoir, and sites in the mainstem as far downstream as Lehighton and Walnutport. In 2001, the water quality of the Francis E. Walter Dam, the mainstem, and various tributaries were extensively monitored to provide the basic information that could be used to subsequently model the river's water quality under various reservoir operating conditions (Versar, 2002). In general, the monitored water quality parameters were within acceptable PADEP and Delaware River Basin Commission (DRBC) criteria with some minor exceptions (Versar 2002).

A proposal was recently prepared by the ACOE and its partners (DCNR, PFBC, DRBC, Wildlands Conservancy, and Lehigh River Coldwater Fish Alliance) for a Federal Section 22 grant to develop the water quality/flow model based on the data collected in the 2001 study (Versar 2002). The intent of the proposed study would be to model the Lehigh River from the Francis E. Walter Dam downstream to the dam at Northampton. The model would be calibrated to evaluate the effects of operating alternatives for both Francis E. Walter Dam and Beltzville Dam. To date, the proposed study has not been funded.

Ford et al. (1983) conducted a modeling study (STRATIFY) of reservoir dynamics based on various water impoundment scenarios. That study was done in response to an ACOE proposal to elevate the Francis E. Walter pool to provide water supply and recreational benefits. The model simulation was based on two wet years (1977 and 1979) and an average flow year (1981) when the pool was temporarily raised to 1,392 ft. Model results indicated that reservoir water quality would not be drastically impacted; however, some acidification of the reservoir would occur and anoxic conditions near the bottom were predicted due to the decay of inundated terrestrial vegetation and thermal stratification. These results were verified by Baker (1983).

The Pennsylvania Fish and Boat Commission (PFBC) has numerous point samples of basic water quality measures (water temperature, pH, specific conductivity, and total alkalinity) from the Lehigh River. These measurements were made in conjunction with other game fish assessments on the river (Table 5). In cooperation with DRBC and the PA Department of Health, the PFBC sampled the water quality of the Lehigh River from 1965-1966 to relate it to biological productivity (Pollison and Craighead 1968). The conclusions of the study were that water quality was poor from Sandy Run (RM 66.77) to Northampton (RM 24.00) due to acid mine drainage, and from Allentown (RM 17.00) to Easton (RM 0.00) due to inadequate domestic and industrial waste treatment.

Several non-governmental agencies have also gathered water quality data from the Lehigh River. Jirka (1990) suggested that summertime whitewater releases in 1990 did not significantly degrade the water quality of the Lehigh River from the Francis E. Walter Dam to Jim Thorpe.

The Parkland School District (Miller 2001, 2000, 1999, 1998) measured several water quality parameters at Treichlers Bridge and Northampton Borough from December 1996 to April 2001 as partial fulfillment of independent studies students. The students noted that basic water quality parameters were annually variable. Water temperatures exceeded Chapter 93 TSF designations during summer months; pH increased in the last three years of the study (1999-2001) with increasing frequency of values greater than 9.0; and dissolved oxygen values were well within Chapter 93 designations. A study conducted by Lehigh University (1982) during the summer of 1981 in the lower Lehigh River indicated high levels of coliform bacteria, and ammonia nitrogen and orthophosphate levels were higher than desirable for gamefish. The benthic macroinvertebrate community from Hokendauqua (RM 21.33) to Freemansburg (RM 9.36) was determined to be indicative of pollution in that study. In 1987-1988 the Pennsylvania Cooperative Fish and Wildlife Research Unit, of the Pennsylvania State University (1989) reported on the extent of metal pollution near Palmerton, PA and its impact on the aquatic fauna. The study found that the high concentration of metals downstream of the smelting plant along Aquashicola Creek reduced the diversity of fish in that stream and elevated levels of metals in fish tissue upstream attributed to downwind aerial fallout of metals. Finally, in 1994-1995 the Wildlands Conservancy (1995) conducted a survey of the upper Lehigh River (north of the Francis E. Walter Dam) to support the reclassification of the water quality designation from HQ-CWF to EV. They concluded that several parameters (temperature, pH, aluminum, alkalinity, and dissolved oxygen) occasionally exceeded state water quality criteria, thereby warranting further investigation.

4.81 Regional Summary of Geology and Selected Water Quality Parameters of the Lehigh River.

This section presents a synopsis of the water quality for various regions of the Lehigh River. This synopsis is based primarily on the long-term data that has been gathered by the USGS, ACOE and PADEP at WQN sites.

4.81a Headwaters to Francis E Walter Reservoir (RM 105.56 – 82.51)

The mainstem Lehigh River above the Francis E Walter Dam, including the two major tributaries, Tobyhanna Creek and Bear Creek, have a Chapter 93 designation of HQ-CWF. High-Quality (HQ) designation indicates “surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water by satisfying §93.4b(a)” (http://www.pacode.com/secure/data/025/chapter93/chap93toc.html).

4.81a – i. Geology

The underlying geologic formations in this segment consist of sandstone and shale formed during the Upper Devonian (Catskill Formation) and Mississippian (Pocono Group) Periods. These geological strata are severely lacking in calcium carbonate components, which is reflected in the very low alkalinity and buffering capacity of the river and its tributaries.

4.81a – ii. Water temperature

Daily water temperatures were recorded at the USGS gaging station near Stoddartsville, PA (ID: 1447500) from October 1980 to September 2004. Water temperatures during this period have varied from a minimum of 0.0 ^{o}C (32.0 ^{o}F) to maximum of 27.2 ^{o}C (81.0 ^{o}F). The warmest average monthly water temperatures occurred during July (20.2^{o}C; 68.4 ^{o}F) and August (19.5^{o}C; 61.3 ^{o}F), for all years combined.

Data gathered by Versar (2002) in 2001 from one site on the mainstem at the confluence of Tobyhanna Creek found that water temperatures ranged from 14.0 to 26 ^{o}C (57.2 – 78.8 ^{o}F; June – November). Water temperatures were generally lower in both 2005 (7.9 – 21.2 ^{o}C; 42.2 – 70.2 ^{o}F) and 2006 (11.0 – 22.7 ^{o}C; 51.8 – 72.9 ^{o}F). The highest temperatures occurred during July (ACOE 2005b; ACOE 2007).

PADEP WQN bimonthly monitoring of water temperature at the Stoddartsville site (WQN0126) from April 2002 to November 2006, ranged from 0.1-19.5 ^{o}C (32.2 – 67.1 ^{o}F) with an annual average of 9.8 ^{o}C (49.6 ^{o}F). Warmest values occurred during July (19.5 ^{o}C: 67.1 ^{o}F) and August (18.0 ^{o}C; 64.4 ^{o}F), but these months were generally sampled every other year due to the bi-monthly sampling schedule. Temperatures remained above Chapter 93 criteria for most of the summer and periodically during the late spring (May) and early fall months at this site (Figure 5).

4.81a – iii. pH

The pH has varied from 6.0 to 7.6, with minimal annual variation in this section of the river. Generally it has remained well within Chapter 93 criteria for the entire monitoring period in 2001 (Versar 2002, 2005 (ACOE 2005b), and 2006 (ACOE 2007).

From 1986-1991 and 1993-1996 the PFBC collected monthly grab samples of pH at RM 93.92 during the spring runoff period of January - April. This site is located 0.72 km (0.45 mi) downstream from the confluence of Ash Creek (an acidic spring runoff affected tributary). Values during this period ranged from a low of 5.7 (1994) to a high of 6.3 (1986, 1987, and 1995). The pH fell below Chapter 93 criteria of 6.0 in 1989, 1990, 1994 and 1996.

4.81a – iv. Dissolved oxygen

Dissolved oxygen concentrations have generally remained well above the Chapter 93 criteria of 7.0 mg/l as measured near the confluence of Tobyhanna Creek in historical sampling. Dissolved oxygen concentrations ranged from 3.3-15.2 mg/l in 2001 (Versar 2002), 6.47-12.09 mg/l in 2005 (ACOE 2005b), and 7.65-14.04 mg/l in 2006 (ACOE 2007). Dissolved oxygen concentrations were usually lowest during July and August and fell below Chapter 93 criteria during 2001 and 2005.

4.81a – v. Total Alkalinity

As with pH, from 1987 to 1996 the PFBC collected monthly grab samples of alkalinity at RM 93.92, during the spring runoff period of January - April. Values during this period ranged from 1.0 to 5.0 mg/l. This indicates poor buffering capacity, which makes the river in this section susceptible to pH depression related to episodic acidic inputs. Alkalinity measured by Versar in

the river above Francis E. Walter Dam has averaged 8.9 mg/l with a range of 6.0 mg/l to 16 mg/l (Versar 2002).

4.81a – vi. Impact of Water Quality to Gamefishes

Water quality can have dramatic effects on the occurrence and distribution of fishes. Water temperatures within this region of the mainstem Lehigh River have periodically exceeded Chapter 93 HQ-CWF criteria. Average monthly water temperatures exceed Chapter 93 criteria from May through August (Figure 5). These water temperatures are still within the tolerance limits of thermally sensitive but popular gamefishes that utilize these waters, however, and in particular brook and brown trout (Table 6). Still, the prolonged duration of temperatures above Chapter 93 criteria, particularly during the summer months, could likely impact the distribution of coldwater fishes within this region. Potentially, cold water fishes could emigrate from the mainstem waters into colder tributaries, move up or downstream, congregate in cold seeps that serve as refuges, or die if temperatures conditions are excessively severe.

Concentrations of pH and dissolved oxygen, while periodically exceeding Chapter 93 criteria, did not endure for a long enough time period to be a cause of concern in regards to fish occurrence and distributions in this region of the mainstem. The waters within this region of the river are poorly buffered. Therefore, episodic acidic input could acidify riverine waters and force the more sensitive fish species to either die or temporarily move to other areas, with the expectation that they would return once an acidic event passed.

4.81b Francis E Walter Dam Reservoir

The Francis E. Walter Dam was completed in 1961 for the congressionally authorized purpose of flood control. In 1988, as the result of Public Law 100-676, Section 6, the provision of recreational opportunities, and specifically whitewater rafting, was added as a second authorized purpose. Prior to 2005, Francis E. Walter Dam had been operated to maintain a stable conservative pool at elevation 1,300 ft (80 acre surface area) with a range of 1,297-1,306 ft while maintaining a minimum outflow of 50 cfs. Pool elevations and release flows could fluctuate slightly due to hydrologic conditions in the watershed, but, large pool elevation changes could occur to control downstream flooding or to store water during droughts. During periods of flood control, water is stored in the reservoir with an outflow of 100 cfs. This condition is maintained only long enough to obtain the maximum reduction of damaging flood stages downstream. Release of the stored reservoir waters is immediate thereafter, with the rate dependent on maintaining the maximum acceptable riverine stage (below flood stage) as dictated by downstream gaging. Additionally, the Delaware River Basin commission (DRBC) has the authority to request drought storage of up to 11.3 billion gallons for releases to prevent the intrusion of saline waters from the Delaware estuary. When under contract with DRBC to store for drought emergencies the minimum release is 43 cfs. When storing for whitewater boating releases prior to the establishment of the adaptive Experimental Release Plan in 2005, the minimum release was 144 cfs.

Reservoir pools have been held at high elevations for extended periods due to drought and flood control on several occasions. During the late 1960’s pool elevations were maintained at

approximately 1,360 ft (460 acre surface pool) in 1965, 1966, and 1967. The pool also reached 1360 ft for flood control in 1972 during Hurricane Agnes and in 1973 (Betz, Converse, Murdoch Inc., 1981). On January 26, 1981, the pool was raised to an elevation of 1,396 ft for drought control per DRBC regulations (Betz, Converse, Murdoch Inc., 1981; Barker 1983). In 2002 the pool elevation was raised to 1,392 ft (approximately 824 surface acres) from February through November (Versar 2003).

Downstream recreation in the form of whitewater rafting is secondary to flood control as a project purpose at Francis E. Walter Dam. Prior to 2005, five whitewater events were scheduled (two weekend events in June, single day event in September, and two single day events in October) each year. Storage of water commenced approximately two weeks prior to a scheduled event to a maximum pool elevation of 1,309 ft (nine feet above the normal pool elevation). Outflow during the storage period was a minimum of 144 cfs until the target pool elevation was achieved, at which time outflow equaled inflow, with the allowable minimum release rate during non-drought storage conditions of 50 cfs. During drought emergencies, flow could be dropped to 43 cfs as specified under contract with DRBC. The flow level of 144 cfs was established in consultation with the PFBC. This flow is equal to approximately 23% of the average daily flow of the river at the location of the dam.

Prior to the amended operations plan in 2005, the reservoir storage was more highly dependent on pool elevation and inflow. The water column was weakly stratified thermally during the summer when pool elevations were low (1,300ft), which allowed mixing of the entire water column. Coupled with the fact that Francis E. Walter Dam does not have selective withdrawal capability, a complete reservoir volume exchange occurred approximately every three days (ACOE 2002). At higher pool elevations (1,392ft), waters are more strongly stratified thermally, which reduces the rate of mixing between surface and bottom waters. With minimal scheduled whitewater releases, a complete exchange of reservoir waters would occur approximately every 60 days at this higher pool, assuming an average of 300 cfs inflow in August and September. Due to the lack of selective withdrawal facilities, the Francis E. Walter Dam cannot impound cold water for storage. Rather, the Francis E. Walter Dam impedes riverine flow enough such that the cool springtime water can, to a certain extent, can be rationed for a short-term duration, dependent upon outflow rates. After exhausting bottom cool waters replacement inflow waters are not retained for long enough duration for reforming the thermocline. Thus, bottom waters are only slightly cooler (1-2 degrees) than surface waters after the loss of the thermocline.

During periods when high pool elevations are maintained in the Francis E. Walter reservoir, water chemistries in the reservoir and river immediately downstream of the dam are known to be adversely impacted. Francis E. Walter reservoir conditions were evaluated during two periods of high pool elevations in 1981 and 2002 (Baker 1983; Versar 2003). These studies documented that the water quality of the mid-to bottom areas of the reservoir and the river immediate downstream of the dam were temporally rendered anoxic. Mid-water median pH values were low, particularly during the 1981 drought storage event, with values less than 6.0 recorded (Baker 1983). However, other water quality parameters were generally similar to years of operation at a lower pool elevation (Baker 1983, Versar 2003).

In 2002, in the waters immediately downstream of the dam, Ashby (2002) documented elevated levels of hydrogen sulfide and iron precipitation. Young (2002) found that this was associated

with a general decline in the benthic macroinvertebrate community when compared to the control condition at a site upstream of the reservoir. Depressed benthic conditions were also documented in 1998 and 1999 downstream of the dam (Reynolds and Young, 2000) but in 2002 the downstream benthic community was depressed even further.

Recent operating plans (2005 to present) for the Francis E. Walter Dam reservoir create a pool of water whose volume and acreage is seasonally adjusted (ACOE 2005, 2006, 2007a). During the late fall and winter months, the pool occupies approximately 80 surface acres at elevation 1,300 ft. Typically, the outflow from the dam is set to the inflow such that minimal water is stored. In 2005 the pool was raised 35 feet above normal pool to 1,335 ft and in 2006 and 2007 it was raised 65 feet above normal pool to 1,365 ft. Storage to the higher pool during the last three years has begun in early April and pools remain elevated, although to a lesser degree, through mid-October to facilitate whitewater rafting events and to augment minimum flows. For whitewater releases, outflow is augmented up to a maximum of 750-1,000 cfs. These releases are scheduled for every other weekend from mid-May through mid-September. To store water after an event, outflow is set at a maximum of 250 cfs until the target pool elevation is reached, at which time outflow is set equal to inflow. Subsequent pool elevations and associated water chemistries in the reservoir and river downstream of the dam are subject to the management of the releases for recreational purposes coupled with the effects of natural changes in flow. Controlled releases from Beltzville Reservoir also affect water chemistries in the Lehigh River. Reservoir dynamics are further affected by the withdrawal of water primarily from the main gates located near the bottom of the reservoir. This greatly affects the ability of the dam to maintain cool hypolimnetic water temperatures. Due to the higher outflow rates and frequency of high outflow rates, the retention and replacement rate of the bottom cold water is unknown.

Interestingly, climate conditions in 2005 and 2006 varied greatly. While DRBC did not mandate drought storage of water, rainfall in 2005 was exceptionally low creating low riverine flow conditions that resulted in the cancellation of more than half of the scheduled whitewater events. In contrast, significant rainfall events were plentiful in 2006, which kept riverine flows elevated. At the end of June, flood storage control raised the reservoir pool to a record high of 1,442 ft. Subsequent evacuation of the stored water caused a complete replacement of pool waters that were stored prior to the rain event with inflowing mainstem waters, as the pool level was returned to the summertime operational level of 1,365 ft elevation called for in the 2006 Experimental Release plan.

4.81b – i. Water Temperature

From April – November**,** 2006, Francis E. Walter Reservoir surface water temperatures ranged from 8.0 to 27.0 ^{o}C (46.4 – 80.6 ^{o}F). Temperatures increased throughout the summer, peaked in mid-July at 27.3 ^{o}C (81.1 ^{o}F) and decreasing thereafter through November being generally 2-4 ^{o}C (3.6 – 7.2 ^{o}F) warmer than stream water temperatures upstream in both the Lehigh River and Bear Creek (ACPE 2007). Water temperatures in the outflow ranged from 9.0 – 22.0 ^{o}C (48.2 – 71.6 ^{o}F; April-November, 2006). River temperatures tend to increase as the cold-water reserves are depleted and typically surpass 20 ^{o}C (68.0 ^{o}F) by mid to late June. Outflow water temperatures are usually 1.0 – 5.0 ^{o}C (1.9 – 9.0 ^{o}F) cooler than surface water temperatures but 1.0 – 4.0 ^{o}C (1.8 – 7.2 ^{o}F) warmer than stream temperatures upstream of the reservoir.

Temperature profiles of the pool are taken at the dam's tower annually by the ACOE. Sampling in 2006 (ACOE 2007) showed that the lake stratified approximately 5 to 10 feet below the surface and the stratification was limited to the May to early June period. Typically, stratification lasts until water withdrawals have depleted the deeper, colder waters of the lake, after which time the lake remains weakly stratified, with bottom waters generally only 1.0 – 3.0 ^{o}C (1.8 – 5.4 ^{o}F) cooler than surface waters. In June 2006, a significant rain event required the storage and subsequent large release of bottom waters, which facilitated the degradation of the reservoirs stratification. Thus, maintenance of temperature stratification as it relates to operating at a higher baseline pool level in the summer cannot be assured (ACOE 2007).

The reservoir was weakly stratified for a short duration during the long-term high pool elevations of 1981 (2-weeks in July) (Baker 1981) and 2002 (June-August) (Versar 2003). In 2002, surface water temperatures peaked in August at 24 ^{o}C (75.2 ^{o}F) with about a 7 ^{o}C (12.6 ^{o}F) difference between the surface and bottom. The lack of a persistent well-developed thermocline, even during long-term high pool elevations, is due to the inability of Francis E. Walter Dam to selectively discharge water from different thermal regimes.

4.81b – ii. pH

Measures of reservoir surface water pH remained relatively constant (6.23 - 6.80) during April – November 2006 (ACOE 2007). Reservoir values were slightly lower (0.5 - 1.0) than measurements in the river upstream of the reservoir (ACOE 2007).

Little stratification of pH has been observed in the reservoir (5.74 - 6.75) (ACOE 2005b, ACOE 2007). In most cases, higher pH levels have been seen at or near the surface, which is likely due to increased algal productivity in the trophic zone. Occasionally, mid-level waters can drop below a pH of 6.0 in the reservoir, as in 2006 when waters 10-85 ft deep in mid to late July had a pH of 5.74 - 5.95.

During periods of long-term high pool elevations in 1981 and 2002, the reservoir was weakly stratified with respect to pH with slightly higher values near the bottom of the reservoir (Baker 1983, Versar 2003). In the main body of the reservoir, pH was acidic, at 5.0 - 6.0 in both years with extremes of 4.8 to 6.2 in 1983 (Baker 1983) and 5.6 to 6.6 in 2002 (Versar 2003). The lower pH was probably due to the raised pool inundating terrestrial vegetation that began decaying, resulting in an increase of carbon dioxide, which combines with water to form carbonic acid (Baker 1983).

4.81b – iii. Dissolved Oxygen

Dissolved oxygen levels in the reservoir are subject to diurnal and seasonal fluctuations that can be influenced, in part, by temperature, river discharge, and photosynthetic activity. Reservoir surface water dissolved oxygen concentrations (7.09 - 13.54 mg/l) are acceptable and usually slightly lower than that of the streams that flow into the reservoir. Reservoir dissolved oxygen levels tend to increase in mid-to-late fall months (Baker 1983, Versar 2003, ACOE2005b, ACOE 2007).

ACOE (2007) monitoring suggests that the reservoir is weakly stratified with respect to dissolved oxygen concentrations with levels generally remaining above 5 mg/l (the lower preferred limit for most fish species). However, in some years concentrations have decreased towards the bottom of the reservoir. Extremely low concentrations (<2.0 mg/l) were associated with periods of high pool elevations in 1981 (Baker 1983) and 2002 (Versar 2003) and during low flow conditions in 2005 when bottom waters were less than 3 mg/l from late-May to mid-August (ACOE 2005b). However, outflow dissolved oxygen concentrations are quickly restored as the water is re-aerated as it passes through the conduit system of the reservoir and a series of rapids less than 152 m (500 ft) downstream of the dam.

4.81b – iv. Total alkalinity

The ACOE monitors total alkalinity (mg/l) at three locations (Bear Creek and Lehigh River arms and at the gate tower) in the Francis E. Walter Reservoir. Alkalinity is measured at the surface, middle and bottom of the reservoir at each monitoring point. Alkalinity has ranged from 2 to 8 mg/l in recent years, indicating poor buffering capacity, which renders the lake relatively sensitive to acidic inputs (Versar 2003, ACOE 2005b, ACOE 2007).

4.81c Francis E. Walter Dam to Former Relic Dam at Palmerton (RM 76.51 – 37.70)

Waters from the Francis E Walter Dam downstream to the SR 903 Bridge located in the borough of Jim Thorpe have a Chapter 93 designation of HQ-CWF. Mainstem waters from the SR 903 Bridge downstream to Palmerton are classified TSF for protection of stocked trout.

4.81c – i. Geology

The underlying geologic formations in this segment are predominately sandstone and shale with little beds of marine fossils and limestone (Palmerton area), which were formed during the Upper to Lower Devonian Period (Catskill Formation and Hamilton Groups). These geological strata are severely lacking in calcium carbonate components, which is reflected in the very low alkalinities and poor buffering capacity of the river and tributaries, especially upstream of Palmerton.

4.81c – ii. Water temperature

In 2005 and 2006 the ACOE monitored water temperature from June through early October near several USGS gaging stations. These stations are located just below the Francis E. Walter Dam (2005: 15.0 - 24.3 ^{o}C, 59.0 – 75.7 ^{o}F; 2006: 8.0 - 14.0 ^{o}C, 46.4 – 57.2 ^{o}F), at Tannery Bridge (2005: 12.0 – 28.8 ^{o}C, 53.6 – 83.8 ^{o}F; 2006: 8.0 - 27.1 ^{o}C, 46.4 – 80.8 ^{o}F), and at Lehighton (2005: 13.0 - 28.3 ^{o}C, 55.4 – 82.9 ^{o}F; 2006: 8.9 – 26.5 ^{o}C, 48.0 – 79.7 ^{o}F) (ACOE 2005b, ACOE 2007). Water temperatures at the Tannery Bridge and at the Francis E. Walter Dam outflow routinely exceeded Chapter 93 HQ-CWF criteria during the July and August in both years. However, during 2006, water temperatures immediately below the Francis E. Walter outflow did not exceed HQ-CWF criteria. Observed water temperatures at Lehighton occasionally exceeded Chapter 93 TSF criteria from late June through late August (ACOE 2005b, ACOE 2007).

Interestingly, in 2006, the average water temperature measured at the Lehighton gage from July 1 to August 31 were slightly cooler 2.0 ^{o}C (3.6 ^{o}F), on average, than water temperatures gathered at the Tannery Bridge gage, which is located farther upstream. This cooling of the Lehigh River is most likely due to numerous inputs of cold water from tributaries, most of which are located below the Tannery Bridge monitoring station (ACOE 2007).

Similarly, Versar (2002) reported elevated water temperatures from June – September 2001 at three stations on the mainstem located immediately below the Dam (19.0 – 24.0 ^{o}C; 66.2 – 75.2 ^{o}F), at Tannery Bridge (16.0 -26.0 ^{o}C; 60.8 – 78.8 ^{o}F), and at Glen Onoko (16.0 – 27.0 ^{o}C; 60.8 – 80.6 ^{o}F). Temperatures exceeded Chapter 93 HQ-CWF criteria for most of the monitoring period at these sites. However, temperatures in tributaries in the same region (Hayes Creek, Sandy Run, Buck Mountain, Nesquehoning Creek, and Black Creek) generally remained below seasonal HQ-CWF temperature criteria during the same time period at 10.0 – 19.0 ^{o}C (50.0 – 66.2 ^{o}F). Temperatures at the Lehighton water supply intake ranged from 12.0 – 27.0 ^{o}C (53.6 – 80.6 ^{o}F) and from June – September and, with minor exceptions, stayed below TSF Chapter 93 criteria.

During the long-term maintenance of the high pool elevation in 2002, Versar (2003) measured temperatures at the same three locations downstream of the dam. Temperatures immediately downstream of the Francis E. Walter outflow ranged from 13.7 - 22.1 ^{o}C (56.7 – 71.8 ^{o}F), compared to 13.0 – 25.0 ^{o}C (55.4 – 77.0 ^{o}F) at Tannery Bridge and 10.0 – 26.0 ^{o}C (50.0 – 78.8 ^{o}F) at Lehighton. Water temperatures at the dam's outflow exceeded Chapter 93 HQ-CWF criteria from late June through October whereas water temperatures always exceeded HQ-CWF criteria at Tannery Bridge. Water temperatures at Lehighton generally only exceeded chapter 93 criteria during late July through mid-August.

Mean monthly water temperatures, referenced above, for all years and from all monitoring agencies combined are illustrated in relation to Chapter 93 criteria in Figures 6 and 7 for the HQ-CWF and TSF designations, respectively.

4.81c – iii. pH

In 2001, pH generally ranged from 4.6 - 7.4 in waters just below the Francis E. Walter Dam (HQ-CWF) and from 5.6 - 8.2 in waters above Lehighton (TSF). Only rarely were Chapter 93 criteria exceeded in either the HQ-CWF or TSF designated regions of the Lehigh River (Versar 2002).

From 1986 to 1991 and 1993 to 1996 the PFBC monitored pH with monthly grab samples at RM 71.86 (I-80 Bridge) during the spring runoff period of January- May. Values ranged from a low of 5.7 (January 1986, March 1988, February 1990, March 1994, and May 1994) to a high of 6.5 in (February 1993) during this period. The pH fell below 6.0 in 1986, 1988, 1990, 1994 and 1995.

4.81c – vi. Dissolved oxygen

In 2001, dissolved oxygen levels rarely dropped below Chapter 93 criteria at any of the monitored stations either on the mainstem or in the tributaries. In the HQ-CWF region dissolved

oxygen levels have typically remained above 7.0 mg/l (Versar, 2002). In TSF designated waters, dissolved oxygen levels have typically exceeded 6.0 mg/l (Versar, 2002).

4.81c – v. Total Alkalinity

From 1987 to 1996 the PFBC monitored total alkalinity with monthly grab samples at RM 71.86 (I-80 Bridge) during the spring runoff period of January through May. Values ranged from 1 to 4 mg/l during this period. Measurements of alkalinity taken by Versar (2003) in 2002 from the late spring to late fall months at various points between the Francis E. Walter Dam and Lehighton ranged from 4 to 40 mg/l. Most measurements of alkalinity, however are quite low, demonstrating that the river is poorly buffered and vulnerable to episodic acid inputs.

4.81c – vi. Impact of Water Quality to Gamefishes

Water quality in this region of the Lehigh River mainstem is a major cause for concern to fishery managers with regard to coldwater fishes. Within this region, mainstem waters are transitioning from being dominated by coldwater fishes to those with coolwater preferences. The extent of this transition is heavily dependent on a variety of factors including but not limited to rainfall, air temperatures, and coldwater tributary input. Mean river water temperatures exceed Chapter 93 HQ-CWF criteria for extended periods of time (April-September) in waters above Jim Thorpe (Figure 6). Average water temperatures within this reach are not optimal for most coldwater fishes but generally still fall within their thermal tolerances (Table 6). Coldwater fishes will generally either seek coldwater refuges in tributaries or within the mainstem waters, particularly during the warmest months (e.g., August). Prolonged high water temperatures can stress coldwater fishes, regardless of whether they are stocked or wild (Table 6). Below Jim Thorpe, Chapter 93 criteria change to TSF, which exceed tolerances of coldwater fishes for part of the year. The occurrence and distribution of some coldwater and coolwater fishes, such as muskellunge and walleye, could be affected as they will tend to be distributed in waters closer to their optimal preferences (Table 6). For example, brown trout will likely be more common in waters farther upstream whereas muskellunge and walleye will favor the warmer downstream waters.

The rare occurrences when pH and dissolved oxygen do not meet Chapter 93 criteria in both the HQ-CWF and TSF designated areas should not cause fish mortality in this region of the mainstem. However, the low total alkalinities in this reach suggest that the distribution of some more acid intolerant fish species could be temporarily impacted by episodic acid inputs. Furthermore, alkalinity is an indication of the productivity of system. Waters with low alkalinities tend to have more limited food resources available to sustain aquatic communities. Thus this reach of the Lehigh might be anticipated to sustain a relatively low biomass of fish.

4.81d Former Relic Dam at Palmerton to Northampton Dam (RM 37.70 – 24.00)

This entire region is designated for protection of Trout Stocking (TSF) in 25 PA Code Chapter 93.

4.81d –i. Geology

The underlying geologic formations in the upper region of this segment consist primarily of sandstone and shale formed during the Mid-to-Lower Devonian Period (Hamilton Group), and limestone, shale, and fossil limestone below Palmerton formed during the Silurian Period (Keyser, Bloomsburg, and Makenzie Formations). These geological strata are the beginning of the substantial input of calcium carbonate, which is reflected in the increasing alkalinity and buffering capacity of the river and its tributaries.

4.81d –ii. Water temperature

Water temperature data in this region were gathered either from the upper portion of the reach in the vicinity of Walnutport (Versar 2002, Versar 2003, ACOE 2005b, ACOE 2007) and Treichlers Bridge (PADEP WQN site 0125; Parkland High School 1997-2001), 8.3 km (5.2 mi) downstream of Walnutport, or at the lower end of the reach by Northampton (Versar 2002; Parkland High School 1997-2001). The ACOE monitors water temperatures from late spring to late fall at Walnutport, which provides excellent long-term data on seasonal (May-November) temperatures. PADEP WQN monitoring is also a long-term annual assessment of thermal conditions but is limited to one-time bi-monthly grab samples. Thermal conditions in this region of the Lehigh River are known to have substantial diurnal and seasonal variation, which bi-monthly grab sampling underestimates. The students from Parkland High School monitored water quality over a 5-year period offering an excellent historical dataset, but current conditions are necessary for evaluating possible impacts to game fish populations.

The PADEP WQN bimonthly monitoring of water temperature at the Treichlers Bridge (WQN0125) from April 2002 to November 2006 ranged from 0.0 - 25.3 ^{o}C (32.0 – 77.5 ^{o}F) with an annual average of 11.7 ^{o}C (53.8 ^{o}F). Further upstream, at the USGS gaging station in Walnutport, water temperature ranged from 0.0 to 23.0 ^{o}C (32.0 – 73.4 ^{o}F) with an average of 12.2 ^{o}C (54.0 ^{o}F) in bimonthly sampling between Oct. 1967 and September 1968. In both datasets the summer temperatures (June – August) did not exceed TSF criteria with the exception of one incident in July 2005 (25.3 ^{o}C; 77.5 ^{o}F) at Treichlers Bridge.

Water temperatures near the USGS gage station in Walnutport as measured by the ACOE ranged from 18.0 – 28.0 ^{o}C (64.4 – 82.4 ^{o}F) during 2001 (Versar 2002), 7.0 - 30.9 ^{o}C (48.2 – 87.6 ^{o}F) during 2005 (ACOE 2005b), and 13.5 - 28.6 ^{o}C (56.3 – 83.5 ^{o}F) during 2006. In general, water temperatures intermittently exceeded Chapter 93 criteria from June through early August, except during 2005 when water temperatures routinely exceeded TSF criteria.

Water temperatures of 7.7 - 28.7 ^{o}C (45.9 – 83.7 ^{o}F) were recorded further downstream near the Northampton treatment plant intake during 2001 (Versar 2002). TSF criteria were also intermittently exceeded at this site (Versar 2002).

Temperatures from two of the major tributaries, Aquashicola Creek (18.0 – 26.0 ^{o}C; 64.4 – 78.8 ^{o}F) and Bertsch Creek (17.0 -24.0 ^{o}C; 62.6 – 75.2 ^{o}F) were well below TSF criteria the warmer summer months of June through August, 2001 (Versar 2002).

Mean monthly water temperatures, referenced above, from all years and monitoring agencies combined are illustrated in relation to Chapter 93 criteria in Figure 8.

4.81d –iii. pH

Measured values of pH have ranged from 6.5 to 8.9 in this section, which is within Chapter 93 TSF criteria (Versar 2002, and PADEP WQN0125)

4.81d –iv. Dissolved oxygen

Levels of dissolved oxygen measured at various times from June through November, 2001 ranged from 4.9 - 12.1 mg/l and were typically above the Chapter 93 criteria of 6.0 mg/l as a daily average. Dissolved oxygen levels, however, fell below 6.0 mg/l for short durations in early August with two observations just below 5 mg/l (Versar, 2002).

PADEP WQN monitoring at Treichlers Bridge (WQN0125) has documented dissolved oxygen values of 8.4 -15.2 mg/l from 2002 to 2006. These results are well above Chapter 93 criteria.

4.81d – v. Total Alkalinity

PADEP WQN monitoring in the vicinity of the Treichlers Bridge (WQN0125) from 2002-2006 has documented total alkalinity values of 5.7 - 11.0 mg/l , which is indicative of poor buffering capacity in this section of the mainstem.

4.81d – vi. Impact of Water Quality to Gamefishes

Water quality within this region of the Lehigh River is a major source of concern for fishery managers as it can be a limiting factor to coldwater fish species. Mean monthly temperatures increase in this reach with thermal conditions periodically exceeding thermal tolerances of trout. Typically, during the summer months, trout are forced to seek refuge in coldwater tributaries or seeps within the mainstem. PADEP (1995) investigated a fish kill of stocked catchable trout in late spring in 1995 in waters between the confluence of the Aquashicola Creek and Walnutport. They found that the mortalities were related to naturally occurring warm water temperatures. Distributions of coolwater and cool water transitional fishes are minimally impacted by temperature in this reach with mean monthly water temperatures remaining well within preferred limits (Table 6). Annual monitoring of water temperatures within this region of the mainstem would give PFBC fisheries managers a better understanding of the suitability of river conditions for all fish species, as it related to their varying thermal tolerances. Particular attention should be given to mainstem waters below the USGS gaging station at Walnutport, which receive minimal monitoring.

The rare occurrences when concentrations of pH and dissolved oxygen violate Chapter 93 criteria are generally not causes for concern with regard to fish distributions within this region of the mainstem. However, the low total alkalinities in this reach suggest that the distribution of some more acid intolerant fish species could be impacted by episodic acid inputs. Furthermore, alkalinity is an indication of the productivity of system. Waters with low alkalinities tend to have more limited food resources available to sustain aquatic communities. Thus this reach of the Lehigh might be anticipated to sustain a relatively low biomass of fish.

4.81e Northampton Dam to Confluence with Delaware River at Easton (RM 24.00 – 0.00)

Waters from the Northampton Dam downstream to the Hamilton Street Dam in Allentown have a Chapter 93 designation of TSF. From the Hamilton Street Dam to the mouth the Lehigh River is classified for protection of Warm Water Fishes (WWF).

4.81e –i. Geology

The underlying geologic formations in the upper region of this segment consist of limestone, shale, fossil limestone, dolomite, shale, siltstone, shist, quartzite, and marble formed during the Silurian (Keyser, Bloomsburg, and Makenzie Formations), Ordovician (Martinsburg Formation), and Cambrian Periods (Leitsville and Hardyston Formations). These geological strata contribute significant calcium carbonate influence, which is reflected in the relatively high alkalinity values of the river and its tributaries.

4.81e –ii. Water temperature

Monitoring of water temperatures in this region of the Lehigh River were gathered only within the WWF designated waters of the lower reach (RM 0-3.0) either at the PADEP WQN site located at Glendon (RM 3.0) or the USGS gage station (RM 0.2) in Easton, PA. There is no current monitoring of water temperatures upstream of Glendon to the Northampton Dam a distance of 33.6 km (20.8 mi), particularly in the TSF waters between Northampton to Hamilton Street Dams (total distance 10.7 km, 6.6 mi).

Combined water temperature data measured at the USGS gage at Glendon (Aug. 1998- Sep. 2005) and the PADEP WQN (Oct 1998 – June 2004) site (WQN0123 located at the USGS Glendon gage station) varied seasonally from an average low of 3.5 ^{o}C (38.3 ^{o}F) during winter months (December- February) to an average high of 21.7 ^{o}C (71.1 ^{o}F) during summer months (June.-August). Warmest water temperatures occurred during July (22.9 ^{o}C; 73.2 ^{o}F) and August (23.8 ^{o}C; 74.8 ^{o}F). Water temperatures recorded from 1964 to 1972 at the USGS Bethlehem gage followed similar pattern with monthly average highs of 23.3 ^{o}C (73.9 ^{o}F) in both July and August. For all of these data, water temperatures, even during the summertime peaks, remained below the Chapter 93 WWF criteria.

Daily water temperatures have been measured at the USGS Easton gaging station since October 1961. These data, summarized over the last 16 years (1990-2006) ranged from 5.1 - 28.8 ^{o}C (41.2 – 83.8 ^{o}F) with the highest temperatures recorded in July (23.7 ^{o}C; 74.7 ^{o}F) and August (23.3 ^{o}C; 73.9 ^{o}F).

Mean monthly water temperatures, referenced above, for all years and monitoring agencies combined are illustrated in relation to Chapter 93 WWF criteria in Figure 9. No water temperature data is available for the TSF designated waters between the Northampton Dam and the Hamilton Street Dam in Allentown.

4.81e –iii. pH

Combined pH data gathered from the USGS Glendon gage (November 1998 September 2005) and PADEP WQN station at (WQN0123 located at USGS Glendon gaging station) during (October 1998 – June 2004), showed little seasonal variation from an average low of 7.4 during the spring months (March - May) to an average high of 7.7 during the summer months (June - August). The lowest pH values were documented during May (7.3) and the highest were observed in August (7.8) reflecting the springtime runoff that tends to acidify the river. Measurements of pH from 1958 to1972 at the USGS gage stations at Bethlehem and Glendon, PA, showed similar minimal seasonal variations in pH (6.9 - 7.2). On average, the Lehigh River was slightly more acidic in the earlier years than in the present.

Daily pH has been measured at the USGS Easton gage station since November 1972 with most measurements between March and October of each year. In the 16 years from 1990 to 2006, pH values ranged from a minimum of 6.8 to a maximum of 8.8, with monthly averages ranged from 7.4 to 7.5 during this period. Greater stability of pH within this river section is related to the higher total alkalinity.

4.81e –iv. Dissolved oxygen

Combined dissolved oxygen values gathered Glendon from the USGS gage (August 1998-September 2005) and PADEP WQN (Dec. 1998 – June 2004) sites, varied seasonally from an average low of 9.5 mg/l during summer months (June – August) to an average high of 13.6 mg/l during winter months (December- February). The lowest dissolved oxygen levels recorded at these sties occurred during August (8.8 mg/l) with average monthly values in June (9.8 mg/l) and July (9.9 mg/l) slightly higher. During the entire monitoring period, the minimum dissolved oxygen level was 7.2 mg/l during July at the Glendon station, which is well above the Chapter 93 WWF criteria (5.0 mg/l daily average).

Since June 1966 dissolved oxygen levels have been measured daily at the USGS Easton gaging station. Most measurements have been made at this site during the period of March through October. In the 16-year period from 1990-2006, individual dissolved oxygen levels at this site ranged from 3.7-15.4 mg/l with the highest mean monthly levels observed in March (11.9 mg/l) and April (10.8 mg/l). Even during summer, mean monthly dissolved oxygen levels were not limiting for fishes at this site: 8.2 mg/l in June, 7.8 mg/l in July, and 8.0 mg/l in August which represent the low range of values measured, but were sufficiently higher than Chapter 93 designations, and well above the 5.0 mg/l needed for most fish species.

4.81e –v. Total alkalinity

PADEP monitoring at the WQN station (WQN0123 located at USGS Glendon gaging station) from 2002-2006 has documented total alkalinity values ranging from 19 to 115 mg/l. This indicates that the mainstem is strongly buffered compared to areas further upstream.

4.81e – vi. Impact of Water Quality to Gamefishes

Water quality conditions in this region of the Lehigh River are not a source of concern for fishery managers with respect to fish occurrences and distributions. Thermal conditions generally exceed tolerances for trout and other coldwater fishes but are expected to be acceptable for cool

and warmwater species (Table 6). One issue within this reach that should be addressed, however, is the complete lack of water temperature data in the Chapter 93 TSF designated waters from Northampton Dam to the Hamilton Street Dam. The occurrences of coldwater fish in this reach are usually strays from nearby coldwater tributaries. Concentrations of dissolved oxygen and levels of pH do not likely limit the occurrence and distribution of cool or warmwater fishes within this region. In addition, the since the mainstem has a relatively high alkalinity and is well buffered in this reach, episodic inputs of acid water are not expected to have significant impacts here. The high alkalinity values suggest that the productivity of this region should be high. However, as indicated in Section 3.3 of this plan, habitat is a limiting factor that keeps the river's fishery from reaching its full potential here.

4.9 Proposed Actions

1. Along with existing partners (ACOE, DCNR, Wildlands Conservancy, Lehigh Coldwater Fishery Alliance), support pursuit of a water quality modeling through a federal Section 22 Planning Aid to the States study (Section 22 of the Water Resources Development Act of 1974, as amended). The model developed from this study will allow managers to assess the effects of various operational changes at Francis E. Walter and Beltzville Dams on downstream flows, temperatures and water quality. This will allow resource agencies to manage operations such that whitewater rafting opportunities are balance with potential improvements to downstream water quality and flows for fish and other aquatic life.

2. Sampling of basic water quality parameters within the mid to lower reach of the Lehigh River (Walnutport to Easton) should be improved. The ACOE provides excellent coverage of water temperatures from Lehighton to Walnutport but does not monitor water quality further downstream. The PADEP monitors water quality at WQN sites located at Treichlers Bridge and Glendon; however, sampling is done on a bi-monthly schedule, which is too infrequent to document short-term changes in conditions, which can be important to aquatic life. The only other active water temperature monitoring site is at the USGS gaging station in Easton. Thus, the Lehigh River from Walnutport to Easton (a distance of approximately 33 river miles) is inadequately assessed for water temperature. This is particularly problematic in the TSF designated waters from Northampton to the Hamilton Street Dam in Allentown. Additional daily monitoring of at least water temperature should be done at locations within the WWF and TSF designated waters. Possible locations include the Chain and Hamilton Dam fishways, PFBC Route 33 boat launch, TriBoro Sportsmen's Club, and Treichlers Bridge. Monitoring should coincide with ACOE efforts (April-November) at its monitoring sites located further upstream.

3. The PFBC Division of Fisheries Management should continue to provide assistance to PFBC Division of Environmental Services for the mitigation of damage associated with the Palmerton Zinc Pile Superfund Site. As necessary, provide recommendations in regards to the fishery relative to these mitigation efforts.

5.0 Fisheries Management

The PFBC strives to offer anglers a variety of fishing experiences through the protection, conservation, and enhancement of aquatic resources. The main goal of the PFBC Division of Fishery Management (DFM) is to manage species-specific fisheries for optimizing angler experiences. To achieve this goal, DFM will proactively manage individual gamefishes across existing sectioning strategies for achieving species-specific target management benchmarks detailed in later portions of this document. Evaluation of attainment of target benchmarks may include fishery resource assessments, angler use and harvest surveys, regulations, stocking, and various restoration efforts. For fisheries management efforts on the Lehigh River, the PFBC Division of Fisheries Management has established nine management sections, which encompass over 106 river miles extending from the headwaters near Gouldsboro, PA to the mouth at RM 183.6 of the Delaware River at Easton PA (Figure 2, Table 7). Within each of these management sections, the Division of Fisheries Management monitors game and non-game fish populations, and manages the resource using the tools mentioned above. This sectioning of the Lehigh River mainstem waters are more for daily PFBC operational considerations rather than limits of any particular species fisheries. Additionally, there are three special fishery management jurisdictions associated with the mainstem; Francis E. Walter Reservoir, Beltzville Reservoir, and the remnant sections of the Lehigh River Coal and Navigation Canal. These waters are managed separately from the mainstem river sections.

Fisheries assessments are conducted through the periodic monitoring of established survey sites sampled at the same time of year with similar types of equipment. These surveys provide PFBC biologists with data to determine the status of the target species, the effects of any stocking programs, and whether or not any changes in fishing regulations or stocking programs are necessary for the protection and management of the fishery.

Routine fisheries assessments are typically concentrated in those areas of the river open to public angling. Most surveys are conducted to monitor the status of key gamefish species or those that may be in restoration status. Key gamefish species in the Lehigh River include trout, smallmouth bass *Micropterus dolomieu*, walleye, muskellunge, and American shad, a species that has been the focus of restoration efforts.

5.1 Lehigh River Fisheries Management Sections

Fishing for all species in the nine fisheries management sections on the Lehigh River (Figure 2, Table 7) is currently regulated under §61.1 of the Fish and Boat Code (Commonwealth Inland Waters; Table 8). Sections 1 through 4 extend for a distance of 18.56 miles from the headwaters downstream to point 1.1 miles downstream of Choke Creek, is relatively narrow, reaching a mean stream width of 17.0 m (55.8 ft) in section 4. Waters less than 20 m (66.0 ft) in width are considered “streams” in the PFBC trout management plan, which has significance to stocking rates (PFBC 1997). From this point the river increases in mean width to 20 m, which makes it a “small river” as defined in the PFBC trout management plan (>20 m to <30 m (99.0). In Section 5 (the area between Section 4 and the Francis E. Walter Reservoir) the width eventually increases to 112 m, which places it in the PFBC stream width class for designation as a “large river” (> 30 m). It remains in the large river category to the mouth.

5.11 Headwaters to Francis E Walter Reservoir (RM 105.69 – 82.51) – Fisheries Management Sections 1 – 5

5.11a Survey and Management History

Early PFBC reports by Davis (1931) and Schadt (1933) documented that the 15-mile stretch of river flowing along the Lackawanna/Wayne and Lackawanna/Monroe county borders was open to fishing (currently contained within Sections 3 and 4). These reports noted that the water contained brook trout, brown trout, largemouth bass *Micropterus salmoides*, smallmouth bass, chubs, suckers, perch, sunfish, and catfish, as well as minnows and insects. Davis recommended stocking brook trout fingerlings upstream of Colby Dam and brown trout fingerlings downstream of the dam. Colby Dam was located about five miles downstream of Gouldsboro. Schadt changed the stocked trout fingerling allocation to all brown trout and recommended an annual stocking of 160 "cans" within this 15-mile stretch of river (at one time fish were hauled in milk cans).

Schadt (1933) reported that the approximately 18-mile stretch of river flowing from the Luzerne-Lackawanna/Monroe county border (Choke Creek, RM 90.53, currently Section 4) downstream along the Luzerne/Carbon County border to White Haven (currently Section 6) was open to fishing. This area of the river was described as containing brook trout and brown trout, minnows and insects. Annual stockings of 240 cans containing brown trout and rainbow trout *Oncorhynchus mykiss* fingerlings were recommended for this reach of river.

In 1968, the Oley and Nesky Rod and Gun Club requested that a "Fly Fishing Only" section be established on the Lehigh River. Buss (1968) informed the club that the area upstream of Sandy Run that is not currently stocked be considered for inclusion in this program. However, there is no indication that this area of the river was ever actually included in the program. The area of consideration is located near the current lower limit of Section 6.

Effective for the 1975 trout season, nearly 5.0 miles of the river, from Choke Creek to the Dutter Farm near Stoddartsville, was removed from the Approved Trout Waters list, due to posting (Snyder 1975, Daniels 1974). Posting in this region has been documented as a growing problem since at least 1965. The stocking limits in 1975 extended from the vicinity of Tobyhanna Creek (RM 83.50, currently Section 5) downstream to the vicinity of Sandy Run (RM 67.80; current end of Section 6), bypassing the "Bear Creek Flood Control Reservoir" (Francis E. Walter Dam).

Billingsley et al. (1977) surveyed nine sites in 1977 located within current management sections 2 – 5. These sites were located at the T308 Bridge (RM 99.80), the T304 Bridge (RM 97.20), the T597 Bridge (RM 95.40), Spruce Run (RM 94.20), the SR4003 Bridge (RM 89.48), 800 m downstream of Choke Creek (RM 88.10), 2.0 km downstream of Choke Ck (RM 87.30), the SR 115 Bridge (RM 85.00), and Tobyhanna Creek (RM 83.90). Backpack and towboat electrofishing at the nine survey sites in June and July showed that the trout fishery was largely sustained through the stocking of brook, brown, and rainbow trout. Limited natural reproduction of brook trout at RM 94.20, 89.48, and 85.00 (currently Sections 3-5) and brown trout at RM 99.80, 97.20, 95.40, 94.20, 89.48, and 85.00 (currently Sections 2-5) was documented. Brown trout was the dominant species. Other gamefish species listed as present were brown bullhead *Ameiurus nebulosus* (RM 99.80, and 89.48), chain pickerel *Esox niger* (RM 99.80), largemouth bass (RM 94.20), pumpkinseed *Lepomis gibbosus* (RM 95.40), white sucker *Catostomus commersoni* (RM 99.80,65.40, and 83.90), and yellow perch *Perca flavescens* (RM 99.80 and

88.10). Air temperatures, water temperatures, pH, and total alkalinity at the time of the surveys ranged from 20.0 ^{o}C to 29.0 ^{o}C (68.0 ^{o}F - 84.2 ^{o}F), 16.5 ^{o}C to 21.0 ^{o}C (61.7 ^{o}F - 69.8 ^{o}F), 6.4 to 6.9, and 5 to 12 mg/l, respectively.

Billingsley et al. (1977) documented that 25 percent of the area was private and closed to fishing. Field personnel noted that public access to private owned land was becoming more problematic. Nevertheless, the catchable trout program was continued. Brook trout were stocked from West End Pond downstream 3.0 miles to the Wayne/Monroe County Line (this is currently in Sections 1-2). Brown trout and rainbow trout were stocked from the T 304 Bridge downstream 9.0 miles to the confluence of Choke Creek in Lackawanna/Monroe (this is currently in Sections 3 and 4). Brown trout and rainbow trout were also stocked from Choke Creek (Luzerne/Lackawanna County Line) downstream 6.0 miles to the F.E Walter Reservation boundary (currently Sections 4-5).

Arnold (1998) surveyed Section 4 of the Lehigh River in July of 1997. Natural reproduction was documented for brook trout and brown trout. This area is currently stocked by the PFBC with brook trout, brown trout, and rainbow trout. All three species were caught during the survey. A review of spring runoff data from 1986 through 1997 (previously noted in water quality section) revealed the river's sensitivity to acidic runoff. However, pH values were still within the tolerance range of brook and brown trout. Based on the findings of the survey, no change in management was recommended. Section 4 was to be retained in the Approved Trout Waters program under the Optimum Yield II-Rural Subprogram (PFBC 1997). As a result of population changes from the 2000 census, the Rural (<40 people/km^2, <104 people/mi^2) designation was changed to Suburban ($\geq$40 but <125/km^2, $\geq$104 but <324/mi^2) and stocking allocations were increased accordingly. Habitat improvement efforts, consisting of low flow channel deflectors, were recommended for this section. A review of PFBC files indicates that this recommendation has not been acted upon. No change in Chapter 93 water quality designation was recommended, as it was determined that the HQ-CWF adequately protected the aquatic community.

Arnold (2000) surveyed Section 3 of the Lehigh River in June of 2000. One brook trout and nine brown trout were caught during the survey. Limited reproduction was documented for brown trout. No change in management was initiated due to the low abundance of trout present. This section was retained in the Approved Trout Waters High Yield sub-program, due to the vast amount of publicly owned land located within the section.

5.11b Current Management

The management goals of the PFBC in this river reach are: 1) to continue to provide anglers with a catchable trout fishery in sections open to public angling, 2) increase angling opportunities by seeking to open posted lands for fishing access, 3) protect and improve water quality. This segment of river contains five fisheries management sections (Figure 2), all of which are designated as waters that support natural reproduction of trout by the PFBC. The Chapter 93 water quality designation for all of these sections is HQ-CWF. The sectioning is based on the area's suitability for stocking as part of the PFBC Approved Trout Waters program. Although sectioning of a waterway is initially based on changes in stream morphology, additional reasons for sub-sectioning a waterway area of similar habitat characteristics are: stocking with catchable trout and/or access issues (open or closed to fishing). These sections support wild trout, their

biomass reflects a relatively low Class C population (10 - 19 kg/ha (22.0 – 41.9 lbs/ha) of brook trout or 10 - 30 kg/ha (22.0 – 66.1 lbs/ha) of brown trout or a mixed brook and brown population). The PFBC currently provides anglers with fishing opportunities for stocked catchable trout in Sections 3 and 4, as access is comparatively unrestricted.

Sections 1 and 2 are private and closed to the angling public. Section 2 was removed from the Approved Trout Waters program in 1994 due to posting (89 % of the section length was closed to public angling). Section 5 is mainly closed, but recently the PA Game Commission acquired approximately 0.5 miles on the eastern riverbank. This section extends from just downstream of the SR 115 Bridge at Stoddartsville to near Boy Scouts of America Camp Acahela. Wild trout reproduction water, Chapter 93 water quality designations, and stocking occurrence in the Lehigh River and its tributaries are listed in Tables 1-2. All fish species are regulated by Commonwealth Inland Waters regulations (Table 8). Fish species occurrence in these waters and tributaries are shown in Tables 9-10.

5.11c Proposed Actions

5.11c – i. Fisheries Management Sections 1-5

1. Habitat improvement such as low flow channel deflectors should be considered for this area. These devices will speed the passage of water, reduce travel time, thereby aiding in reducing stream temperatures. This work can be accomplished through the PFBC Habitat Management Section as sponsors (i.e. private clubs, Trout Unlimited Groups, etc.) show interest in this area.

2. With the assistance of the Bureau of Law Enforcement, Northeast Region, the Bureau of Engineering and Development, and other agencies, continue to watch for opportunities to purchase land or obtain easements along the river for public access and/or watershed protection.

5.11c – ii. Fisheries Management Sections 1,2,5

1. No change in current fisheries management status. Do not stock with catchable trout due to closure of the area to public fishing.

2. Reassess posting in 2008 and every five years thereafter.

5.11c – iii. Fisheries Management Sections 3 and 4

1. No change in current status. Continue management in the Approved Trout Waters program, and stock according to program guidelines.

2. Conduct stream surveys every 10 years, beginning in 2008 to monitor the abundance of wild trout and document the presence and at a minimum, the relative abundance of other fish species. Adjust stocking or regulations if necessary based on survey findings

5.12 Francis E Walter Dam to Sandy Run (RM 76.51 – 66.77) – Fisheries Management Section 6

5.12a Survey and Management History

Davis (1932) reported that the Lehigh River from White Haven (RM 72.0) to the current downstream section limit at Sandy Run (66.77) was polluted and unapproved for the stocking of any fish species. Public access was described as unrestricted. In the report section asking "What species of fish does the water now contain?". Davis listed "none." The river at the point of entry into the Delaware River was classified as a warm water stream.

Section 6 has been stocked by the PFBC with catchable brook and brown trout since at least the late 1960's, and was also stocked from 1961 to 1992 with catchable rainbow trout by the US Fish and Wildlife Service (USFWS). Fingerling brown trout have been stocked annually since 1982 by the PFBC. Brook trout fingerlings have also been sporadically stocked in the past. Due to concerns regarding low pH during the spring runoff period, the preseason component consists of brook trout and brown trout only. In, 2002, rainbow trout were included in the allocation during the inseason stocking period.

Billingsley et al. (1977) surveyed three sites in current management section 6 in September 1977. These sites were located at the F.E. Walter tailrace (RM 76.50), the I-80 Bridge (RM 71.90), and at Black (Hayes) Creek (RM 68.80). Towboat electrofishing at these sites showed that the trout fishery was sustained through the stocking of brown trout. There was no evidence of natural reproduction of any trout species in this section. Other gamefish species present in very low numbers were American eel (RM 76.50, 71.90, and 68.80), black crappie *Pomoxis nigromaculatus* (RM 76.50), brown bullhead (RM 76.50), pumpkinseed (RM 76.50, 71.90. and 68.80), redbreast sunfish *Lepomis auritus* (RM 76.50, 71.90, and 68.80), smallmouth bass (RM 76.50), white sucker (RM 76.50, 71.90, 68.80), and yellow perch (RM 76.50)). Air temperatures, water temperatures, pH, and total alkalinity at the time of the surveys ranged from 18.0 to 22.0 ^{o}C (64.4 ^{o}F - 71.6 ^{o}F), 16.0 ^{o}C to 17.0 ^{o}C (60.8 ^{o}F - 62.6 ^{o}F), 6.3 to 6.8, and 4 to 5 mg/l, respectively. The entire river was open to public fishing, but 95 percent of the section was privately owned. Although, the river was open to fishing, access was identified as a problem due to limited numbers of access points with adequate parking. Prior to 2002, the USFWS stocked rainbow trout in the reservoir and in the immediate region of the tailrace. At the time, the PFBC stocked the area with brown trout and rainbow trout. Billingsley et al. (1977) eliminated rainbow trout from the allocation due to the sensitivity of this species to low pH during high flows.

Billingsely et al (1985) surveyed four sites in Section 6 in 1985 (RM 76.39, FE Walter Tailrace; RM 75.88, USGS Gaging Station; RM 72.29, SR 940 Bridge; and RM 68.55 Black (Hayes) Creek). Sampling was conducted by both towboat and backpack electrofishing along the shoreline. They caught four legal size brown trout (one at RM 75.88, and three at RM 68.55) in that survey. No evidence of natural reproduction of brown trout was observed. Other gamefish species present in very low numbers were bluegill *Lepmois macrochirus* (RM 76.39), brown bullhead (RM 76.39, 75.88, and 72.29), chain pickerel (RM 76.39), green sunfish *Lepomis cyanellus* (RM 76.39), largemouth bass (RM 76.29, 72.29, and 68.55), pumpkinseed (RM 76.39 and 68.55), redbreast sunfish (RM 76/39, 75.88, 72.29, and 68.55), rock bass *Ambloplities rupestris* (RM 76.39 and 75.88), smallmouth bass (RM 76.39 and 72.29), tiger muskellunge *Esox*

lucius x e. masquinon (RM 75.88) and yellow perch (RM 76.39, 75.88, and 72.29). Air temperatures, water temperatures, pH, and total alkalinity (mg/l) values at the time of the surveys ranged from 22.0 ^{o}C to 26.7 ^{o}C (71.6 ^{o}F – 80.1 ^{o}F), 18.0 ^{o}C to 22.0 ^{o}C (64.4 ^{o}F – 71.6 ^{o}F), 6.1 to 6.3, and 3 to 4 mg/l, respectively.

On 12 June 2006 PFBC staff collected a sea lamprey ammocoete in while testing backpack electrofishing equipment in the Lehigh River near the USGS Gaging Station below Francis E Water Dam. This finding is significant, as sea lamprey have not been documented in the Lehigh River prior the opening of the Easton and Chain Dam fishways (Section 9) in 1994, nor was the actual extent of their spawning territory known.

In 2004, 2005, and 2006 the ACOE, DCNR, and PFBC developed and annually updated an experimental release plan for Francis E. Walter Dam (previously discussed in Section 4.81b of the Water Quality Section). Private stakeholders provided input to the development of these plans. The goals of the plans have been to increase the number of whitewater rafting events, to store coldwater to mitigate summer temperatures in the tailrace and as far downstream as possible, and to enhance the lake fishery by stabilizing the lake level from May through the end of June. Historic water quality data has demonstrated that the benefits of the coldwater release dissipate by the time the releases reaches the Tannery Bridge, which is located approximately 7.5 miles downstream of the dam.

5.12b Current Management

This reach of the Lehigh River principally supports a trout fishery, supported primarily by stocked trout. The objective of the FMD is to maintain or increase angler catch rates regardless of the origin of trout (hatchery or wild). Target fisheries benchmarks are detailed in the Proposed Actions Section 5.12c. Promotion of the trout fishery will be pursued through the continued partnership with ACOE, DCNR, and public stakeholders regarding the releases from the Francis E. Walter Dam, especially during the summer season.

This segment of river contains one fisheries management section, Section 6 (Table 7; Figure 2). Section 6 is the farthest downstream reach of the Lehigh River to be designated as water supporting natural reproduction of trout by the PFBC. It is currently managed as an Approved Trout Waters, within the Large Rivers subprogram. The current trout biomass classification for Section 6 is Class D ($\leq$10 kg/ha; 22.0 lbs/ha). As noted above, all fish species are regulated by Commonwealth Inland Waters regulations (Table 8). The Chapter 93 water quality designation for Section 6 is HQ-CWF for its entire length. The status of wild trout reproduction, Chapter 93 water quality designations, and stocking occurrence in the Lehigh River and its tributaries are listed in Tables 1 and 2. Fish species occurrences for the mainstem and its tributaries are listed in Tables 9-10. The PFBC stocks this section annually with catchable brown trout, brook trout, and rainbow trout per current PFBC guidelines. Additionally, this section is also stocked annually with at least 18,000 fingerling brown trout (approximately 2-4 inches in total length).
In preparation for the development of the fisheries management sampling strategies laid out in the current plan, PFBC Area 5 staff conducted cursory sampling in September - October of 2006 in this section. On 16 October 2006 Area 5 staff sampled at RM 76.30 (USGS Gaging Station Pool below FE Walter Dam) using daytime boat electrofishing and the total catch is listed in Table 11. Sampling was conducted along the shoreline and in the center of the river. Trout were

the most abundant species collected (n=50), followed by white suckers (n=48), fallfish (n=37), and smallmouth bass (n=25). Sampled trout consisted of hatchery and what appeared to be wild brown trout. The hatchery trout accounted for at least 70 percent (n=35) of the total. A total of nine sub-legal brown trout were collected. One appeared to be of hatchery origin and eight appeared to be wild. Due to annual PFBC stockings of fingerling brown trout in the spring, one cannot say for sure that the sub-legal trout are the result of natural reproduction. Legal size smallmouth bass ($\geq$300 mm, 12 in) accounted for four percent (n=7) of the total shoreline catch. Other species present in low numbers were redbreast sunfish (n=11), rock bass (n=8), bluegill (n=6), and common carp *Cyprinus carpio* (n=1). Shoreline catches were generally higher for most species caught than center of river catches. Center of river and shoreline catches were similar for white sucker (26 vs. 22) and brown trout (7 vs. 8), but, were higher for stocked brown trout (27 vs. 8).

5.12c Proposed Actions

5.12c – i. Fisheries Management Section 6

1. Continue to work in partnership with ACOE, DCNR Lehigh Gorge State Park, and private stakeholders in development of the Francis E. Water Experimental Release Plan. This plan is crucial to the establishment of more sustainable and prolonged thermal relief in the river, especially during the summer months.

2. In addition to the fish survey site established in 2006, at least two additional surveys sites below the USGS Gaging Station at Francis E. Walter tailrace should be established for monitoring purposes. These sites will be monitored in 2007, 2008, 2009, and 2010 to develop a long-term dataset and management changes implemented in a timely fashion as necessary.

3. The trout fishery present in Section 6 is primarily supported through hatchery stockings of adult and fingerling trout. The management goal regarding catchable trout for this reach of the river is to achieve an overall day boat or night boat electrofishing mean catch rate of 10 legal size ($\geq$ 7 inches) trout per hour regardless of origin (hatchery adult/fingerlings or wild). A second goal is to achieve a mean angler catch rate of 0.70 trout per hour. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented:

    a. Continue to manage Section 6 as an Approved Trout Water and stock per current program guidelines.

    c. Continue annual stockings of 18,000 spring brown trout fingerlings. Fingerlings will be marked in at least 2008 and 2009 pending an evaluation of logistics so that the proportion of the adult fishery composed of stocked fingerlings can be determined. Marks shall be different than those used for fingerlings that are stocked in Section 7 (discussed below).

d. If the goal of 10 legal size trout per hour through day boat or night boat electrofishing is achieved during the course of this plan, then current stocking rates will remain in place for catchable trout. However, if the marking study shows that fingerling trout are not significantly contributing to the fishery then that program will be either eliminated or adjusted based on a cost-benefit analysis.

e. If the goal of 10 legal size trout per hour through day boat or night boat electrofishing is not achieved during the course of this plan, then stocking rates for fingerlings and/or catchable trout may be adjusted. These adjustments may include: 1) increasing the spring fingerling stocking rate if the study shows they are making a significant contribution and are cost effective; 2) terminate fingerling stocking if their contribution to the fishery is negligible or not cost effective; or 3) adjust the catchable trout stocking rate either preseason and/or inseason.

4. Commonwealth Inland Regulations should continue to apply for all species within this section, except trout, as described in the following section.

5.12c –ii. Fisheries Management Section 6 – Special Regulation Area

In 2006, the Evening Hatch Shop in Lake Harmony and the Stanley Cooper Chapter of Trout Unlimited circulated a petition requesting the establishment of a Special Regulation Area, such as Catch and Release Fly Fishing Only or Catch and Release Artificial Lures Only, in an area downstream of Francis E Walter Dam. The impetus for the petition is the recent changes in reservoir operations as previously discussed. PFBC Commissioner Frederick Osifat forwarded the petitions and letters of support from the Tobyhanna Creek/Tunkhannock Creek Watershed Association, North Pocono Care, Brodhead Creek Chapter Trout Unlimited 289, and the Lehigh Coldwater Fishery Alliance to the Division of Fisheries Management.

The Division of Fisheries Management has given the request to establish a Special Regulation Area that would include catch and release angling in the Lehigh River below Francis E Walter Dam serious attention. An angler use and harvest study conducted in 2006 (discussed below) took place in those areas perceived to receive the most use, as they are the areas that provide the most access to the river. Bait anglers comprised a major user group of both study areas regardless of the season, and have been documented to release slightly more that half of the trout they caught. The trout fishery, based on the 2006 pilot electrofishing survey immediately below the dam, is primarily maintained through PFBC stocking of adult catchable trout. The motivation of individuals requesting a catch and release regulation appears to be that these regulations would make the fishery better. We believe this approach is too restrictive. Because of the high level of catch and release angling already occurring on the Lehigh River and relatively light use by all angling methods, we believe there is no biological need for the implementation of a Special Regulation Area that would restrict angling to Catch and Release at this time. In addition, bait anglers, a documented major user group, would endure a substantial loss of access to some of the most beautiful fishing spots on the Lehigh River if catch and release regulations (other than Catch and Release All Tackle) were implemented. Therefore our plan relative to special regulations is as follows:

1. Implementation of Catch and Release regulations of any form is not warranted at this time. Commonwealth Inland Waters regulations are more that sufficient to protect this stocked trout fishery in Section 6. This is apparent in light of our findings that catch and release is already a common practice among all user groups and use is relatively light.

2. Place Section 6 in the Approved Trout Waters Open to Year Round Fishing program. This would increase angling opportunities on the river, by allowing fishing from March 1 through the opening day of trout season, However, no trout may be taken or possessed during this period. The preliminary results of the 2006 Lehigh River Angler Use and Harvest Survey suggests that this section of the river is underutilized and may benefit from some program changes that will enhance the fishing experience and opportunity for anglers regardless of choice of terminal tackle. Inquiries to both the ACOE and the Manager of the DCNR Hickory Run and Lehigh Gorge State Parks resulted in positive feedback regarding this change. Both agencies noted that access roads will be open but are not maintained year round, which may impact access in some winters. To implement this recommendation the PFBC proposes to:

    a. Obtain consent of riverine landowners and adjacent affected property owners by May 30.

    b. Depending on landowner response, present this proposal at the July 2007 Commission meeting. If approved, the regulation would go into effect in 2008.

3. The implementation of more conservative regulations will be reevaluated if PFBC biological sampling and/or additional angler use and harvest surveys demonstrate a need for more restrictive regulations.

5.13 Sandy Run to confluence with the Northampton Dam (RM 66.77 – 24.00) – Fisheries Management Sections 7 and 8

5.13a Survey and Fisheries Management History

5.13a – i. Section 7 - Sandy Run to Former Relic Dam at Palmerton (RM 66.77 - 37.70)

Davis (1932) reported that the Lehigh River, in the area represented by current as per present day section limits (Table 7; Figure 2), was polluted and unapproved for the stocking of any fish species. Pollution sources noted included mine water, municipal sewage, and industrial waste. Public access was described as unrestricted. In the report section asking Davis stated that there were no fish species present in this section of water

In 1972, nine sites in the area of the Lehigh River between Sandy Run (RM 67.80) and near the islands at Palmerton (RM 38.40) were surveyed in mid-September to determine the feasibility of stocking warmwater species in the River. This area is currently in Section 7 (Table 7). The PFBC worked in partnership with the Lehigh River Restoration Association in that study (Hesser et al., 1972). This survey also included four acid mine drainage impacted tributaries (Sandy Run, Buck Mountain Run, Black Creek, and Nesquehoning Creek). Few fish species and individuals were collected from one mile below Sandy Run (RM 66.80) to about one mile below the confluence of

Little Mahoning Creek (RM 41.80). Researchers noted that fish life seemed to have improved near Palmerton, as several individuals representing seven species were collected. Water quality was reported to have improved since the 1965 survey, but Sandy Run, Black Creek, and Nesquehoning Creek, which contributed acid mine drainage to the Lehigh River were still quite degraded. The authors noted "Although there has been some apparent overall improvement in water quality from Sandy Run downstream, this stream remains marginal as far as fish and aquatic life is concerned." Thus no stocking of any species of fish is to occur within this segment of stream in Luzerne and Carbon Counties."

Billingsley et al. (1980) surveyed three sites in what is now Section 7 (RM 47.05, Jim Thorpe STP; RM 43.52, Lehighton RXR Bridge; and RM 39.92, SR0895 Bridge; Table 7) in 1980. Backpack and towboat electrofishing conducted along the shoreline during July caught two brown trout (one at RM 47.05 – 50 mm (2 in), and the other at RM 43.52 – 475 mm (19in)). Other gamefish species present in very low numbers were American eel (RM 43.52 and 39.92), bluegill (RM 39.93), chain pickerel (RM 43.52 and 39.92), redbreast sunfish (RM 39.92), rock bass (RM 39.92)) and white sucker (RM 47.05, 43.52, and 39.92). Air temperatures, water temperatures, pH and total alkalinity values at the time of the surveys ranged from 19.5 ^{o}C to 22.0 ^{o}C (67.1 ^{o}F - 71.6 ^{o}F), 16.0 ^{o}C to 17.5 ^{o}C (60.8 ^{o}F - 63.5 ^{o}F), 6.5 to 6.7, and 4 to 8 mg/l, respectively.

In 1982, Billingsley et al. (1982) surveyed six sites on the Lehigh River that were located upstream of the sites sampled in 1980 but still in current management Section 7 (Table 7). These sites were as follows: Leslie Run, RM 66.22; Mud Run, RM 65.33; Rockport Tunnel, RM 61.70; Drakes Creek, RM 60.18; Stony Creek, RM 58.90; and Bear Creek, RM 53.33. Biological assessments were conducted along the shoreline using either a towboat and backpack electrofisher in combination or only a backpack electrofisher. Limited evidence of natural reproduction of brown trout was documented at RM 65.33. A few legal size brown trout were caught at four (RM 65.33, 61.70, 60.18, and 58.90) of the six survey sites. Other gamefish species collected at all sites were American eel, brown bullhead, pumpkinseed, white sucker, and yellow perch. Black crappie were caught at RM 65.33, 61.70, 60.18, 58.90, and 53.33, and chain pickerel at RM 53.33. Air temperatures, water temperatures, pH, and total alkalinity values at the time of the surveys ranged from 20.0 ^{o}C to 26.0 ^{o}C (68.0 ^{o}F – 78.8 ^{o}F), 18.0 ^{o}C to 21.0 ^{o}C (64.4 ^{o}F – 69.8 ^{o}F), 6.2 to 6.9, and 3 to 8 mg/l, respectively.

On 30 August 2006, the PFBC Fisheries Management Division met with concerned trout groups/clubs, private stocking associations, and individual anglers regarding the stocking of walleye fry in Section 7. Their objections stemmed from the perception that walleye are voracious eaters of trout and they will destroy the already thermally stressed hatchery and wild trout component in this section of river. The PFBC announced its intentions to continue the stocking of walleye fry with an evaluation in 2009 and then make a final determination regarding whether or not to continue stocking walleye in Section 7. It should be noted that walleye have been stocked in Section 8 for years with unimpeded access into Section 7.

In preparation for the development of the management sampling strategies laid out in this plan, initial fish community characterization occurred in September/October of 2006 in Section 7 (Tables 12-13). The following two sites were surveyed by night boat electrofishing: RM 47.78 (Glen Onoko pool; shoreline and center of river on 27 September, and shoreline only on 25

October) and RM 40.00-01 (Bowmanstown Pool, upstream of the SR 895 Bridge, shoreline and center of river on 2 October).

The dominant fish species collected were smallmouth bass, redbreast sunfish, rock bass, white sucker, fallfish *Semotilus corporalis*, and trout sp. (brown, rainbow, brook and tiger listed in order of dominance; Tables 12-13) the spatial distribution of these species is depicted in Figures 10 and 11.

Shoreline catches at RM 47.78 on 27 September, 2006 were dominated by smallmouth bass (n=51), redbreast sunfish (n=45), rock bass (n=40), fallfish (n=31) and white sucker (n=25) (Table 12). Other species present in low numbers were brown trout of unknown origin (i.e. wild or stocked – private stockings; n=2), stocked brown trout (n=4), stocked rainbow trout (n=1), brown bullhead (n=2), and white catfish *Ictalurus catus* (n=1). Legal size smallmouth bass (≥300 mm, 12 in) accounted for four percent (n=7) of the total shoreline catch but none reached 375 mm (15 in). No walleye, muskellunge, or tiger muskellunge were caught or seen during the survey.

Center of river catches at RM 47.79 declined drastically for all species except stocked brown trout compared to shoreline catches on 27 September, 2006 (Table 13). Legal size smallmouth bass (≥300 mm, 12 in) and those ≥375 mm (15 in) accounted for 8 percent (n=4) and 2 percent (n=1) of the total shoreline catch. No walleye, muskellunge, or tiger muskellunge were caught or seen during the survey.

Shoreline catches on 25 October, 2006 at RM 47.78 (Glen Onoko pool) again demonstrated that smallmouth bass (n=47) were the dominant species (Table 12). Legal size smallmouth bass (≥300 mm, 12 in) and those ≥375 mm (15 in) accounted for 15 percent (n=7) and 0 percent (n=0) of the total shoreline catch. Smallmouth bass catch was similar to that on 27 September, although the increase in the legal size component may reflect a change in behavior that has been observed in this species by PFBC staff in the later and cooler times of year. Brook trout, and stocked brown, rainbow and tiger trout were the only other species caught (n=14). The sole brook trout caught appeared to be of wild origin, and may have originated from either the small tributary (locally know as Glen Onoko Run) that empties directly into this pool or one of the other brook trout laden tributaries in the immediate area. All trout were of legal size (≥175 mm; Table 12). As on 27 September, stocked brown trout were the major component of the trout fishery (n=9). Species diversity decreased from 13 on 27 September to 5 on 25 October. This decrease may reflect the reduced activity of many species late in the year as waters cool, which makes them less vulnerable to electrofishing. No walleye, muskellunge, or tiger muskellunge were caught or seen during this survey.

Shoreline catches on 2 October 2006 at RM 40.00 (Bowmanstown Pool - upstream of the SR 895 bridge) were dominated by smallmouth bass (n=61), redbreast sunfish (n=51), rock bass (n=37), and white sucker (n=21; Table 12). Other species present were fallfish (n=15), bluegill (n=12), pumpkinseed (n=2), legal size stocked brown and rainbow trout, brown bullhead and chain pickerel (n=1 for each species; Table 12. Legal size smallmouth bass comprised three percent (N=2) of the total catch, and none obtained a length of 375 mm (15 in).

Center of river catches on 2 October 2006 at RM 40.01 (Bowmanstown pool) were low for all species. The species collected were white sucker (n=6), brown trout (n=3, all legal size), smallmouth bass (n=2) and fallfish (N=2; Table 13)

5.13a –ii. Section 8 - Former Relic Dam at Palmerton to Northampton Dam (37.70 - 24.00)

Davis (1932) reported that the area of the Lehigh River in what is currently Section 8 (Table 7; Figure 2), as per current section limits, was polluted and unapproved for the stocking of any fish species. Noted pollution sources included mine water, municipal sewage and industrial waste. Public access was described as being unrestricted. Davis stated that there were no fish present in this section.

The first recorded fisheries assessment for this section of the Lehigh River was conducted by the PFBC in 1953 (Bradford 1953). Five sites were sampled (Table 7; Figure 2). The survey began above the Pohopoco Creek confluence (RM 41.10) downstream, to the Northampton dam (RM 24.00). Two distinct zones were identified based on water quality and biology. Zone 1 consisted of two sites - from above the Pohopoco Creek confluence downstream approximately 1.14 miles to Bowmanstown. This zone was characterized by extremely acidic conditions, very clear water conditions, and minnows and benthic organisms were absent. Total alkalinity and pH values ranged from 5.0 to 7.0 mg/l, and 4.5 and 4.6 (which can be lethal to fish) respectively. Zone 2 consisted of three sites, which showed that acidic conditions dissipated by the time the river reached the Lehigh Gap (Carbon/Lehigh/Northampton County Line; RM 36.15). Although the water quality improved as alkalinity and pH values increased from 8.0 to 11.0 mg/l and 6.1 to 6.9, respectively, still no minnows or benthic organisms were observed downstream to the 21st Street Bridge (SR 0329; RM 24.08) located 0.08 miles upstream of the Northampton Dam. The stream bottom was whitish with sludge from the beginning of the reach (above the Pohopoco Creek confluence) downstream to 21st Street Bridge where the riverbed was also coated with algae. Based on this survey it was recommended that fish not be stocked in this area.

In 1972, the area of the Lehigh River between the former relic dam at Palmerton (RM 37.70, Sandy Run (RM 67.80) and the 25th Street Bridge at Glendon (SR 2012; RM 2.36) was surveyed to determine the feasibility of stocking warmwater species in the river. The PFBC worked in partnership with the Lehigh River Restoration Association in that study (Hesser et al., 1972). One site was sampled within the limits of Section 8 was surveyed in mid-September (Table 7). It was located at the SR 145 Bridge at Treichlers (RM 28.4). Twelve species of fish were caught at this site. The authors recommended stocking muskellunge, smallmouth bass, and channel catfish *Ictalurus punctatus* from the Slatington-Walnutport area (RM 33.30) downstream to the Northampton Dam (RM 24.00). The stocking of smallmouth bass was recommended because the physical features of the Lehigh River and improved water quality appeared to favor this species.

Billingsley et al. (1980) surveyed four sites in what is now Section 8 (RM 36.31 upstream of Aquashicola Creek (water quality only); RM 35.26, Breached Dam Lehigh Gap below SR 873 Bridge; RM 35.25, opposite side of Lehigh Gap Dam (water quality only); and RM 28.75, breached Treichlers Dam; Table 7) in June and July, 1980. Fish were sampled using towboat and backpack electrofishing along the shoreline. No trout were caught during this survey. Other gamefish species present in low numbers at all sites were American eel, chain pickerel, redbreast sunfish, and rock bass, and white sucker were present at both RM 35.26 and 28.75. Bluegill,

brown bullhead, and pumpkinseed were found only at RM 28.75. Air temperatures, water temperatures, pH and total alkalinity values at the four sites ranged from 17.5 ^{o}C to 21.7 ^{o}C (63.5 ^{o}F - 71.1 ^{o}F), 16.0 ^{o}C to 19.0 ^{o}C (60.8 ^{o}F - 66.2 ^{o}F), 6.9 to 7.0, and 7 to 16 mg/l, respectively.

Billingsely et al (1985) surveyed one site contained within the limits of Section 8 in 1985. Day boat electrofishing was conducted in August of that year at RM 24.01. No trout were caught. Other game species present in very low numbers were chain pickerel, largemouth bass, muskellunge, pumpkinseed, redbreast sunfish, and yellow bullhead *Ameiurus natalis*.

In 1990 and 1991, the site at RM 24.01 (Northampton Dam pool) was surveyed for adult smallmouth bass. The 1990 survey yielded 13 smallmouth bass in 2.0 hours of night boat electrofishing. Two were of legal size (225 mm, 9 in) but less than 300 mm (12 in). In 1991, a total of 19 sub-legal smallmouth bass were caught in 2.0 hours of electrofishing.

In preparation for the development of the management sampling strategies laid out in this plan, a preliminary fish community characterization was done in September/October of 2006 in Section 8 by PFBC Area 5 Fisheries Management Division staff (Table 14). Dominant fish species collected were smallmouth bass, trout (brown, rainbow, brook and tiger), redbreast sunfish, rock bass, white sucker, and fallfish; spatial distribution of these species is depicted in Figures 10 and 11.

One site (RM 24.10; the Northampton Dam pool) was surveyed by nightboat electrofishing by the PFBC in Section 8 on 5 October 2006. Smallmouth bass (n=94) and redbreast sunfish dominated the catch (n=33; Table 14). Other species present in low numbers were rock bass (n=10), bluegill, white sucker, legal size brown and rainbow trout and channel catfish (n=1 for each species). Legal size smallmouth bass ($\geq$300 mm) accounted for four percent (n=4) of the total shoreline catch and none were greater than or equal to 375 mm (15 in).

5.13b Current Management

This segment of river contains current fisheries management sections 7 and 8 (Table 7; Figure 2). The trout biomass classification for both sections is Class D (< 10 kg/ha). Wild trout reproduction and Chapter 93 water quality designations, stocking occurrence are listed in Tables 1-2. Commonwealth Inland Waters regulations apply to all species present in these sections (Table 8). Fish species occurrence in the Lehigh River and its tributaries, and stocking history within the Lehigh River sections is listed in Tables 9 and 10, and Appendix A.

5.13b – i. Section 7

This reach of the Lehigh River principally supports a mixed fishery for trout and small-mouth bass. The trout fishery is supported in part by private stocking of catchable and fingerling trout. The objective of the FMD is to maintain or increase angler catch rates regardless of the origin of trout (hatchery or wild). Target fisheries benchmarks are detailed in the Proposed Actions Section 5.13c-i. Target benchmarks, at this time, have not been established for smallmouth bass since it is a self-sustaining fishery. Additionally, PFBC is interested in developing a walleye fishery to further enhance angler opportunities, through stocking, within this reach of the Lehigh River with target benchmarks as detailed in Section 5.13c-i.

Section 7 extends from the confluence of Sandy Run downstream to the former relic dam at Palmerton (RM 37.70). The Chapter 93 water quality designations in this section are HQ-CWF (Sandy Run (RM 66.77 downstream to the SR 903 Bridge at Jim Thorpe (RM 47.57) and TSF (SR 903 Bridge at Jim Thorpe (RM 47.57) downstream to former relic dam at Palmerton RM 37.70. The lower 11.1 miles, from the SR 903 Bridge downstream to the former dam at Palmerton was added to the fingerling trout program in 2007. This section generally experiences water temperatures near or above the criteria for the current TSF designation, based on temperature data recorded in the lower region near Jim Thorpe area (see water quality section). Because some trout are present in this area during mid-summer, and typically seek out refuges in the cooler tributaries (Daryl Pierce, PFBC Fisheries Biologist, field observation during young-of-year smallmouth bass assessment work in July, 2006 at mouth of Mauch Chunk Creek), suggests that stocking may enhance the trout fishery. However, the peak summer temperatures may limit success. Based on the request of anglers, the PFBC Fisheries Management Area 5 staff decided to try stocking fingerling brown (30,000) and rainbow (20,000) trout in this section on an experimental basis beginning in May 2007.

5.13b – ii. Section 8

This reach of the Lehigh River principally supports a mixed fishery for trout and small-mouth bass. The trout fishery is supported in part by private stocking of catchable and fingerling trout. The objective of the FMD is to maintain or increase angler catch rates regardless of the origin of trout (hatchery or wild). Target fisheries benchmarks are detailed in the Proposed Actions Section 5.13c-ii. Target benchmarks, at this time, have not been established for smallmouth bass since it is a self-sustaining fishery. Additionally, PFBC is interested in developing a walleye fishery to further enhance angler opportunities, through stocking, within this reach of the Lehigh River with target benchmarks as detailed in Section 5.13c-ii.

Section limits extend from the former relic dam at Palmerton downstream to the Northampton Dam. The Chapter 93 water quality designation for this section is TSF. The Northampton Dam is a barrier for upstream movement of most fish species, as it currently does not have a fish passage device. American eels and sea lamprey are not impeded during the spring migration period due to the relatively high flows. Muskellunge were stocked prior to 2006 in Section 8, but were removed from the program due to changes in the PFBC statewide program that year. These changes involved eliminating stocking on some waters with more limited potential for successful management with this species and then allocating those fish to other waters that had greater potential for management success. Walleye fry are stocked annually in this section of the river.

5.13c Proposed Actions

5.13c –i. Fisheries Management Section 7

1. In conjunction with the gamefish survey sites established in 2006, at least two additional sites, upstream of Glen Onoko, should be established for fishery monitoring purposes. These sites will be monitored in 2007, 2008, 2009, and 2010 to develop a long-term dataset to assess the fishery and make fisheries management changes as necessary.

2. The trout fishery in Section 7 continues to be supported primarily through private trout stockings and perhaps immigration from PFBC stocked waters within the drainage. The management goal regarding catchable trout for this reach of the river is to achieve an overall boat electrofishing mean catch rate of 10 legal size trout (≥ 7 inches) per hour regardless of origin (hatchery adult/fingerlings, or wild). A second goal is to achieve a mean angler catch rate of 0.50 trout per hour. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented:

    a. Continue annual stockings of 30,000 brown trout and 20,000 rainbow trout fingerlings through at least 2011. Fingerlings will be marked in at least 2008, 2009, and 2010 with final assessment occurring in 2011 to determine their contribution to the fishery. Marks shall be different than those used for fingerlings stocked in Section 6 (discussed above).

    a. If the management goals are achieved during the course of this plan, then current stocking rates will remain in place. However, if the marking study shows that fingerling trout are not making a significant contribution to the fishery then fingerling stocking will either be terminated or stocking rates will be adjusted.

    b. If the management goals are not achieved, then:

        i. Stocking rates may be adjusted to achieve the goal. Adjustments may include: 1) increasing the spring fingerling stocking rate if the study shows they are making a viable contribution and are cost effective; 2) consider stocking only in the most suitable area based on catch data; 3) terminate fingerling stocking if contribution to legal catch negligible or not cost effective

        ii. Consider incorporating an area of Section 7 into the Catchable Trout program and stock per current program guidelines.

3. The walleye fishery in Section 7 is supported by annual fry stockings, which began in 2003, and possibly escapement from two PFBC stocked lakes within the region (Beltzville Lake – Pohopoco Creek, and Mauch Chunk Lake – Mauch Chunk Creek). To date there have been no reports of private stockings occurring in this section of river. The management goals for walleye for this reach of the river is to achieve a day boat or night boat electrofishing mean catch rate of 2.5 legal size walleye (≥ 15 inches) per hour, or a mean catch rate of 0.15 walleye per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean angler catch rate of 0.50 walleye per hour of fishing. This will be measured by creels survey(s) conducted in the months of May through October. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented. To achieve these goals the following actions will be implemented:

    a. If the management goals are met, then stocking will continue at the current rate.

b. If the management goals are not met, then the following options will be considered:

i. Data will be reviewed to determine if the stocking area can be truncated to achieve the goal(s) stated above. This will allow the program to continue in the most suitable area of the river.

ii. Terminate the program.

4. Commonwealth Inland Regulations should apply for all species located within these sections. Future regulation changes pertaining to any fish species will be guided by the annual surveys described above.

5. Fisheries Management Area 5 staff shall work with the PFBC Division of Habitat Management, Stream Habitat Section to find innovative methods to enhance the river fishery through by improving habitat.

5.13c – ii. Fisheries Management Section 8

1. In conjunction with the game fish survey sites established in 2006, at least two additional sites should be established upstream of the Northampton Dam for fishery monitoring purposes. These sites will be monitored in 2007, 2008, 2009, and 2010 to develop a long-term dataset to assess the fishery and make fisheries management changes as necessary.

2. The walleye fishery in Section 8 is supported by annual fry stockings, which began in 1984, and possibly escapement from two PFBC stocked lakes within the region (Beltzville Lake – Pohopoco Creek, and Mauch Chunk Lake – Mauch Chunk Creek). To date there have been no reports of private stockings occurring in this section of river. The management goals for walleye for this reach of the river is to achieve a day boat or night boat electrofishing mean catch rate of 2.5 legal size walleye ($\geq$ 15 inches) per hour, or a mean catch rate of 0.15 walleye per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean angler catch rate of 0.50 walleye per hour of fishing. This will be measured by creels survey(s) conducted in the months of May through October. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented. To achieve these goals the following actions will be implemented:

a. If the management goals are met, then stocking will continue at the current rate.

b. If the management goals are not met, then the following options will be considered:

i. Change the stocking lifestage from fry to Phase 1 fingerlings. (Early summer, Total Length ~1-2 inches) Stock and monitor annually from 2012 through 2017.

ii. If a change to walleye Phase 1 fingerlings is not a viable option due to production constraints then terminate the stocking program in 2012.

3. Commonwealth Inland Waters regulations should apply for all species located within this section. Future regulation changes pertaining to any fish species will be guided by the annual surveys described above.

4. Fisheries Management Area 5 staff will work with the PFBC Division of Habitat Management, Stream Habitat Section to finding innovative methods to enhance the river fishery by increasing spawning habitat and cover.

5.14 Northampton Dam to the Confluence with the Delaware River (RM 24.00 – 0.00) – Fisheries Management Section 9

5.14a Survey and Fisheries Management History

Davis (1932) reported that the Lehigh River within the limits of current Section 9 (Table 7; Figure 2) was polluted and unapproved for the stocking of any fish species. Pollution sources noted to impact this area include mine water, municipal sewage, and industrial waste. Public access was described as unrestricted. Davis stated that there were no fish living in this section of the river. The river at the point of entry into the Delaware River was classified as a warm water stream.

The first recorded fisheries assessment of the Lehigh River in current Section 9 was conducted by the PFBC in 1953 (Bradford). Five sites were surveyed beginning above the Pine Street Bridge (RM 20.94) downstream to Island Park (RM 3.10; Table 7). Water chemistry samples for pH and total alkalinity increased downstream from those sites sampled by Bradford (1053) in Section 8. Alkalinity and pH values ranged from 40 to 98 mg/l, and 7.7 to 9.1, respectively. The highest alkalinity and pH values occurred at the Nancy Run confluence (RM 8.80) and the Hill-to-Hill Bridge (SR 378/191; RM 12.85). Minnows, suckers, and sunfish were observed at various sites in this zone. Benthic organisms ranged from present to absent. The river bottom was covered with sludge, and water clarity was brackish in the vicinity of Island Park. Most sites had an oily film on the water surface. Based on this survey, it was recommended that "forked-tailed catfish" be stocked from Northampton Dam downstream to Island Park (just up river of the Chain Dam, RM 3.00). No records have been found at this time indicated that the stocking of "fork-tailed catfish" had occurred.

Experimental plantings of walleye and smallmouth bass were made by the PFBC in the river reach flowing through Northampton and Lehigh Counties in 1956 and 1957. Bielo (1960) then recommended the termination of stocking due to unsuitable water quality.

In 1972, the area of the Lehigh River between the Northampton Dam (RM 24.00) and the 25th Street Bridge at Glendon (SR 2012; RM 2.36) was surveyed to determine the feasibility of stocking warmwater species. The PFBC worked in partnership with the Lehigh River Restoration Association in that study (Hesser et al., 1972). Four survey sites sampled were located from the Northampton Dam (RM 24.00) downstream to the 25th Street Bridge (SR 2012; RM 2.36). This area is currently located in Section 9 (Table 7, Figure 2). These sites were located at RM 22.60

(Hokendauqua Creek Pool), RM 16.63 (Allentown Sewage Works on Kline Island (formally Jeter Island)), RM 8.80 (upstream from Nancy Run confluence), and RM 2.36 (Glendon Bridge S. 25th Street). All sampling was done in mid-September. The number of fish species present ranged from 6 to 17. Species diversity declined in the area of RM 8.80 and 2.36 to six and nine respectively. The authors recommended stocking muskellunge, smallmouth bass, and channel catfish when available from the Northampton Dam (RM 24.00) downstream to the Hill-to-Hill Bridge at Bethlehem (SR 378/191 Bridge, RM 12.85). The stocking of smallmouth bass was recommended because the physical features of the Lehigh River and improved water quality appeared to favor this species.

In 1980, Billingsley et al (1980) surveyed eight sites in current Section 9 (RM 22.65, Hokendauqua Creek; RM 21.42, Eugene Street Bridge; RM 17.01, Hamilton Street Dam Pool; RM 15.02, Sterner Island; RM 9.00, Laubach Island; RM 3.01, Chain Dam Pool; RM 2.99 Chain Dam Tailrace; and RM 0.01, Easton Dam Pool) which extended from the confluence of Sandy Run (RM 66.77) downstream to the former lowhead dam at Palmerton (RM 37.70), from the former low head dam at Palmerton downstream to the Northampton Dam (RM 24.00), and from the Northampton Dam downstream to the confluence with the Delaware River (RM 0.00).

Dayboat electrofishing yielded only one trout (a hatchery origin brook trout), which was caught at RM 22.65. Other gamefish species collected were black crappie (RM 3.01 and 0.01), bluegill (RM 3.01), brown bullhead (RM 9.00, 3.01, and 0.01), chain pickerel (RM 22.65), common carp (RM 22.65, 17.01, 15.02, and 2.99), largemouth bass (RM 9.00, 3.01, 2.99, and 0.01), pumpkinseed (RM 17.01, 15.02, 3.01, and 0.01), redbreast sunfish (RM 21.42, and 15.02), rock bass (RM 22.65, 21.42, 17.01 15.02, and 9.00), smallmouth bass (RM 22.65, 21.42, 17.01, and 2.99), and tiger muskellunge (RM 15.02). Air temperatures, water temperatures, pH and total alkalinity values at the time of the surveys ranged from 20.5 ^{o}C to 32.2 ^{o}C (68.9 ^{o}F – 90.0 ^{o}F), 14.8 ^{o}C to 21.0 ^{o}C (58.6 ^{o}F - 69.8 ^{o}F), 7.1 to 7.7, and 12 to 70 mg/l, respectively.

The abundance of adult smallmouth bass was monitored by nightboat electrofishing by PFBC staff at two sites in Section 9 of the Lehigh River in the 1980's and 1990's. From 1986-1992 sampling was done from RM 17.01 (Hamilton Street Dam Pool at the SR22 Bridge) downstream 3.70 km (1.9 mi) to the Hamilton Street Dam), and in 1986-1995 sampling was done from RM 15.02 (Head of Canal Park Pool downstream 2.3 km (1.4 mi) to the tip of Sterner Island; PFBC Resource Database). The low abundance of adult smallmouth bass was reflective of siltation and poor habitat (Table 15). The regulations changed in 1992, which was during the monitoring period. The minimum size limit increased from 225 mm (9 in) to 300 mm (12 in), the daily creel limit increased from five to six fish. The regulations prior to this change had been in effect since 1973. Monitoring at RM 17.01 was terminated in 1992 thus the effects of the regulation change were not determined. However, at RM 15.02 where sampling continued through 1995, the data suggests that the new regulation may have resulted in increased numbers of bass between 225 mm (9 in) and 299 mm (<12 in). However, there was no change in the numbers of bass greater than or equal to 12 inches. In 2006 the catch was dramatically higher (N=101 but all bass were sub-legal with 73 percent (n=73) within the 125 (5 in) and 150 mm (6 in) length groups (see below). In addition to the adult smallmouth bass surveys, PFBC personnel also collected walleye, muskellunge, and tiger muskellunge when encountered. Walleye were caught at RM 17.01 in 1987 (three sublegal), and at RM 15.02 in 1987 (two sub-legal), 1992 (two legal), 1993

(three legal), and 1994 (one legal). Muskellunge were caught at RM 15.02 in 1995 (two legal). Tiger Muskellunge were caught at RM 15.02 in 1991 (one sub-legal).

Young-of-year assessments of smallmouth bass were conducted in conjunction with the adult surveys in Section 9 (PFBC Resource Data Base). The sites were located within the Hamilton Street Dam Pool (RM 17.57 eastern shoreline north of Adams Island) and Canal Park Pool (RM 16.30). The low abundance young-of-year may reflect the low quality silted pool habitat in this section (Table 16).

In preparation with the development of the management sampling strategies laid out within this plan, cursory sampling began in September/October of 2006. Dominate fish species were smallmouth bass, trout, redbreast sunfish, rock bass, white sucker, and fallfish and their spatial distribution depicted in Figures 10 and 11. Total catch of all species caught are listed in Table 17. The following three were surveyed along the shoreline via nightboat electrofishing: RM 22.65 (Hokendauqua Creek Pool), RM 15.02 (Canal Park Pool), and RM 3.92 (PFBC RT 33 Access Pool) from October 3-5, 2006.

Shoreline catches at RM 22.65 on October 5, 2006 were chiefly comprised of white sucker (n=136), redbreast sunfish (n=56), smallmouth bass (n=52), fallfish (n=46), and redbreast sunfish (n=45; Tables 17). Other species occurring in low numbers are rock bass (n=16), common carp (n=6), bluegill and hatchery rainbow trout (n=2 each species), and a legal size brown trout. Legal size smallmouth bass ($\geq$300 mm, 12in) and those $\geq$375 mm (15 inches) accounted for eight (n=4) and six (n=3) percent of the total shoreline catch.

Shoreline catches at RM 15.02 on 3 October, 2006 were dominated by white sucker (n=149), smallmouth bass (n=101), fallfish (n=62), common carp (n=37) and redbreast sunfish (n=26; Table 17). Other species occurring in low numbers were rock bass (n=15), bluegill (n=6), and muskellunge (n=1). All smallmouth bass caught were of sublegal size (<300 mm, 12 in). The sole muskellunge landed was in the 200 mm (8 in) length group. Staff missed one muskellunge that was approximately 36 inches in length. No trout, walleye, or tiger muskellunge were caught or seen during the survey.

Shoreline catches at RM 3.92 on 4 October 2006 were mainly comprised of redbreast sunfish (n=43), white sucker (n=41), and rock bass (n=29; Table 17). Other species occurring in low numbers were smallmouth bass (n=16), pumpkinseed (n=11), fallfish (n=4), channel catfish (n=2), and bluegill, chain pickerel and yellow perch (n=1 each). All smallmouth bass caught were of sublegal size (<300 mm, 12 in). One legal size ($\geq$450 mm, 18 in) chain pickerel was collected. No trout, walleye, or tiger muskellunge were caught or seen during this survey.

5.14b Current Management

This reach of the Lehigh River principally supports mixed cool and warm water fishery, comprised of smallmouth bass, panfishes, catfishes, and suckers.d fishery for trout and small-mouth bass. Target benchmarks, at this time, have not been established for these species since they are self-sustaining fisheries. Additionally, PFBC is interested in developing walleye and muskellunge fisheries to further enhance angler opportunities, through stocking, within this reach of the Lehigh River with target benchmarks as detailed in Section 5.14c-i.

This segment of river contains one fisheries management section, Section 9 (Table 7; Figure 2). The trout biomass classification of this region reflects a Class D population. Wild trout reproduction water and Chapter 93 water quality designations, stocking occurrence and species occurrence, and stocking history in the Lehigh River and its tributaries are listed in Tables (1-2, 9-10; Appendix A).

Section 9 encompasses the lower 24.0 miles of river from the Northampton Dam down to the confluence with the Delaware River (Table 7). The water quality designation of this section is TSF in the upper seven miles of (Northampton Dam downstream to the Hamilton Street Dam) and WWF for the 17 miles from Hamilton Street Dam to the mouth. Section 9 contains three dams (Easton, Chain and Hamilton Street). All three have fish passage facilities and fish passage as been documented at the Easton Dam since 1994, and at the Chain Dam since 1996 (see Lehigh River Restoration Program/Fish passage section for more information; Table 18, Figure 12).

5.14c Proposed Actions

5.14c – i. Fisheries Management Section 9

1. In addition to the three fish survey sites established in 2006 in Section 9, at least two additional survey sites should be established: one up river of the Hamilton Street Dam, and one below the Chain Dam. These sites shall be monitored in 2007, 2008, 2009, and 2010 to develop long-term data for gamefish and forage species abundance. These data will be used to evaluate whether management changes are need to bolster the smallmouth bass and or sunfish populations, and to determine if annual stocking of walleye fry and muskellunge should continue. Decisions regarding stocking will be based on the PFBC cool/warmwater stocking guidelines. Decisions regarding the smallmouth bass and or sunfish fishery will also be based on catch rate as compared to similar reaches of river statewide and a scientific literature review. The poor habitat of this section may reduce the effectiveness of any management changes.

2. The walleye fishery in Section 9 is supported by annual fry stockings, which began in 1984, and possibly escapement from two PFBC stocked lakes within the region (Beltzville Lake – Pohopoco Creek, and Mauch Chunk Lake – Mauch Chunk Creek). To date there have been no reports of private stockings occurring in this section of river. The management goals for walleye for this reach of the river is to achieve a day boat or night boat electrofishing mean catch rate of 2.5 legal size walleye ($\geq$ 15 inches) per hour, or a mean catch rate of 0.15 walleye per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean angler catch rate of 0.50 walleye per hour of fishing. This will be measured by creels survey(s) conducted in the months of May through October. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented. To achieve these goals the following actions will be implemented:

    a. If the management goals are met, then stocking will continue at the current rate.

b. If the managemement goals are not me, then the following options will be considered:

i. Change the stocking lifestage from fry to Phase 1 fingerlings (Early summer, total length ~1-2 inches). Stock and monitor annually from 2012 through 2017.

ii. If a change to walleye Phase 1 fingerlings is not a viable option due to production constraints then terminate the stocking program in 2012.

3. The muskellunge fishery in Section 9 is supported by annual fingerling stockings, which began in 1984, and possibly escapement from Beltzville Lake on Pohopoco Creek. Also, Muskies Inc is considering stocking this area of the river when funding is available. The management goal for musky for Section 9 is to achieve a mean day boat and/or night boat electrofishing catch rate of 1.5 legal size muskellunge ($\geq$ 40 inches) per hour, or a mean catch rate of 0.10 legal muskellunge per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean annual angler catch rate of 2.4 legal muskellunge per year based on collective angler diaries as reported to Muskies Inc. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. The following actions will be implemented to achieve these goals:

a. If the management goals are met, then stocking will continue at the current rate.

b. If the management goals are not met, then the following options will be considered:

i. Change the size of stocked fingerlings and/or the stocking rate. Monitor annually from 2012 through 2017.

ii. Terminate stocking.

4. Commonwealth Inland Waters regulations will continue for all species in this section.

5. Fisheries Management Area 5 staff shall work with the PFBC Division of Habitat Management, Stream Habitat Section to find innovative methods to enhance the river fishery by increasing spawning habitat and cover.

5.2 Non-PFBC Trout Stockings

The Lehigh River Stocking Association, and the Northampton Lehigh and Carbon County Stocking Association annually stock adult and fingerling trout in the vicinity of Rockport downstream to the Northampton Dam area, covering PFBC fisheries management section 7-8 (Figure 2). The area of the Lehigh River in Jim Thorpe is also stocked by the Germantown Club, a PFBC Cooperative Nursery.

These private organizations began stocking this reach of river in order to enhance the trout fishery present. Stockings occur well below our catchable trout and fingering trout supported area in Section 6, nearly 20 miles upstream from the heart of the private stocking area from Jim Thorpe downstream to Walnutport. This active stocking program, and the presence of trout throughout most of the fishable year have led to the formation of profession fishing guide services.

Although the PFBC does not stock adult trout in this area, beginning in 2007 the PFBC will be annually stocking 50,000 fingerlings (30,000 brown trout and 20,000 rainbow trout) in a pilot program in Section 7 for at least five years (Table 7, Figure 2). Recruitment of these fish into the fishery will be monitored through a marking study (as noted above for Section 7; 5.13c-i). Summer temperatures are a concern in this reach of the river. Anglers, PFBC Waterways Conservation Officers, and Fisheries Management staff have reported common incidences of trout seeking refuge in the cooler tributaries during the peak summer season. This situation occurs even in relatively cool summers, such as in 2006.

5.3 Angler Use and Harvest

Angler use and harvest surveys are critical for evaluating angler impacts on fishery resources. Angler use levels are determined by counts of anglers according to a statistical sampling design. Catch and harvest are determined through angler interviews and/or angler logbook surveys. These surveys also allow direct interaction between the angler and PFBC staff, and typically include questions regarding upcoming site specific or statewide management changes that are proposed.

The only angler use and harvest survey that has been conducted on the Lehigh River occurred in 2006. It began on15 April (Opening Day of Trout Season) and concluded on 25 August (Pierce and Arnold, 2007). A logbook survey was conducted during this same period for the entire river. Two survey locations were selected. The first encompassed the reach from a point 0.83 km (0.52 mi) downstream of the Francis E. Walter Dam downstream to the White Haven Pocono Lehigh Gorge State Park Access, which is a distance of nearly 3.17 km (1.97 mi). The second reach extended from the SR 940 Bridge at White Haven downstream to Black Creek (also locally known as Hayes Creek) covering a distance of 5.15 km (3.2 mi). Nearly half of the 1,163 anglers counted in this study were observed on the opening weekend of trout season. Angler trips averaged less than four hours regardless of the date of the interview. Most anglers (66.5%) indicated they had not caught a trout at the time of the interview.

A total of 600 hatchery trout (n=388 from Francis E. Walter; n=212 from White Haven) were caught by interviewed anglers, of which 257 (42.8%) were harvested (n=172 from Francis E. Walter; n=85 from White Haven). Seven “wild” trout (n=5 brown trout from Francis E. Walter; n=1 each for brook trout and brown trout from White Haven) were caught by interviewed anglers during the entire survey period (Opening Day to August 30th, 2006). The use of the term “wild” does not mean that these trout are the result of natural reproduction, as they could also arise from the PFBC’s fingerling stockings. One should note that these catches have not yet been statistically expanded, so the total estimated catch and harvest from this reach will be significantly higher.

Regardless of the type of tackle utilized by anglers, there was a strong tendency to release the catch. Bait anglers released just under half of their catch in either of the two regions surveyed (47.9% in Francis E. Walter; 60.3% in White Haven) whereas fly anglers released over 74% of their catch in both surveyed regions (74.5% in Francis E. Walter; 78.9% in White Haven) within Section 6.

Local anglers from Luzerne County comprised the majority (55.1%) of the anglers interviewed and most out-of-state anglers were from New Jersey (72.4%). Most interviewed anglers used bait (42.1%), followed by flies (23.1%), and lures (13.6%). The percentage of anglers using flies increased through the summer months in the region immediately downstream of the Francis E. Walter Dam. However, the high percentage of bait anglers in both survey areas throughout the year suggests that any proposed fisheries management actions to eliminate the use of bait as tackle should be viewed with caution, since such a regulation could discourage the major users of the resource from fishing in this area.

5.31 Proposed Actions

1. Conduct angler use and harvest surveys in the mainstem waters for the entire river between Francis E. Walter dam and the mouth on a recurring basis (approximately every 10 years). The first full-scale angler use and harvest survey should be in 2010.

2. Conduct specialized angler surveys for limited reaches on the mainstem or tributary waters on an as needed basis to evaluate future PFBC management changes, such as changes in regulations.

3. Develop an on-line angler survey by way of the PFBC website for estimation of angler catch rates and harvest rates in the Lehigh River. This survey should be an annual event. The program should start as soon as possible, and should be a component of a statewide effort. Online surveys specific to the Lehigh River may need to be developed if angler responses to specific issues germane only to the Lehigh River are being sought.

4. Continue the mail in angler logbook program (that was started in 2006) in 2007 and 2008 and assess if the response warrants continuation of the program. This will be based on the number of response and the utility of the data being provided.

5.4 Special Areas of Concern Pertaining to the Management of the Lehigh River

5.41 Francis E Walter Dam

The ACOE Francis E. Walter Flood Control project is located at the confluence of the Lehigh River and Bear Creek at the Luzerne – Carbon County border. Species occurrence as determined by PFBC surveys is listed in Table 19. At this point in time surveys have been limited to due to the past operations of the reservoir primarily for flood control, which severely limited the development of a high quality gamefish population in the reservoir. Recent changes in operation of the dam (2005-2007, previously discussed) have allowed a higher and more stable pool in May and June, which is when most warm water species spawn. Another reason for these changes, besides preserving water for whitewater releases later in the year when natural river

flows are lower, is to preserve the water in the hypolimnion so that cooler releases will result, thereby benefiting trout downstream of the dam. The most significant impacts of this cooling will occur in the area between the dam at RM 76.51 and the Tannery Bridge at RM 70.00. The recent change in pool elevation from 1,300 ft to 1,365 ft increases the surface area from 80 to 524 acres, and the depth from 55 to 115 feet. Current management requires the maintenance of the elevated pool from May through June with fluctuations of no more than 5 ft even during weekend whitewater release events. In practice, pool elevations rarely fluctuate more than three feet, even during periods of highest releases for whitewater events. As noted previously, holding the lake at elevation 1,365 ft is subject to evacuation down to 1,300 ft at any time if warranted by impending weather conditions to protect downstream areas from flooding.

The fishery of Francis E. Walter Reservoir is currently regulated under §61.1 of the Fish and Boat Code (Commonwealth Inland Regulations; Table 8). Fish species occurrence in Francis E Walter and other PFBC managed lakes within the Lehigh River watershed is listed in Table 19. Because there has been no recent biological sampling in Francis E. Walter Dam, the gamefish species composition is unknown. However, in field observations PFBC staff has observed brook trout, brown trout, rainbow trout, black basses, and catfish. Fish escapement from the lake is possible, especially when high flow releases occur, which can influence the fishery in downstream areas.

A review of the cool- and warmwater fish stocking history indicates that 3,000 fingerling tiger muskellunge were stocked in 1981; fingerling black crappie *Pomoxis nigromaculatus* and smallmouth bass (2,250 each species) were stocked in 1977; and 2,200 black crappie fingerlings, 1,200 smallmouth bass fingerlings, and 360,000 walleye fry were stocked in 1976.

The US Fish and Wildlife Service stocked rainbow trout in Francis E. Walter from 1961 until the stocking program was terminated in 1993. The PFBC continued the annual stocking of catchable trout in the reservoir, at that time. PFBC stocking consists of preseason stocking of brook and brown trout, and rainbow trout are added inseason after water chemistries (primarily pH) are expected to be more suitable for this specie, i.e., after the spring runoff period. The reservoir is stocked in accordance with the PFBC catchable trout program guidelines.

5.41a Proposed Actions

1. Continue cooperative efforts with the ACOE, PA DCNR, and public stakeholders to fine-tune and adjust the Experimental Release Plan (ACOE 2006, ACOE 2007a) to further enhance both reservoir and riverine water quality and fish habitat conditions.

2. Continue stocking the lake with catchable trout both preseason and inseason per PFBC program guidelines.

3. Support any reasonable initiative to improve boating access to the lake.

4. Monitor the smallmouth bass population prior to the opening day of bass season in 2007, 2009, and 2011, and make any necessary management changes based on the data collected.

5. Conduct a complete fisheries assessment during the early spring for species other than smallmouth bass in 2009 and 2011. Make management changes if necessary based on the data collected. Changes may include stocking of cool/warmwater species presently in the lake, the addition of new species, such as walleye if future lake operations are conducive, and implementation of special regulations.

6. Support any action to install a multi-level withdrawal system in the dam to better utilize and protect the cold hypolimnetic water for the purpose of cooling the river sufficiently to benefit trout.

5.42 User Group Conflicts Pertaining to Francis E. Walter Dam and Fisheries Management Sections 6 and 7

Releases from Francis E. Walter Dam have long been a contentious issue between the major user groups, i.e., anglers and whitewater boaters. The conflict began soon after the Dam was constructed back in 1961 with one or two whitewater boating events scheduled per year. As time went on and the popularity of whitewater boating grew, more whitewater events were included during the summer and fall months. In 1975 there were four single day events held, one each, during the months of July, August, September, and October. Water was stored for these events by raising the lake elevation from 1,300 to 1, 306 ft, just two feet below the old dam road surface. Releases for the event began at 11:00 PM Friday evening preceding the scheduled Saturday event and continued until the normal pool elevation of 1,300 was reached. In the event of heavy rainfall concurrent with any scheduled event, releases were made in accordance with the flood control regulatory requirements for the project (Phillips 1974).

This schedule continued until the late 1980's when, as a result of Public Law 100-676, Section 6, the provision of recreational opportunities, and specifically the inclusion of whitewater rafting opportunities was added as a second authorized operational purpose. Soon after this law was in place the number of scheduled release days increased from four to seven, with one release weekend event in June and July, a one day event in September, and two single day events in October. The release rate was set at 500 cfs for the June and July events, and from 500-750 cfs for the September and October events. During this period, once the gates were adjusted for the event, they were not closed until after the event period. This release schedule was maintain until the Experimental Release Plans for 2005, 2006 and 2007 were developed and continued to be refined (previously in Section 4.81b).

Throughout the years, ACOE, DRBC, DCNR, DEP, and PFBC staff worked together to balance the use of the resource among the user groups. Early on, an accord was struck in consideration to local anglers, so that no commercial rafting would take place on the upper section of the Lehigh River (Section 6 and a portion of 7; Table 7) between White Haven and Rockport on the opening day of trout season in mid-April. In 1994, this rafting prohibition for Opening Day was extended to the opening weekend and the following week of the trout season.

During the since between the 1960's and 2004, governmental agencies, anglers, and boaters were at odds regarding the impact of these events on the river's ecosystem, and the interference between the groups as they wanted to enjoy the river at the same time. White Water Challengers went as far to hire Ichthyological Associates, Inc (Jirka 1990) to determine impacts of white

water releases to downstream fishes and aquatic habitats. Many heated and contentious meetings were held to develop the historic release schedule.

Agency personnel through hard work and in cooperation with the general public including commercial and non-commercial angler and boating organizations, and private anglers and boaters developed the Experimental Release Plan now in effect (ACOE 2007a). This plan is likely to be periodically altered in order to achieve the best possible scenario for both anglers and boaters while affording the river and lake ecosystems as much protection as possible. The excellent cooperation between the various user groups and agencies in recent years speaks well of all those involved in seeking the best utilization this limited resource.

5.43 Beltzville Dam

The Beltzville Dam is located on Pohopoco Creek approximately 5.2 miles upstream from the confluence of the Lehigh River. This facility is owned and operated by the U. S. Army Corps of Engineers (ACOE) as a flood control facility, and has recreational use authorized as a project purpose. Because of the recreational purpose, the ACOE is able to maintain the lake at a more stable elevation, thus it does not experience the wide fluctuations in depth and surface area that occur at Francis E. Walter. The PFBC annually stocks the Beltzville Lake with brown trout, walleye, striped bass, muskellunge, and tiger muskellunge fingerlings. Due to the variable water column withdrawal release structure, live escape is possible for all resident species. This could effect the species composition of the river through escapement of species such as walleye. Currently the lake is regulated under §61.1 of the Fish and Boat Code (Commonwealth Inland Waters Regulations; Table 8) for all fish species. Species occurrence and stocking histories area listed in Tables 19 and Appendix B.

5.43a Proposed Actions

1. Continue current stocking.

2. A complete fisheries assessment should be conducted in 2009 to update Beltzville Lake's management plan.

5.44 Lehigh River Coal and Navigation Canal

Historically, the Lehigh River was part of an extensive canal system that was connected to the Delaware Canal for transportation of merchandise and resource commodities. At the peak usage there were a total of 76 locks, eight guard locks, six aqueducts, and 28 dams from Easton to Jim Thorpe providing water to the canal systems on the Lehigh River. Through the years these canals, locks, and dams have been either removed or incorporated into public parks. The largest portion of the remaining canal system is the Lehigh Canal west of Easton, Pennsylvania. Species occurrence and stocking history are listed in Table 20 and Appendix C. The PFBC manages 10 sections of the remnant canal system. Currently the canal is regulated under Commonwealth Inland Waters regulations for all species, with one exception regarding trout: Opening Day for Section 2 is the second Saturday in April, and for Sections 5 and 8 it is the last Saturday in March, effective for the 2007 trout season. This is as the result of the new Regional Opening Day of Trout Program, which established the opening day in 18 southeastern PA counties two weeks

earlier than opening day in the rest of the state. Three canal sections (2,5, and 8) are stocked with catchable trout both pre and inseason. Channel catfish are stocked in Sections 3, 5, and 7.

Due to the historic value placed on the canal system, the Historical Canal Society and DCNR promote the maintenance of the Lehigh Canal and its associated dams for posterity. This severely limits ecological restoration of the Lehigh River, in particular American shad.

5.4a Proposed Actions

1. Continue current regulations and stocking activities to maintain the fishery currently being offered.

2. Develop a more fisheries management plan for cover cold, cool, and warmwater species by 2011.

5.5 Lehigh River Restoration Program/Fish Passage

The PFBC is heavily engaged in restoring American shad spawning runs to the Lehigh River. The agency has set a goal of achieving an annual spawning run of 165,000 to 465,000 American shad, and providing 20,000 to 100,000 angler trips for shad at an estimated economic value of $508,000 to $2,540,000 annually (PFBC 1988). This goal is based on the assessment of available habitat that could be potentially provided as dams are removed or fish passage devices installed. Work conducted by the PFBC and the Delaware Shad Fisherman's Association from the mid 1970s through the early 1980s demonstrated that adult American shad, artificially fertilized eggs, and hatchery produced fry could survive in the Lehigh River. The PFBC began annual stocking of oxytetracycline (OTC) marked shad fry in the Lehigh River in 1985 (Table 21). The egg source for the fry was the PFBC's American shad spawning operation in the Delaware Water Gap National Recreation Area at Smithfield Beach (RM 218.0) in the Delaware River. The stocking program was started to ensure that a component of the Delaware River American shad run would be imprinted to the Lehigh River once passage facilities were opened.

5.51 Background

There are five dams impairing or blocking fish movement into and within the Lehigh River. They are the Easton Dam (RM 0.00), Chain Dam (RM 3.00), and Hamilton Street Dam in Allentown (RM 17.00) in Section 9; the Northampton Dam (RM 24.00), which borders Sections 8 and 9; and the Francis E. Walter Dam (RM 77.60) in Section 6. The lower three dams were built in the early 1820's to supply water for the Lehigh Coal and Navigation Canal system, which ran from White Haven to Easton. These dams continue to supply water to the historic sections of the canal system and provide recreational value. The Northampton Dam, from the time of its construction around the 1820's to the present date has supplied water for the Whitehall Cement Company, now a subsidiary of the LaFarge North America Company. The ACOE constructed Francis E Walter Reservoir for flood control purposes. It first became operational in 1961.

Fish passage facilities are currently in place at the Easton, Chain and Hamilton Street Dams (Figure 12). The Easton and Chain Dam fishways were constructed in 1993 and were operational

for the 1994 American shad spawning run. The Hamilton Street Dam fishway was constructed and operational in 1983. Both the Easton and Chain Dam fishways have observation rooms, which allows for monitoring of fish passage. The Hamilton Street Dam fishway does not have an observation room. The Delaware Canal State Park is responsible for the maintenance and operation of the Easton and Chain Dam fishways, while the City of Allentown is responsible for the Hamilton Street Dam fishway.

The PFBC began monitoring the passage of American shad and other species through the Easton Fishway in 1994 and the Chain Dam Fishway in 1996 (Table 18). Fish passage has been monitored using time-lapsed video. This is typically done from April through June. Fish passage monitoring from 1994 through 1999 revealed the following problems at both fishways: a malfunctioning auxiliary flow system, and an accelerated inflow volume impinging debris at the head of the fishway. This impingement further reduced water flowing into the auxiliary flow system. The auxiliary flow system was designed to supplement the attraction flow, increasing it from 25 cfs to 100 cfs in order to entice fish, primarily American shad, to enter. The unwanted addition of aeration into this system severely decreased its ability to supply an adequate amount of water for attraction purposes, as the air was taking the place of the required water volume of the piping system. This problem further compounded the operation of the fishway by increasing flow rates on the upstream supply side causing grates to be clogged with debris and reducing or eliminating the effect of the auxiliary flow system. The situation required that the fishways be cleaned seven days a week in an attempt to maintain suitable attraction flows for at least part of the day. Furthermore, at the Chain Dam, additional problems existed with the angle of the attraction flow. At that dam, attraction flows followed the riverbank, which minimized its potential as an attractant flow for the fish passage (Snyder 1997-2000). These findings were brought to the attention of DCNR and were corrected in October of 2000, in time for the 2001 American shad run. This work included adjusting the orientation of the fish passage outflow to 45 degrees out from the riverbank. Subsequent monitoring suggested that the changes had a beneficial effect on passage (Arnold 2001-2006). Although the overall ratio of passage of shad through the Chain Dam as compared to passage at Easton Dam has increased slightly since these changes, our data still suggests that the fishway efficiency is still relatively low, which hinders the potential of the success of the restoration program. The passage of other diadromous and resident species is also likely compromised. Additionally, during this period of operation, formation of a sandbar had been noted in front of the entrance to the Chain Dam, which may hinder passage under low flow conditions.

Analysis of adult American shad passage data shows that the annual spawning runs are largely supported by the annual PFBC stocking of American shad fry at the Triboro Sportsman's Club in Northampton. Returning adults are collected in May and/or June by electrofishing to determine their origin (hatchery vs wild). The 2006 sample coupled with data from previous years suggests that the wild component of the run is increasing, especially during the last four years of the 2001-2006 post-fishway-modification period. Adult shad were not sampled in 2003. Of the 55 adult shad collected in 2006, 15 (27.3%) were of wild origin (Arnold 2006). The wild component of adult shad sampled in 2005 was 38.5 percent (5 of 13 shad). This compares to 19.4% (12 of 62 shad) in 2004, 11% (11 of 100 shad) in 2002, and 1.9 to 11% in the years from 1996 to 2002, and 27% (9 of 33 shad) in 1995 (Arnold 2006-2004; Snyder 1997-2003). The origin of the wild component is unknown at this time. It could be the result of natural reproduction in the Lehigh River or straying from other rivers. The relatively high wild component in the 1995 sample

suggests that straying from the Delaware Run can be high at times. The recent increases in wild fish in the Lehigh may suggest that American shad are spawning in the Lehigh River and returning. The rate of increase of wild shad during the latter part of the post-modification period doesn't necessarily demonstrate that the fishways are operating properly or to full potential, only that they may be operating better than they did during the pre-modification period.

The stocking program has established and continues to support an annual spawning run with a repeat spawning component. Repeat spawning means that the shad had spawned at least once prior to the current year of spawning. Most repeat spawners, bear a single repeat spawning mark on their scales, but multiple repeats (of two or three marks) have been documented. The 2006 run recorded a repeat estimate of 5.7 percent (3 of 53 shad). The repeat spawning rates of adult shad sampled in 2005 was 23.1 percent (3 of 13 shad), 3.3 percent (2 of 60 shad in 2004), 18.4 percent (18 of 98 shad) in 2002), 3.1 percent (3 of 96) in 1999, and 12.5 percent (13 of 96 shad in 1998 was). Repeat spawning rates appear to be flow dependent, generally increasing as flow increases and decreasing as flow decreases. It is unknown what effect the fishways may have on the passage of returning shad. Repeat spawning is a gage of the population; the rate of repeat spawning in the Lehigh and Delaware River is quite low as listed above. However, in well-established runs such as in the Hudson River repeat spawning varies from 30 to 60 % per year (K. Hattala personal communication). However, it is know what effects the spawning stress has, as the shad in the Lehigh River have to traverse 183 miles from the ocean to find their natal spawning grounds. Scales are use for aging purposes, and those collected from the Lehigh River shad are very worn due to being reabsorbed to provide nutrients to the fish during its stay in freshwater. Hudson River fish and those collected in the lower Delaware River regardless of time (April through June) barely show any signs of re-absorption. Therefore, its quite possible that the rate of repeat spawning may be underestimated as previous marks may have been obliterated by the re-absorption process.

Passage through the Hamilton Street Dam fishway at this time is unknown, since there is no observation room for monitoring purposes. Furthermore, outflow from the fish passage is aligned along the shoreline, which minimizes its efficiency as an attractant. In 1987 City of Allentown received a license from the Federal Energy Regulatory Commission (FERC) to develop a hydroelectric project at the Hamilton Street Dam (Project No. 5146-020-PA). The City never began construction, however, stating that the project was not economically feasible. FERC withdrew the license on 12 June 1990.

Northampton Dam has been identified as a blockage to fish passage, particularly for American shad, due to the lack of any kind of fish passage device. Recently completed groundwater tests by Whitehall Cement Company (owners of the Dam), determined that the groundwater supply was not sufficient for daily plant operations and they still needed the surface waters provided by the dam for a water supply. Currently the PFBC Division of Habitat Management, Fish Passage Section is working with the company to install a fish passage device.

American shad have been documented to occur in the tail waters of the Northampton Dam. In 2001, an angler reported catching two adult American shad there. A June 2001 survey by PFBC personnel yielded one adult American shad in the tailrace and eight shad in the Hokendauqua Creek pool, which is located about 1.61 km (1.0 mi) downstream of the tailrace (Arnold 2001).

The last impediment to fish passage on the Lehigh River is the Francis E. Walter Dam, which is located at RM 76.51. This is a large earthen Dam that lacks any form of fish passage device and effectively prevents upstream movement of any fish species. However, escapement offish from the reservoir is possible through the outlet, especially during the high release events.

5.51a Proposed Actions

5.51a – i. Easton and Chain Dam Fishways (RM 0.00; 3.00)

1. Continue annual monitoring of fish passage through the Easton and Chain Dam Fishways.

2. Continue annual evaluations of the origin of the adult run (hatchery vs. wild) using OTC marking techniques.

3. Seek to improve the annual spawning run of American shad and other riverine fishes into the Lehigh River by the following measures at the Easton and Chain Dams:

    a. The best way to ensure unrestricted passage of adult American shad and other riverine species is the removal the Easton and Chain Dams. The historic sections of the Delaware River Canal (Easton Dam) and those of the Lehigh River (Chain Dam) can feasibly be supplied with water through a pumping system. The Delaware Canal from Riegelsville down to New Hope has been and continues to be sustained through pumping. If such a system was implemented at the Easton and Chain Dams, the impoundments wouldn't be necessary for canal flow maintenance. One option that is being considered for funding of dam removal is restoration efforts that may result from damage assessments at the Palmerton Zinc Pile Superfund Site. Assessment of damages at this site and development of a restoration plan is currently being pursued by a number of resource agencies. Information on the current status of this effort is available at the following website: http://www.fws.gov/contaminants/restorationplans/Palmerton/Palmerton.cfm.

    b. The PFBC Division of Fish Production, Production Services, Van Dyke Research Section is working with the Delaware River Shad Fisherman's Association in order to fund radio telemetry work to try and ascertain if any problems exists with American shad finding the entrance to the Easton Dam Fishway. Funding may be available through a possible settlement agreement with PPL for the accidental fly ash release into the Delaware River from the Martins Creek facility in August 2005. Other alternatives would be through funding sources such as a State Wildlife Grant (SWG) or restoration fund from the Palmerton Zinc Pile Superfund site.

4. Monitor and determine juvenile American shad abundance, origin (wild vs. hatchery – OTC marks), preferred habitat areas and movement periods in the Lehigh River. Initial work should be confined to the area of river down from the Northampton Dam. Seek funding through the SWG program or other outside funding source for this project.

5. Work with the PFBC Division of Environmental Services in the review of any future hydropower applications for dams on the Lehigh River to minimize any negative impacts to the American shad restoration program and perhaps enhance the program by way of fish passage or other efforts.

5.51a – ii. Hamilton Street Dam Fishway (RM 17.00)

1. Seek to improve the annual spawning run of American shad and other riverine fishes within the Lehigh River by the following measures:

    a. The best way to ensure safe and unrestricted passage of adult American shad and other riverine species is the remove the Hamilton Street Dam.

    b. Assess the movement of adult American shad in the vicinity of fishway entrance in order to determine the effectiveness of this fishway. This could be funded through a State Wildlife Grant (SWG) or other sources mentioned above.

2. Seek funding to establish a monitoring system to document passage of American shad and other species. This was recommended for a potential SWG project for 2007, but was not selected. If alternate funding sources cannot be identified then reapply for SWG consideration in 2008.

3. With assistance from the Division of Habitat Management, seek funding through grants or other sources to alter the angle of the attraction flow projecting out of the fishway to at least 45 degrees from the shoreline. Work with the City of Allentown on this matter during the 2007 spawning run and recommend that a temporary concrete insert be used if feasible.

5.51a – iii. Northampton Dam (RM 24.00)

1. Continue to support the PFBC Division of Habitat Management's efforts to gain fish passage at the Northampton Dam.. It is important that any fish passage device installed be usable by not only American shad (although that is the target species), but all other riverine fishes as well.

5.51a – iv. Francis E Walter Dam (RM 76.51)

1. No action recommended at this time.

6.0 Recreational Access

The Lehigh River is a popular recreational area that supports numerous outdoor water activities for both the public, private, and commercial sectors. Access to the Lehigh River is possible though various unimproved and improved points located on both private and public lands, but is severely limited for handicapped individuals. Individual property owners maintain many of the private accesses along the mainstem. Some of these accesses are extensive and include

unimproved or improved ramps for trailer able boats. Unfortunately, the majority of these private accesses are off limits to the general public. Public assess is generally through public lands such as State Game Lands; state, county of township parks; or public easements. Access to the Lehigh River is severely limited for disabled users. The only current access that is available to this user group is the Rte 33 boat launch near Easton.

Currently, as part of the mitigation restoration plan for the Palmerton Zinc Pile Superfund Site, the Pennsylvania Fish and Boat Commission (PFBC) Division of Environmental Services is negotiating with the responsible party for the development of improved access to the Lehigh River. Hartle (2006) has suggested a total of 15 access sites that could handle trailered boats on the mainstem of the Lehigh River. Nine of the sites identified by Hartle (2006) are considered to have major development potential for generating increased fishing trips on the Lehigh River (Table 22).

6.1 Headwaters to Francis E. Walter Reservoir (RM 105.69 – 82.51)

The headwaters and waters immediately above the Francis E. Walter reservoir are under private ownership and closed to the public. A total of 9.8 river miles are available to the general public starting at a point approximately 2.5 river miles upstream of Stoddartsville to approximately 0.75 river miles downstream of the I-380 bridges (PFBC data files). This access is mostly through State Game Land 127 and some private but open land. Boat access to this water is very limited, as the roads through the Game Lands are not conducive to trailers and portage of boats is difficult.

6.2 Francis E. Walter Reservoir

Boat access is available to the Francis E. Walter Reservoir by way of the old road across the upstream side of the dam breast which gives access to a gently sloped flood plain on southeastern side of the dam when lake elevations are below 1,309 ft, and by the dry portions of the road on the southeastern and northwestern side of the lake when lake elevations are higher than 1,309 ft. When the road is flooded, boaters must back a long way to reach the waters edge. This road is maintained by the ACOE, and is fully traversable when the lake is being maintained at stable pool (1,300 ft). The boat motor rating is limited to a maximum of 10 horsepower. There is also considerable shoreline access around the lake. Currently, an unimproved access to the reservoir is available on the Bear Creek side of the reservoir. A proposal is being pursued by the ACOE and the township of Bear Creek to build a multilevel boat access in the Bear Creek arm. This would allow boat access, which is now very difficult whenever the pool is raised above 1,308 ft, at the higher pool levels that are currently being maintained by the ACOE. This project has not been funded to date. However the ACOE is seriously looking into excavating a turnaround area on the southern arm of the roadway in order to assist boaters in the launching of their boats during times of relatively high pools. This may be done this year or next year.

6.3 Francis E Walter Reservoir to Palmerton (RM 76.51 – 37.70)

Public access to the Lehigh River is extensive for both shore anglers and boaters in this section of the Lehigh River with most of the river directly accessible from public lands. Most of the mainstem in this section is bordered by extensive state parks (Lehigh Gorge State Park and

Hickory Run State Park) and State Game Lands (#40, #141, and #149). Within the Lehigh Gorge State Park, a 30 mile Rails-to-Trails is maintained from Glen Onoko upstream to Port Jenkins just north of White Haven. Anglers can walk or bike on this trail to any vantage point along the mainstem for fishing. The Wildlands Conservancy Water Trail for the northern Lehigh River (above Palmerton, PA) lists a total of six public access ramps for boating. Some of these are limited to use by rafts (Table 22). These ramps also offer easy access to the river for shore and wade anglers. Other access points are provided by the ACOE in the tail-waters of Francis E. Walter Dam. Here the public can launch rafts, kayaks, and drift boats, or fish from shore or by wading.

6.4 Palmerton to Easton (RM 37.70 – 0.00)

Public access below Palmerton, PA is restricted to public lands, particularly once the river enters the urban areas from Northampton to Easton. Several county and borough parks offer shore and wade angling opportunities but boating access is generally limited to the 14 sites listed by the Wildlands Conservancy Trail access guide (Table 22). Half of the sites identified by Hartle (2006) for possible inclusion as part of the Palmerton Zinc Pile Superfund restoration plan are within the upper portion of this region of the Lehigh River (Sections 7 and 8).

6.5 Proposed Actions

1. Pursue efforts with PFBC Division of Environmental Services for continued development of access sites on the Lehigh River as part of the mitigation of the Palmerton Zinc Superfund Site (Hartle 2006) and/or additional funding sources.

2. Encourage pursuit of funding by the Township of Bear Creek in an effort to develop an improved boating access to the Francis E. Walter Reservoir on the Bear Creek arm. Encourage the township to pursue funding for this purpose through the PFBC Boating Facility Grant Program or other funding sources. Encourage other municipalities to pursue these grants for development of access in other areas of this section of the Lehigh River as well.

3. Work with PFBC Division of Property Services for the generation of proposals for acquiring funding sources for improving and developing handicap accessibility at PFBC sponsored fishing and boat accesses on the Lehigh River mainstem.

7.0 Public Interaction

The PFBC is committed to seeking public involvement in the development of the Lehigh River Fisheries Management Plan. General public commentary is collected from open public forums, through the PFBC website, and traditional mailings. Input from the public is being sought on the plan including perhaps even new ideas or issues not presently in the plan pertaining to fisheries management.

7.1 Proposed Actions

1. To keep the public informed, post a year-end summary of biological surveys on the PFBC website.

2. A Public meeting will be held the year prior to the next major revision of this plan, which is planned for 2012. Therefore the next meeting should be held in 2011 to begin preparation for action for the next five-year period.

8.0 Summary of Proposed Actions for the Lehigh River

This a quick reference section of all Proposed Action listed under each of the major subheadings in the plan: Riverine Fish Habitat Types (3.4, page 10); Water Quality (4.9, page 31); Fisheries Management (5.0, page 36, 39,47 and 53): Recreational Access (6.0; page 68); and Public Interaction (7.0; page 68).

Riverine Habitat – Proposed Actions (3.4, page 10)

1. Identify and quantify the available instream habitat (vegetative and structural) in the portion of the Lehigh River from Northampton Dam downstream to its confluence with the Delaware River. A synoptic survey should be conducted every ten years to provide a time series of habitat quality. Preliminary surveys should be initiated as soon as possible given the fishery management practices of stocking fry and fingerlings of various game fish species that utilize this type of habitat, particularly muskellunge. Funding should be sought through various grant sources.

2. Describe the occurrence, extent, and duration of cold-water thermal seeps and coldwater tributaries within the mid to lower reaches of the Lehigh River to further quantify the amount of habitat thermally suitable for cold and coolwater fishes. Assessment of available instream thermal habitat from the seeps should be based on a synoptic survey potentially which could be contracted, funded in part from grant sources; however, once seep locations have been identified, quantification of the extent and duration of the habitat will need to be addressed on a site-specific basis. The projected timeframe for the initiation of pilot surveys should be within the next five years (prior to 2011). This data will give PFBC fishery managers a more comprehensive understanding of the ability of these sections of the river to support cold and coolwater fish species.

3. Review the current status of riverine habitat as outlined by the 1995-2000 PADEP RBP habitat study on a ten-year basis to provide a time series of generalized habitat quality. Based on standard RBP protocols quantification of habitat within the Lehigh Watershed should be comparable to other similar sized streams for evaluation of habitat degradation. Findings will be used to assess habitat changes compared to the initial PA DEP study. Further actions will be based upon these findings (e.g., further degradation should accelerate efforts to address habitat impacts. Funding for both the habitat assessment and potential restoration efforts should be sought from various grant sources.

Water Quality - Proposed Actions (4.9; page 31)

1. Along with existing partners (ACOE, DCNR, Wildlands Conservancy, Lehigh Coldwater Fishery Alliance), support pursuit of a water quality modeling through a federal Section 22 Planning Aid to the States study (Section 22 of the Water Resources Development Act of 1974, as amended). The model developed from this study will allow managers to assess the effects of various operational changes at Francis E. Walter and Beltzville Dams on downstream flows, temperatures and water quality. This will allow resource agencies to manage operations such that whitewater rafting opportunities are balance with

potential improvements to downstream water quality and flows for fish and other aquatic life.

2. Sampling of basic water quality parameters within the mid to lower reach of the Lehigh River (Walnutport to Easton) should be improved. The ACOE provides excellent coverage of water temperatures from Lehighton to Walnutport but does not monitor water quality further downstream. The PADEP monitors water quality at WQN sites located at Treichlers Bridge and Glendon; however, sampling is done on a bi-monthly schedule, which is too infrequent to document short-term changes in conditions, which can be important to aquatic life. The only other active water temperature monitoring site is at the USGS gaging station in Easton. Thus, the Lehigh River from Walnutport to Easton (a distance of approximately 33 river miles) is inadequately assessed for water temperature. This is particularly problematic in the TSF designated waters from Northampton to the Hamilton Street Dam in Allentown. Additional daily monitoring of at least water temperature should be done at locations within the WWF and TSF designated waters. Possible locations include the Chain and Hamilton Dam fishways, PFBC Route 33 boat launch, TriBoro Sportsmen's Club, and Treichlers Bridge. Monitoring should coincide with ACOE efforts (April-November) at its monitoring sites located further upstream.

3. The PFBC Division of Fisheries Management should continue to provide assistance to PFBC Division of Environmental Services for the mitigation of the Palmerton Zinc Pile Superfund Site. As necessary, provide recommendations in regards to the fishery relative to these mitigation efforts.

Fisheries Management (5.0; page 36, 39,47, and 53)

Headwaters to Francis E Walter Reservoir (RM 105.69-82.51) Sections 1-5; Proposed Actions (5.11c i-iii; page 36)

Fisheries Management Sections 1-5 (5.11c i; page 36)

1. Habitat improvement such as low flow channel deflectors should be considered for this area. These devices will speed the passage of water, reduce travel time, thereby aiding in reducing stream temperatures. This work can be accomplished through the PFBC Habitat Management Section as sponsors (i.e. private clubs, Trout Unlimited Groups, etc.) show interest in this area.

2. With the assistance of the Bureau of Law Enforcement, Northeast Region, the Bureau of Engineering and Development, and other agencies, continue to watch for opportunities to purchase land or obtain easements along the river for public access and/or watershed protection.

Fisheries Management Sections 1,2,5 (5.11c ii; page 36)

1. No change in current fisheries management status. Do not stock with catchable trout due to closure of the area to public fishing.

2. Reassess posting in 2008 and every five years thereafter.

Fisheries Management Sections 3 and 4 (512c iii; page 36)

1. No change in current status. Continue management in the Approved Trout Waters program, and stock according to program guidelines.

2. Conduct stream surveys every 10 years, beginning in 2008 to monitor the abundance of wild trout and document the presence of other fish species. Adjust stocking or regulations if necessary based on survey findings

Francis E Walter Dam to Sandy Run (RM 76.51-66.77) Section 6 - Proposed Action (5.12c i-ii; pages 40-41)

Fisheries Management Section 6 (5.12c i; page 39-40)

1. Continue to work in partnership with ACOE, DCNR Lehigh Gorge State Park, and private stakeholders in development of the Francis E. Water Experimental Release Plan. This plan is crucial to the establishment of more sustainable and prolonged thermal relief in the river, especially during the summer months.

2. In addition to the fish survey site established in 2006, at least two additional surveys sites below the USGS Gaging Station at Francis E. Walter trailrace should be established for monitoring purposes. These sites will be monitored in 2007, 2008, 2009, and 2010 to develop a long-term dataset and management changes implemented in a timely fashion as necessary.

3. The trout fishery present in Section 6 is primarily supported through hatchery stockings of adult and fingerling trout. The management goal regarding catchable trout for this reach of the river is to achieve an overall day boat or night boat electrofishing mean catch rate of 10 legal size ($\geq$ 7 inches) trout per hour regardless of origin (hatchery adult/fingerlings or wild). A second goal is to achieve a mean angler catch rate of 0.70 trout per hour. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented:

    a. Continue to manage Section 6 as an Approved Trout Water and stock per current program guidelines.

b. Continue annual stockings of 18,000 spring brown trout fingerlings. Fingerlings will be marked in at least 2008 and 2009 pending an evaluation of logistics so that the proportion of the adult fishery composed of stocked fingerlings can be determined. Marks shall be different than those used for fingerlings that are stocked in Section 7 (discussed below).

c. If the goal of 10 legal size trout per hour through day boat or night boat electrofishing is achieved during the course of this plan, then current stocking rates will remain in place for catchable trout. However, if the marking study shows that fingerling trout are not significantly contributing to the fishery then that program will be either eliminated or adjusted based on a cost-benefit analysis.

d. If the goal of 10 legal size trout per hour through day boat or night boat electrofishing is not achieved during the course of this plan, then stocking rates for fingerlings and/or catchable trout may be adjusted. These adjustments may include: 1) increasing the spring fingerling stocking rate if the study shows they are making a significant contribution and are cost effective; 2) terminate fingerling stocking if their contribution to the fishery is negligible or not cost effective; or 3) adjust the catchable trout stocking rate either preseason and/or inseason.

4. Commonwealth Inland Regulations should continue to apply for all species within this section, except trout.

Fisheries Management Section 6 – Special Regulation Area (5.12c ii; pages 40-41)

1. Implementation of Catch and Release regulations of any form is not warranted at this time. Commonwealth Inland Waters regulations are more that sufficient to protect this stocked trout fishery in Section 6. This is apparent in light of our findings that catch and release is already a common practice among all user groups and use is relatively light.
2. Place Section 6 in the Approved Trout Waters Open to Year Round Fishing program. This would increase angling opportunities on the river, by allowing fishing from March 1 through the opening day of trout season, However, no trout may be taken or possessed during this period. The preliminary results of the 2006 Lehigh River Angler Use and Harvest Survey suggests that this section of the river is underutilized and may benefit from some program changes that will enhance the fishing experience and opportunity for anglers regardless of choice of terminal tackle. Inquiries to both the ACOE and the Manager of the DCNR Hickory Run and Lehigh Gorge State Parks resulted in positive feedback regarding this change. Both agencies noted that access roads will be open but are not maintained year round, which may impact access in some winters. To implement this recommendation the PFBC proposes to:

    a. Obtain consent of riverine landowners and adjacent affected property owners by May 30.

b. Depending on landowner response, present this proposal at the July 2007 Commission meeting. If approved, the regulation would go into effect in 2008.

3. The implementation of more conservative regulations will be reevaluated if PFBC biological sampling and/or additional angler use and harvest surveys demonstrate a need for more restrictive regulations.

Sandy Run to the Northampton Dam (RM 66.77–24.00) Sections 7 and 8 - Proposed Actions (5.13c i-ii; Page 47-50)

Fisheries Management Section 7 (RM 66.77–37.70; 5.13C i; pages 47-49)

1. In conjunction with the gamefish survey sites established in 2006, at least two additional sites, two upstream of Glen Onoko should be established for fishery monitoring purposes. These sites will be monitored in 2007, 2008, 2009, and 2010 to develop a long-term dataset to assess the fishery and make fisheries management changes as necessary.

2. The trout fishery in Section 7 continues to be supported primarily through private trout stockings and perhaps immigration from PFBC stocked waters within the drainage. The management goal regarding catchable trout for this reach of the river is to achieve an overall boat electrofishing mean catch rate of 10 legal size trout ($\geq$ 7 inches) per hour regardless of origin (hatchery adult/fingerlings, or wild). A second goal is to achieve a mean angler catch rate of 0.50 trout per hour. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented:

    a. Continue annual stockings of 30,000 brown trout and 20,000 rainbow trout fingerlings through at least 2011. Fingerlings will be marked in at least 2008, 2009, and 2010 with final assessment occurring in 2011 to determine their contribution to the fishery. Marks shall be different than those used for fingerlings stocked in Section 6 (discussed above).

    b. If the management goals are achieved during the course of this plan, then current stocking rates will remain in place. However, if the marking study shows that fingerling trout are not making a significant contribution to the fishery then fingerling stocking will either be terminated or stocking rates will be adjusted.

    c. If the management goals are not achieved, then:

        i. Stocking rates may be adjusted to achieve the goal. Adjustments may include: 1) increasing the spring fingerling stocking rate if the study shows they are making a viable contribution and are cost effective; 2) consider stocking only in the most suitable area based on catch data; 3) terminate fingerling stocking if contribution to legal catch negligible or not cost effective.

ii. Consider incorporating an area of Section 7 into the Catchable Trout program and stock per current program guidelines.

3. The walleye fishery in Section 7 is supported by annual fry stockings, which began in 2003, and possibly escapement from two PFBC stocked lakes within the region (Beltzville Lake – Pohopoco Creek, and Mauch Chunk Lake – Mauch Chunk Creek). To date there have been no reports of private stockings occurring in this section of river. The management goals for walleye for this reach of the river is to achieve a day boat or night boat electrofishing mean catch rate of 2.5 legal size walleye (≥ 15 inches) per hour, or a mean catch rate of 0.15 walleye per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean angler catch rate of 0.50 walleye per hour of fishing. This will be measured by creels survey(s) conducted in the months of May through October. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented. To achieve these goals the following actions will be implemented:

    a. If the management goals are met, then stocking will continue at the current rate.

    b. If the management goals are not met, then the following options will be considered:

        i. Data will be reviewed to determine if the stocking area can be truncated to achieve the goal(s) stated above. This will allow the program to continue in the most suitable area of the river.

        ii. Terminate the program.

4. Commonwealth Inland Regulations should apply for all species located within these sections. Future regulation changes pertaining to any fish species will be guided by the annual surveys described above.

5. Fisheries Management Area 5 staff shall work with the PFBC Division of Habitat Management, Stream Habitat Section to find innovative methods to enhance the river fishery through by improving habitat.

Fisheries Management Section 8 (RM 37.70–24.00; 5.13c ii; pages 40-50)

1. In conjunction with the game fish survey sites established in 2006, at least two additional sites should be established upstream of the Northampton Dam for fishery monitoring purposes. These sites will be monitored in 2007, 2008, 2009, and 2010 to develop a long-term dataset to assess the fishery and make fisheries management changes as necessary.

2. The walleye fishery in Section 8 is supported by annual fry stockings, which began in 1984, and possibly escapement from two PFBC stocked lakes within the region (Beltzville Lake – Pohopoco Creek, and Mauch Chunk Lake – Mauch Chunk Creek). To date there have been no reports of private stockings occurring in this section of river. The management goals for walleye for this reach of the river is to achieve a day boat or night boat electrofishing mean catch rate of 2.5 legal size walleye (≥ 15 inches) per hour, or a mean catch rate of 0.15 walleye per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean angler catch rate of 0.50 walleye per hour of fishing. This will be measured by creels survey(s) conducted in the months of May through October. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented. To achieve these goals the following actions will be implemented:

    a. If the management goals are met, then stocking will continue at the current rate.

    b. If the management goals are not met, then the following options will be considered:

        i. Change the stocking lifestage from fry to Phase 1 fingerlings. (Early summer, Total Length ~1-2 inches) Stock and monitor annually from 2012 through 2017.

        ii. If a change to walleye Phase 1 fingerlings is not a viable option due to production constraints then terminate the stocking program in 2012.

3. Commonwealth Inland Waters regulations should apply for all species located within this section. Future regulation changes pertaining to any fish species will be guided by the annual surveys described above.

4. Fisheries Management Area 5 staff will work with the PFBC Division of Habitat Management, Stream Habitat Section to finding innovative methods to enhance the river fishery by increasing spawning habitat and cover.

Northampton Dam to the Confluence with the Delaware River (RM 24.00–0.00) Section 9 - Proposed Actions (5.14c i; pages 53-55)

1. In addition to the three fish survey sites established in 2006 in Section 9, at least two additional survey sites should be established: one up river of the Hamilton Street Dam, and one below the Chain Dam. These sites shall be monitored in 2007, 2008, 2009, and 2010 to develop long-term data for gamefish and forage species abundance. These data will be used to evaluate whether management changes are need to bolster the smallmouth bass and or sunfish populations, and to determine if annual stocking of walleye fry and muskellunge should continue. Decisions regarding stocking will be based on the PFBC

cool/warmwater stocking guidelines. Decisions regarding the smallmouth bass and or sunfish fishery will also be based on catch rate as compared to similar reaches of river statewide and a scientific literature review. The poor habitat of this section may reduce the effectiveness of any management changes.

2. The walleye fishery in Section 9 is supported by annual fry stockings, which began in 1984, and possibly escapement from two PFBC stocked lakes within the region (Beltzville Lake – Pohopoco Creek, and Mauch Chunk Lake – Mauch Chunk Creek). To date there have been no reports of private stockings occurring in this section of river. The management goals for walleye for this reach of the river is to achieve a day boat or night boat electrofishing mean catch rate of 2.5 legal size walleye ($\geq$ 15 inches) per hour, or a mean catch rate of 0.15 walleye per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean angler catch rate of 0.50 walleye per hour of fishing. This will be measured by creels survey(s) conducted in the months of May through October. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. To achieve this goal the following actions will be implemented. To achieve these goals the following actions will be implemented:

    a. If the management goals are met, then stocking will continue at the current rate.

    b. If the managemement goals are not me, then the following options will be considered:

        i. Change the stocking lifestage from fry to Phase 1 fingerlings (Early summer, total length ~1-2 inches). Stock and monitor annually from 2012 through 2017.

        ii. If a change to walleye Phase 1 fingerlings is not a viable option due to production constraints then terminate the stocking program in 2012.

3. The muskellunge fishery in Section 9 is supported by annual fingerling stockings, which began in 1984, and possibly escapement from Beltzville Lake on Pohopoco Creek. Also, Muskies Inc, is considering stocking this area when funding is available. The management goal for musky for Section 9 is to achieve a mean day boat and/or night boat electrofishing catch rate of 1.5 legal size muskellunge ($\geq$ 40 inches) per hour, or a mean catch rate of 0.10 legal muskellunge per hour collected in a fixed panel sinking gillnet. The primary sampling method will be night boat electrofishing. A third goal is to achieve a mean annual angler catch rate of 2.4 legal muskellunge per year based on collective angler diaries as reported to Muskies Inc. These goals are subject to modification if further statewide work by the PFBC suggests that modifications are needed. The following actions will be implemented to achieve these goals:

    a. If the management goals are met, then stocking will continue at the current rate.

b. If the management goals are not met, then the following options will be considered:

i. Change the size of stocked fingerlings and/or the stocking rate. Monitor annually from 2012 through 2017.

ii. Terminate stocking.

4. Commonwealth Inland Waters regulations will continue for all species located within this section.

5. Fisheries Management Area 5 staff shall work with the PFBC Division of Habitat Management, Stream Habitat Section to find innovative methods to enhance the river fishery by increasing spawning habitat and cover.

Angler Use and Harvest – Proposed Actions (5.31; page 57)

1. Conduct angler use and harvest surveys in the mainstem waters for the entire river between Francis E. Walter dam and the mouth on a recurring basis (approximately every 10 years). The first full-scale angler use and harvest survey should be in 2010.

2. Conduct specialized angler surveys for limited reaches on the mainstem or tributary waters on an as needed basis to evaluate future PFBC management changes, such as changes in regulations.

3. Develop an on-line angler survey by way of the PFBC website for estimation of angler catch rates and harvest rates in the Lehigh River. This survey should be an annual event. The program should start as soon as possible, and should be a component of a statewide effort. Online surveys specific to the Lehigh River may need to be developed if angler responses to specific issues germane only to the Lehigh River are being sought.

4. Continue the mail in angler logbook program (that was started in 2006) in 2007 and 2008 and assess if the response warrants continuation of the program. This will be based on the number of response and the utility of the data being provided.

Special Areas of Concern Pertaining to the Overall Management of the Lehigh River – Proposed Actions (5.4; page 57)

Francis E. Walter Dam (RM 76.51; 5.41a; pages 58-59)

1. Continue cooperative efforts with the ACOE, PA DCNR, and public stakeholders to fine-tune and adjust the Experimental Release Plan (ACOE 2006, ACOE 2007a) to further enhance both reservoir and riverine water quality and fish habitat conditions.

2. Continue stocking the lake with catchable trout both preseason and inseason per PFBC program guidelines.

3. Support any reasonable initiative to improve boating access to the lake.

4. Monitor the smallmouth bass population prior to the opening day of bass season in 2007, 2009, and 2011, and make any necessary management changes based on the data collected.

5. Conduct a complete fisheries assessment during the early spring for species other than smallmouth bass in 2009 and 2011. Make management changes if necessary based on the data collected. Changes may include stocking of cool/warmwater species presently in the lake, the addition of new species, such as walleye if future lake operations are conducive, and implementation of special regulations.

6. Support any action to install a multi-level withdrawal system in the dam to better utilize and protect the cold hypolimnetic water for the purpose of cooling the river sufficiently to benefit trout.

Beltzville Dam (5.43a; page 60)

1. Continue current stocking.

2. A complete fisheries assessment should be conducted in 2009 to update Beltzville Lake's management plan..

Lehigh Coal and Navigation Canal (5.44a; page 61)

1. Continue current regulations and stocking activities to maintain the fishery currently being offered.

2. Develop a more fisheries management plan for cover cold, cool, and warmwater species by 2011.

Lehigh River Restoration Program/Fish Passage – Proposed Actions (5.51a i-iv; pages 64-66)

Eason (RM 0.0) and Chain Dam (RM 3.0) Fishways (5.51a i; page 64-65)

1. Continue annual monitoring of fish passage through the Easton and Chain Dam Fishways.

2. Continue annual evaluations of the origin of the adult run (hatchery vs. wild) using OTC marking techniques.

3. Seek to improve the annual spawning run of American shad and other riverine fishes into the Lehigh River by the following measures at the Easton and Chain Dams:

    a. The best way to ensure unrestricted passage of adult American shad and other riverine species is the removal the Easton and Chain Dams. The historic sections of the Delaware River Canal (Easton Dam) and those of the Lehigh River (Chain Dam) can feasibly be supplied with water through a pumping system. The Delaware Canal from Riegelsville down to New Hope has been and continues to be sustained through pumping. If such a system was implemented at the Easton and Chain Dams, the impoundments wouldn't be necessary for canal flow maintenance. One option that is being considered for funding of dam removal is restoration efforts that may result from damage assessments at the Palmerton Zinc Pile Superfund Site. Assessment of damages at this site and development of a restoration plan is currently being pursued by a number of resource agencies. Information on the current status of this effort is available at the following website: http://www.fws.gov/contaminants/restorationplans/Palmerton/Palmerton.cfm.

    b. The PFBC Division of Fish Production, Production Services, Van Dyke Research Section is working with the Delaware River Shad Fisherman's Association in order to fund radio telemetry work to try and ascertain if any problems exists with American shad finding the entrance to the Easton Dam Fishway. Funding may be available through a possible settlement agreement with PPL for the accidental fly ash release into the Delaware River from the Martins Creek facility in August 2005. Other alternatives would be through funding sources such as a State Wildlife Grant (SWG) or restoration fund from the Palmerton Zinc Pile Superfund site.

4. Monitor and determine juvenile American shad abundance, origin (wild vs. hatchery – OTC marks), preferred habitat areas and movement periods in the Lehigh River. Initial work should be confined to the area of river down from the Northampton Dam. Seek funding through the SWG program or other outside funding source for this project.

5. Work with the PFBC Division of Environmental Services in the review of any future hydropower applications for dams on the Lehigh River to minimize any negative impacts to the American shad restoration program and perhaps enhance the program by way of fish passage or other efforts.

Hamilton Street Dam (RM 17.00) Fishway (5.51a ii; page 65-66))

1. Seek to improve the annual spawning run of American shad and other riverine fishes within the Lehigh River by the following measures:

    a. The best way to ensure safe and unrestricted passage of adult American shad and other riverine species is the remove the Hamilton Street Dam.

b. Assess the movement of adult American shad in the vicinity of fishway entrance in order to determine the effectiveness of this fishway. This could be funded through a State Wildlife Grant (SWG) or other sources mentioned above.

2. Seek funding to establish a monitoring system to document passage of American shad and other species. This was recommended for a potential SWG project for 2007, but was not selected. If alternate funding sources cannot be identified then reapply for SWG consideration in 2008.

3. With assistance from the Division of Habitat Management, seek funding through grants or other sources to alter the angle of the attraction flow projecting out of the fishway to at least 45 degrees from the shoreline. Work with the City of Allentown on this matter during the 2007 spawning run and recommend that a temporary concrete insert be used if feasible.

Northampton Dam (RM 24.00) (5.51a iii; page 66)

1. Continue to support the PFBC Division of Habitat Management's efforts to gain fish passage at the Northampton Dam.. It is important that any fish passage device installed be usable by not only American shad (although that is the target species), but all other riverine fishes as well.

Francis E. Walter Dam (RM 76.51) (5.51a iv; page 66)

No action recommended at this time.

Recreational Access – Proposed Actions (6.5; page 68)

1. Work with the PFBC Division of Environmental Services for continued development of access sites with handicap accessibility where appropriate on the Lehigh River through various funding sources.

2. Encourage pursuit of funding by the Township of Bear Creek in an effort to develop an improved boating access to the Francis E. Walter Reservoir on the Bear Creek arm. Encourage the township to pursue funding for this purpose through the PFBC Boating Facility Grant Program or other funding sources. Encourage other municipalities to pursue these grants for development of access in other areas of this section of the Lehigh River as well.

3. Work with PFBC Division of Property Services for the generation of proposals for acquiring funding sources for improving and developing handicap accessibility at existing PFBC sponsored fishing and boat accesses on the Lehigh River.

Public Interaction – Proposed Actions (7.1; page 68)

1. To keep the public informed, post a year-end summary of biological surveys on the PFBC website.

2. A Public meeting will be held the year prior to the next major revision of this plan, which is planned for 2012. Therefore the next meeting should be held in 2011 to begin preparation for action for the next five-year period.

9.0 References

ACOE 2002. Final Environmental Assessment. Emergency drought storage at Francis E. Walter Dam and reservoir Carbon and Luzerne counties, Pennsylvania. Prepared by U.S. Army Corps of Engineers. Philadelphia, Pennsylvania 19107

ACOE 2005. 2005 Temporary Operations Plan Frances E. Walter Dam and Reservoir Carbon and Luzerne Counties, Pennsylvania. Prepared by U.S. Army Corps of Engineers. Philadelphia, Pennsylvania 19107.

ACOE 2005b. 2005 F.E. Walter Dam Water Quality Report. Prepared by U.S. Army Corps of Engineers. Philadelphia, Pennsylvania 19107.

ACOE 2006. 2006 Temporary operations Plan Fancies E. Walter Dam and reservoir Carbon and Luzerne Counties, Pennsylvania. Prepared by U.S. Army Corps of Engineers, Philadelphia, Pennsylvania 19107.
http://www.nap.usace.army.mil/Projects/FEWalter/Finding%20of%20No%20Significant%20Impact_2006.pdf

ACOE, 2007. 2006 Water Quality Monitoring F.E. Walter Reservoir White Haven, Pennsylvania. U.S. Army Corps of Engineers. Philadelphia District. Environmental Resources Branch.

ACOE 2007a. Francis E Walter Recreation Operations Plan for 2007. Prepared by U.S. Army Corps of Engineers. Philadelphia, Pennsylvania 19107.
http://www.nap.usace.army.mil/Projects/FEWalter/walter2007plan.pdf

Ashby, S. 2002. F.E. Walter Reservoir hydrogen sulfide investigation. U.S. Army Corps of Engineers Report.

Arnold, D. A., 2007. Nesquehoning Creek Section 2-5 Survey Report. In press, PDBC files. 450 Robinson Lane, Bellefonte, PA 16823

2006. NA05NMF4071206. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

2005, NA04NMF4070242. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

2004. NA03NMF4070127. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

2003. NA16F12358. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

2003. Beltzville Lake Mangement Report, In preparation, PFBC 450 Robinson Lane, Bellefonte, PA 16823.

1998. Lehigh River Section 4 Mangement Report. PFBC Files, 450 Robinson Lane, Bellefonte, PA 16823.

Barker, J. L. 1983. Water quality assessment of Francis E. Walter reservoir Luzerne and Carbon counties, Pennsylvania. Water Resources Investigation Report 83-4032. U.S. Army Corps of Engineers. Philadelphia, Pennsylvania 19107.

Betz, Converse, Murdoch Inc. 1981. Environmental assessment for the proposed modification of the Francis E. Walter Dam. Prepared for US Army Corps of Engineers Philadelphia District.

Billingsley, C., D. Bourke, Steiner. 1977. Lehigh River Management Report – Section 6. PFBC Files, 450 Robinson Lane, Bellefonte, PA 16823.

Billingsley, C., D. Bourke, W. Burkart. 1978. Lehigh River Section 7 Survey Data Forms, PFBC Files. 450 Robinson Lane, Bellefonte, PA 16823.

Billingsley, C., D. Bourke, Ercolani. 1985. Lehigh River Section 6 Survey Data Forms, PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

Billingsley, C., D. Bourke, R. Lorson, T. Hannold. 1980. Lehigh River Sections 8 and 9 Survey Data Forms. PFBC Files, 450 Robinson Lane, Bellefonte, PA 16823.

Bovee, K. D., 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper 12. USDI, Fish andWildlife Service, Office of Biological Services. FWS/OBS-82/26. 248pp.

Bradford, A.D. 1953. Water Analysis and Inspection of the Lehigh River Carbon, Lehigh, Northampton Counties, PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

Daniels, D. W., 1974, Lehigh River Luzerne County Memo regarding the termination of stocking 2.3 miles from Choke Creek to the SR0115 bridge at Stoddartsville, PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

Davis, E. W. (1931). Stream Survey Report – Lehigh River Lackawanna County – PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

Ford, D. E., K.W. Thornton, J. L. Norton. 1983. Thermal analysis of the proposed Francis E. Walter reservoir modification: Guidance on selective withdrawal. Prepared for U.S.

Army engineer District, Philadelphia contract Number DACW61-82-C-0040 by Ford, Thorton, Norton and Associates, Ltd. Vicksburg, MS 39180.

Hartle, M. 2006. Access points. Palmerton zinc pile superfund site natural resource damage assessment: Recreational fishing proposal for restoration of lost angler trips. Draft Report. Prepared for Palmerton Trustee Council.

Hesser, R.; B. Weirich, R. Hoopes, and D. Snyder, 1972. Stream Survey Report Lehigh River, Luzerne and Carbon Counties, PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

1972[a]. Stream Survey Report Lehigh River, Northampton and Lehigh Counties, PFBC Files, 450 Robinson Lane, Bellefonte, PA, 16823.

Jirka, K.T. 1990. An evaluation of recreational white-water releases from Francis E. Walter Dam, Lehigh River, Luzerne and Carbon counties, Pennsylvania, 22 June through 31 July 1990. Prepared for Whitewater Challengers, Inc. by Ichthyological Associates, Inc. Lansing NY 14882.

Lehigh Falls Fishing Club v. Andrejewski, 2000, 735 A.2d 718 (Pa. Super. 1999), petition for allowance of appeal denied, 563 Pa. 702, 761 A.2d 550.

Lehigh River, Pennsylvania Francis E. Walter Dam and reservoir design memorandum No. 10A: Recreation –Resource Appendices to the Master Plan. U.S. Army Corps of Engineers. 1974.

Lehigh University. 1982. A biological and chemical survey of the lower Lehigh River. Lehigh University.

Miller, R. 2001. Fourth Annual Report of the Parkland High School Lehigh River Watch on Water Quality Factors in the Treichlers and Northampton Areas, Parkland High School, 2675 PA Route 309, Orefield, PA 18069.

2000. Third Annual Report of the Parkland High School Lehigh River Watch on Water Quality Factors in the Treichlers and Northampton Areas, Parkland High School, 2675 PA Route 309, Orefield, PA 18069.

1999. Second Annual Report of the Parkland High School Lehigh River Watch on Water Quality Factors in the Treichlers and Northampton Areas, Parkland High School, 2675 PA Route 309, Orefield, PA 18069.

1998. First Annual Report of the Parkland High School Lehigh River Watch on Water Quality Factors in the Treichlers and Northampton Areas, Parkland High School, 2675 PA Route 309, Orefield, PA 18069.

Palmerton Natural Resource Trustee Council 2007. Data Report for the Scoping Study on Metal Contaminant Levels in Sediment and Concurrent Aquatic Habitat Evaluation for the Palmerton Zinc Natural Resource Damage Assessment, Palmerton, Pennsylvania. 29 pp.

Pennsylvania Code, Title 25. Environmental resources, Chapter 93 Water Quality Standards. Department of Environmental Resources, Bureau of Water Quality Management, Division of Assessment and Standards. 2001. Harrisburg, Pennsylvania.

Pennsylvania Department of Environmental Protection (PA DEP). 1995. Lehigh River fish kill, April and May, 1995.

1989. Priority water body survey report, Lehigh River and tributaries, and Little Lehigh Creek and tributaries. DER Bureau of Water Quality Management.

2007. 2006 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. Clean Water Act Section 305(b) and 303(d). http://www.depweb.state.pa.uswatersupply/cwp/view.asp?a=1261&q=480056

Pennsylvania Fish and Boat Commission. 1997. Management of trout fisheries in Pennsylvania Waters. PFBC report. 132 pp.

1988. Revised strategic fishery management plan for American shad restoration in the Schuylkill and Lehigh River Basins. PFBC report. PFBC files. 450 Robinson Lane, Bellefonte, PA 18623

Phillips, W. D (1974). Army Corps of Engineers Letter dated 27 November, 1974 regarding the 1975 schedule for weekend releases from Francis E. Walter Dam on the Lehigh River canoeing activities. PFBC files. 450 Robinson Lane, Bellefonte, PA 16823.

Pennsylvania Cooperative Fish and Wildlife Research Unit , 1989. Effects of heavy metal contamination on aquatic fauna near the Palmerton, Pennsylvania smelters. Pennsylvania State University.

Pierce, D. and D. Arnold. 2007. Angler Use and Harvest in the Trout Stocked Section 6 of the Lehigh River, PFBC files. 450 Robinson Lane, Bellefonte, PA 16823.

Pollison, D.P. and W.M. Craighead. 1968. Lehigh River biological investigation. Cooperative study between Delaware River Basin Commission, Pennsylvania Fish Commission, and Pennsylvania Department of Health.

Reynolds, L. and L. M. Young. 2000. Investigation of the effect of whitewater boating releases from the F.E. Walter Reservoir on benthic macroinvertebrate communities in the Lehigh River. Pennsylvania Fish and Boat Commission Report, Bellefonte PA. 16823

Schadt, J. A. 1933. Stream Survey Report – Lehigh River – Lackawanna and Luzerne Counties, PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

Snyder, R. A. 2002. NA16FI1107. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

2001. NA06FI0191. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

2000. NA96FI0220. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

1999. NA86FI0214. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

1998. NA76FI0083. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

1997. NA66FI0292. Documentation and Quantification of Alosids Utilizing Fish Passage Facilities and Collection of Biological Data on Adult American Shad. PFBC Files, 450 Robinson Lane, Bellefonte, PA.

1975, Lehigh River Luzerne County Memo authorizing the termination of stocking 2.3 miles from Choke Creek to the SR0115 bridge at Stoddartsville, PFBC files, 450 Robinson Lane, Bellefonte, PA 16823.

Versar Inc. 2002. Lehigh River 2001 Water Quality Monitoring. Prepared for U.S. Army Corps of Engineers. Contract No. DACW61-00-D-0009.

Versar 2003. Water quality monitoring at the F. E. Walter Dam during 2002. Prepared for U.S. Army Corps of Engineers. Contract No. DACW61-00-D-0009.

Weirich, C. B. 1973. Pre and post whitewater discharge benthic sampling on the Lehigh River downstream from Francis E. Walter reservoir. PFBC files, Division of Fisheries Management, 450 Robinson Lane Bellefonte, PA 16823.

Wildlands Conservancy 1995. Upper Lehigh River Exceptional Value feasibility report.

Wildlands Conservancy. 2003. Lehigh River watershed conservation management plan. http://wildlandspa.org/Rivers/lr_cp.html.

Young, L. 2002. Evaluation of the effect of water quality degradation and iron oxide precipitation on the benthic macroinvertebrate community downstream of F.E. Walter Reservoir. PFBC Division of Environmental Services, Bellefonte, PA 16823.